

# The XVth International Conference on Mechanics in Medicine and Biology

**ICMMB-15 2006  
Conference Guide**



**6 – 8 December 2006  
Furama Riverfront, Singapore**

**Organized by:**



**NANYANG  
TECHNOLOGICAL  
UNIVERSITY**



The Pacific Centre for  
Thermal-Fluids Engineering  
Hawaii, USA

---

# CONTENT PAGE

---

<b>Message From The General Chairs</b> .....	<b>1</b>
<b>Address From The Guest Of Honour</b> .....	<b>2</b>
<b>Message From The VVIP: Dean, College Of Engineering, Nanyang Technological University</b> .....	<b>3</b>
<b>Organizing Committee and International Scientific Advisory Committee</b> .....	<b>4</b>
<b>General Conference Information</b> .....	<b>5</b>
<b>Exhibition Layout Plan</b> .....	<b>6</b>
<b>Venue Floor Plans</b> .....	<b>7</b>
<b>About Singapore</b> .....	<b>8 - 10</b>
<b>Program Overview</b> .....	<b>11</b>
<b>Sessions And Abstracts</b>	
<b>6 December 2006, Wednesday</b> .....	<b>12 – 32</b>
<b>7 December 2006, Thursday</b> .....	<b>33 – 55</b>
<b>8 December 2006, Friday</b> .....	<b>56 – 74</b>
<b>Author Index</b> .....	<b>75 - 79</b>

---

## MESSAGE FROM THE GENERAL CHAIRS

---

On behalf of the Conference Organising Committee, we extend our warmest welcome to all those participating in the XVth International Conference on Mechanics in Medicine and Biology (15th ICMMB) 2006. The 15th ICMMB is a biennial event presenting an interdisciplinary forum of engineers, medicos and biologists. The scientific programme consist of keynote lectures, invited special sessions and free paper sessions, covering all fields of mechanics in medicine and biology, with a particular emphasis in "Tissue Engineering and Cell/molecular Mechanics of Future Medicine".

The ICMMB provides an interdisciplinary forum bringing together the fields of engineering, medicine and biology. The idea of this Conference was conceived in 1977 by a group of researchers from various countries including Profs. Wen-Jei Yang, Dhanjoo Ghista, Helmut Reul, Gunter Rau, Eric van Vollenhoven, and Tin-Kan Hung. Later it was joined by Profs Kajiya and Pallotti.

The first conference was held in Aachen, Germany in 1978. Since then, the conferences have been held in Asia, Europe and North America. The 2nd was held in Osaka, Japan (1980); the 3rd in Compiègne, France (1982); the 4th in Buffalo, USA (1984); the 5th in Bologna, Italy (1986); the 6th in San Antonio, USA (1988), the 7th in Pörschach, Austria (1991); the 8th (in conjunction with the Second World Congress of Biomechanics), in Amsterdam, The Netherlands (1994); the 9th in Ljubljana, Slovenia (1996); the 10th in Oahu, Hawaii (1998), the 11th in Maui, Hawaii (2000), the 12th in Lemnos Island, Greece (2002), the 13th in Tainan, Taiwan (2003), and the 14th in Bologna, Italy (2004). The conference has gone from strength to strength. Some exceptionally good papers have been presented over the years, and this year is no exception. We are honoured to be hosting ICMMB-15th in Singapore.

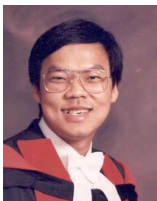
The Committee has invited six renowned keynote speakers, Professor Bruce Milthorpe, University of New South Wales; Professor Christian Oddou, University Paris; Professor Romano Zannoli and Professor Giovanni Pallotti, University of Bologna; Professor Savio L-Y Woo and Professor Tin-Kan Hung, University of Pittsburgh. We are certain that you will enjoy their inspiring lectures.

Further, a promising Programme has been assembled to cover a board spectrum of 21 theme areas. We received more than 220 submissions from 30 countries for regular sessions and proposals for 12 invited sessions. The best three papers will be made at the Conference based on both the technical content and presentation.

We take this opportunity to thank our Guest of Honour Mr. Gan Kim Yong, the Minister of State (Ministry of Education & Ministry of Manpower), Government of Republic of Singapore, for taking time off from his busy schedule to grace the opening session and speech. Special thanks should go to Prof. Pan Tso-Chien, Dean, College of Engineering, and Prof. Lam Khin Yong, Chair of the School of Mechanical and Aerospace Engineering, NTU, for their advice and support in ensuring that the preparation of the conference proceeds smoothly.

At this conference, not only will you be able to keep abreast of the latest biomedical research, you will also have the opportunity to discover the unique experience that is Singapore, with its multi-racial cultures and traditions. You can also just relax and enjoy the climate, architecture, and scenery of this tropical island city.

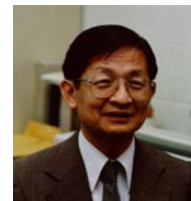
Last but not least, we thank members of the Organising Committee for their enthusiasm, dedications and hard work. The Conference will not be a success without your expertise and active participation. We appreciate the financial support of our industry sponsors, World Scientific Publishing Co., Eetarp Engineering Pte Ltd, United BMEC Pte Ltd., i-Math Pte Ltd, and BES Technology Pte Ltd. We also thank all authors, session chairs, reviewers and delegates for your tremendous support and wish all of you a successful, stimulating and fruitful meeting. We hope that the delegates will make time to enjoy the fun and excitement and have a pleasant stay in Singapore.



Eddie Y-K Ng, Ph.D.  
General Co-Chair, Singapore



K K Phua, Ph.D.  
General Co-Chair, Singapore



W-J Yang, Ph.D.  
Conference Chair, USA

---

## ADDRESS FROM THE GUEST OF HONOUR

---



**Mr. Gan Kim Yong**  
**Minister of State (Ministry of Education & Ministry of Manpower), Singapore**

Inaugurated in 1977, the International Conference on Mechanics in Medicine and Biology (ICMMB) is a biennial event that has proven to be a premium conference where researchers, engineers and professionals in the areas of mechanics in medicine and biology meet to interact and share with each other on the latest experimental, theoretical and computational knowledge.

This is the first time that ICMMB is held in Singapore. ICMMB-15th has received more than 220 submissions of papers from over 30 countries for regular sessions and proposals for 12 invited sessions. Credit must go to the organizers of this conference for such an overwhelming response. As Singapore pushes ahead with biomedical research, many new initiatives and research institutes have been set up to spearhead R & D in this fast-changing field of life sciences, physical sciences and engineering with application to medical problems. ICMMB offers a unique and timely opportunity for inter-disciplinary collaborations among scientists and researchers to showcase and discuss their research.

I wish all of you a productive and pleasant time at the Conference.

---

**MESSAGE FROM THE VVIP:  
DEAN, COLLEGE OF ENGINEERING, NANYANG TECHNOLOGICAL UNIVERSITY**

---



**Professor Pan Tso-Chien  
Dean, College of Engineering, Nanyang Technological University, Singapore**

With the 1st ICMMB held more than two and half decades ago, researchers in the fields of engineering, medicine and biology had the visionary foresight of organizing an international and interdisciplinary forum to promote interaction and exchange of information across disciplines, a fundamental feature of research and technological advancement today - many of the important world problems are tackled with research in multidisciplinary knowledge fields. Indeed, many breakthroughs and inventions are spawned at the intersection of disciplines.

The ICMMB 2006 hosted in Singapore for the first time offers a strong and diverse scientific program covering a wide range of issues and challenges that presently exist in multidisciplinary Mechanics in Medicine and Biology. With this year's theme on "Tissue Engineering and Cell/Molecular Mechanics of Future Medicine" and with more than 200 papers and participants, the conference provides a timely and meaningful forum for important technical discussions that will integrate knowledge, ideas and experience to yield improvements in health care to benefit mankind.

As a research-intensive University with globally acknowledged strengths in science and engineering and strategic initiatives in biomedical and bioengineering, we are pleased that faculty and researchers at the Nanyang Technological University (NTU) have the exciting opportunity to participate and network in this premium conference and to have Assoc. Professor Eddie Ng from the School of Mechanical and Aerospace Engineering, a School of the NTU's College of Engineering, co-chair the conference.

On behalf of NTU, I welcome all overseas participants and/or participating Institutions to visit our campus during your stay - we have a number of biomedical related Research Centres hosted under the Biomedical and Pharmaceutical Engineering cluster.

I like to take the opportunity to congratulate the Conference Organizing Committee for putting together an excellent program and wish all delegates a rewarding and enriching time at the conference.

---

## ORGANIZING COMMITTEE AND INTERNATIONAL SCIENTIFIC ADVISORY COMMITTEE

---

### Honorary Congress Chair

- Yuan-Cheng Fung, USA
- Shu Chien, USA

### Congress Chair

- W-J Yang, USA

### Founders Committee

- W-J Yang, USA
- D N Ghista, Singapore/India
- T K Hung, USA
- Gunter Rau, Germany
- G Pallotti, Italy
- F Kajiya, Japan

### Local Congress Advisors

- M K Lim
- T Woo
- K Y Lam
- L E N Lim
- K K Phua
- D N Ghista

### Congress Co-Chair

- Eddie Y-K Ng, Nanyang Technological University
- K K Phua, Nanyang Technological University

### Secretary General

- S Idapalapati, Nanyang Technological University

### Scientific Chair

- D N Ghista, University of New South Wales

### Treasurer

- S M Chou, Nanyang Technological University

### Facilities Chair

- C K Kwoh, Nanyang Technological University

### Publicity Chair

- K Tai, Nanyang Technological University

### Technical Visit Chair

- M K Sakharkar, Nanyang Technological University

### Social Program Chair

- A C Ritchie, Nanyang Technological University

### Members

- L P Chua
- C K Chong
- K W Choo
- A N Danker
- K L Goh
- V V. Kulish
- P Kanguane
- M D N Lew
- W S Ng
- F R Ong
- Rajendra Acharya U

### International Scientific Advisory Committee

- W-J Yang, USA – Chairman
- B Ahlborn, Canada
- K-N An, USA
- W A Bakar, Malaysia
- R Besar, Malaysia
- F A Bljakhman, Russia
- C A Cain, USA
- W K Chan, Singapore
- Y W Chan, Singapore
- T Chua, Singapore
- C Craig, USA
- S C Fok, Abu Dhabi
- Y C Fung, USA
- D N Ghista, Singapore/India
- J C H Goh, Singapore
- S Haake, UK
- K Hayashi, Japan
- T K Hung, USA
- N H C Hwang, Taiwan
- F Kajiya, Japan
- T K Karalis, Greece
- K A Khor, Singapore
- A Kitabatake, Japan
- Tim Kriewall, USA
- D T T Lie, Singapore
- D. Liepsch, Germany
- C S Lim, Singapore
- S T Lim, Singapore
- P X. Ma, USA
- J Mazumdar, Australia
- B Milthorpe, Australia
- Y S Morsi, Australia
- E Y K Ng, Singapore
- K Ohba, Japan
- G Pallotti, Italy
- K K Phua, Singapore
- G Rau, Germany
- M R Slawomirski, Poland
- F C Su, Taiwan
- N M Sudharsan, India
- M Sugawara, Japan
- S Takayama, USA
- M Tanticharoen, Thailand
- S L Toh, Singapore
- M Tsuang, USA
- Y Tsujimoto, Japan
- P Vadasz, USA
- H E J Veeger, Netherlands
- J H Wang, USA
- T Watanabe, Japan
- S L.-Y. Woo, USA
- J Y Yoo, Korea
- R Zannoli, Italy

---

## GENERAL CONFERENCE INFORMATION

---

### Name Tag

The name tag is your identification to gain entry to all events of ICMMB-15 2006 and MUST be worn at all times.

### Language

The official language of the conference is English.

### Registration and On-site Secretariat Opening Hours

Date	Opening Hours	Venue
5 December 2006	1600 – 1800 hrs	VIP Room, Level 3
6 December 2006	0800 – 1100 hrs	Foyer of Venus Ballroom 1, Level 3
	1100 – 1700 hrs	VIP Room, Level 3
7 December 2006	0800 – 1700 hrs	VIP Room, Level 3
8 December 2006	0830 – 1700 hrs	VIP Room, Level 3

### Site Visit

There will be a site visit to Biopolis on 8 December 2006 (Friday). If you have signed up for the site visit, you will be able to find a **site visit coupon** in your delegate kit. Please bring along this coupon and present to the organizers when you board the bus. **You are required to assemble at the lobby of Furama Riverfront Hotel (Level 1) at 13:30 hours.**

### ICMMB-15 2006 Secretariat

c/o Nanyang Technological University  
Conference Management Centre/CCE  
60 Nanyang View, Nanyang Executive Centre, #02-08  
Singapore 639673  
Tel: +65 6790 4826  
Fax: +65 6774 2911  
Email: [icmb15@ntu.edu.sg](mailto:icmb15@ntu.edu.sg)

### Exhibition

Date : 6 and 7 December 2006  
Venue : Foyer of Venus Ballroom  
Opening Hours : 0930 – 1730 hours

### Conference Venue

405 Havelock Road  
Singapore 169633  
Main Tel: (65) 6333 8898  
Main Fax: (65) 6733 1588  
Email: [riverfront@furama.com](mailto:riverfront@furama.com)

---

EXHIBITION LAYOUT PLAN

---

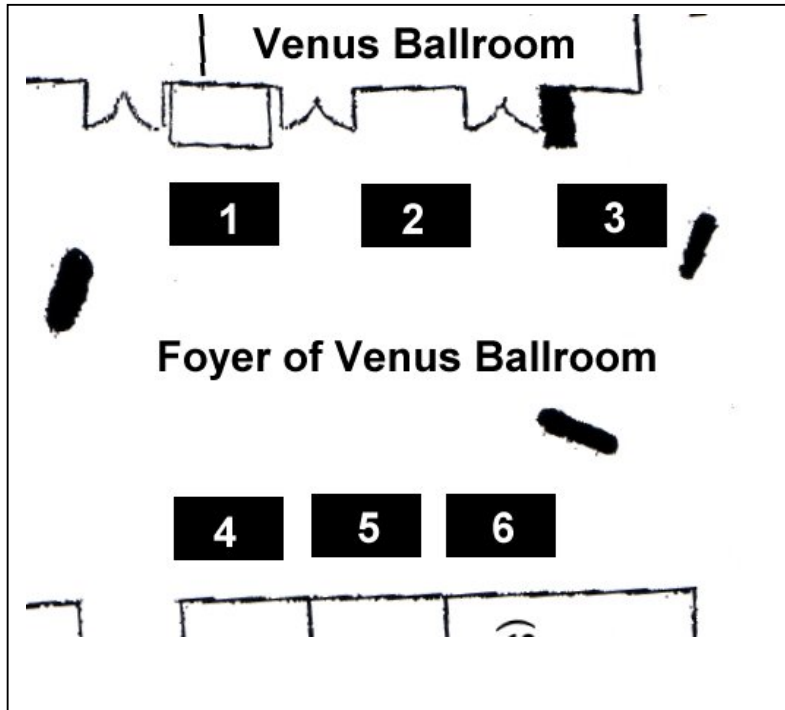


Table 1 : United BMEC Pte Ltd

Table 2 : Eetarp Engineering Pte Ltd

Table 3: BES Technology Pte Ltd

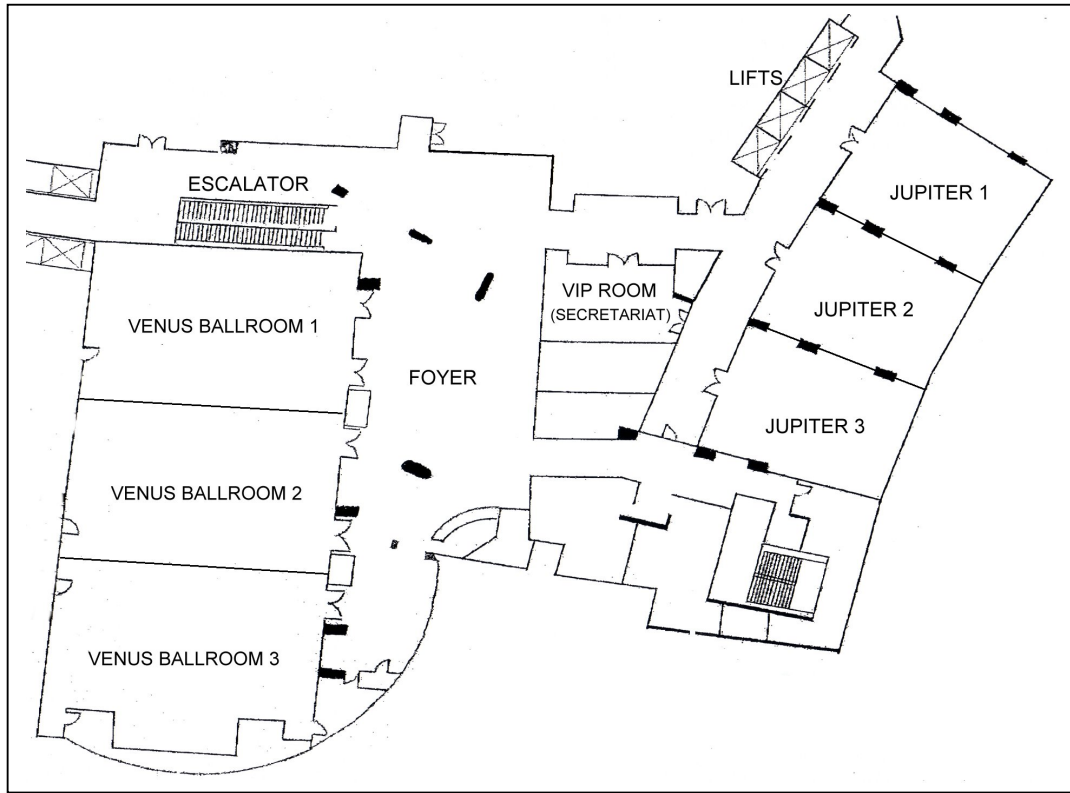
Table 4 : World Scientific Publishing Co. Pte Ltd

Table 5 : World Scientific Publishing Co. Pte Ltd

Table 6: i-Math Pte Ltd



## VENUE FLOOR PLANS



Secretariat Room	VIP Room	Level 3
Opening Ceremony	Venus Ballroom 1	Level 3
Keynotes	Venus Ballroom 1	Level 3
Parallel Sessions	Venus Ballroom 1	Level 3
	Venus Ballroom 3	Level 3
	Jupiter 1	Level 3
	Jupiter 2	Level 3
	Jupiter 3	Level 3
Exhibition	Foyer of Venus Ballroom	Level 3
Coffee breaks	Foyer of Venus Ballroom	Level 3
Luncheons	Venus Ballroom 2	Level 3
Conference Dinner	Venus Ballroom 2 and 3	Level 3
Welcome Reception	Hotel Poolside	Level 5

---

## ABOUT SINGAPORE

---

### Transport

Public transportation, including buses and MRT (Mass Rapid Transit) system provides access for visitors to most areas of the island. There are also taxis which can be hired from taxi stands, hailed by roadside, or booked by phoning the numbers listed below.

CityCab	6552 2222
Comfort Cablink	6552 1111
SMRT Taxi	555 8888

A booking fee is usually charged when hired by telephone.

Website: <http://www.lta.gov.sg>

### Changing Money

The service is available at the airport around the clock, at banks and hotels, and most shopping centers have licensed money changers. Visitors are advised not to change money with unlicensed operator. Most banks open from 9.30am to 3.00pm on weekdays and 9.30am to 11.30am on Saturdays.

### Charge and Credit Cards

Credit cards are widely accepted in Singapore, hotels, retailers, restaurants, travel agents and even some taxis readily accept international credit cards.

### Drinking Water

Water in Singapore is safe enough to drink from the tap.



### Electricity

Singapore's voltage is 220 – 240 AC, 50 Hertz. The plugs for the outlet are three pronged (UK type).

### Medical Facilities

Most hotels have their on-call doctor. In the case of emergency, dial 995 for an ambulance. Pharmaceuticals are available at many outlets including supermarkets, department stores, hotels and shopping centres.

### Lost Passport / Singapore Immigration Service

If you have lost your passport, you need to make a police report, then head to the Immigration & Checkpoints Authority to get a temporary visa. Finally, inform your embassy so you can get through the customs when you reach home.

Website: <http://www.ica.gov.sg>

### Post Office / Telecoms

The Changi Airport Post Office is open from 8.00am to 9.30pm daily. Basic Postal services are available at the Singapore Post Pte Ltd branches.

International Direct Dialing is available at the Comcentre. IDD calls can also be made from the numerous phone card and credit card phones located at the Singapore Post branches and around the city area. Phone cards are available from most money changes stationery shops and post offices in \$3 and \$5 denominations. A 20% levy is normally imposed on IDD calls made from hotels.

Website: <http://www.singpost.com.sg>

## Smoking

Smoking in public areas, taxis, lifts, cinemas, theatres, government offices and air-conditioned restaurants and shopping centers is against the law. First offenders may be fined up to a maximum of S\$1000. The rule of thumb is, if there is an ashtray provided on the premises, you can smoke there.

## Tipping

Tipping is not a way of life in Singapore. It is prohibited at the airport and discouraged at hotels and restaurants where a service charge of 10% is added to your bill.

## Useful Telephone Numbers

Police	999 (no charge)
Ambulance / Fire	995 (no charge)
Ambulance (Non-emergency)	6777 0000
Singapore Tourism Board	800 736 2000 ( <a href="http://www.stb.com.sg">www.stb.com.sg</a> )

## Embassies

American Embassy	6476 9100	Embassy of Ireland	6238 7616
Australian High Commission	6836 4100	Embassy of Japan	6235 8855
Belgium Royal Embassy	6220 7677	Embassy of Mexico	6298 2678
Brazil Embassy	6256 6001	Embassy of The Union of Myanmar	6735 0209
British High Commission	6424 4200	Embassy of Sweden	6415 9720
Canadian High Commission	6325 3200	Germany Embassy	6737 1355
Chinese Embassy	6734 3273	Indian High Commission	6737 6777
Danish Embassy Royal	6355 5010	Malaysian High Commission	6235 0111
Embassy of Chile	6223 8577	New Zealand High Commission	6235 9966
Embassy of Finland	6253 4035	Netherlands Embassy Royal	6737 1155
Embassy of the Republic of France	6880 7800	Sri-Lanka High Commission	6254 4595
Embassy of Greece	6220 8622	Switzerland Embassy	6468 5788

## Sightseeing Destinations

### Asian Civilization Museum

39 Armenian Street

Ancestral heritage of the Eastern Civilizations with important Chinese ceramics, imperial porcelain and aspects of Chinese architecture is on display in this museum.

Open: Mondays 12 noon to 6pm, Tuesdays to Sundays: 9am to 6pm Fridays till 9pm.

### Chinatown Heritage Centre

46, 48, 50 Pagoda Street

This centre showcases the rich heritage of Chinatown. Beautifully restored, highlights include the living cubicles and tailor shop which recreate the bygone era.

Open: Mondays to Sundays 10am to 7pm

**Jurong Bird Park**

Jalan Ahmad Ibrahim

Website: <http://www.birdpark.com.sg>

There are more than 8,000 Birds and a waterfall aviary in this attraction. Enjoy a scenic panorail ride in this breathtaking park and watch the Birds of Prey Show.

Open 9am to 6pm daily

**Singapore Zoological Gardens & Night Safari**

Mandai Lake Road

Website: <http://www.zoo.com.sg> ; <http://www.nightsafari.com.sg>

The Singapore Zoological Gardens, an open-concept zoo which is home to more than 2,000 creatures, has attracted international acclaim because of its clever use of rock walls and streams as natural barriers.

Open 8.30 to 6pm daily

Next to the Zoo is the Night Safari, another world-class attraction, where you can look a single-horned rhinoceros in the eye, prowl through the dark with a pack of striped hyenas and look out for leopards. Strike out on your own along the walking trail or relax in a tram ride - whichever you choose, Night Safari is a wild adventure not to be missed.

Open 7.30pm to midnight daily

**Sentosa Island**

Website: <http://www.sentosa.com.sg>

An island resort, playground for everyone with an assortment of activities – from panoramic rides to nature trails and lots of rich history.

**Singapore Botanic Gardens**

Cluny Road

The Gardens epitomises the tropical island's luxuriant parks. Spread over 52 hectares and close to the centre of the city, the Gardens is a combination of untouched primary forest and specialty gardens displaying frangipanis, roses, ferns and desert plants, to name a few. There are numerous plant species here, including many rare specimens, reflect the Gardens' richness and diversity of plant life.

The present orchid enclosure has 20,000 orchid plants on display. The National Orchid Garden promises sprawling orchid displays, water features, and an exotic bromeliad collection from Central and South America. Other attractions for visitors' enjoyment include Palm Valley, Eco-Lake and outdoor concerts on Symphony Lake.

Open 5am to 12 midnight daily

**More Places of Interest**

Visit Website: <http://www.visitsingapore.com/>

## PROGRAM OVERVIEW

### 6 December 2006, Wednesday

0900 - 0930	Opening Ceremony GOH: Mr. Gan Kim Yong Minister of State for Ministry of Education and Ministry of Manpower					Venus 1
0930 - 1005	Key Notes I : Professor Bruce Milthorpe Vice-President & Head of Graduate School of Biomedical Engineering, University of New South Wales Title: Application of Biomechanics to Tissue Engineering					
1005 - 1040	Key Notes II : Dr. Steven D. Abramowitch, Profs. Savio Woo and T.K. Hung (Musculoskeletal Research Center, University of Pittsburgh). Title: New Bioengineering Approaches for Management of Soft Tissue Injuries					
1040 - 1110	TEABREAK (Foyer of Venus Ballroom)					
	Jupiter 1	Jupiter 2	Jupiter 3	Venus 1	Venus 3	
1110 - 1230	Biomaterials 1	Biomedical Engineering Education, Industry, and Society 1	Biomedical Imaging and Imaging Processing 1	Biomedical Instrumentation and Biosensors 1	Biomedical Signal Processing	
1230-1340	LUNCH (Venus 2)					
1340 - 1520	Biomaterials 2	Cardiovascular System Engineering 1	Biomedical Imaging and Image Processing 2	Biomedical Instrumentation and Biosensors 2	Healthcare Management Information Systems 1	
1520-1600	TEABREAK (Foyer of Venus Ballroom)					
1600 - 1730	Others 1	Cardiovascular System Engineering 2	Clinical Biomechanics 1	Computational Biology and Bioinformatics 1	Healthcare Management Information Systems 2	

### 7 December 2006, Thursday

0900 - 0945	Key Note Speech III: Speaker: Professor Dr Christian ODDOU – University of Paris Title: Mechanics of ACTIVE Porous Media: Bone Tissue Engineering Application					Venus 1
0945 - 1030	Key Note Speech IV: Speaker: Professor Romano Zannoli – University of Bologna Title: Mechanical Aorto-ventricular Matching in Heart Failure					
1030 - 1100	TEABREAK (Foyer of Venus Ballroom)					
Venue	Jupiter 1	Jupiter 2	Jupiter 3	Venus 1	Venus 3	
1100 - 1220	Others 2	Cardiovascular System Engineering 3	Clinical Biomechanics 2	Computational Biology and Bioinformatics 2	Rehabilitation Engineering 1	
1220-1350	LUNCH (Venus 2)					
1350 - 1510	Cardiac Biomechanics	Application of 1D and 2D signal processing for bio-signals 1	Microfluidics and Nanotechnology	Bio-manufacturing and Tissue Engineering Applications	Micropolar Biofluid Mechanics and Applications	
1510 - 1540	TEABREAK (Foyer of Venus Ballroom)					
1540 - 1800	Innovative Strategy for Rehabilitation following Neurological Injuries	Application of 1D and 2D signal processing for bio-signals 2	Respiratory System Engineering; Telemedicine and Healthcare	Motion Analysis	Rehabilitation Engineering 2	

### 8 December 2006, Friday

0900 - 0945	Key Note Speech V: Speaker: Professor Dr Tin-Kan Hung – University of Pittsburgh Title: Fluid Mechanics Analyses of Cardiac Pumping and Balloon Assist					Venus 1
0945 - 1030	Key Note Speech VI: Speaker: Professor Dr Giovanni Pallotti – University of Bologna Title: Study on the Mechanical Properties of Large Arteries: the tissues of the vessels and the transplant. theoretical study and clinical applications					
1030 - 1100	TEABREAK (Foyer of Venus Ballroom)					
Venue	Jupiter 1	Jupiter 2	Jupiter 3	Venus 1	Venus 3	
1100 - 1240	Medical Robotics; Neural-, Neuro- and Neuro-Behavioral Engineering	Biomedical Engineering Education, Industry and Society 2	Physiologic System Modeling 1	Microfluidics	Nanobiotechnology, Cellular and Tissue Engineering 1	
1240 - 1400	LUNCH (Venus 2)					
1400 - 1540	Neuromuscular Systems and Biomechanics 1	Orthopaedic Biomechanics 1	Physiologic System Modeling 2	Therapeutic Physics and Rehabilitation Engineering 1	Nanobiotechnology, Cellular and Tissue Engineering 2	
1540 - 1610	TEABREAK (Foyer of Venus Ballroom)					
1610 - 1730	Neuromuscular Systems and Biomechanics 2	Orthopaedic Biomechanics 2	Neural Engineering	Therapeutic Physics and Rehabilitation Engineering 2		

## Sessions and Abstracts

**Session A1**

**Biomaterials 1**

**Jupiter Room 1**

**1110 - 1230 6 December 2006 Wednesday**

**A1.1 P0193**

**Downregulated Endothelial Nitric Oxide Synthase in Endothelial Cells Grown on Biodegradable Materials**

S K Lu, \*H I Yeh, \*T Y Tian, W H Lee  
National Taipei University of Technology, TAIWAN  
\*Mackay Memorial Hospital, TAIWAN

We investigated the effect of endothelial nitric oxide synthase (eNOS) in endothelial cells grown on various biodegradable "magnesium alloys" materials. Human Aortic Endothelial Cells (HAEC) were seeded (800 cells/mm<sup>2</sup>) onto various magnesium alloy sheets, including Mg-Al-Zn alloys (AZ31, AZ91) and Mg-Al-Mn alloy (AM60). Cells seeded onto tissue culture treated polystyrene dish coated with gelatin were used as controls. Forty-eight hours later, the cellularity and eNOS expression were examined by immunofluorescence microscopy.

**A1.2 P0197**

**Preconditioning of Swine Skin using Cyclic Tensile Loading**

K Yeung, Z Liu  
The University of Sydney, AUSTRALIA

Preconditioning is required prior to testing of biological soft tissue. It allows the tissue to reach homeostasis, thus providing more reliable data. This paper reports our recent experimental investigations on the preconditioning of fresh swine skin. Focusing on retrieving preconditioning results at low strains (5% and 10%), a cyclic uniaxial tensile loading method was used. Samples were tested using different loading rates and different percentage strains, and comparison of data was employed to determine the optimal rate, strain and number of cycles repeated for preconditioning of fresh swine skin. Samples were loaded to an initial 5 or 10% strain, in the rate of 3N/min, 5N/min or 10N/min, and unloaded at the same rate using Dynamic Mechanical Analyser. Cyclic loading procedures were repeated in force controlled setting until steady behaviour was observed for each sample. Samples loaded up to 5% strain exhibit a more consistent preconditioned behaviour than those loaded to 10% strain, and experimental results show that the loading/unloading rate of 3N/min is suitable for preconditioning fresh swine skin.

**A1.3 P0218**

**Electric Responses of Skeletal Muscle during Cyclic Uniaxial Tensile Loading**

Z Liu, S M Chan, K Yeung  
The University of Sydney, AUSTRALIA

The clinical significance of piezoelectricity of biological tissues has been reported widely. However, the relationship between mechanical loading and the corresponding electric responses is still largely unknown. In this study we investigated the electric responses of skeletal muscle with mechanical loading. The subsequent voltages of dehydrated sartorius and gastrocnemius muscles of cane toads were tested using an Instron testing machine. Deformation pattern of muscle samples was found by applying constant uniaxial strain rate until presence of fatigue. Two different strain rates were tested in this setting (5mm/min and 50mm/min). The test results showed that, on average, muscle samples have an ultimate tensile strength of 0.18MPa, and samples exhibited elastic response up to 5.4N of loading. The electric responses were recorded in another experimental setting - cyclic tensile loading at constant rate of 20mm/min up to a controlled force of 3N for 50 cycles. The recorded range of electric voltage during cyclic loading was within 1V-2V with respect to its mean value axis. The results of this study will provide a foundation for understanding the piezoelectric properties of soft tissue.

**A1.4 P0173**

**Mechanical Properties of Tropical Cancellous Swine Bones**

D Shu, G Ma  
Nanyang Technological University, SINGAPORE

The potential use of swine bones to regenerate human bones is the starting point of this paper which evaluates the effect of water content coupled with anatomical directions on the Young's modulus, compressive yield stress and yield strain of swine cancellous bones through mechanical testing. It was found that in the frontal loading direction, the Young's modulus and compressive yield strength increased while the yield strain decreased as the water content of the bones was reduced. As for the transverse direction, only the Young's modulus increased while the compressive yield strength and yield strain remained the same as the water content of the bones was reduced. And for the sagittal loading direction, there were no differences in the mechanical properties assessed between the 2 samples.

## Session A2

### Biomedical Engineering Education, Industry, and Society 1

Jupiter Room 2

1110 - 1230 6 December 2006 Wednesday

#### A2.1 P0398

##### Some perspective comments on future of Biomechanics

G Rau

University of Technology, GERMANY

#### A2.2 P0138

##### Segment Based Dynamic Time Warping Approach for Modeling and Interpreting Motion Characteristics

K C Liu, \*M S Tsai, Y H Chiu, \*\*J Y Chang, \*\*C H Chang

Industrial Technology Research Institute, TAIWAN

\*Potz General Hospital, TAIWAN

\*\*National Cheng Kung University, TAIWAN

Most of motion analysis used for clinical applications is based on inverse dynamics approach, the main disadvantage for using this approach is too complicated. Alternatively, this paper proposes a statistically-oriented pattern matching approach applied dynamic time warping algorithm for modeling and interpreting the movement characteristics. The purpose of this study is to develop a concept-of-proof rapid prototyping system for mitigating vibration tennis rackets design, verification, and evaluation.

#### A2.3 P0183

##### Experimental Study of the Whirling Fluid Force on the Impeller of a Centrifugal Pump as a VAD

T Tsukiya, \*H Horiguchi, \*Y Tsujimoto, Y Taenaka

National Cardiovascular Center, JAPAN

\*Osaka University, JAPAN

#### A2.4 P0233

##### Application of Transport Phenomena in Avian Respiratory Flow

E Sakai, T Watanabe, T Himeno

University of Tokyo, JAPAN

Oscillatory flow fields in avian trachea models were both experimentally and numerically studied to clarify the generation mechanism of the unidirectional flow. The results showed that separation vortex and convective inertia force played important roles for generation of the unidirectional net flow. By the numerical simulation, it was clearly shown that unidirectional net flow strongly enhanced axial gas transport in the process of avian respiration. Experimental study was therefore performed to verify the enhancement of heat transport by the unidirectional net flow toward the development of a highly efficient heat exchange device.



## Session A3

### Biomedical Imaging and Image Processing 1

Jupiter Room 3

1110 - 1230 6 December 2006 Wednesday

#### A3.1 P0126

##### Registration of Brain Volumes by Modified Radial Basis Functions Preserving Specific Internal Regions

A Sarayu Parimal, N Ivanov, W L Nowinski  
Singapore Bioimaging Consortium, SINGAPORE

We propose a method of registration that aligns specific parts of internal structures and the cortical surfaces of brain. The method is based on special class of modified radial basis functions. Preliminary alignment of the brain volumes against the standard atlas is done by either simple merging or by Talairach transformation. This alignment may render matching of certain internal structures. We register the cortex preserving such pre-aligned regions. The transformation is done with the help of derived mapping functions that are monotone and continuous. The resultant transformation provides one-to-one mapping and overcomes limitations faced by classical radial basis function.

#### A3.2 P0137

##### Quantitative Analysis of Pesticides using Chemiluminescence and Image Processing Techniques

P M Shivamurthy, S K Katti, \*M A Kumar, \*M S Thakur  
Sri Jayachamarajendra College of Engineering, INDIA  
\*Central Food Technological Research Institute, INDIA

Machine interpretation (Vision System) is an open avenue in Biosensors research field. The knowledge of Image processing supports such a relevant area of research. Maintaining the quality control aspects & healthy content of the food is a rigorous issue in a food industry. A methodology presented in this paper involves a chemical phenomenon, automatic Image acquisition system and Image analysis software tool. The relation between intensity level of the light produced in the chemical phenomena and the microscopic concentration of the pesticide has been explored in this work. A calibration plot of intensities v/s concentration is used to quantify the unknown concentration. The outcome of this methodology has proven to be highly efficient than the present methods (existing instrumental methodologies), being a user-friendly and inexpensive software solution. The entire software tool, which is named as Pestilizer, is developed using VC++. The work reported in this paper will lead to new avenues in the area of Biosensors as applied to food processing.

#### A3.3 P0194

##### Fast, High Precision, and High Quality Digitally Reconstructed Radiograph (DRR) Generation

C L Yang, J L Wang, B D Yang  
National Taiwan University, TAIWAN

We bend our efforts on developing a fast, high precision, and high quality Digitally Reconstructed Radiograph (DRR) generation on the platform of consumer personal computer (PC). In our method, the parallel computation of graphical processing unit (GPU) is regards an efficiency calculator for DRR generation. We composed the native supported functions of GPU as floating point calculation and successfully generated high precision 12bit DRR. In this study, we also introduce a method to generate high quality DRR by applying a compensation filter. By applying this method, images appears with clear outline of anatomic structures and with uniform optical density. Composing GPU calculation and compensation filter, we can perform a 512x512 12bit DRR from 512x512x463 12bit CT dataset in 0.8 frame per second (fps) and with appearance outline of anatomic structures.

#### A3.4 P0198

##### Blood Flow Assessment in the Aortic Heart Valve based on Magnetic Resonance Images using Optical Flow Analysis

K K L Wong, \*P Kuklik, R M Kelso, S G Worthley, P Sanders, J Mazumdar, D Abbott  
University of Adelaide, AUSTRALIA  
\*Warsaw University of Technology, POLAND

The optical flow technique has been introduced for evaluating blood flow from MRI images of the aorta and heart valves. We perform flow quantification vis-à-vis blood movement through a natural aortic heart valve, based on the measured flow field. The human subject is scanned using the standard MRI procedure and postprocessing of the flow images quantifies the flow characteristics. The global estimation of velocity vector fields over the flow channel provides useful information of the flow characteristics that is related to the operation of valve leaflets.

## Session A4

### Biomedical Instrumentation and Biosensors 1

Venus Room 1

1110 - 1230 6 December 2006 Wednesday

#### A4.1 P0116

##### A Photoplethysmographic by two Wavelengths Method for Real Time Hematocrit Monitoring

P Phonphruksa, M Chaichanyut, I Potjanasaja, A Naktawan, S Tungjitkusolmun  
King Mongkut's Institute of Technology Ladkrabang, THAILAND

The objective of the present study is to investigate the optical transmittance of hematocrit for wavelengths are potential for measured transcutaneously across the finger. From the acquired information we found four Wavelengths (525nm, 585nm, 875nm and 950nm) are optimal to used in the algorithm and the design of a real-time hematocrit monitoring system. We constructed a simplified system with a light detecting finger probe to measure the transmittance spectra. The LEDs were used as the light source and a photodiode was placed at the other side of the finger. We compared the results from our simplified measurement system with the hematocrit levels measured with the centrifuge using blood sample drawn from patients. From the analysis, we discovered that wavelengths 525nm and 585 nm are sensitivity to hematocrit levels and the wavelengths 875nm and 950nm are insensitivity to hematocrit levels, and the wavelengths 525nm, 585nm and 875nm can be used to predict the hematocrit value to obtained 90% of the data is given an error less then 25%.

#### A4.2 P0134

##### Modelling of Ultrasonic Transdermal Applicator for Twinport Non-Steroidal Drug Delivery System

R Subbaraman, Y Xu, J K Y Lee, M R Z Sim, D J J Hu, H J Toh, S T Eng  
Temasek Polytechnic, SINGAPORE

Use of portable hand held ultrasonic applicators for the delivery of specific hydrophobic drugs is gaining popularity in recent times due to the availability of suitable drugs which can be delivered transdermally to the target site. The major limitations with standard applicators is that they are designed for simple drug delivery procedure and are not suitable for use in dual port applications involving two different hydrophobic drugs. The augmented dual port applicators discussed in this study are unlike the simple applicators and have several advantages in treatment. In this applicator, the drug infusion port has a dual port architecture interfacing internal drug reservoirs containing the drugs of choice. Since therapeutic applications with these applicators involves modulation of biological processes at the level of epidermis and dermis in the delivery of drugs, it is more promising than a simple applicator. The dual port architecture thus effectively allows the use of two hydrophobic medium to enhance the penetration of the drugs through the skin with the aid of ultrasound delivered through an ultrasonic head. Preliminary studies with these applicators have been promising when compared to the simple applicators and hence are valuable tools in non invasive drug delivery applications.

#### A4.3 P0231

##### Using Multi-Slot Coaxial Antenna for Microwave Ablation Therapy

P Phasukkit, M Sangworasil, S Tungjitkusolmun  
King Mongkut's Institute of Technology Ladkrabang, THAILAND

Every year, more than one million people around the world die with hepatocellular carcinoma. Thus, finding a more effective cure of HCC is one of the challenging problems for the medical community. Microwave antennas have been used for many years in various medical applications. There are many geo-metrical configurations for microwave antennas, such as symmetric dipole, monopoles, as well as slot antennas. The present radiating electromagnetic powers have been used at either 915 MHz or 2.45 GHz. Electromagnetic wave propagation at microwave frequencies heats the targeted region by dielectric excitation rather than by conduction, which makes it possible to heat tumors to temperature above 50 °C at a much faster rate. This study investigates different coaxial slot antenna designs for use in hepatic ablation. Each antenna had the same dimensions (3.58 mm diameter, and 70 mm in length). We incremented the number of slots at the distal tip of antenna from one to six. We compared and considered the specific absorption ratio (SAR) and temperature distributions generated from each antenna using the bio-heat equation and finite element analyses. We used nonuniform mesh and axisymmetric models in this study. From the results, we discovered that SAR and temperature distributions have a high correlation, thus the maximum SAR and temperature values occurred at essentially the same locations in all cases.

#### **A4.4 P0298**

##### **New Extensometer to Measure in Vivo Uniaxial Mechanical Properties of Human Skin**

K H Lim, \*H N Ho, \*C M Chew, \*C Y P Chen, \*S Jeyapalina, \*C L Teo, \*B H Lim

National University Hospital, SINGAPORE

\*National University of Singapore, SINGAPORE

In vivo uniaxial measurements of skin using existing extensometers presents several issues, including external force contribution due to stretching of surrounding skin tissues, lack of measurement standardization, etc. In order to improve the measurement accuracy, a new portable extensometer, which measures in vivo mechanical properties of skin has been designed and constructed. This design incorporates pads to shield the load cell from external forces, resulting in measurements that are significantly closer to in vitro measurements. The results have been verified on rubber sheet and pig model experiments, and finite element modeling.

## Session A5

### Biomedical Signal Processing

Venus Room 3

1110 - 1150 6 December 2006 Wednesday

#### A5.1 P0177

##### **The Light Emission Characteristics of CdS Nanoparticles Labeled DNA Molecules**

W Shi, X Ma

Shaoxing College of Arts and Science, CHINA

We present the light emission characteristics of CdS nanoparticles conjugated with an active DNA (A-DNA) and an aqueous DNA (W-DNA). Having the action of activators, A-DNA-CdS has a stronger absorption in the absorption spectrum than that of W-DNA-CdS, showing that A-DNA conjugates with CdS nanoparticles more easily and tightly. We find that the luminescence from W-DNA-CdS is slightly stronger than that of A-DNA-CdS, but the latter is more photostable in terms of time behavior of the optical bleaching. Moreover, the emission of A-DNA-CdS keeps relatively steady as temperature ranging from -40 °C to room temperature, indicating that it is suitable to use in the detection of biological analysis.

#### A5.2 P0328

##### **Asymptomatic and Knee Osteoarthritis Automatic Gait Pattern Analysis using a Wavelet Representation of Kinetic Data and the Nearest Neighbor Classifier**

N Mezghani, S Husse, \*K Bovin, \*\*K Turcot, N Hagemeister, R Aissaoui, J A De Guise

Ecole de Technologie Superieure, CANADA

\*Universite de Montreal, CANADA

\*\*Ecole Polytechnique de Montreal, CANADA

The aim of this study is to develop an automatic computer method to discriminate asymptomatic from knee osteoarthritis pathological gait patterns using ground reaction forces. We investigate a discriminant feature of kinetic data based on wavelets. Classification is based on the nearest neighbor classifier. Experiments were conducted using data of 43 cases, 16 asymptomatic and 27 pathological. The proposed method has a high success rate of 39/43.

## Session B1

### Biomaterials 2

Jupiter Room 1

1340 - 1440 6 December 2006 Wednesday

#### B1.1 P0228

##### Effect of a Disturbed Flow on Proliferation of the Cells of a Hybrid Vascular Graft-An Invitro Study

L Fan, T Karino  
Hokkaido University, JAPAN

To elucidate the mechanism of localization of atherosclerosis in man, the effect of a disturbed flow on proliferation of the cells of an arterial wall was studied by exposing a model of an artery (a hybrid vascular graft) to a disturbed flow (an annular vortex) formed distal to a sudden tubular expansion. It was found that the thickness of the cell layer as an indication of cell growth and cell proliferation was much greater around the stagnation point close to the inlet of the expansion and the reattachment point (distal end of the annular vortex) where flow was slow and wall shear stress was low than middle portion of the vortex and far downstream of the reattachment point where flow was fast and wall shear stress was high.

#### B1.2 P0232

##### Effect of Hydrostatic Pressure on Wound Healing -An in Vitro Study with Cultured EC Monolayer-

X He, T Karino  
Hokkaido University, JAPAN

A straight scratch-wound was created on a confluent monolayer of vascular endothelial cells cultured on a plastic dish or a porous membrane and allowed to heal under various hydrostatic pressures. The degree of healing was assessed by measuring the migration velocity of the cells at the edge of the wound and the width of the wound as a function of the time elapsed. It was found that imposition of a hydrostatic pressure of 60-120 mmHg significantly suppressed cell migration and wound healing compared to the controls allowed to heal under a hydrostatic pressure of 0 mmHg. Healing of a scratch-wound was much slower in cells grown on a porous membrane than that grown on a plastic dish. The results suggested that in hypertensive subjects, healing of an injured vessel might be delayed compared to the case of normotensive subjects.

#### B1.3 P0287

##### Adipose Precursor Cells Seeded on Hyaluronic Scaffolds: A Pilot Clinical Trial

F B Stillaert, \*C Di Bartolo, \*\*J Hunt, \*\*\*P N Blondeel  
University Hospital Ghent, BELGIUM  
\*Fidia Advanced Biopolymers, ITALY  
\*\*University of Liverpool, UNITED KINGDOM  
\*\*\*University Hospital Ghent, BELGIUM

Soft tissue reconstruction requires the (re)generation of a long-term stable organoid which survives in an equilibrium with adjacent tissue. Histoconductive approaches use biocompatible and -degradable scaffolds which are seeded with lineage- and host-specific progenitor cells. Those tissue engineered bio-hybrids can be (re)implanted in deficient sites. The scaffold functions as a temporary nutritional extracellular matrix which guides histogenesis by maintaining cell-cell and cell-matrix interactions. We tested hyaluronic acid scaffolds for their biocompatibility and efficiency in 3D-adipogenesis in humans.

## Session B2

### Cardiovascular System Engineering 1

Jupiter Room 2

1340 - 1520 6 December 2006 Wednesday

#### B2.1 P0148

##### Bio-Reactor for in Vitro Evaluation of Tissue Engineered Arteries and Heart Valves

Y S Morsi, \*W Yang, C S Wong, A A Owida

Swinburne University of Technology, AUSTRALIA

\*Commonwealth Scientific and Industrial Research Organisation, AUSTRALIA

Arterial bypass and heart valve replacements are two of the most common surgical treatments in cardiovascular surgery today. Currently, artificial materials are used as substitute for these cardiac tissues. However, these foreign materials do not have the ability to grow, repair or remodel and are thrombogenic, which leads to stenosis. With the aid of tissue engineering, it is possible to develop functional identical copies of healthy heart valves and arteries which are biocompatible. In this paper, we discussed the design concept, criteria and the development of a multi-functional bioreactor for tissue culture. This system is capable of providing physiological pressure and flow of nutrient medium for arteries and heart valves. The developed system is compact and can be placed in an incubator to provide a typical cellular growth environment. Moreover, the proposed reactor design, in addition to mimicking conditions in vivo, is highly flexible, allowing different types of tissues, arteries and heart valves to be engineered under various haemodynamic stresses. Initial verification and haemodynamic testing on fluid flow using Laser Doppler and Particle Images Velocimetry indicated that the bioreactor performed well and is producing the correct physics expected.

#### B2.2 P0154

##### Chitin – A Promising Biopolymer for Curing Coronary Heart Disease

M A Jothi Rajan, \*T Mathavan, \*\*V Ganesan, \*\*\*A Thaddeus, \*\*\*V Fragrance Latha, T S Vivekanandam, P S

Dhandapany, S Umopathy

Madurai Kamaraj University, INDIA

\*Nmssvn College, INDIA

\*\*UGC – DAE, INDIA

\*\*\*Govt. Hr. Sec. School, IRAN

Chitin was extracted from the shells of crabs obtained from the extreme south coast of India. Chitin obtained from these shells is superior to the ones from the other regions. The chitin was characterised by PAS, XRD, DSC, TG, DTA, FTIR, AFM, SEM and EDAX studies. The blood containing high serum cholesterol was analysed for its constituents by biochemical analysis and PAS. A known amount of chitin dissolved in a favourable solvent was injected into the blood. The resulting complex was characterised by PAS, XRD, DSC, TG, DTA, FTIR, AFM, SEM, and EDAX methods. The results obtained are precisely presented in this work.

#### B2.3 P0192

##### An Adaptive Mesh Refinement Method for CFD Analysis of Arterial Blood Flow

Y Imai, \*T Aoki, T Ishikawa, K Tsubota, T Yamaguchi

Tohoku University, JAPAN

\*Tokyo Institute of Technology, JAPAN

An efficient numerical method is proposed for arterial blood flow analysis. The method is an Adaptive Mesh Refinement (AMR) method on Cartesian meshes, in which incompressible Navier-Stokes equation is solved by a fourth-order Eulerian scheme, implicit Interpolated Differential Operator (IDO) scheme. An application of the proposed method to blood flow analysis shows that steep gradient of blood pressure at vessel bifurcations can be resolved with an order of magnitude shorter CPU time than that of uniformly refined meshes.

#### B2.4 P0201

##### In Vitro Flow Field and Sound Study of the Mechanical Bi-Leaflet Mitral Prostheses

T Akutsu, J Saito, R Imai, T Suzuki, K Yuyama

Kanto Gakuin University, JAPAN

Bi-leaflet valves with straight leaflets, the St. Jude Medical (SJM) and the On-X valves, and with curved leaflets, the Jyros (JR) and the MIRA valves, were tested in the mitral position under pulsatile-flow condition to investigate the leaflet shapes and overall valve designs on the flow field and valve closing sound. Dynamic PIV system was employed to analyze the flow field. Flow field pattern differences during the peak flow phase seem to affect closing behavior of the bileaflet valves, thus, affecting the closing valve sound level. Old design of the SJM valve and newer designs of the MIRA and the On-X valves exhibited larger closing sound.

**B2.5 P0203****Influence of the Pulse Waveform and Working Fluid on the In Vitro Flow Field Study of the Mechanical Bi-Leaflet Mitral Prostheses**

T Akutsu, T Suzuki, J Saito, K Mori  
Kanto Gakuin University, JAPAN

The St. Jude Medical (SJM) and the Jyros (JR) valves were tested in the mitral position under pulsatile-flow condition. Dynamic PIV system was employed to analyze the flow field affected by the leaflet shapes, valve designs, working solutions, and the pulse waveforms. Influence of the pulse waveform and the working slution was apparent during early stage of the accelerating flow phase.

## Session B3

### Biomedical Imaging and Image Processing 2

Jupiter Room 3

1340 - 1500 6 December 2006 Wednesday

#### B3.1 P0294

##### **Isotherm Distribution using Finite Element Model for Cryosurgical Optimisation**

E Tortal, U Gunawardana, V Ilic, R Liyana-Pathirana, Y Xiang  
University of Western Sydney, AUSTRALIA

Cryosurgery is an invasive procedure using very low temperature to freeze tumour cells. The procedure utilizes a cryogenic probe which is made in contact with the tumour to cause necrosis or death of cancer cells. There were reported cases of recurrence of the disease brought about by inadequate delivery of the lethal freezing temperature to the entire targeted tumour volume [1], [2]. Insufficient control of freezing temperature, inadequate probe placement and insufficient imaging of the ice ball usually cause undesirable side effects rather than benefits to patient undergoing cryosurgical treatment [1], [3]. The objective of this research is to optimise cryosurgical procedure by simulation and imaging of the temperature distribution before surgery that will serve as the basis for optimisation of the proper probe placement at the targeted site.

#### B3.2 P0318

##### **2-D Vision System for Detection and Measurement of Wound and Flap in Reconstructive Surgery**

T H Du, J K Rappel, \*H N Ho, \*\*E Burdet, \*C L Teo, \*B H Lim  
National University Hospital, SINGAPORE  
\*National University of Singapore, SINGAPORE  
\*\*Imperial College London, UNITED STATES

We present a computer vision system to assist surgeons to measure wound and skin flap geometry in reconstructive surgery semi-automatically and without contact. Our vision system uses regular digital camera and a reference object – making it affordable and convenient. We introduce an automatic wound and skin flap detection and measurement method and a semi-automatic method. Our experiments studied the impact of various imaging scenarios on accuracy and compared it with that of commercial vision software IMAQ. We found our vision system more accurate and easier to use compared to IMAQ. We also find our vision system adequate for reconstructive surgery scenarios involving planar flaps.

#### B3.3 P0365

##### **Radiological Image Transmission using Web**

K A Mohamed Junaid, \*G Ravindran  
R M K Engineering College, INDIA  
\*Anna University, INDIA

Nowadays there are a large number of patients that need specific health support using latest technological developments in the area of Information Technology. There are number of web based communication systems which are possible but they are very costly to afford by a common public. An innovative low cost telehealthcare system that can complement the existing picture archiving and communication system (PACS) network by providing live monitoring of ongoing procedures through a web-based interface. This should allow radiologist / doctors to supervise radiological procedures remotely by getting a "live" replica of the technologists console of every CT scanner. A web based video transmission of images from CT console is implemented in an intranet environment. Images captured from the console are compressed to video resolution and broadcast through a web server. The system is implemented to monitor CT images distributed in different departments within hospital. This system significantly improved the radiologist productivity by saving valuable time spent in trips between reading rooms and examination rooms. It is also improved patient care and throughput by reducing the time spent waiting for the radiologist to check a study before removing the patient from the scanner.



### **B3.4 P0366**

#### **FPGA Accelerator for DSP Image Compression System**

K A Mohamed Junaid, \*G Ravindran  
R M K Engineering College, INDIA  
\*Anna University, INDIA

Previously, the Digital Signal Processing applications are dominated by general purpose DSP and ASIC devices. Now Field Programmable Gate Array (FPGA) have become a competitive alternative for high performance DSP applications. This Project describes the benefits of using an FPGA as a Co-processor for Digital Signal Processor, for increasing speed and reducing the power consumption. This approach uses the advantage of fine grain parallel operation of FPGA. The External Memory Interface (EMIF) in the TMS DSP platform is used to interface the FPGA. Here the DS Processor is used to handle the analog input/output signals and make a communication with FPGA through EMIF. The DSP-FPGA combination gives better speed as ASIC, cost effectiveness like a general-purpose DSP. The designer can make changes quickly without the additional cost and lead-time. FPGAs have no minimum volume requirements as ASICs. ASIC technology offers the ability to design a custom architecture that is optimized for the target application. The digital filtering typically requires numerous MAC (Multiply and Accumulate) operation—one MAC operation for each filter tap, a traditional DSP has a single MAC, so each filter tap must be executed sequentially.

## Session B4

### Biomedical Instrumentation and Biosensors 2

Venus Room 1

1340 - 1420 6 December 2006 Wednesday

#### B4.1 P0299

##### Non-Invasive in Vivo Measurement of Skin Flap Shrinkage

K H Lim, \*H N Ho, \*C M Chew, \*C Y P Chen, \*S Jeyapalina, \*C L Teo, \*B H Lim  
National University Hospital, SINGAPORE  
\*National University of Singapore, SINGAPORE

A non-invasive, in-vivo method has been developed to measure the shrinkage of skin flap in a flap transplant surgery. It involves the use of a custom designed extensometer to measure the force-displacement behavior of skin in the compressive direction, followed by data analysis to estimate the shrinkage. The measurement accuracy has been tested on pig models, and has been shown to have an accuracy of at least 85%.

#### B4.2 P0362

##### Raman Spectroscopy for Evaluation of Structure Deformation in Stressed Bone Tissue

Z Huang, S K Teh, W Zheng, C F Yu, \*C H J Goh  
National University of Singapore, SINGAPORE  
\*National University Hospital, SINGAPORE

8 normal and 3 osteoporotic cortical bones were harvested and mechanically tested through compression tests and indentation tests to correlate with corresponding Raman signals. The 5 tissue Raman peaks, including 3 mineral peaks (phosphate  $\nu_1$ , phosphate  $\nu_4$ , and carbonate  $\nu_1$ ) and 2 organic peaks (methylene CH<sub>2</sub> (wag) and amide I), were studied thoroughly. Analysis and discussions were primarily made with respect to the degree of mineralization and changes in content of type-B carbonate substitution. Our results show that the degree of mineralization and type-B carbonate substitution correlates well with both compression and indentation tests for normal pig cortical bone, and with indentation tests for osteoporotic human cortical bone.

## Session B5

### Healthcare Management Information Systems 1

Venus Room 3

1340 - 1440 6 December 2006 Wednesday

#### B5.1 P0200

##### Applications of Matlab in Hospital Bed Management

V S Subbhuraam, P W Khong  
Nanyang Technological University, SINGAPORE

Bed allocation concerns the permanent number of beds assigned to the different medical and surgical specialties in a hospital. Administrators should allocate beds to serve demands for each medical and surgical service. Computers are widely used in developing models for this purpose. This paper discusses on the application of Matlab, a data-manipulation software package that allows data to be analyzed and visualized using existing functions and user-designed programs, for determination of the optimal bed capacity. The algorithm is based on the variation of one of the parameters used in a simple method already proposed in literature. It is further attempted to validate the use of Matlab for such healthcare applications.

#### B5.2 P0202

##### Minimizing Bed-Overflow Conditions in Hospital Units

V S Subbhuraam, P W Khong  
Nanyang Technological University, SINGAPORE

The provision of adequate numbers of beds, whilst making efficient and effective use of the available beds, is of key concern for hospitals. Administrators have to allocate beds to all the hospital units such that demands are managed effectively. Simulation models for this purpose have become highly complex as health care problems have increased in sophistication and they also demand more time and money for efficient implementation. In this paper a simple but efficient optimization technique using Matlab has been proposed which takes into account the occupancy rate, overflows, the number of empty beds, patient gender and also the overall hospital performance to determine the capacity that is most suitable to minimize overflows and to cater to unpredicted demand.

#### B5.3 P0217

##### Patent Technology of Contemporary Biomedical Informatics

P W Khong, \*R M Ren  
Nanyang Technological University, SINGAPORE  
\*Shanghai Jiaotong University, CHINA

The aims of this biomedical informatics initiative are to design, implement and validate research direction for data migration and knowledge pooling between academic research and industrial application. We do not intend to interfere in the individual institutions data acquisition or information management systems. Instead we provide a scheme that allows researchers to not only access biomedical information available at different member databases, but integrate and mine these cumulative data.

## Session C1

### Others 1

#### Jupiter Room 1

1600 - 1730 6 December 2006 Wednesday

#### C1.1 P0119

##### "Catch and Release" Gas Exchange Mechanism in Human Tracheo-Bronchial Airways

S Mochizuki, \*J M Miao, \*\*W J Yang  
Tokyo University of Agriculture and Technology, JAPAN  
\*National Defense University, TAIWAN  
\*\*University of Michigan, UNITED STATES

Both experimental and CFD studies are performed to investigate gas exchange mechanism during the respiratory cycle in human lungs using triple bifurcation airways of Weibel model. The necessary and sufficient conditions to trigger the mechanism are identified.

#### C1.2 P0120

##### Comparison of Respiratory Flow and Gas Exchange Mechanism in Avian and Human Lungs

J M Miao, H C Chang, \*C K Huang, \*\*W J Yang  
National Defense University, TAIWAN  
\*University of Michigan, UNITED STATES  
\*\*University of Michigan, UNITED STATES

A bifurcation model of avian trachea consists of several right-angle branched tubes, as shown in Fig. 1, providing a unidirectional air flow in the counter-current direction with blood stream during the whole respiratory cycle. In contrast, the human dichotomy consists of a multiple of two conjugate airway branchings of Weibel model, as illustrated in Fig. 2. In this paper, a CFD method is employed to analyze and compare the difference in the respiratory flow and gas exchange mechanism between the two lungs

#### C1.3 P0132

##### Towards Optimized Data Structures for Real-Time Tissue Deformations by Mass-Spring Models

T Halic, S Kockara, C Bayrak, K Iqbal, \*R Rowe  
University of Arkansas at Little Rock, UNITED STATES  
\*UAMS, UNITED STATES

In the last two decades, computers have become indispensable in every part of the medical area. As the computation power increases, the capability and ability of computers continues to gain recognition as a powerful medical educational tool. Virtual Reality (VR) is an example of such recognition, which has emerged as one of the most cost-effective and efficient ways of implementing medical simulators. With the usage of VR technology, training medical students and residents becomes evidently easier than traditional methods of education. Nevertheless, in order to replace the traditional training with VR technology, medical simulators should have acceptable realism that allows surgeons to feel that they are truly in a surgery environment. One of the most challenging issues in the VR medical simulator is the deformation of computer generated tissue geometry in real-time. Therefore, the focus of this research is to provide an optimized data structures for tissue deformations using the mass-spring model.

#### C1.4 P0133

##### Mechanical Evaluation in the Interface between Face and Spectacles

H Kaneko, S Kakuknai, T Sakamoto, M Morita, J Nishimura  
University of Hyogo, JAPAN

For spectacles to be worn comfortably it is important to achieve good fitting between the frame and the face. This paper reports the results of mechanically modeling the contact conditions in the vicinity of the ear. We created a computer aided design (CAD) model that incorporated skin thickness distribution as determined by 3D measurements and computer tomography (CT) imaging. We then performed finite element method (FEM) analysis about the contact region between the spectacle frame and the skin. The well-adapted frame revealed that there was a large contact area between the spectacles and the skin at the tip of the spectacle frames. In particular, the skin above the ear was considerably indented. The pressure was constant from above the ear to the center of the temple tip of the frame but increased behind the temple tip.

## Session C2

### Cardiovascular System Engineering 2

Jupiter Room 2

1600 - 1730 6 December 2006 Wednesday

#### C2.1 P0127

##### Investigation on Coronary Artery Intimal Thickening and the Wall Shear Stress using CFD

K M Munisamy, M Z Yusoff, S Balachandran  
Universiti Tenaga Nasional, MALAYSIA

Abnormal blood flow in arteries leads to the risk of intimal thickening in the blood vessel lumen. In order to circulate blood flow throughout the human body, the viscous drag of the blood on the wall of the vessel (wall shear stress; WSS) is believed to play a role in this circulation. The precise relationship between WSS and intimal thickening remains unresolved puzzle. However, there is currently an increased amount of interest in producing vivo techniques that would permit a very accurate blood flow estimation and quantification of the WSS. Unfortunately, these techniques have not been fully developed as yet for the procurement of clinical use. Following a renewed interest in the research of haemodynamic flow, in this paper a 3D geometric model of coronary artery and coronary artery bifurcation of the aorta was created and the WSS is predicted with presence of two different type of intimal thickening. The mid stream velocity and WSS correlation shows the higher the midstream velocity the higher the WSS at the walls. The flow pattern is also presented for all the computational models. The sharp converging intimal thickening has a very poor down stream velocity and high WSS as compared to all the other cases.

#### C2.2 P0160

##### Numerical Study of Cardiac Output and Pressure Waveform in Carotid Artery

R Agarwal, \*V K Katiyar, P Pradhan  
Gurukul Kangari University, Haridwar, INDIA  
\*Indian Institute of Technology Roorkee, INDIA

Cerebral transient ischemic attacks and strokes are usually related to embolic occlusion of cerebral arteries, which originates from the heart. It causes due to the hemodynamic impact of cardiac function on the flow in the brain-supplying arteries, i.e., carotid arteries. The ischemic attacks and strokes can be minimized by increasing cardiac output and reducing the resistance which decreases the arterial pressure. The relationship between the cardiac output, flow rate, arterial pressure and flow velocity in terms of pressure waveform has also obtained. The obtained result was compared with the available experimental observations.

#### C2.3 P0223

##### The Gaussian Curvature Application as a Reflection of the Cardiac Wall Regional Geometry

E S Dzgmuhadze, S G Kolchanova, \*Y V Kremleva, \*A B Mironkov, A M Naidich, S Y Sokolov, F A Blyakhman  
Ural State University, RUSSIA  
\*Institute of Transplantology and Artificial Organs, RUSSIA

The goal of this study is to apply the regional Gaussian curvature (GC) distribution as a measure of the LV geometry complexity and an extent of the cardiac diseases severity. Eight post-infracted IHD patients and six dialyzed patients with glomerulonephritis in terminal renal failure (RF) were underwent the trans-esophageal ultrasound examination with subsequent LV 3-D reconstruction. To describe LV geometry complexity the variation coefficient of more than thousand regional GC (CvGC) was calculated. We found that IHD and RF patients had CvGC:  $288 \pm 41$  and  $214 \pm 33\%$  ( $p < 0.05$ ), EF:  $47.2 \pm 2.1$  and  $38.6 \pm 3.0\%$  ( $p < 0.05$ ), respectively. The correlation coefficient between CvGC and EF for IHD patients corresponded to  $-0.75$  ( $n=8$ ,  $p < 0.05$ ), and for RF patients:  $0.81$  ( $n=6$ ,  $p < 0.05$ ). We concluded that the regional GC distribution analysis contains useful information for estimation of the LV geometry peculiarities and severity of heart failure.

#### C2.4 P0182

##### Identification of Susceptible Sites for Atherosclerotic Lesion Formation in a Coronary Artery Bypass Model

J Zhang, L P Chua, \*D N Ghista, \*\*Y S Tan  
Nanyang Technological University, SINGAPORE  
\*University of New South Wales Asia, SINGAPORE  
\*\*National Heart Centre, SINGAPORE

Contrary to earlier studies mainly reported on subsections of the bypass, especially on the distal anastomosis, this study investigated the distributions of hemodynamic parameters in a complete anastomosis model (including both proximal and distal anastomoses) numerically under physiological flow condition. The results indicated the regions of high-OSI-and-low-WSS and low-OSI-and-high-WSS in the proximal and distal anastomoses, especially at the toe and heel regions of distal anastomosis, which were suspected to initiate the atherosclerotic lesion growth and were further worsened by increasing the low-density lipoprotein permeability as implied by high WSSG.

## Session C3

### Clinical Biomechanics 1

Jupiter Room 3

1600 - 1730 6 December 2006 Wednesday

#### C3.1 P0153

##### Computational Fluid Dynamics Study on Budd-Chiari Syndrome

M Matsubara, M Watanabe, S Watanabe, K Konishi, S Yamaguchi, M Hashizume  
Kyushu University, JAPAN

Budd-Chiari syndrome (BCS) is a disorder caused by blood clots that completely or partially block hepatic vein and/or inferior vena cava. The cause of Budd-Chiari syndrome is not well known yet, however: abnormal vessel wall shear stress caused by blood flow is thought to increase the likelihood of developing blood clots. We investigate the blood flow field in the vicinity of the confluence of hepatic vein with inferior vena cava by means of numerical simulation. First medical image analysis and segmentation are carried out to create image based modelling of targeted vessels of individual volunteers, and then blood flow field and wall shear stress on the modelled vessels are evaluated by computational fluid dynamics. We discuss the characteristics of the blood flow in the vicinity of the confluence of hepatic vein with inferior vena cava.

#### C3.2 P0189

##### Effects of Seat Surface Inclination on Postural Control during a Forward Reaching in Children with Cerebral Palsy

H C Lin, R J Cherng  
National Cheng Kung University, TAIWAN

Ten children with cerebral palsy (CP) (6 boys, 4 girls; age 7.8 $\pm$ 1.48 years) and sixteen normal children (8 boys and 8 girls; aged 8.85 $\pm$ 1.89 years) participated in the study to examine the effects of seat surface inclination on postural control during a forward reaching. During a trial, a child was seated and pressed a switch which was located at a 140% arm $\pm$  length distance. Seven seat surfaces: flat, and three degrees (5 $^\circ$ , 10 $^\circ$  and 15 $^\circ$ ) of inclination in two directions were randomly assigned. Center of pressure (COP) variables derived from ground reaction force, EMG data of lower extremities, reaction time and movement time were measured and used as dependent variables. The results showed the children with CP presented less postural stability than nondisabled children in all test conditions. However, in anterior inclined seat surface, children with CP showed more increased weight bearing of lower extremities and better postural stability (more straight forward movement of COP and less medial-lateral movement of COP) than normal children during reaching. The anterior inclined seat surface allow children with CP to increase the contribution of the lower extremities for support, thus improving postural stability during a forward reaching.

#### C3.3 P0208

##### Analysis of Text Messaging (SMS) on Mobile Phone

F R Ong  
Singapore Polytechnic, SINGAPORE

The objective of the study was to determine the forces and motion related to text messaging on a mobile phone. Preliminary test indicated that extreme keys of '1' and '#' accounted for the highest peak force incidence. Together with keys '3' and '\*', they accounted for 60% of the peak force incidence. The angular displacements of thumb segments have not been established yet.

### **C3.4 P0211**

#### **Analysis of Viscoelasticity of Human Skin for Prevention of Pressure Ulcers**

Y Akiyama, Y Yamamoto, Y Doi, S I Takeda, Y Izumi, \*H Kimura, S Nishijima

Osaka University, JAPAN

\*Osaka Prefecture, JAPAN

Change in viscoelasticity of human skin with aging was evaluated by measurement of deformation under suction and resonance frequency change under probe indentation. In order to clarify the region in depth which can be measured by each technique, strain distribution was calculated by the finite element method (FEM) for each technique. As a result, epidermis was mainly deformed by the skin suction method, and dermis and subcutaneous tissue was mainly deformed by measurement of resonance frequency change. To examine whether it is possible to evaluate the viscoelasticity of epidermis and dermis individually, the skin models made of the silicone rubber with different elastic modulus for epidermis and dermis were prepared, and were measured by two methods. Viscoelasticity at the region in depth from surface to several hundred micrometers of the material was obtained by skin suction method and that at the region from several millimetres to several centimetres was obtained by the resonance frequency change. Based on these results, change in human skin properties with aging was studied. The tendency was shown that the elastic modulus of epidermis was increased, and that of dermis and subcutaneous tissue decreased with aging. From these results, damage of epidermis caused by the difference of elastic modulus between epidermis and dermis can be one of causes of pressure ulcers.

## Session C4

### Computational Biology and Bioinformatics 1

Venus Room 1

1600 - 1730 6 December 2006 Wednesday

#### C4.1 P0102

##### Temperature Distributions of Hepatic Cancer Tissue in Temperature-Controlled Microwave Ablation Mode

M Chaichanyut, P Lertpasert, P Phonphruksa, S Tungjitkusolmun  
King Mongkut's Institute of Technology Ladkrabang, THAILAND

This paper presents three-dimensional finite element analyses of microwave hepatic tumor ablation. We studied the characteristics of various monopole antennas for microwave ablations by analyzing the temperature distributions at frequency of 2.45 GHz. Three configurations of monopole antennas were considered: open-tip, dielectric-tip and metal-tip antennas. The ablation duration used in all cases was 300s, and the controlled temperature was 90 °C. From our simulation results, the temperature distributions of open-tip, dielectric-tip and metal-tip had similar characteristics although their dimensions were different. The Open-tip antenna had the widest temperature distribution (28 mm.) while the temperature distributions for metaltip antenna and the dielectric-tip antenna were second and third widest, respectively (27 mm and 22.5 mm). In addition, we considered the region where temperature exceeds 50 °C, the threshold for successful hepatic ablation or irreversible tissue damage. Thus, the metal-tip monopole antenna can be maximum ablation cancer tissue (11.74 cm<sup>3</sup>). The dielectric-tip antennas can minimum ablation cancer tissue (7.57cm<sup>3</sup>).

#### C4.2 P0103

##### Hepatic Microwave Ablation with Metal-Tip Monopole Antenna: Effects of Changes Power Source on Lesion Size

M Chaichanyut, P Lertpasert, A Naktawan, S Tungjitkusolmun  
King Mongkut's Institute of Technology Ladkrabang, THAILAND

This paper presents three-dimensional finite element analyses of microwave hepatic tumor ablation. We studied the effect of change power source for metal-tip monopole antennas to ablation on tissue heating (temperature distribution) and lesion size in temperature-controlled mode by analyzing at frequency of 2.45 GHz. The controlled temperature used in all cases was 95°C. We set the potential difference between the inner and outer conductors in the range of 50 V, 60V, 70V, 80V and 100V. Our numerical analyzes showed that during temperature-controlled ablation at 90°C. The temperature distributions had similar characteristics although their dimensions were different when we set the potential was 50 V the lesion size was larger, with a lesion width of approximately 30 mm, compared to 12 mm for set the potential was 100 V. For lesion volumes, if we considered the region where temperature exceeds 50 °C, the threshold for successful hepatic ablation or irreversible tissue damage when we set the potential was 50 V the lesion volume was widest (33 cm<sup>3</sup>) while if we set the potential was 100 V the lesion volume was 1.63 cm<sup>3</sup>.

#### C4.3 P0122

##### Thermal Transport Phenomenon in Processed Meat Heated by Laser Heat Source

S Torii, \*W J Yang  
Kumamoto University, JAPAN  
\*University of Michigan, UNITED STATES

The present study deals with the effect of laser radiation on the propagation phenomenon of a thermal wave in processed meat subjected to a symmetrical heating on both sides. Laser heating is modelled as an internal heat source with various time characteristics. The Cattaneo heat flux law together with the energy conservation equation is solved by a numerical technique based on explicit scheme, i.e., MacCormack's predictor-corrector scheme. The study concludes (1) if the absorption coefficient of the continuously-operated-laser heat source increases, temperature overshoot causes in processed meat within a very short period of time, and (2) the overshoot and oscillation of thermal wave depend on the frequency of the heat source time characteristics.



#### **C4.4 P0135**

##### **Solute Transport in Cartilage: Effects of Cyclic Deformation and ECM Binding**

L Zhang, B S Gardiner, D W Smith, P Pivonka  
The University of Melbourne, AUSTRALIA

Solute transport through articular cartilage under cyclic loading has recently been modelled mathematically using porous media and transport theories to investigate the role of advection that potentially enhance solute transport through cartilage. The objective of this study is to develop a mathematical model describing the effects of cyclic deformation and ECM binding on solute transport through cartilage. The mechanical and transport theories for porous media are used to model the articular cartilage as a deformable multi-phase mixture. It is assumed that the total solute concentration is comprised of unbound solute in the cartilage fluid phase and solute bound to the solid phase (ECM). The solute in solution can be transported in the interstitial fluid by diffusion and advection or it may bound onto ECM (i.e. to binding proteins). It is shown that at low initial solute bath concentration, ignoring binding effects leads to a significant underestimation of the steady-state solute concentration within the cartilage tissue; however, the influence of binding becomes negligible at high bath concentrations due to the finite number of binding sites. A transient analysis revealed that dynamic compression generally increases both unbound and bound solute concentration in the cartilage, in comparison to free diffusion.

## Session C5

### Healthcare Management Information Systems 2

Venus Room 3

1600 - 1730 6 December 2006 Wednesday

#### C5.1 P0144

##### Discovering the Relationship between Learning Behaviour and Satisfaction for CKD Health Education

H C Wang, \*Y H Chiu, J J Lee, Y J Jang

Chang Jung University, TAIWAN

\*Industrial Technology Research Institute, TAIWAN

This paper proposes an interactive CKD multimedia health education system with statistical analysis of the automatically logged learning sequence. The purpose is to discover the relationship between learning behaviour and satisfaction, and suggest important factors for system improvement. The health education content comes from several official websites and hospitals. The interactive education platform integrates multimedia materials such as text, images, photos and speech, making the proposed system more user-friendly. The experiment was carried out by 54 users. They are invited to browse the health education content and fill the questionnaire of their satisfaction about the system. Their characteristics of browsing behaviour are analyzed to discover whether there are relationship between browsing behaviour and satisfaction. The experimental results show that the satisfaction is highly related to the average-staying-time of web pages. The discovered relationship suggests that we can predicate the satisfaction through the analysis of user's behaviour in stead of conducting the time-consuming questionnaire.

#### C5.2 P0235

##### Gastric Cancer Knowledge Management System

A E H Png, L W M Tham, K W Choo, \*A K H Eng, \*\*O L Kon, \*\*W K Wong

Nanyang Polytechnic, SINGAPORE

\*Singapore General Hospital, SINGAPORE

\*\*National Cancer Centre Singapore, SINGAPORE

Gastric cancer is one of the leading causes of cancer-related deaths both locally and internationally. Prognosis for most gastric cancer patients is poor and survival rates are low when compared with other common cancers. The Gastric Cancer Knowledge Management System (GCKMS) was developed to aggregate both clinical and experimental data, which until today, are scattered in a heterogeneous database environment. The system currently contains information on both retrospective and prospective patients. With the accumulation of clinical and experimental data in a central repository, data mining and statistical tools can then be used to explore and extract valuable knowledge of the disease.

#### C5.3 P0237

##### Prediction of Risk for Cardiovascular Heart Disease Development

S C Fok, \*L P Khoo

Petroleum Institute, UNITED ARAB EMIRATES

\*Nanyang Technological University, SINGAPORE

The paper discusses the prediction of risk for coronary heart disease development. A framework is proposed for the conduct of mass routine screening exercises to assist the doctors in identifying high risk subjects. The considerations of the prediction techniques and preliminary investigations indicated the potential of neural networks for the risk prediction of coronary heart disease. The implementation of this framework constitutes initial efforts in the development of a digital clinical atherosclerosis tool to assist in the prevention of cardiovascular heart disease.

#### C5.4 P0309

##### Development of a Wearable System for an Quantification Measurement of Human Motions in Daily Life

M Kishimoto, H Nakamura, T Yoshida, \*F Mizuno, T Hayasaka, Y Imai, K I Tsubota, et al

Tohoku University, JAPAN

\*Nagoya Institute of Technology, JAPAN

To solve an aging problem in the society, it is important that the aged people are encouraged to be independent and spend healthy life. Therefore, we developed a system to acquire data set of human physical activity to recognize a health condition. To measure the active mass of a muscle using integrated EMG of lower limbs in everyday life, we developed a wearable electromyograph measuring system.

**Session D1**

**Others 2**

**Jupiter Room 1**

**1100 - 1220 7 December 2006 Thursday**

**D1.1 P0155**

**Analysis of Bronze Medal Archer's Aiming Style based on Aiming Time and Arrow Speed**

C K Hwang, \*K B Lin, Y H Lin  
Chung Hua University, TAIWAN  
\*Yuanpei University of Science and Technology, TAIWAN

In order to improve the archery performance, we study the stability of archery aiming procedure. The valuable analyzed results can be feedback to archers and their coaches as key points to work on. Especially, for elite archers, owing to their consistent archery stability, their aiming data are very suitable for archery researchers to establish a standard reference. Therefore, the female archer of the bronze medal winner of 2004 Olympic Athens was invited to participate in this research. After checking her experimental data, two special characteristics can be observed that her aiming time is shorter and her arrow speed is slower as compared with the other attendances. Both of distinct parameters apparently become the focus to determine the relations among them and her performance. We also develop a sorting method based on them to further discover valuable results. Particularly, her arrow speed plays a significant role in her performance, so she and her coaches can concentrate on it. The major suggestion after analysis is that her performance can be improved by increasing the arrow speed. There are also some important results that can be utilized as standard criteria for other archers to follow.

**D1.2 P0156**

**Relationship between Arrow Speed and Shot Points based on a Radial Deviation Sorting Method**

K B Lin, \*Y H Lin, \*C K Hwang  
Yuanpei University of Science and Technology, TAIWAN  
\*Chung Hua University, TAIWAN

How the releasing arrow speed affects the archery performance is the main target of the study. Archery stability is established from measurements including the arrow speed and the deviations on the target along the vertical, the horizontal and the radial directions. A sorting criterion based on the radial deviation is then applied to classify the experimental data into three data groups. A simple correlation analysis using the measurements as its variables is employed to the classified data groups. For an elite archer, the aiming point should be very consistent, so a large and positive correlation between arrow speed and the vertical deviation can be expected because of the gravity effect acting on the vertical deflection. Therefore, the positive significance of these correlations can be used as an important guideline to evaluate the aiming consistency. Moreover, monotonic trend of correlations can also be utilized to check the aiming consistency and releasing stability. The statistics of these measurements is also incorporated to enhance the aiming style analysis.

**D1.3 P0301**

**Micro-Biomechanics of Ceramic Veneer at Adhesive Interface using Finite Element Sub-Modeling Technology**

H L Liu, C L Lin, M T Sun, \*Y H Chang, C H Kuo  
Chang Gung University, TAIWAN  
\*Chang Gung Memorial Hospital, TAIWAN

Adhesive complex ceramic/cement/tooth is one of the weakest sites for dental veneer restoration. Although several biomechanical studies were investigated to understand the adhesive interface of bonded veneer, the biomechanical responses of micro-structure near cement layers were still unknown. Therefore, the finite element sub-modeling technology was applied in this study to examine the micro-region stress distribution near the adhesive interface with various cement thicknesses under occlusion. Both two-dimensional finite element full and sub-model models with window type restorative system were made. Boundary conditions were applied to finite element sub-model based on the results from finite element full model. The results of the calculation from finite element full models with various cement thickness showed that higher stresses mainly occurred near cement layer of incisal area. The ceramic veneer with 100µm cement thickness demonstrated significantly higher levels of von Mises stress than that 25µm. Stress concentrations were also found at the etched porosities of the enamel from results of finite element sub-model. Thinner cement layer is recommended for ceramic veneer preparations. The etched porosities could be act as sources of crack initiation.

**D1.4 P0396****A Simple Model of Nutrition of Cell Systems by Substances Dispersed in Slowly Flowing Lymph**

M R Slawomirski, Z Czempinska-Switalska  
Polish Academy of Sciences, POLAND

Many substances used as substrates of cell metabolism are transferred to cell systems by slowly flowing lymph. Opposite to the blood the lymph does not possess a 'dedicated' circulatory system. The lymph transfer is realised as a slow seepage through successive collections of cells. From the hydrodynamic point of view the lymph movement is similar to the flows of fluids through porous media. The lymph is not a homogeneous fluid. Many organic substances dispersed in the lymph and transferred by it in the advection mode are involved in cell metabolism. The transfer of active substances dispersed in the lymph to the cell cytoplasm across the cell membrane is implied by the difference of concentration.

## Session D2

### Cardiovascular System Engineering 3

Jupiter Room 2

1100 - 1140 7 December 2006 Thursday

#### D2.1 P0227

##### **Effect of Anastomosis Geometry on Hemodynamic Performance of CABG: A Particle Image Velocimetry Study**

L P Chua, W Ji, \*D N Ghista, \*\*Y S Tan

Nanyang Technological University, SINGAPORE

\*University of New South Wales Asia, SINGAPORE

\*\*National Heart Centre, SINGAPORE

Geometrical improvement for the distal anastomosis was carried out in order to minimize the hemodynamics nonuniformity of the bypass grafting. An improved model was designed and fabricated from a baseline model with geometrical improvements of larger diameter ratio, increased anastomotic area and smooth junction curvatures (increased hood length). Significant flow field improvements were evident due to measurable reductions in WSSG magnitude in the improved model which would be resulted in enhancing the long-term hemodynamic performance and patency of coronary bypass graft.

#### D2.2 P0322

##### **Numerical Study of Bio-Centrifugal Blood Pump with Different Impellers**

G Song, L P Chua, T M Lim, T Zhou

Nanyang Technological University, SINGAPORE

Computational fluid dynamic simulations of the Kyoto-NTN magnetically suspended centrifugal blood pump with different impeller configurations were performed in this study. Numerical solution of the flow field in the pump as well as the shear stress distributions of the blood were presented. The results showed that reverse flow and vortices prevailed in the straight blade impeller channels. Flow in the backward-bending blade channels was smoother. Based on the results of simulation, comparison of the scaled shear stresses of the flow fields were also presented.

## Session D3

### Clinical Biomechanics 2

Jupiter Room 3

1100 - 1220 7 December 2006 Thursday

#### D3.1 P0225

##### Simulation of Stress Distribution for Prevention of Bedsores

Y Yamamoto, Y Akiyama, Y Doi, S I Takeda, Y Izumi, \*H Kimura, S Nishijima

Osaka University, JAPAN

\*Osaka Prefecture, JAPAN

Bedsore is formed at bony prominence part where the pressure is easily concentrated. To clarify the formation mechanism of bedsore, the mechanical simulation was performed by finite element method (FEM) analysis. The internal stress distribution and the tissue deformation were calculated by zooming analysis of FEM models. Then, the site in the tissue of gluteal region where the capillary vessels would be relatively easy to occlude was verified. To evaluate effects of a mattress, two patterns of the analysis condition were applied in this simulation; lying spine on hard floor, or lying spine on a soft mattress that disperses stresses. From the results of analysis, capillaries near the edge of the bone prominence were relatively easy to occlude. This showed that it is possible that bedsores are generated at the deep layers near the bony prominences and progress towards the surface. In addition, it was also shown the internal stresses were reduced by the stress dispersion effect of a mattress, so occlusion of capillaries was avoided. Based on these simulations, it will be able to clearly the mechanism of formation and progress of bedsores, which will be useful for designing of the mattresses for effective prevention of bedsores.

#### D3.2 P0337

##### Influence of Lower Limb Flexibility on Foot Progression Angle

R S Parihar, P Dhakshinamoorthy, \*J Sharma

Garhwal University, INDIA

\*Biomedical Sciences and Research, Dehradun, INDIA

Medical and ergonomic field studies indicate that bad standing and sitting posture are sometimes accompanied with pain in muscle and connective tissue of tendons joint capsules and ligaments. There is evidence that such pains can become the symptoms of chronic diseases. Research revealed that inappropriate standing & sitting postures provoke excessive increase in muscle load. Bad posture is associated with lack of connective tissue flexibility. In addition to anatomical variations in the foot itself, rotational abnormalities of the lower limb play a major role in the appearance of gait. AIM To find out the co-relation between foot progression angle and various other lower limb rotational profiles. and To analyze the relation between foot progression angle, physiological transverse plane lower limb rotation and lower limb dysfunction (lack of flexibility).Hypothesis- Is their any relation existing between foot progression angle and flexibility? METHOD- Normal (physically & medically fit) boys sample between 19 ?23 years of age were taken as subjects. FPA more than 7\*.Having no history of fracture in lower limb. This was random sampling design in which out of 400 students studying in Department of Physiotherapy, Sardar Bhagwan Singh Post Graduate Institute of Biomedical Science & Research, Balawala, 30 subjects were chosen based on inclusion and exclusion criteria.

#### D3.3 P0338

##### Comparison of Kinematic Analysis of Foot, Skin Proprioception & Nerve Conduction between Normal & Flat Foot Indians

P Dhakshinamoorthy, R S Parihar, A Rajini, K Rasana, R Basker, \*S Singh, . Pragya, et al

Garhwal University, INDIA

\*Biomedical Sciences and Research, Dehradun, INDIA

Foot acts as an interface between ground and human body as its function is to transfer body weight to the ground equally. Due to alignment modification its function will be affected and because of that there will be changes in the nerves and the skin. Purpose of the study was to compare the effect of normal foot and flat foot in kinematic analysis, nerve conduction velocity & skin proprioception. METHOD- 50 female subjects of mean age of  $21.25 \pm 1.25$  have been included and among them 25 were normal foot and 25 were flat foot subjects. For all of them kinematic analysis of foot have been done by making them to walk on tread mill for 6 minutes at a speed of 4 - 5 kms / hr with the markers on bony landmarks on medial, lateral & posterior side. Then skin proprioception has been represented as vibratory threshold by perception and disappearance in the sole of the foot (head of 1st & 5th metatarsal, heel). Then sensory nerve conduction velocity has been measured for medial & lateral plantar nerves and also for the tibial nerve. DATA ANALYSIS -Independent T Test has been performed to compare the variables between two groups.

#### **D3.4 P0367**

##### **Modeling and Simulation of Blood Vessel Twisting during Skin Flap Surgery**

F Cui, Z Liu, \*C Wong, \*\*H P Lee, C Lu, \*B K Tan

Institute of High Performance Computing, SINGAPORE

\*Singapore General Hospital, SINGAPORE

\*\*National University of Singapore, SINGAPORE

Finite element models are built to simulate the blood vessel collapsing of patients undergoing skin flaps in reconstructive plastic surgery. The aim of the work is to understand the biomechanical behavior of two vessels twisting with each other and provide guideline for such a clinical surgery. In the finite element models, the material models chosen for modeling the artery and the vein are both hyperelastic. Also, the boundary conditions of FE models that play an important role for the final results are discussed in an attempt both for representing the actual conditions and reasonable simulations. The constructed finite element models consist of three different diameters from 1mm, 2 mm to 3 mm with three different length. of 20 mm, 30 mm to 40 mm. The vessels are twisted from 45 degrees to 360 degrees. Internal pressures are introduced to vessels to simulate the blood pressure. The simulated results of vessels are compared and the effect of diameters, lengths, as well as twisting angles of vessels are highlighted.

## Session D4

### Computational Biology and Bioinformatics 2

Venus Room 1

1100 - 1200 7 December 2006 Thursday

#### D4.1 P0159

##### Simplified Discrete Fourier Transform (s-DFT) for Identification of Differentially Expressed Genes

K W Choo, W Kong

Nanyang Polytechnic, SINGAPORE

We proposed a method of identifying differentially expressed genes for a pair of T-N conditions. The expression values from condition T and N are arranged such that they are alternatively interposed. A Discrete Fourier Transform (DFT) is applied to the arranged expression values. From the transform, we found that the expression of differentially expressed gene produces higher amplitude at the Nyquist Frequency than other harmonics, and its phase allows us to distinguish over and under expressed genes. We further simplified the DFT and tested the approach on two sets of GeneChip array datasets, the prostate cancer dataset and the macular de-generation dataset. The prediction results are comparable to those published. We conclude that the proposed DFT method can efficiently identify differentially expressed genes from multiple sets gene expression data.

#### D4.2 P0161

##### Identification of Core and Distinct Pathway Networks from Expression Profiles

K W Choo

Nanyang Polytechnic, SINGAPORE

Genomic and proteomics technologies have made feasible large-scale experiments that measure activities and interactions of many genes and proteins in living organism. Many research groups have been annotating these activities in the form of pathways and store them in database. Electronic versions of these databases, together with querying and analysis tools are made available. In this work, we developed new approaches based on graph algorithm – Dijkstra's algorithm. With some modifications to the algorithm, we identify a group of interconnected pathways – pathway network, affected by a list of genes or proteins. A source pathway, defined as a pathway when perturbed would affect maximum number of pathways within its pathway network, is also identified. In addition, it allows comparison of two or more pathway networks in order to identify core/common and distinct pathways between them. To demonstrate its usefulness, we applied the method onto published colon and prostate cancer datasets and present the results in this paper.

#### D4.3 P0172

##### Hierarchical Model Describing Bone Cell Dynamics: Application to Bone Remodeling

P Pivonka, D W Smith, B S Gardiner, \*C Dunstan

The University of Melbourne, AUSTRALIA

\*ANZAC Research Institute, Sydney, AUSTRALIA

Building on previous research, we propose a hierarchical model of bone cell population dynamics based on two different time scales. A short time scale (i.e. hours) is required in order to capture intermittent administration of drugs such as parathyroid hormone (PTH). On the other hand, capturing effects of such drugs on bone remodeling units (BMUs) needs incorporation of a longer time scale (i.e. months). The short time scale is modeled by means of a (two state) receptor model previously proposed by Potter et al. (2005), whereas the interactions of bone cells are modeled by means of a cell population dynamics model based on the work of Lemaire et al. (2004). Receptor occupancy and mean value of drug obtained from the receptor model become input values for the cell population dynamics model. A key advantage of modeling is that it is integrative. This model allows quantitative investigations of various aspects in bone remodeling such as effectiveness of current bone therapies and verification of hypotheses.



## Session D5

### Rehabilitation Engineering 1

Venus Room 3

1100 - 1220 7 December 2006 Thursday

#### D5.1 P0354

##### Design of Closed-loop Differential Speed Controller for Powered Wheelchairs

C L Fu, \*Y J S H E R Sher, \*\*K C Chung

Chi Mei Hospital, TAIWAN

\*Shu Zen College of Medicine and Management, TAIWAN

\*\*National Cheng Kung University, TAIWAN

Most controller designs for the powered wheelchair (PWC) are lack of considerations in W/C structure, kinematics/kinetics, dynamics drive, and motor characteristics. The mismatching of components has led to poor efficiency and instability. This project is to systemically design a digital closed-loop differential speed controller for PWCs. The design consists of a DSP microprocessor, low pass filter, Hall sensor to detect current for velocity feedback, motor driver circuit, PID control, joystick speed control, and control algorithms. The testing results of the prototype show that: (1) a max. difference between the analytic differential speed of two motors and the measured speed has less than 1 km/hr in all directional turnings and this indicates the different speed control is stable; (2) torque is positively linear to PMDC motor current under different voltage inputs; (3) torque is negatively linear to motor speed and the relationships are parallel for different voltage inputs; (4) the performance of PMDC motor achieves optimal driving efficiency with the average PWM voltage of 23 V at 20 kHz frequency with current between 7.5 A to 12 A. The PMDC motor testing provides fundamental and valuable information to develop more cost-effective controller for improved PWCs.

#### D5.2 P0355

##### A 3-D Vibration Platform Design to Investigate the Effects on Muscle Tone and Coordination for the Cerebral Palsied

R L Hsiao, Y J S H E R Sher, \*K C Chung

Shu Zen College of Medicine and Management, TAIWAN

\*National Cheng Kung University, TAIWAN

The cerebral palsied (CP) have multiple disabilities, particularly motor problems from abnormal muscle tone and reflex. Hippotherapy, using equine movement producing a corresponding movement in the pelvis of the subject sitting astride the horse that closely resembles pelvic movement during human ambulation, has been shown to improve posture, balance, mobility and function. This research is to develop a vibration platform with adjustable frequencies and amplitudes in the orthogonal coordinate directions to provide quantitative 3-D controlled motion stimulation for therapeutic intervention. A pendulum test system is set up to evaluate the effects of treatment on muscle tone for the CP. The vibration design consists of X and Z axis vibration systems, GUI signal transmitting interface. X and Z vibration systems are designed by the same component to provide quasi-sine wave vibration with adjustable amplitude and frequency. The Y axis vibration is through 90-degree rotation from the X axis. An ADLINK 8164 motion card and ADLINK 9112 A/D signal acquisition card are interfaced to an industrial PC. The GUI interface is written in C++ Language for frequencies, amplitudes, and time length input. The vibration platform provides controllable vibration stimulation to systematically investigate therapeutic effects of vibration stimulation on the CP.

#### D5.3 P0356

##### Design of Robot-Aided System for Assessment and Therapy of Arm Movement

J Y Chang, Z F Liu, \*M S Tsai, G L Chang, K C Chung

National Cheng Kung University, TAIWAN

\*Potz General Hospital, TAIWAN

Stroke is a leading cause of physical disabilities worldwide. The upper limb function is important for many activities of daily living; however, rehabilitation of the impaired upper limb is more challenging than the lower limb. The post-stroke management is labor-intensive and limited to subjective assessment. This research is aimed to design a robot-aided assessment and training system with feedback control for the upper limb on the hemiplegic. The system consists of a five-bar-link parallel drive manipulator, servo motors, clutches, encoders, torque sensors, a six-axes load cell, an industrial PC. The GUI controlling panel, kinematic, kinetic and dynamic algorithms are programmed in Borland C++ Builder 5.0. The components and system performance including end-effector path and velocity are calibrated. The encoded tasks are to (1) allow the hemiplegic subjects to conduct passive and active planer arm movements under varying constant velocities; (2) provide augmented perturbation with constant and variation forces for training; (3) assess biomechanical properties of the upper limb endpoint. Visual feedback is given while executing the task. Endpoint kinematics and kinetics as well as EMG are measured. Further motor control investigation for improved understanding of fundamental biomechanics and neuroscience in the motor control of upper extremity can be facilitated by the robot-aided system.

#### **D5.4 P0358**

##### **Effect of Combined Knee Brace and Lateral Wedge Shoes in Management of Subjects with Osteoarthritic Knee**

F L Kuo, \*S W Yang, \*\*L F Hsieh

Taipei Medical University-Wan Fang Hospital, TAIWAN

\*National Yang-Ming University, TAIWAN

\*\*Shin Kong Wu Ho-Su Memorial Hospital, TAIWAN

The people having knee osteoarthritis (OA) usually present stiff knee symposium and pain, it is mainly due to excessive varus torque on the knee joint. Knee brace or lateral heel wedge insole is used for management the medial knee compartment pain and to assist the mobility. The goal of this study is to investigate the effect of the wedge insole and Aligner knee brace using questionnaires, kinetic and kinematic analysis. The results showed pain and functional ability improved; the knee varus moment decreased significantly when walking. The lateral wedge insole shoes can effectively reduce pain and knee varus moment for OA grade 2 and under. With the knee brace added on, the combined mobility aids significantly reduced the knee varus moment, pain, and improved the gait pattern, especial for severe subjects.

## Session E1

### Cardiac Biomechanics

Jupiter Room 1

1350 - 1450 7 December 2006 Thursday

#### E1.1 P0361

##### Robotic Compensation of Biological Motion for Surgery

C N Riviere, N A Patronik, D Y Choi  
Carnegie Mellon University, UNITED STATES

Robotic and mechatronic technologies are increasingly being applied for compensation of biological motion in order to enhance accuracy of manipulation during surgery. This paper describes recent progress in two ongoing research efforts, dealing with vitreoretinal and cardiac surgery.

#### E1.2 P0272

##### Left Ventricular Systolic Performance and Function in Patients with Thalassaemia Major Related to Myocardial Iron Overload

L Zhong, R S Tan, \*T T Le, S Y Yeo, \*\*D N Ghista  
National Heart Center, SINGAPORE  
\*Nanyang Technological University, SINGAPORE  
\*\*University of New South Wales Asia, SINGAPORE

Objectives: To determine whether and to what extent myocardial iron overload occur in association with abnormalities in left ventricular (LV) systolic performance, function and contractility in thalassaemia major patients. Methods and Results: The systolic properties of the LV were examined in 39 patients with thalassaemia major. LV systolic properties were determined with magnetic resonance image (MRI) and two-dimensional and M-mode echocardiography. The patients were stratified into two groups based on the heart T2\* value (group A: heart T2\* < 20 ms with myocardial iron overload; group B: heart T2\* > 20 ms without heart iron overload) LV volumes and shapes, mass index, mass/volume ratio, stroke work (an index of LV systolic performance), preload recruitable stroke work, ejection fraction, fraction shortening and circumferential fiber shortening velocity (indices of LV systolic function) and end-systolic elastance (ratio of end-systolic pressure and volume) (index of LV contractility) were examined. The stroke work was 0.74 +/- 0.14 Nm in group A versus 0.72 +/- 0.20 Nm in group B (P=0.73). Preload recruitable stroke work was 0.66 +/- 0.12 N/cm<sup>2</sup> in group A versus 0.64 +/- 0.054 N/cm<sup>2</sup> in group B (P=0.48). The fraction shortening was 0.36 +/- 0.062 in group A versus 0.34 +/- 0.07 in group B (P=0.42). The mean velocity of circumferential fiber shortening was 0.98 +/- 0.17 in group A versus 1.00 +/- 0.26 in group B (P=0.79).

#### E1.3 P0383

##### Botanical Study Some on Some Ethnic Medicinal Plants for Hypertency Treatment in Komerling Peoples

H Marisa  
Sriwijaya University, INDONESIA

Survey and literature study was done to know some ethnic medicinal plants at Komerling sub tribe community as the traditional plant use for hypertension of blood, and found for a while four main plants; *Apium graveolens* L, *Averrhoa bilimbi* L, *Physalis angulata* L, and *Persea Americana* Mill.. Plants leaves extracted by cooking with water and be drunk frequently. *Lansium domesticum* tree-bark and *Carica papaya* seedling also reported. All those plants were not documented in 'Tumbuhan Obat' book that published by LIPI (1978).

## Session E2

### Application of 1D and 2D Signal Processing for Bio-signals 1

Jupiter Room 2

1350 - 1510 7 December 2006 Thursday

#### E2.1 P0384

##### Frequency Domain Analysis of Plantar Pressure Distribution in Obese and Non-Obese Subjects

R Acharya U, E Teh, F T Lum, P H Tan, E Goh, C M Lim, K C Chua, \*J Suri

Ngee Ann polytechnic, SINGAPORE

\*Idaho State Biomedical Research Institute, UNITED STATES

The purpose of this study was to examine the pressure distribution under the feet in obese and non-obese subjects. The subjects were classified into four categories, each containing 20 study participants, as under weight, normal, over weight and obese subjects according to their Body Mass Index (BMI) values. Footscans were obtained using the F-scan (Tekscan USA) in-shoe pressure measurement system. Various pedobarographic parameters such as the total plantar force, total contact area, peak pressures and power ratio (PR, the ratio of high frequency power to the total power in an image) were evaluated. These parameters were subjected to ANOVA (Analysis of Variance) test with more than 95% confidence interval giving excellent 'p' values in all the categories.

#### E2.2 P0385

##### Non-Linear Analysis of Eeg Signals at Various Sleep Stages

R Acharya U, N Kannathal, \*O Faust, C M Lim, K C Chua, \*J Suri

Ngee Ann polytechnic, SINGAPORE

\*Idaho State Biomedical Research Institute, SINGAPORE

Electroencephalogram (EEG) is a reliable reflection of the many physiological factors modulating the brain. It shows that the structure generating the signal is not simply linear, but also involves nonlinear contributions. These signals are essentially non-stationary and vary with the state of the mind. Application of chaotic analysis methods to the physiological sciences demonstrated that non-linear models are useful for understanding complex physiological phenomena such as abrupt transitions and chaotic behavior. Sleep stages and sustained fluctuations of autonomic functions such as temperature, blood pressure, electroencephalogram (EEG) etc. can be described as a chaotic process. The EEG signals are highly subjective and the information about the various states may appear at random in the time scale. Therefore, EEG signal parameters, extracted and analyzed using computers, are highly useful in diagnostics. The sleep data analysis is carried out using nonlinear parameters: correlation dimension, fractal dimension, approximate entropy, Hurst exponent and phase space plots. These nonlinear parameters quantify the cortical function at different sleep stages and the results are tabulated below.

#### E2.3 P0386

##### Identification of Different Stages of Diabetic Retinopathy Using Retinal Optical Images

L Y Wong, \*R Acharya U, Y V Venkatesh, \*\*C Chee, \*C M Lim, \*K C Chua

National University of Singapore, SINGAPORE

\*Ngee Ann polytechnic, SINGAPORE

\*\*National University Hospital, SINGAPORE

Diabetes is a disease that occurs when the pancreas does not secrete enough insulin or the body is unable to process it properly. Over time, diabetes affects the circulatory system of the retina. As diabetes progresses in a patient, his vision may start to be affected, causing diabetic retinopathy. Our study uses, 124 subjects consisting of four different kinds of retinal conditions. The various classes are normal retina, moderate diabetic retinopathy, severe diabetic retinopathy and prolific diabetic retinopathy. This work presents classification of four eye diseases using neural network. The features are extracted from the raw images using the image processing techniques and fed to the feedforward neural network classifier for classification. We demonstrate a sensitivity of more than 90% and specificity of 100% for the classifier. Our system is ready clinically to run on large amount of data sets.

## **E2.4 P0387**

### **Higher Order Spectra Analysis for Heart Rate Variability**

K C Chua, \*V Chandran, R Acharya U, C M Lim

Ngee Ann polytechnic, SINGAPORE

\*Queensland University of Technology, AUSTRALIA

Heart rate variability (HRV) refers to the regulation of the sinoatrial node, the natural pacemaker of the heart by the sympathetic and parasympathetic branches of the autonomic nervous system. Heart rate variability analysis is an important tool to observe the heart's ability to respond to normal regulatory impulses that affect its rhythm. A computer-based intelligent system for analysis of cardiac states is very useful in diagnostics and disease management. Like many bio-signals, HRV signals are non-linear in nature. Higher order spectral analysis (HOS) is known to be a good tool for the analysis of non-linear systems and provides good noise immunity. In this paper we propose different bicoherence patterns and bispectrum parameters for detecting various cardiac arrhythmia.

## Session E3

### Microfluidics and Nanotechnology

Jupiter Room 3

1350 - 1410 7 December 2006 Thursday

#### E3.1 P0330

##### Measurements of Microbubbles in Different Diamond-Shaped Cylinder Bundles

S Umeda, \*W J Yang

Fukuyama University, JAPAN

\*University of Michigan, UNITED STATES

A series of experimental studies have been performed by the authors and their associates over last decade to explore the characteristics of single diamond-shaped cylinder bundles and their composites. The most important findings include (1) the generation of a switching flow phenomenon, called flip-flop flow oscillation due mainly to the ramming effect at the edge section of two adjacent cylinders and (2) the item (1) induces uniformization of the flow field, resulting in multiple, uniform flowrate jet streams. In the present work, an experimental study is conducted on a mini-size diamond-shaped cylinder bundle and self-excited switching phenomenon and micro-bubbles are simultaneously produced. The same experimental apparatus and procedure may be employed to simultaneously generate self-sustaining flip-flop flow oscillation and micro-mists by supplying vapor instead of liquid. Both micro-bubbles and mists have many applications in medicine and biology.

## Session E4

### Bio-manufacturing and Tissue Engineering Applications

Venus Room 1

1350 - 1450 7 December 2006 Thursday

#### E4.1 P0335

##### Hmm-Fuzzy Model for Breast Cancer Diagnosis

M R Hassan, \*R Begg, \*\*Y S Morsi, \*K Lynch

The University of Melbourne, AUSTRALIA

\*Victoria University, AUSTRALIA

\*\*Swinburne University of Technology, AUSTRALIA

This paper presents a Hidden Markov Model (HMM) based fuzzy model for breast cancer recognition and classification. The feasibility of using HMM for generating a minimum number of fuzzy rules for a given problem has been introduced in a recent study. In this study, we apply this new approach to investigate whether or not it can differentiate effectively the two important breast cancer types: benign and malignant. Artificial neural networks (ANNs) have been proposed to improve the diagnosis of breast cancers. Fuzzy logics have the advantage compared to the ANNs in that it (Fuzzy model) is interpretable and can represent the solution of a problem with reduced computational complexity. In this paper, we demonstrate the suitability on the use of fuzzy model over ANNs for breast cancer diagnosis, as the model was able to provide a comparable classification performance (accuracy) with reduced complexity.

#### E4.2 P0373

##### Pancreas Progenitor Cell Survival and Differentiation in Vascularised Chambers Implanted in SCID Mice

K R Knight, A J Hussey, \*L J Gonez, S J Feeney, \*I Banakh, \*L C Harrison, \*\*A J Penington, et al

Bernard O'Brien Institute of Microsurgery, AUSTRALIA

\*Walter and Eliza Hall Institute of Medical Research, AUSTRALIA

\*\*University of Melbourne, AUSTRALIA

Pancreas progenitor cells (PPCs) found in or near pancreatic ducts in adult mice are thought to be involved in the neogenesis of insulin secreting cells. The aim of this study was to assess the survival and differentiation potential of PPCs using a vascularised chamber model. Silicone tube microchambers (15µl volume), based on the inferior epigastric vessels, were established in SCID mice. FACS-sorted PPCs derived from adult mice, suspended in bFGF-supplemented Matrigel™, were implanted into each chamber then encased in adipose tissue from the epigastric fat pad. In tissue harvested from the chambers at 3 or 6 weeks there was excellent vascularisation of the implanted cells. Many PPCs survived and some differentiated into ductal structures, reflecting their origin. Cells with positive immunostaining for insulin and glucagons were also detected. It is concluded that vascularised chambers create a suitable environment for the survival and differentiation of PPCs.

#### E4.3 P0326

##### Electrospinning-Recently Bio-manufacturing Solving the Tissue Engineering Issue

X Mo, Z Chen, \*H J Weber

Donghua University, CHINA

\*Aachen University of Applied Sciences, GERMANY

Electrospinning nanofibers can be used to mimic the nanofibrous structure of extracellular matrix (ECM) in native tissue. In tissue engineering those ECM could be used as tissue engineering scaffold to solve the tissue engineering issue. In this paper, P(LLA-CL) nanofibers and collagen-chitosan complex nanofibers were fabricated by electrospinning. The mechanical properties of collagen-chitosan complex nanofibers were varied with the collagen content in the complex. The biodegradability of P(LLA-CL) nanofibers was faster than its membrane. SMC cells grows faster on collagen nanofibers than on P(LLA-CL) nanofibers.

## Session E5

### Micropolar Biofluid Mechanics and Applications

Venus Room 3

1350 - 1430 7 December 2006 Thursday

#### E5.1 P0214

##### Experimental Research on Measuring the Zeta Potential of Electroosmoticflow Micropump Made by Capillary

H Yang, H Jiang, Y Wang  
Harbin Institute of Technology, CHINA

To measure the zeta potential is a challenge work. To solve the question, an electroosmosis pump made by quartz capillary was manufactured and its pumping rate has been measured under various experimental conditions. The process of this pump and the measure method have presented. A theoretical mode calculating the zeta potential has developed. The experimental platform was built. With experiments, the pumping rates of various micropumps under various experimental conditions were measured. Through analysis and calculating, the zeta potential was get and it demonstrated the zeta potential of same material in same electrolyte is same. Those results offer the theory of designing micropump applying microfluidis in biochemical bioengineering.

#### E5.2 P0209

##### Automatic Power Control in FES Cycling

C Ma, H Jiang, H Ao, N Lu, W Wei  
Harbin Institute of Technology, CHINA

In order to improve the performance of the lower-limb FES cycling, a method of measuring the automatic control Power in the cycling was developed based on the estimation of dynamic models of the response from muscle stimulation intensity to power. The identified models were used for analytical design of feedback controllers. The results showed that this method had ability to achieve an accurate control of power and track arbitrary signals obtained from healthy adults, which shows its feasibility to the experiment on the paraplegic.



## Session F1

### Innovative Strategy for Rehabilitation following Neurological Injuries

Jupiter Room 1

1540 - 1720 7 December 2006 Thursday

#### F1.1 P0240

##### **Ambient Intelligent Microsystems – The Healthy Aims Project and its Impact on Neuroprosthetic Developments**

S Thies, P Tresadern, L Kenney, D Howard, J Y Goulermas  
University of Salford, UNITED KINGDOM

Healthy AIMS (Ambient Intelligent Microsystems) is a multi-disciplinary project focused on the development of advanced microsystem technologies and communication methods and their integration into intelligent medical devices. Twentysix partners from nine EU countries have come together to share their expertise in the areas of design, materials, processes and manufacturing to create new assistive devices and implants for the elderly and impaired. Salford University's role is to develop and implement software tools for inertial sensor-based neuroprosthetic devices. More specifically, Salford is developing algorithms that interpret inertial sensor data to identify a stroke patient's intent to grasp/release objects and accordingly trigger onset or termination of muscle stimulation to assist with hand opening.

#### F1.2 P0270

##### **The use of Self-Regulation and Mental Imagery in Stroke Rehabilitation**

K P Y Liu, C C H Chan  
The Hong Kong Polytechnic University, HONG KONG S.A.R.

This study examines the use of self-regulation and mental imagery in promoting the relearning potential of patients with stroke.

#### F1.3 P0278

##### **Motor Learning of Normal Subjects in Tracking with Rehabilitation Robot**

Z W Wu, M S Ju, \*C C K Lin  
National Cheng Kung University, TAIWAN  
\*National Cheng Kung University Hospital, TAIWAN

To gain further insight of motor learning in a robot-aided rehabilitation system is the main objective in this research. As a pilot study, motor learning of normal subjects to the rehabilitation system was studied. A biomechanical model for interaction between normal subjects and the rehabilitation system was developed and a series of experiments with the rehabilitation robot system was made. Six normal subjects were asked to guide the end-effector of the robot to perform circular tracking motion in transverse plane at shoulder level in a designed force field. Muscle dynamics was solved with a biomechanical model based on Hill-type muscles and a force sharing algorithm, minimizing sum of squared muscle stress. Patterns of performance indices showed that tracking skill of the subjects was improved after weeks of training. A new index, zero-crossing number of muscle shortening acceleration, was capable for evaluation of motor learning for the specific tasks.

#### F1.4 P0289

##### **Vibratory Afferent Inputs Modulated Motor Pathway Excitability and Hand Function Following Stroke**

B S Yang, \*K Settle, E J Perreault  
Northwestern University, UNITED STATES  
\*Rehabilitation Institute of Chicago, UNITED STATES

Lack of finger muscle individuation is a major contributor to hand dysfunction following stroke and rehabilitation paradigms aimed at increasing individuation may significantly improve hand function in the stroke population. The purpose of this study was to explore the possibility of using muscle vibration to modulate hand corticomotor excitability and improve hand function following stroke. Small amplitude vibration was applied to individual muscle of bilateral three hand muscles of nine chronic stroke and six age-matched control subjects using an electromagnetic vibrator. Transcranial magnetic stimulation was used to assess the influence of muscle vibration on corticomotor excitability in the stroke-affected hand. The results from the control group were consistent across subjects and with previous studies. In stroke individuals, we demonstrated that vibration could alter excitability of motor pathways controlling stroke-affected hand muscles and provide differential effects to motor pathways ( $p < .002$ ), although the pattern of observed excitability changes varied greatly across subjects. Nevertheless, measurements across multiple days demonstrated that vibration produced consistent changes within individual subjects ( $p > .14$ ). These results suggest that vibration may be an effective means for altering hand muscle excitability following stroke but that rehabilitation paradigms incorporating vibration would need to be adjusted on a subject-specific basis.

**F1.5 P0336**

**Utilizing Tech-Based Therapeutic Recreation Techniques in Rehabilitation on Promoting Enjoyment and Quality of Life for a Child with C3/4 Spinal Cord Injury: A Case Report**

Y F Hsu, \*I T J Chiang, H Cheng, Y A Tsai  
Neurological Institute, TAIWAN

\*Taipei Physical Education College, TAIWAN

We present a case report of a 10-year girl with C3/4 spinal cord injury and the tech-based therapeutic recreation (TR) interventions. Method: An individualized TR program was offered after multiple assessments, which were included Leisure Interest Measure, observation, informal conversation, and interviews. Rehabilitation interventions with tech-based TR techniques were implemented once a week for 8 weeks. Outcomes measure: Enjoyment and quality of life measurements were conducted pre- and post-interventions. Result: Quantitative data showed that the quality of life and the self-controllability had a slight improvement and the enjoyment score showed positive responds during the intervention. Qualitative data also showed that the program impacted positively on the patient, her parents, and medical-related professionals. Conclusion: Results demonstrated that tech-based therapeutic recreation facilitation techniques are viable and valuable approaches for rehabilitation team by multidisciplinary collaboration for promoting and quality of life for children with spinal cord injuries.

## Session F2

### Application of 1D and 2D Signal Processing for Bio-signals 2

Jupiter Room 2

1540 - 1720 7 December 2006 Thursday

#### F2.1 P0388

##### Analysis of Epileptic EEG Signals using Higher Order Spectra

K C Chua, \*V Chandran, R Acharya U, C M Lim

Ngee Ann polytechnic, SINGAPORE

\*Queensland University of Technology, AUSTRALIA

Epilepsy is a neurological condition, which affects the nervous system. Automatic seizure detection is very important in clinical practice and has to be achieved by analyzing the Electroencephalogram (EEG). Seizures are the clinical manifestations of excessive and hypersynchronous activity of the neurons in the cerebral cortex and represent one of the most frequent malfunctions of the human central nervous system. Therefore, the search for precursors and predictors of a seizure in the human EEG is of utmost clinical relevance and may even lead to a deeper understanding of the seizure generating mechanisms. In this paper, a chaotic analysis of the normal and epileptic EEG signals is studied using higher order spectra. These measures distinguish epileptic EEG from normal with an accuracy of more than 95%.

#### F2.2 P0390

##### Computer- Based Analysis of Cardiac State Recurrence Plots

K C Chua, \*V Chandran, R Acharya U, C M Lim

Ngee Ann polytechnic, SINGAPORE

\*Queensland University of Technology, AUSTRALIA

Heart rate variability refers to the regulation of the sinoatrial node, the natural pacemaker of the heart by the sympathetic and parasympathetic branches of the autonomic nervous system. Heart rate variability is important because it provides a window to observe the heart's ability to respond to normal regulatory impulses that affect its rhythm. A computer-based intelligent system for analysis of cardiac states is very useful in diagnostics and disease management. Parameters are extracted from the heart rate signals and analyzed using computers for diagnostics. This paper describes the analysis of normal and six other types of cardiac abnormal signals using Recurrence plots and Recurrence Quantification Analysis (RQA). Ranges of these parameters for various cardiac abnormalities are presented with an accuracy of more than 95%.

#### F2.3 P0391

##### Effects of External and Internal Indicators for Learning Soccer Chip

J Y Chow, M Koh, \*P H Tan, \*M F Mohd Kairi, \*N Meenachi Sundram, \*X N, S Tan

National Institute of Education, SINGAPORE

\*Ngee Ann Polytechnic, SINGAPORE

The purpose of this study is to determine the effects of Internal and External information sources (focus of attention) for learning the soccer chip. Three soccer novices practiced kicks to a live receiver at a fixed distance (5 metres) away from a height barrier (1.6 m) for 6 sessions. Each individual player was given instructions categorised as, a) internal focus of attention, b) external focus of attention and c) no instructions. 2-D filming techniques were employed to capture kinematic data for 10 trials of kicks at pre and post test sessions. Performer with internal focus attention instructions performed better than novices with external and no instructions.

#### F2.4 P0392

##### An Experiment on Haemodynamic Pulse Detection using Diffusion of Visible Light

J Chee, N Lee, H Chan

Ngee Ann Polytechnic, SINGAPORE

As blood pulsates through arterioles near the skin, the amount of blood present per unit volume changes in tandem with the contraction of the heart. This change in volume modifies the characteristic diffusion of light passing through the skin and is detectable with a combination of photo-emitter (LED) and photo-sensor (photodiode). This study shows that haemodynamic pulse detection can be successfully achieved using a non-conventional approach of placing both of emitter and sensor on a single plane. Such an arrangement eliminates the need for any 3-D structures (such as those used by conventional pulse oximeters) and opens up possibilities for different applications.

## **F2.5 P0389**

### **Computer Based Identification of Anterior Segment Eye Abnormality**

L Y Wong, \*R Acharya U, \*\*E Y K Ng, \*C M Lim, \*K C Chua, \*\*\*J Suri

National University of Singapore, SINGAPORE

\*Ngee Ann polytechnic, SINGAPORE

\*\*Nanyang Technological University, SINGAPORE

\*\*\*Idaho State Biomedical Research Institute, UNITED STATES

The eyes are complex sensory organs and are designed to optimize vision under conditions of varying light. There are a number of eye disorders that can influence vision. Eye disorders among the elderly are a major health problem. With advancing age, the normal function of eye tissues decreases and there is an increased incidence of ocular pathology. The most common symptoms elicited from ocular diseases are few in number and non-specific in nature: blurred vision, pain, and redness. Cataracts occur most frequently in older people and have significant impact on an individual's quality of life. There are effective therapies and visual aids for these potential vision-limiting conditions. Corneal Haze a complication of refractive surgery characterized a cloudiness of the normally clear cornea. Iridocyclitis is the inflammation of the Iris and ciliary body. In Corneal arcus are white circles in the cornea of the eye caused by fatty deposits. So, proper eye care and management, there is a need to diagnose the normal eye from the abnormal. This paper presents a comparative approach for classification of normal eye image and abnormal (consists of five kinds of eye images) classes using classifiers namely, self organizing map neural network and radial basis function neural network.

## Session F3

### Respiratory System Engineering; Telemedicine and Healthcare

Jupiter Room 3

1540 - 1640 7 December 2006 Thursday

#### F3.1 P0141

##### Applying Gaussian Mixture Model to Design an Assistant Detection System for Breath Sounds

G L Yan, \*M S Tsai, C J Hou, \*\*C C Tseng  
Southern Taiwan University of Technology, TAIWAN  
\*Potz General Hospital, TAIWAN  
\*\*Chang Gung Memorial Hospital, TAIWAN

This paper proposed a statistical modelling technique to design an intelligent assistant detection system for monitoring intubated status from breath sounds. High quality breath sounds are acquired by a reliable recording device with user-friendly interface. The average vibration parameter and frequency-domain energy variance are estimated to quantify breath sound signals. Gaussian Mixture Model (GMM) is adopted to precisely represent the distributions of the acoustic parameters of breath sounds from the correct intubated process. A smoothing score is defined to well capture the intubated status by the smoothed logarithm value of the probabilities from GMM. A threshold T is set to distinguish correct and incorrect intubated status. Animal model was established to evaluate the performance of the detection system. The breath sound signals were collected from 10 pigs with endo-trachea (control group) and endo-esophagus (experimental group). Seventeen signals both in control and experimental group were recorded and used to train the GMM by maximum likelihood. Preliminary experimental results showed that the average detection cycle is 3.33.

#### F3.2 P0321

##### Analysis on Spirometric Respiratory Measurements using Radial Basis Function Neural Network

M Veezhinathan, S Ramakrishnan  
Anna University, INDIA

In this work analysis on spirometric human respiratory measurements is attempted using neural networks. The pulmonary function data (N=112) for this study were obtained from volunteers through commercially available spirometer. The data are then subjected to neural network based training (N=92) and analysis (N=15). The classification is carried out using radial basis function neural network to generate the desired outputs. The outputs are then validated through sensitivity and specificity measurements together with clinical observation. The sensitivity and specificity are found to be 87.57% and 85.72% respectively. Further it seems that this method is useful in assessing the pulmonary function dynamics in cases with incomplete data and data with poor recordings. In this paper the methodology, data collection procedure and neural network based analysis and results are described in detail.

#### F3.3 P0296

##### Telerehabilitation Assessment of Gait for Hemiparetic Locomotion

R C Lemoyne, R Jafari  
University of California, Los Angeles, UNITED STATES

Progressively tracking the quality of locomotion subsequent to neurological trauma, such as stroke, is fundamental to properly allocating therapy strategy and dosage. However, with the increasing quantity of people with neurological disorders, and the limited number of medical professionals; a new approach to addressing therapeutic strategies for stroke must be considered. One alternative strategy is the integration of Mednode technology with locomotion. Mednodes effectively quantify motion. The integration of an accelerometer to quantify the position of the femur worn on an elastic knee band, can quantify the characteristics of gait. Also gait analysis can be derived by a temporal analysis of reflex response, using the Mednode accelerometers. The integrated Mednode system can convey quantified data to a portable computer. Such a system would allow for telerehabilitation of the subject. Medical professionals could remotely assess the subject's locomotor functionality, and apply therapy strategy from a remote location, in light of the quality of recovery or degeneration. The findings support that the Mednode integrated system can assess the locomotor quality of gait cycle for both nominal and hemiparetic subjects. The subsequent data can be conveyed over internet for telerehabilitation.

## Session F4

### Motion Analysis

#### Venus Room 1

1540 - 1800 7 December 2006 Thursday

#### F4.1 P0312

##### The Effects of Body Weight Support and Treadmill Speed on Gait in Children with Cerebral Palsy

R J Cherng, Y F Kuo, F C Su  
National Cheng Kung University, TAIWAN

Nine children with spastic CP (5 boys and 4 girls; age:  $8.4 \pm 1.8$  years) and 14 non-disabled children (9 boys and 5 girls; age:  $9 \pm 1.7$  years) participated in the study to investigate the effects of body weight support (BWS) and treadmill speeds (TS) on gait parameters and ground reaction force (GRF) profile in children with cerebral palsy (CP). Temporal distance parameters and GRF data were collected with Kistler Gaitway Treadmill System. Each participant performed 2 trials under 12 test conditions with a combination of 4 BWS (0, 10%, 20%, and 30% of body weight) and 3 TS (130%, 100% and 70% of preferred speed). The results showed that children with CP showed significant differences of all dependent variables from nondisabled children in all conditions. Children with CP showed longer gait cycle time, shorter stride length, fewer cadence, lower peak force than non-disabled children. However, at the conditions of the fast TS and 10 % BWS and fast TS and 20 % BWS, children with CP had better gait symmetry and less differences from non-disabled children. It is suggested that children with CP may benefit with gait training with fast TS and 10% BWS or 20% BWS.

#### F4.2 P0313

##### Effects of Disturbed Vision and Vestibular System on Gait

W L Tung, H W Chang, Y C Chen, C H Li, S B Chen, F C Su  
National Cheng Kung University, TAIWAN

The purpose of this study was to investigate the effects of the block of vision and/or vestibular disturbance on walking patterns. Seven health subjects were recruited in this study. A motion analysis system and two Kistler force plates were used to measure the kinematic and kinetic parameters during five walking conditions. The results showed that vision and vestibular system influence walking patterns significantly. As a result, the outcome can provide to clinical applications for the blind or give precautions to the human walking in a dark environment.

#### F4.3 P0314

##### Influence of Induced Impaired Sensation on Precision Pinch Force Control in Pinch-Holding-Up Activities

H Y Hsu, F C Su, \*H Y Chiu, L C Kuo, \*J H Chang, \*S C Lu  
National Cheng Kung University, TAIWAN  
\*National Cheng Kung University Hospital, TAIWAN

Muscles are tightly controlled by sensory message in different phases during the course of pinch-holding-up task. If the sensory system is disrupted, the brain cannot integrate sensory information and program into an appropriate default response. The objective of the study was to analyze the effect of induced mild impair sensation of grasping digits on the precision control of pinch force modulation during the manipulation of mechanically predictable loads. The results revealed that mild impairment of sensation affected significantly on the parameters of peak pinch force, baseline pinch force and pinch efficiency during performing pinch-holding-up activity ( $p < 0.05$ ).

#### F4.4 P0316

##### Kinematics and Postural Control in Tai Chi Chuan

L H Wang, C J Lin, F C Su  
National Cheng Kung University, TAIWAN

Abstract: This study was to investigate the lower limb kinematics and postural control in push-hands in Tai Chi Chuan (TCC) by examining the distance between the center of mass (COM) and center of pressure (COP). The results show that the trajectory of COP was smooth and concentrated in push-hands. The mean COP-COM variable was much smaller than that of level walking. The most significant range of motion of lower limbs was the knee joint in push-hands in TCC.

#### **F4.5 P0317**

##### **Glenohumeral Joint Laxity Measurement in Normal Subjects and its Validation**

H T Lin, A T Hsu, \*K N An, G L Chang  
National Cheng Kung University, TAIWAN  
\*Mayo Clinic, Rochester, UNITED STATES

The purpose of this study is to estimate glenohumeral joint center of rotation and to measure displacement of the glenohumeral joint during humeral head translation tests using a kinematic model. The measurement system was validated with a mechanical model to investigate its feasibility in application on the measurement of the glenohumeral joint laxity in vivo. A designed mechanical model was used to simulate translation of the glenohumeral joint during clinical laxity test. This measurement system was also tested in normal subjects. Data showed this model can achieve 97% and 98% accuracy of displacement of center of rotation in anterior-posterior direction and posterior-anterior direction in the mechanical model. In normal glenohumeral joint, the average of variation for the estimated joint center is 3.79 mm, 2.91 mm, and 1.88 mm standard deviation for x-, y-, and z-coordinate, respectively. Good intrasession reliability of anterior-posterior displacement of humeral head during gliding test indicates that the measurement of humeral head displacement using our mechanical model may be a reliable technique used in vivo. However, the inter-session reliability is from poor to fair suggests that several factors such as the muscle tension of the subjects or other sources appear to contribute to the variability of the data.

#### **F4.6 P0372**

##### **Kinematic and Static Analyses of the Pedaling by Means of the New Slider-Crank Mechanism**

Y Yoshizawa, K Watanabe, K Nizeki  
Yamagata University, JAPAN

A slider-crank mechanism whose coupler curve is the approximate ellipse is designed so that a man may perform the pedaling of the elliptical motion of the foot. Because the thigh, the shank and the foot constitute the three-link chain, the system of a man and the bicycle with the slider-crank pedal mechanism is the planar seven-link mechanism of two degree freedom. The system of a man and the ordinary bicycle is the planar five-link mechanism of two degree freedom. Kinematic characteristics of these systems are analyzed with the given pattern of the pedal angle curve during a crank rotation. Then, the crank moment and the pin joint forces of these systems are calculated for given patterns of the hip moment and the knee moment during a crank rotation and the average crank moment is estimated. The calculated results of the pedal angle, the pedal force and the crank moment are verified experimentally.

#### **F4.7 P0374**

##### **Effects of Shoe and Walking Speed on the Smoothness of Movement during Walking**

G R Tack, B Lee, S C Chung, J H Yi, G M Eom, \*C H Kim, J S Choi  
Konkuk University, KOREA  
\*Korea Institute of Science and Technology, KOREA

The purpose of this study was to evaluate the effects of shoe and walking speed on the smoothness of the movement during treadmill walking. Eleven university students used three different types of shoes (running shoes, mountain climbing boots, and elevated forefoot walking shoes) at various walking speeds (1.19, 1.25, 1.33, 1.56, 1.78, 1.9, 2, 2.11, and 2.33m/sec) on a treadmill. Three-dimensional motion analysis was conducted with four high speed digital motion capture cameras. Utilizing the maximum smoothness theory, it was hypothesized that there would be differences in normalized jerk according to shoe types and walking speeds. Furthermore, it was assumed that running shoes would have the lowest values for normalized jerk because subjects were most accustomed to wearing these shoes. The results demonstrated that elevated forefoot walking shoes had lowest value for normalized jerk at heel. In contrast, elevated forefoot walking shoes had greater normalized jerk at the center of mass (COM) at most walking speeds. Although the elevated forefoot walking shoes have the highest levels of jerk at the COM, the structure of the pelvis and spine allows for greater compensatory movement than the ankle. This movement at the COM might even have a beneficial effect of activating the muscles in the back and abdomen more than other shoes.

## Session F5

### Rehabilitation Engineering 2

Venus Room 3

1540 - 1740 7 December 2006 Thursday

#### F5.1 P0332

##### **Describe the Tendency of the User-Wheelchair System when Performing a Whole Wheelie Activity**

P C P Lin, F C Su, \*B Kotajarvi, \*K R Kaufman, \*K N An

National Cheng Kung University, TAIWAN

\*Mayo Clinic, Rochester, UNITED STATES

A wheelie activity is a very important skill for wheelchair users. 3 normal subjects attended this study. Motion Analysis system with ten cameras, two force plates and SMARTWHEEL were used to collect the kinematic and kinetic data. We used the pitch angle to divide whole activity into four phases. We can use pitch angle, COM angle, COP angle and total axial moment to describe the tendency of user-wheelchair system when performing a wheelie.

#### F5.2 P0349

##### **Physiological Cost Index of Hemiplegic Patient Propelling a New Wheelchair with FES**

H C Lo, \*K H Tsai, \*\*C Y Yeh, G L Chang

National Cheng Kung University, TAIWAN

\*National University of Tainan, TAIWAN

\*\*Chung Shan Medical University, TAIWAN

In general, patients with hemiplegia due to stroke may operate manual wheelchair by their unaffected hand and leg. The asymmetrical forces may cause the manual wheelchair to deviate toward the affected side. The novel leg propelled wheelchair was announced, which was designed for patient propelling by both legs. In this study, sixteen patients were recruited to participate in this cardiopulmonary exercise test. They are asked to propel three kinds of wheelchair including, manual wheelchair (MW), leg propel wheelchair (LW) and functional electrical stimulation (FES) assisted leg propel wheelchair (FW) for 200m. The results demonstrated that patients got higher HR change, oxygen consumption to finish the test by LW and FW. The velocity of LW and FW were also faster than that of MW. In the aspect of energy consumption, both physiological cost index (PCI) and oxygen index demonstrated that leg propelled wheelchair (LW and FW) were much lower than that of arm wheeling wheelchair (MW). It concluded that, for patient with hemiplegia, the wheelchair propelled by both legs is more efficient than manual wheelchair.

#### F5.3 P0350

##### **Design and Evaluation of Unilateral-Propelled Wheelchair for Stroke Patients**

K H Tsai, \*C Y Yeh, \*\*H C Lo, \*\*G L Chang

National University of Tainan, TAIWAN

\*Chung Shan Medical University, TAIWAN

\*\*National Cheng Kung University, TAIWAN

More of stroke patients who survive the acute phase are unable to walk and require a period of rehabilitation to achieve a functional mobility. About 70% of stroke patients suffer from hemiplegia and weakness of unilateral limbs. For the physiological characteristic of hemiplegic patient, traditional manual wheelchair was not suitable for this specific group. In the present study, a new unilateral-propelled wheelchair for stroke patients was developed with the clinical users' requirements by the multifunction team experts including of rehabilitation engineering, biomedical engineering and industrial design. Fifteen hemiplegia patients are recruited to participate in this study. The field test was performed for comparisons among the three types of wheelchairs. The advantages of the new device are patients can use unilateral leg to propel wheelchair that provides plenty of power supply and reduces upper limbs injuries caused by fatigue or overuse. Through elementary clinical evaluation new wheelchair performs well manoeuvrability and proved to be usability.



#### **F5.4 P0351**

##### **Mobile Gait Rehabilitation System using Functional Electrical Stimulation**

T Y Kuo, \*T Y Huang, \*T Y Lin

Southern Taiwan University of Technology , TAIWAN

\*Southern Taiwan University of Technology, TAIWAN

This work is to build a gait training system for rehabilitating non-ambulatory patients, so they might recover the motor function of lower limbs. The proposed system, featuring mobility, alleviates a patient's burden by supporting his/her weight and is equipped with rhythmic functional electrical stimulation (FES) for gait rehabilitation. It has a high-strength alloy frame, and a harness to support the patient. It is easy to disassemble to a compact size fitting a car's trunk. Meanwhile, the gait rehabilitation is achieved by a rhythmic stimulator, which produces electrical impulses to activate muscles, and self-adhesive patches to be placed on the patient's lower limbs. Hence, muscles of lower limbs can be activated accordingly to complete each gait cycle. The stimulation pattern, frequency and intensity can be consulted with physical therapists. It is hoped that the rehabilitation system may be used to prevent myotonic dystrophy, and served as a walking gait trainer. Moreover, through the mobile characteristic of our proposed system, the patients have the opportunity to explore the outdoors and boost their passion for life.

#### **F5.5 P0352**

##### **Design of a New Auxiliary Driving Unit for Wheelchair**

T Y Lin, T Y Huang, \*T Y Kuo, S Y Chou

Southern Taiwan University of Technology, TAIWAN

\*Southern Taiwan University of Technology , TAIWAN

The design of a "New Auxiliary Driving Unit" is to modify a Front Auxiliary Power Unit for manual wheelchair by adding a retract mechanism which can retract or release the power wheel and the steering handle so that the users can switch the wheelchair between the manual and electric modes at will. By this way, a manual wheelchair can be easily upgraded as a manual/electric wheelchair.

#### **F5.6 P0357**

##### **The CoP Velocity during Normal Walking in Dancers and Non-dancers**

C W Lung, \*J S Chern, S W Yang

National Yang-Ming University, TAIWAN

\*Chang Gung University, TAIWAN

Professional ballet dancers routinely undertake hours of daily training. On stage, ballet performances are quite elegant, however, the limb segment motions are exaggerated markedly from normal. This abnormal foot-ankle posture and intensive exercise reportedly increases the likelihood of foot-ankle injury. The aim of this work, therefore, was to investigate whether the exercise regime unique to ballet alters the regular walking pattern of professional dancers. Thirteen professional ballet dancers and twenty age-matched normal healthy subjects were recruited. All subjects were examined with respect to their active lower limb motion and then walking along a 10-meter walkway at normal speed. The results of our study showed that ballet dancers had different gait patterns from that of non-dancers in terms of delayed time of three velocity peak in the three rocker mechanism and decreased CoP velocity in pre-swing.

**Session G1**

**Medical Robotics; Neural-, Neuro- and Neuro-Behavioral Engineering**

**Jupiter Room 1**

**1100 - 1200 8 December 2006 Friday**

**G1.1 P0175**

**Development of a Patient Simulation Robot for Manual Muscle Testing Training**

K Onishi, K Hase, A Nakayama, K Kawakami, T Futohashi, G Obinata  
Nagoya University, JAPAN

Manual Muscle Testing (MMT) is the primary means of muscle strength assessment in rehabilitation medicine. The present paper proposes a patient simulation robot for MMT training. The robot is controlled by an algorithm that is based on a human joint movement model. The proposed method first identifies the load generated by a physical therapist and the knee joint movement characteristics of the subject as a human joint movement model from experimental data collected during MMT. The human patient model was then implemented in the robot manipulator as a control law. Although the proposed robot is a prototype, the robot demonstrated the characteristics of knee movement and the parameters in the model regulated its motions. The present paper indicates the possibility of a new MMT training program using the proposed robot.

**G1.2 P0186**

**Dual-Convertible Lens for Accommodative Compensation in 3D Scenography**

Y Nakanishi, \*T Takashima, T Okamoto, \*H Higaki, H Miura, Y Iwamoto  
Kyushu University, JAPAN  
\*Kyushu Sangyo University, JAPAN

Dual-convertible lens for accommodative compensation in three-dimensional (3D) scenography is proposed in this paper. They have the potential to reproduce 'visual depth perception' with 3D images by making use of mechatronics technologies. Two serial convertible lenses, which were simultaneously operated by computer control, were installed between the observer and the display. They were able to reduce visual fatigue, and the observer could easily use them to achieve binocular vision. This simple and scalable architecture can be applied to most 3D scenography systems currently in use.

**G1.3 P0178**

**The Effect of Rare Earth Samarium on Learning and Memory Behaviors of Rats**

W Shi, \*X Shen, X Ma  
Shaoxing College of Arts and Science, CHINA  
\*Zhejiang Normal University, CHINA

The effect and mechanism of the rare earth element samarium (Sm) on learning-memory behaviors of rats have been studied. Sprague-Dawley (SD) big rats with weaning weight of 195±15g are randomly divided into 4 groups of 8 males and females each. One group, drink de-ionized water, served as control and was also used for analysis of the background. The other three groups rats are raised by drinking de-ionized water containing low, middle and high concentration of Sm for four months, then they were carried out learning and memory tests in term of Y-electric maze. Another month later, all rats were sacrificed by disjuncting the neck-vertebra and weighed. Compare with the control group, the learning-memory of the low and middle Sm groups of rats presented a deterioration trend that detected in terms of Y-electric maze. The results show that the degradation of learning and memory of rats relates to the decreased activity of SOD and the increased MDA concentration in rats' brain.

## Session G2

### Biomedical Engineering Education, Industry and Society 2

Jupiter Room 2

1100 - 1140 8 December 2006 Friday

#### G2.1 P0150

##### A Model for Cornea Swelling: Glaucoma and Cataract

T K Karalis

Democritus University, GREECE

The mechanical properties of the cornea stroma, with respect to the aqueous inflow, are explained in the basis of swelling mechanics. With this formulation we are explaining why if outflow facility decreases faster than does aqueous inflow, glaucoma may result. The opposite situation, e.g. of hypotony is also considered.

#### G2.2 P0115

##### Placement of Catheter in the Liver Artery for TACE Surgery

T W H Sheu, \*S F Tsai, H P Rani

National Taiwan University, TAIWAN

\*National Taiwan Ocean University, TAIWAN

Trans Arterial Chemo Embolisation (TACE) has been developed for the liver tumor patients who can't be treated by the invasive resection. In the TACE procedure, the chemotherapeutic drugs are ejected from the catheters. Thus, the oxygen and nutrients needed for the tumor growth are deprived and will eventually cause the tumor cells to die very quickly. It is important to estimate factors that may affect the placement of chemotherapeutic drugs properly in the tumor location using the TACE surgery. In order to make sure that the chemotherapeutic drugs won't kill the cells other than the tumor cells, a 3D patient-specific model for the liver tumor surgeries is presented and discussed.

## Session G3

### Physiologic System Modeling 1

Jupiter Room 3

1100 - 1240 8 December 2006 Friday

#### G3.1 P0164

##### Simulation of Corneal Surface Temperature in the Presence of Contact Lens

E H Ooi, E Y K Ng

Nanyang Technological University, SINGAPORE

The 2D heat transfer eye model is developed to simulate the temperature distribution during contact lens wear. The steady state corneal surface temperature was found to decrease for lens wearers compared to a bare cornea. In the transient analysis, the changes of temperature with time are dependent on the initial temperature of the contact lens. The lower corneal temperature compared to the bare cornea is caused by the increased evaporation rate during contact lens wear.

#### G3.2 P0199

##### Analytical Study of Temperature Distribution in Biological Tissue

J Okajima, S Maruyama, A Komiya

Tohoku University, JAPAN

A living body has a system of maintenance of its own temperature. We have investigated heat transfer characteristic in biological tissue included heat generation by metabolism. One-dimensional bio-heat transfer equation with metabolic heat generation is solved by Laplace transformation on the assumption that biological tissue is homogeneous. Steady state solution and transient solution were derived analytically. The existence of steady state solution represents that there is a region where temperature change does not occur. A dimensionless parameter with regard to blood perfusion term was used. Temperature profile can be evaluated in the tissue by using dimensionless number. It is proved that the size of region where temperature change occurs, steady state thermal penetration depth, is decided by biological properties. Additionally temperature chart was proposed with these solutions. This temperature chart can be guideline for medical doctors in the precise medical treatment.

#### G3.3 P0274

##### Case Studies of Infra Red System for Clinical Diagnosis Applications and Management of Erectile Dysfunction

W K Ng, E Y K Ng, \*Y K Tan, \*S J Chia

Nanyang Technological University, SINGAPORE

\*Tan Tock Seng Hospital, SINGAPORE

Sildenafil citrate (Viagra) was introduced in 1999 as the first oral phosphodiesterase type 5 (PDE5) inhibitor therapy for erectile dysfunction (ED). Existing data on Sildenafil efficacy and safety/tolerability focus on the assessments of penile rigidity, measures of psychosocial outcomes such as emotional well-being and treatment satisfaction. Increased understanding of the Sildenafil response profile contributes towards optimal Sildenafil treatment, and thus enables clinician to the appropriate management of erectile dysfunction using Sildenafil. This paper first provided a brief update on the efficacy of the abovementioned methods, leading to the introduction and examination of the efficacy of a novel method, the infrared thermography in the assessment of Sildenafil outcome. We based on the principle that blood vessel flow activity and perfusion to Corpa cavernosum at the erect state are almost always higher than that in the flaccid state. It is anticipated that such basic research into blood flow is critical as blood perfusion into Corpa cavernosum is the most influential factor determining functional erectile quality contributing to successful coitus.

#### G3.4 P0297

##### Optimization of Nanoparticle Drug Microcarrier on the Pharmacokinetics of Drug Release

W K Ng, K Tai, \*C K Poh, E Y K Ng

Nanyang Technological University, SINGAPORE

\*TechSource Systems Pte Ltd, SINGAPORE

The ideal drug delivery process exhibits zero-order kinetics. However, in practice, most drug delivery processes are first-order kinetics. This study aims to mathematically model, analyze and determine the optimal polymer shape of the drug microcarrier that achieves a near zero-order release. Applying the Carslaw and Jaeger heat diffusion equations of a sphere with same order of its effective surface area to volume ratio as a reference, how drug delivery would occur in other shapes is predicted. From tests involving changing the microcarrier configuration, shape is confirmed to be an important factor to consider when examining drug release rates, to achieve zero-order design. The study is further extended by performing optimization with an optimization objective function formulated from the mathematical model and MATLAB Optimization Toolbox was used to perform the numerical analysis. From this relationship, the best L/R ratio that can achieve a drug release process most similar to a zero-order drug release process can be found.

### **G3.5 P0302**

#### **Computer Prediction of Human Thermal Regulatory System**

L W Lim, E Y K Ng

Nanyang Technological University, SINGAPORE

The objective of this project is to evaluate a novel adaptive optimal thermal control paradigm inspired by Hebbian covariance synaptic adaptation previously proposed on its potential to predict human thermoregulation. The thermoregulatory mathematical model uses a 2-node core and shell representation of the human body, and is based on Hebbian feedback covariance learning (proposed by Young et al) for predicting human thermoregulatory responses. This model was translated into Matlab to predict thermoregulatory responses during exercise, and was validated in cool, warm and hot environments. The model's predictions are comparable with observed thermoregulatory responses from existing literature. Good general agreement with the measured data was obtained for peak temperature during exercise.

## Session G4

### Microfluidics

#### Venus Room 1

1100 - 1240 8 December 2006 Friday

#### G4.1 P0171

##### Numerical Simulation of a Low Hematocrit Blood Flow in a Small Artery with Stenosis

T Ishikawa, \*N Kawabata, Y Imai, K Tsubota, T Yamaguchi

Tohoku University, JAPAN

\*University of Fukui, JAPAN

In this paper, a bead-spring model for an erythrocyte is used to simulate a low hematocrit blood flow in a small artery with stenosis. The flow field is solved in the Euler coordinates, whereas the motion of erythrocyte models is solved in the Lagrangian coordinates (two-way coupling). The results show that the erythrocytes considerably deform around the stenosis and the separated region downstream of the stenosis weakened by the erythrocytes.

#### G4.2 P0204

##### Computer Simulation of Effects of Deformabilities of Red Blood Cells on Blood Flow using Particle Method

K Tsubota, \*S Wada, Y Imai, T Ishikawa, T Yamaguchi

Tohoku University, JAPAN

\*Osaka University, JAPAN

A computer simulation using a particle method is carried out for the blood flow on the scale of microcirculation. Red blood cells (RBCs) and plasma are modeled by an assembly of the particles that have characteristics of the RBCs and plasma. A spring network model based on the minimum energy principle is applied to solve the motion of the RBC particles. The MPS method is applied to viscous plasma flow analysis. A two-dimensional simulation demonstrates that stiffer RBCs are less deformed, leading to large blood flow resistance.

#### G4.3 P0291

##### Microfluidics for Microphysiology

S Takayama

University of Michigan, UNITED STATES

The biophysical environment of mammalian cells is dynamic and is crucial for regulating cellular processes including signal transduction, growth, differentiation, motility, and apoptosis. This presentation will give an overview of efforts in our laboratory to develop programmable microfluidic systems that enable spatio-temporal control of both the chemical and fluid mechanical environment of cells. This platform technology builds upon polymer microfabrication techniques commonly referred to as "soft lithography" together with an array of pin actuators available in refreshable Braille displays, which are tools used by the blind to read email. The combined elastomeric chip-pin actuator array technology is reconfigurable and versatile in microfluidic control yet experimentally straightforward, relatively inexpensive, and rapidly implemented. Specific biological applications include regulation of myoblast growth and differentiation, study of the effect of fluid mechanical stresses on endothelial cells and lung epithelial cells, subcellular cell signalling, and in vitro fertilization on a chip.

#### G4.4 P0205

##### Dielectrophoretic Behavior and Separation of Viable and Nonviable Yeast Cells

D Chen, H Du, W K Cheah, \*W H Li

Nanyang Technological University, SINGAPORE

\*University of Wollongong, AUSTRALIA

Dielectrophoresis (DEP) is the motion of polarisable particles in non-uniform electric fields arising from the interaction of electric fields with the induced dipole on the particles. Its ability to manipulate and separate particles, especially living cells, is essential to many biological and medical applications. Dielectrophoretic separation works by applying a force field which takes advantage of differences between populations by exploiting differences in their makeup. This paper presents an experimental study of the behavior of *Saccharomyces cerevisiae* (strain RH1657) cells under the effects of AC electric field in microelectrode system. The behaviours of the viable and nonviable cells under varying frequencies are studied and discussed. Based on the understanding of these behaviors, separation of viable and nonviable yeast cells is successfully achieved under the experimental conditions. The cells are able to be dielectrophoretically separated because of their differences in dielectric properties. Under negative DEP, the cells are levitated to a height above the electrode. The levitation height is measured and studied.

#### **G4.5 P0290**

##### **Numerical Simulation of an Axial Blood Pump**

L P Chua, B Su, T M Lim, C M S Yu

Nanyang Technological University, SINGAPORE

The axial blood pump with magnetically suspended impeller has its superiority as compared to other artificial blood pumps because of its small size. In this paper, the numerical results show that the axial blood pump could produce 5.14L/min of blood at 100 mm Hg when rotating at 11,000 rpm, which basically could satisfy the basic physiological requirements. Although the exposure time of the blood cell at the high SS region within the pump was relatively short, which may not cause serious damage to the blood cells, the important of blade profile should be considered in the future design of the axial pump.

## Session G5

### Nanobiotechnology, Cellular and Tissue Engineering 1

Venus Room 3

1100 - 1200 8 December 2006 Friday

#### G5.1 P0117

##### Effect of Extra Cellular Matrix Development on Dextran Transport in Engineered Cartilage Tissue

S Sugino, M Watanabe, K Haari, Y Kitajima, Y Sawae, T Sanada, T Murakami  
Kyushu University, JAPAN

When engineered cartilage tissue transplant is selected as the therapeutic approach, engineered tissue should possess not only structural strength as load bearing tissue, but also physiological and biological function. Cartilage tissue is significantly different from other tissues for its rich highly sulfated extra cellular matrix (ECM), which is mainly composed of collagen and proteoglycan. Cartilage tissue is avascular, hence materials are transported from connective tissue or periosteum by mainly diffusion. Therefore we studied this mass diffusion process as ECM development. We visualized transport process in engineered cartilage tissue by fluorescent labeled dextran. Engineered cartilage tissue was originated from the bovine metacarpal-phalangeal joint with an ultra-low gelling temperature agarose. We discuss the effects of molecular weight and electric property of fluorescent labeled dextran on diffusion process in engineered cartilage tissue.

#### G5.2 P0195

##### Effects of Actin Filaments on the Viscoelastic Properties of Aortic Smooth Muscle Cells

K Nagayama, S Yanagihara, T Matsumoto  
Nagoya Institute of Technology, JAPAN

The stress relaxation test under constant strain was performed for cultured rat aortic smooth muscle cells using a laboratory-made micro tensile tester with feed-back control. Untreated cells and cells treated with cytochalasin D to disrupt their actin filaments were stretched by 70-85%, and their length was kept constant to obtain a stress relaxation curve. Viscoelastic analysis with 4-parameter Maxwell model showed that the stress relaxation process of the cells could be divided into two phases with different time constants: a fast phase with a time constant in the order of minutes, and a slow phase with a time constant in the order of hours. Elastic parameters in the two phases decreased similarly by about a half with actin filament disruption, while viscous parameters decreased to a greater degree in the slow phase than in the fast phase. No difference was observed for the relaxation time constant in the fast phase in response to actin disruption, while the time constant in the slow phase decreased significantly by about a half. Fluctuation in tension was observed in the stress relaxation curve of the untreated cells. Such fluctuation disappeared in cells treated with cytochalasin D. These results indicates that actin filaments may have significant effects on the slow phase and the fluctuation in tension as well as the slow decrease in tension may be caused by the dynamic change of intracellular actin filaments.

#### G5.3 P0273

##### The Human Umbilical Vein as an Acellular Scaffold for Vocal Fold Tissue Engineering

R W Chan, M Rodriguez  
University of Texas Southwestern Medical Center, UNITED STATES

Laryngeal pathologies such as vocal fold scarring, vocal polyps, cysts, and other benign lesions involve disturbed patterns of protein expressions and regulation in the vocal fold lamina propria extracellular matrix (ECM). The human umbilical vein (HUV) is a novel allogenic scaffold that has shown some promise in cardiovascular tissue engineering applications. This study examines the potential of the HUV as an acellular scaffold for engineering the vocal fold lamina propria, in order to develop an implantable tissue substitute that can promote a natural ECM remodelling response. A novel saline-based decellularization protocol developed in our laboratory was used to fabricate a three-dimensional, biodegradable, acellular scaffold from native HUV tissue. Histological examination and scanning electron microscopy demonstrated that native cells in the HUV were removed with a fine three-dimensional structure of proteins and proteoglycans well preserved. Human vocal fold fibroblasts from primary culture were cultivated on the abluminal surface of the acellular scaffold in vitro. Proliferation and infiltration of the fibroblasts in the scaffold were observed. These preliminary findings supported the biocompatibility of the HUV scaffold, and its promise for vocal fold reconstruction and regeneration.



## Session H1

### Neuromuscular Systems and Biomechanics 1

Jupiter Room 1

1400 - 1540 8 December 2006 Friday

#### H1.1 P0105

##### Degrees of Freedom And Resolution Of Kinematic Redundancy in the Coordination of Postural Movements

K Iqbal, \*Y C Pai

University of Arkansas at Little Rock, UNITED STATES

\*University of Illinois at Chicago, UNITED STATES

The degrees of freedom (DOF) problem in the physiological system refers to the profusion of DOF that must be controlled to bring about a coordinated movement [1]. In biomechanical models resolution of kinematic redundancy involves constraints on available DOF, whereas skills acquisition involves movement optimization using static or dynamic programming methods. We employed 1-, 2- and 3-DOF biomechanical models to analyze DOF problem and resolution of kinematic redundancy in the coordination of postural movements. Skills acquisition was measured in terms of improvement in the feasible range of center of mass (COM) anterior velocities that could be terminated over stationary base of support (BOS) given COM locations. We found that when a person learned to increase postural DOF from 1 (ankle only) to 2 (ankle and hip), and to 3 (ankle, knee and hip), the feasible range increased 20 and 31%, respectively, toward avoiding forward fall, as well as 65% in the latter case in avoidance of backward fall. These findings quantify the benefit of motor leaning to "defrost" the rigid motion observed in child development as well in physical rehabilitation.

#### H1.2 P0108

##### The Study on Flying Control of Free Flight Hawkmoth

H Wang, N Ando, R Kanzaki

The University of Tokyo, JAPAN

Conjugating a projected comb-fringe technique and a micro-telemetry technique, the mechanism on flying control of free flight hawkmoth (*Agrus convolvuli*) is studied, especially the role of the dorsal longitudinal muscles (DLM), the dorso-ventral muscles (DVM) and the upper unit of the 3rd axillary muscles (3AXM). The projected comb-fringe technique make it possible to investigate the wing kinematics and locomotion with adequate accuracy and the micro-telemetry device can be mounted on the free flying hawkmoth and transmit the electromyography signals by at least two channels. The results will illustrate that how the direct and indirect muscle activities control the flight maneuvers efficiently in the hawkmoth.

#### H1.3 P0113

##### Causal Relationship between Walking and Physical Malfunctions in Older Adults: A Computer Simulation Study

K Hase, G Obinata, A Nakayama

Nagoya University, JAPAN

The purpose of the present study was to investigate the causal relationship between walking pattern and physical malfunction using a computer simulation method with biomechanical walking models. In the computational experiment, five types of walking models were constructed: a normal model, a delayed response model, a weak muscle model, an inclined posture model, and a joint contracture model. These malfunction factors were hypothesized as having a causal relationship with walking characteristics in older adults. The simulation revealed that the delayed response in the neuronal system was primarily related to walking stability. In addition, the weakening of muscles was strongly related to the reduction of the walking step length. The inclined posture and joint contracture also influenced the walking pattern, but not significantly. The use of such a computer simulation method is essential in order to clarify the causal relationship between aged body function and waking pattern.

#### H1.4 P0123

##### Maximal Muscle Velocity: Reality or Theory?

F K Fuss, M A Tan

Nanyang Technological University, SINGAPORE

Maximal muscle velocity  $v_{max}$  is a theoretical value, which can be verified experimentally, but never reached in reality. Even when moving a limb segment as fast as possible, the linear muscle velocity at maximal angular velocity of the limb segment never corresponds to  $v_{max}$ . This study develops an equation which proves this fact.

## **H1.5 P0124**

### **Modelling of the Force-Displacement Relationship of the Sarcomere**

F K Fuss

Nanyang Technological University, SINGAPORE

This study provides an equation for calculating the sarcomere length at the beginning of the ascending shank of the force-displacement relationship. The hypothesis is that the sarcomere can still produce force at this point, however, it is in equilibrium with the spring forces of the compressed titin and myosin.

## Session H2

### Orthopedic Biomechanics 1

Jupiter Room 2

1400 - 1540 8 December 2006 Friday

#### H2.1 P0106

##### Global Optimization Method for Spherical and Cylindrical Wrapping in Musculoskeletal Modelling

A Audenaert, \*E Audenaert

University of Antwerp, BELGIUM

\*Ghent University Hospital, BELGIUM

In musculoskeletal modelling, many muscles cannot be represented as straight lines from origin to insertion as bony and musculotendinous morphology of neighboring structures causes them to wrap. The majority of these passive structures can be adequately described as simple geometric shapes like spheres and cylinders. Techniques for describing smooth muscles paths over multiple obstacles has been developed for modelling use. Until now obstacle-set methods combine the path of single structures. This does not analytically define the shortest smooth path around multiple objects. In cases a sphere is included in a multiple object wrapping algorithm, muscle paths around that sphere are restricted to a bundle of planes containing the sphere center. This assumed restriction can compromise the iteration process to find the true shortest muscle path that obeys to all restrictions of a smooth path. This can cause model instability. The new method involves selecting the shortest smooth muscle path from all possible smooth muscle paths between origin and insertion in a spherical and cylindrical wrapping algorithm for musculoskeletal modelling of the upper limb.

#### H2.2 P0107

##### Deltoid Mechanics in the Cuff Deficient Shoulder

E Audenaert, L De Wilde, \*A Audenaert, R Verdonk

Ghent University Hospital, BELGIUM

\*University of Antwerp, BELGIUM

Background: In the progression to cuff tear arthropathy (CTA), the shoulder function is often impaired, ranging from weakness to frank pseudoparalysis. The stages can be followed radiographically in terms of progressive ascension and medialization of the humeral centre of rotation. We investigated theoretically to what extent both parameters mechanically influence the functional performance of the deltoid muscle and so contribute to the clinically observed functional loss in CTA. Material and methods: Fifty three true anteroposterior radiographs of the dominant shoulder of young healthy subjects were analyzed to define normal glenohumeral relationships. A biomechanical model of the shoulder was then used to simulate ascension and medialization of the humeral centre of rotation and mechanically analyze their influence on deltoid muscle performance in absence of the rotator cuff muscles. Results: Ascension of the humeral head was found to cause an important loss in total deltoid moment, whereas medialization enhanced the deltoid moment but less importantly. Conclusions: Ascension and medialization of the humeral centre of rotation, as seen in the progression to cuff tear arthropathy significantly alter mechanics of the shoulder.

#### H2.3 P0130

##### Can Ankle Imbalance Determine the Weakness of the Lower Extremity Muscles?

I Corazza, \*M L Zampagni, \*D Casino, \*\*A Paladini Molgora, \*S Zaffagnini, \*M Marcacci, R Zannoli

University of Bologna, ITALY

\*Rizzoli Orthopaedic Institute, ITALY

\*\*C. Ondoli Hospital, ITALY

In clinical practice, kinesiological procedures are used to test muscles' weakness. Sometimes, injuries in lower extremities don't present a known cause and ACL (Anterior Cruciate Ligament) rupture can occur without trauma. A possible explanation could be the temporary inhibition of the muscular control following an alteration of the proprioceptive regulation in the ankle joint. We tested 15 patients affected by Ankle Imbalance Injury. Each subject performed an isometric contraction (Kinesiological Walther Test), involving hip, knee flexor and extensor muscles. Individuals were tested before and after percussion in the subtalus joint. Forces applied by the subjects were measured by a load cell and the signal was acquired by Light software. Statistical analysis was performed by t-Test. No differences in force intensities were obtained between investigations with and without subtalus stimulation. After percussion an evident decrease in the duration of the resistance (from 3.34,±0.69s to 0.92,±0.46s) was measured in all subjects (p<0.001). A perturbation of an overloaded joint can produce effects not only locally but also at the distal and proximal joint. This evidence probably explains all those orthopedic injuries not caused by traumatic events, affecting athletes who submit lower extremity joints to important stresses and overloads.

## **H2.4 P0180**

### **Generation of 3-D Parametric Solid Model of the Human Spine using Anthropomorphic Parameters**

D Breglia, \*B V Mehta

Honda Motor Company, UNITED STATES

\*Ohio University, UNITED STATES

It has been shown that there is a correlation between stature and the dimensions of the vertebra in humans. The objective of this research is to create a computer model of the vertebra that is personalized based on external metrics. Vertebral morphologies presented in the literature are used to create geometric primitives of each bone. Relationships from forensic science are used to relate an individual's stature to the heights of each of the vertebrae. Also, relationships between the vertebral height and the other dimensions of the vertebra are derived. The above information was used to create a parametric model of the human vertebrae which can be modified using few anthropomorphic key parameters like gender, height, and ethnic background of a subject. These models can be used for biomechanical studies like disc replacement, posture and back pain.

## **H2.5 P0181**

### **Customisation of Anatomically Based Musculoskeletal Structures**

K Mithraratne, P J Hunter

University of Auckland, Auckland, NEW ZEALAND

Geometrical accuracy of musculoskeletal structures is an important factor in biomechanical and computer vision applications. Creation of such structures, however, is tedious and time consuming. This difficulty can be overcome by customising (transforming) already existing (generic) anatomically based model geometries to subject specific data. This study looks at three such customising methods, namely the singular value decomposition (SVD) method, direct least squares method and host mesh fitting (HMF) method. All these methods are variants of least squares approach with some additional constraints in the third method. These methods have their own merits and disadvantages depending on the number of control data points available and the degree of transformation that the structure has to undergo. The methods are analysed and compared with the femur (thigh bone) and gastrocnemius (calf muscle) as examples.

## Session H3

### Physiologic System Modeling 2

Jupiter Room 3

1400 - 1500 8 December 2006 Friday

#### H3.1 P0110

##### Transient Transmembrane Potential due to Subthreshold Stimulus

P Giovanni, \*S Igor, P Paolo, \*V Bersenev, B Maria Grazia, L Belletti, G Belmonte  
University of Bologna, ITALY

\*National Academy of Sciences of Ukraine, UKRAINE

The transient response of the active nerve fibre to an extracellular excitation is investigated. Our aim is to evaluate the effect of the exciting pulse deviation from a step-function on changing the transmembrane potential  $V_m$  in time and space. This research is directly connected with the reflex-metameric therapy [1] dealing with the metameric nerve excitation.

#### H3.2 P0111

##### Modelling of Pulse Wave Propagation in Semi-Infinite Blood Vessel with Insertion

P Giovanni, \*S Igor, P Paolo, \*O Zvonareva, L Belletti, B Maria Grazia, G Belmonte  
University of Bologna, ITALY

\*National Academy of Sciences of Ukraine, UKRAINE

Heart pulse propagation in blood vessel in the presence of insertion at some distance from the input is investigated. It is assumed that the vessel material is viscoelastic and fluid is viscous. Corresponding IBV-problem is stated and solved by using the Laplace transform in time with a consequent numerical inversion. Calculations for the radial vessel displacement and shear effort are presented and analysed.

#### H3.3 P0187

##### Chi-Blood Interaction Model for Human Meridian System

T W H Sheu, V C Huang  
National Taiwan University, TAIWAN

With the advent of modern medicines, Meridian is still not observed physiologically. Based on the bio-fluid studies in mechanics, Chi is considered as the tissue fluid with ions. Chi and blood interact in a region near the acupuncture point through the action of many SMB (small meridian body). Following this concept, electro-osmosis flow model is proposed with an aim to translate the phenomena of Chi-blood interaction system. Our simulated results match the physiological theory in the sense that the same conclusions as those reported in the Chinese medicine literature can be drawn. It is confirmed that blood circulation and meridian path form a complicated electro-osmosis nonlinear system. The elliptic nature of meridian phenomenon explains why body fluid reacts immediately with the externally applied acupuncture. The blood circulation would effect the meridian system and vice versa. From this study, "Chi is blood's master, blood is Chi's mother", "Chi and blood depend on each other", and "Chi blocks, blood stasis" can be scientifically interpreted.

## Session H4

### Therapeutic Physics and Rehabilitation Engineering 1

Venus Room 1

1400 - 1540 8 December 2006 Friday

#### H4.1 P0128

##### Stroke Rehabilitation Knowledge Based System for Caregivers

Y H Kang, S Y E Lim

Nanyang Technological University, SINGAPORE

An easy to use computer-based Stroke Rehabilitation Assistant (SRA) has been developed to assist caregivers in their support to the stroke patients. This rule-based knowledge-based system deduces its recommendations similar to the stroke assessment methodology used by clinicians and therapists. Its knowledge was acquired through surveys, interviews, questionnaires, site visits and clinical observations, with close collaboration of experienced therapists. This is subsequently combined with the processes and methodologies of stroke assessment and rehabilitation to form the rules and conditions of the system. Prototype of SRA had been tested by therapists and care-givers in real life situations to validate its accuracy and practicality. SRA was able to guide and assist caregivers by providing useful, relevant and practical information on stroke. They were happy with its ease of use and pragmatic suggestions. SRA was also verified by therapists. This methodology can be extended to other neuromuscular disorders.

#### H4.2 P0139

##### Effects of Stent on the Flow in a Pipe with "Aneurysm"

T Kobori, N Arai, Y Tkakura, \*Y Konishi, \*\*K Fukasaku, \*\*\*N Kikuchi

Tokyo Noko University, JAPAN

\*Kyorin University, JAPAN

\*\*RIKEN, JAPAN

\*\*\*KANEKA Medics, Co. Ltd., JAPAN

The endovascular therapy is performed for aneurysm. The change of flows after the endovascular therapy completed is not yet made clear. The object is to investigate the effects of the three kinds of stents on the flow in a pipe with a "aneurysm". The fluid-dynamic effects of stent on the flow field is mainly that the flow is controlled in streamwise by putting the stent there. The frictional effects of flow caused by the stent alters the flow pattern in the aneurysm.

#### H4.3 P0220

##### Analysis of Walking Motion for Preventing Falling down with Electromyograph

S Sano, T Terada, S I Takeda, Y Izumi, S Nishijima

Osaka University, JAPAN

In this work the particular attention was paid to the motion of muscle during slipping and fall and the mechanism was investigated. The muscle that worked actively was specified and the muscular power was evaluated by the motion analysis and EMG. After the slipping the flexion moment around hip and the extension moment around knee joint increased. This is because the falling down was prevented by using the muscular power of the supporting leg.

#### H4.4 P0221

##### Study of Fatigue using Biomedical Measurement

T Ozaki, T Terada, S I Takeda, Y Izumi, S Nishijima

Osaka University, JAPAN

Stress caused by a VDT (Visual Display Terminal) task was evaluated using magnetoencephalogram (MEG), concentration of cortisol, electrocardiogram (ECG) and sensory test. In MEG, the P300m amplitude decreased after the VDT task. The correlation between the sensory value the intensity of P300m obtained from right auditory area, and that obtained from left auditory area was examined. The P300m latency showed a weak positive relationship with sensory value and the P300m amplitude obtained from left auditory area showed negative relationship with sensory value. It was suggested that the stress could be objectively evaluated using the P300m amplitude obtained from left auditory area. It is expected that the appropriate method for recovering the stress can be selected by using the P300m response, the concentration of cortisol, heart rate, and sensory test comprehensively.

#### **H4.5 P0224**

##### **Machine Control in Real-Time by EEG Analysis**

S Inoue, T Terada, Y Izumi, S I Takeda, S Nishijima  
Osaka University, JAPAN

We succeeded in operating the robot arm in real time by using the alpha wave measured with noninvasive electrodes. When the alpha wave was appearing, the subject selected the movement of the robot arm and controlled four movements. Consequently, the subject succeeded in lifting the object by controlling the robot arm with brain wave. The BCI using the alpha wave needs less training than that using others, since the alpha wave can be developed easily. The alpha wave was distinguished by the FFT analysis and confirming amplitude of the alpha wave. It is thought that this technique is applicable to communications and the control of other external equipments. Quality of Life(QOL) of the mobility disabled is expected to be improved by developing this technique.

## Session H5

### Nanobiotechnology, Cellular and Tissue Engineering 2

Venus Room 3

1400 - 1440 8 December 2006 Friday

#### H5.1 P0158

##### Adhesion Contact Dynamics of Porcine Esophageal Fibroblasts on ECM Protein-Immobilized Poly (Lactic Acid)

N Cai, G Ma, P S Mhaisalkar, K S Chian, V Chan, K Liao  
Nanyang Technological University, SINGAPORE

Poly(lactic acid) (PLA) can be subjected to surface modification by immobilizing natural extracellular matrix (ECM) proteins on its surface to promote cell adhesion because it lacks the bioactive domains needed in cell adhesion. In this study, two typical ECM proteins, type I collagen (COL) and fibronectin (FN) were immobilized on PLA surface by covalent binding and physical absorption, respectively. By using confocal reflectance interference contrast microscopy (C-RICM) in conjunction with phase contrast microscopy, the adhesion contact dynamics of porcine esophageal fibroblasts (PEFs) on three types of surfaces (unmodified PLA, PLA-COL, PLA-FN) was investigated. It is demonstrated by C-RICM results that PEFs form strong adhesion contact on all three types of surfaces. The time needed for PEFs on PLA, PLA-COL, PLA-FN to reach steady state (indicated by the adhesion energy obtaining the maximum value) is about 70, 60, and 20 min, respectively. Furthermore, cell attachment ratio experiments demonstrate that PEF attachment ratio on PLA in 2 h is only 18% comparing with 89% on PLA-FN, and 73% on PLA-COL. Results suggest that fibronectin-coated PLA can promote better PEF adhesion and has the potential application for esophageal tissue engineering in the future.

#### H5.2 P0196

##### Viscoelastic Properties of Human Mesenchymal Stem Cells

S C W Tan, G Ma, N Cai, K Liao  
Nanyang Technological University, SINGAPORE

This study investigates the viscoelastic properties of individual human adult bone marrow-derived mesenchymal stem cells (hMSCs) by using micropipette aspiration technique. At 37°C, the instantaneous and equilibrium Young's moduli were found to be  $518 \pm 280$  Pa and  $126 \pm 81$  Pa respectively. The apparent viscosity,  $\dot{\gamma}$ , was obtained as  $5290 \pm 3026$  Pa.s. During the investigation, 4 different types of viscoelastic behaviors were discovered.



## Session J1

### Neuromuscular Systems and Biomechanics 2

Jupiter Room 1

1610 - 1730 8 December 2006 Friday

#### J1.1 P0136

##### Applications of Efficient Forward Dynamics Simulation in Biomechanics

M Stelzer, O Von Stryk  
Technische Universitaet Darmstadt, GERMANY

Optimizing and analyzing human motion dynamics on a detailed kinetic level is a very complex task. Results are presented for the efficient forward dynamics simulation which is advantageous to inverse dynamics simulation in terms of general merit functions for muscle control and its flexibility with respect to different tasks such as analysis of measured human motion or prediction of free goal oriented human motion. Efficient multibody system dynamics calculation methods as well as efficient numerical optimal control techniques are used and lead to a forward dynamics optimization approach being two orders of magnitude more efficient than existing approaches. Results are presented for a kicking motion.

#### J1.2 P0169

##### Electromyographic and Kinematic Aspects of Landing Movements in Humans with Visual Deficiency

F H Magalhaes, D G Goroso  
Mogi das Cruzes University, BRAZIL

The role of vision in modulating motor control aspects in landing from a drop has been investigated. Subjects (n = 10) performed 6 drops from four heights (0.2, 0.3, 0.4 and 0.5m) with and without vision. Two chronic blind volunteers were submitted to the same task. Leg muscles EMG and knee angle variations were measured. The aim of the study was to assess the extent to which proprioceptive and vestibular information could substitute for the acute and chronic lack of vision in adapting landing movements. Until the present moment it was found larger mean EMG values of TA, ST and VL muscles at the 100ms just before landing for the vision condition and mean EMG 100 ms post landing values for all muscles significantly larger for the some first drops in the non vision condition (except TA also larger in other situations). In conclusion, as it is an on going study, the chronic blind group has to be completed (n=10), as well as other variables must be analysed. The preliminary results show that vision is important for modulating muscle activity amplitude during landing, as it seems that non-visual sensory information could not fully compensate the lack of continuous visual feedback.

#### J1.3 P0191

##### Isokinetic Cycling Versus Elliptical Stepping: A Kinematic and Electromyography Analysis

N A Hamzaid, G M Davis, R M Smith  
The University of Sydney, AUSTRALIA

This study investigated the leg muscle activation pattern and kinematics of two exercise modes – cycling and elliptical stepping. Ten lower limb muscles were investigated, involving EMG recordings with activation duration and power production analysis. At constant velocity (isokinetic) mode, muscle EMG analysis revealed that an elliptical stepping movement evokes greater vastii muscle activation, in terms of activation duration and power production, compared to cycling (p<0.05).

#### J1.4 P0306

##### Upper Limb Kinematic Performance Analysis using Ultrasonic Motion Analysis System

M Y Lee, C F Lin, C C Yang, C C Lo  
Chang Gung University, TAIWAN

An objective test for evaluating the kinematic performance of the upper limbs (UL) in patients with neurological diseases (ND) is presented. The method allows assessment of kinematic motor abilities of UL. Our methodology is based on creating physical and virtual test environment, using a computer monitor for visual display and a 3D movement registration system for motion tracking. The 3D movement registration system employ active markers that emit ultrasonic signals detected by a fixed set of microphones are used as a kinematic measuring device. In virtual environment, a circular reference path was shown in the computer screen in front of the testers at the start of each test. By moving the hand-held test pen the patient was able to move the pointer along the circular reference path in three dimensions. The patient's primary task was to trace the reference trajectory as quickly as possible, with as few contacts (collisions) with the desired path as possible. The test makes various degrees of complexity possible; by choosing different shapes of path with various track width and length. The new test offers a wide range of numerical and graphic results. It has so far been applied to 40 subjects with various forms of ND (e.g., Cerebro-Vascular Accident, Parkinson's disease) as well as to healthy subjects. The comparison in performance between right and left UL has been carried out in healthy subjects.

## Session J2

### Orthopedic Biomechanics 2

Jupiter Room 2

1610 - 1730 8 December 2006 Friday

#### J2.1 P0190

##### **A Study about Mechanical Influence of Spinal Shortening on Titanium Mesh Cage using in the Total En Bloc Spondylectomy**

J Sakamoto, D Tawara, \*C Uesaka, H Kato, \*\*H Murakami, \*\*N Kawahara, J Oda, K Tomita

Kanazawa University, JAPAN

\*Omuron Health Care Co., JAPAN

\*\*Kanazawa University Hospital, JAPAN

Spinal shortening operation has been introduced into the spine reconstruction after total en bloc spondylectomy, because of good effect on spinal cord blood supply and function. However, mechanical influence of spinal shortening has not been cleared. In this study, mechanical influence of spinal shortening on stability of reconstructed structure after total en bloc spondylectomy was investigated by using finite-element analysis. Force distribution around titanium mesh cage, which replaced to tumorous vertebra, was analyzed in the normal and shortening case. Mechanical effect of spinal shortening was discussed by comparing the results each other.

#### J2.2 P0222

##### **Numerical Study of Tracer Transport in Lacuna-Canaliculus System under Cyclic Loading**

E Tung, H Yokota, A Hsu

Purdue University Indianapolis, UNITED STATES

Physiological activities such as walking and jogging can help bones grow and remodel. Many investigations, both experimental and theoretical, were performed in the past with the intention to find ways to control the enhancement of bone remodeling. Early theoretical solution for a solute dispersing in a pulsatile flow through a tube demonstrated the diffusion enhancement effects of pulsatile motions. More recently, with the development of advanced equipment, the transport enhancement is demonstrated in real bones experimentally. The newly developed imaging technique, fluorescent recovery after photobleaching (FRAP), traces the bone mass in lacuna canaliculus (LC) systems. In the present study, we attempt to computationally evaluate the mass transport enhancement effects. The primary goals of the work presented here are (1) to construct a realistic and computationally viable L-C model, (2) to evaluate the effects and relative importance of frequency and amplitude of pressure fluctuation.

#### J2.3 P0319

##### **Preliminary Investigation of Humeral Head and Glenohumeral Joint: A Finite Element Simulation**

W C Hung, C H Chang, A T Hsu

National Cheng Kung University, TAIWAN

The glenohumeral joint activity has the largest range of motion among human joint. It provides different characteristics of mobility and stability during upper extremity activity. Many literatures existed to investigate the biomechanical of the glenohumeral joint. Due to the large range of motion and the complex geometry of glenohumeral joint, few studies reconstruct the intact geometrical model to discuss the force distribution and stability of the glenohumeral joint. Most of the finite element model of the glenohumeral joint were developed to discuss the glenoid contact stress after total shoulder arthroplasty. The objectives of this study was to establish a finite element shoulder model and to investigate the relationship between humeral head and glenoid contact condition. The shoulder geometry was reconstructed from the computerized tomography. The medial border of the scapula was constrained as the boundary condition. The humeral head was applied a displacement toward the glenoid fossa. The peak stress occurred at the superior region of the glenoid. The results were consistent with the general mechanics concept. The finite element method is suitable to discuss the glenohumeral joint stability. The future work was to modify this model and to include the shoulder muscles and ligaments of the glenohumeral joint.

## Session J3

### Neural Engineering

Jupiter Room 3

1610 - 1650 8 December 2006 Friday

#### J3.1 P0295

##### Quantified Deep Tendon Reflex Device, Second Generation

R C Lemoyne, R Jafari

University of California, Los Angeles, UNITED STATES

The deep tendon reflex is a fundamental aspect of a neurological examination. The severity and degree of recovery for a traumatic brain injury can be assessed by the myotatic stretch reflex. A hyperactive reflex response is correlated with spasticity, which also can be correlated with the degree of damage to the supraspinal input, in essence assessing the severity of traumatic brain injury. The myotatic stretch reflex is clinically evaluated by the NINDS reflex scale (0 to 4). The NINDS reflex scale however lacks temporal data and also may vary in terms of interpretation. The solution is a fully quantified evaluation system of the myotatic stretch reflex. A patellar hammer's force input will be based on original potential energy. A MEMS accelerometer will quantify the output. The MEMS accelerometer is attached to a set anchor point near the ankle. The reflex amplitude is based on the maximum acceleration of the reflex response. The quantified data collected from MEMS accelerometers is transmitted by a portable computer (i.e. a Pocket PC). Enclosed is the description of a device which quantitatively evaluates the reflex response using accelerometers, which demonstrates precision for reproducibility.

#### J3.2 P0114

##### Fractional Model of Brain Response to External Stimuli

V V Kulish, W K Chan

Nanyang Technological University, SINGAPORE

The paper presents a novel mathematical model of the brain response to external stimuli. A new concept of the distance in the informational space has been introduced. It has been shown that action potentials and electroencephalograms can be simulated as the solution to the fractional energy equation that governs transport processes within the cortex.

## Session J4

### Therapeutic Physics and Rehabilitation Engineering 2

Venus Room 1

1610 - 1710 8 December 2006 Friday

#### J4.1 P0304

##### **A Trial Study of Prototyped Standing Wheelchair by SCI Patients with Maneuver Skill Training Instruction**

M Y Lee, C F Lin, K S Soon  
Chang Gung University, TAIWAN

The purpose of this study was to survey the satisfaction with a newly developed prototyped powered standing wheelchair for SCI patients in Taiwan. A questionnaire was designed and used to collect information about satisfaction level score in wheelchair stability, operation security and maneuverability (3 items) of powered standing wheelchair maneuvered by SCI subjects with ( n=14 ) or without ( n=9 ) maneuver skill training instruction. A t test for independent samples indicated that a significant difference of satisfactory scores in all 3 items between subjects with or without training instruction. These results demonstrate that SCI patients can easily manipulate powered standing wheelchair satisfactorily and perform upright functional activities after appropriate instructions. Besides, most subjects highly recommended use of standing devices under professional training and instructions to the others with SCI.

#### J4.2 P0305

##### **Improvement of Single Leg Standing Balance Performance using Sub-Sensory Stimulation for Amputees**

M Y Lee, C F Lin, K S Soon  
Chang Gung University, TAIWAN

Abstract: Sub-sensory electrical or mechanical stimulation can enhance the sensitivity of the human somatosensory system to improve the balance control capabilities of elderly was shown in recent rehabilitation articles. In this article, we hypothesized that the static balance of single leg quiet standing could be improved for providing proprioceptive neuromuscular facilitation using sub-sensory stimulation in amputees. To test this hypothesis, a computerized sub-threshold low-level electrical stimulation device was developed and proposed for clinical study. Six unilateral trans-tibial amputees who consecutively wore prosthetics over 2 years were recruited in this study. Subjects performed single leg quiet standing trails with sub-sensory electrical stimulation applied at the quadriceps muscle during the trails. Static balance performance was characterized using Zebris motion analysis system to measure the sway distance and duration of the center of mass (COM) on second sacral (S2) of the subjects. Experimental results show that reduction in all of the postural sway indices (constant time sway length, max sway distance and average sway distance) and increase in single leg support time index during single leg quiet standing by applying sub-sensory stimulation. The improvement ratio of four balance performance indices across subjects for single leg quiet standing tests were resulted in a 132.34% in HTI, 2.52% in SLI, 44.61% in MSDI, and 61.45% in ASDI. These findings suggest that sub-threshold electrical stimulation rehabilitation strategies may be effective in improving static balance performance for amputees.

#### J4.3 P0308

##### **Treadmill Ambulatory Balance Enhancement with Visual-Auditory Biofeedback in Amputees**

K S Soon, M Y Lee, C F Lin  
Chang Gung University, TAIWAN

Abstract: Visual-auditory biofeedback technique can improve sensory compensation of the human somatosensory system to improve the balance control capability of amputees was shown in recent rehabilitation articles. In this article, we hypothesized that the dynamic balance of treadmill walking could be improved by providing visual-auditory biofeedback technique in amputee subject. To test this hypothesis, a computerized foot pressure biofeedback sensory compensation device was developed and proposed for clinical study. Seven unilateral trans-tibial amputees who consecutively wore prosthetics over 2 years were recruited in this study. Treadmill ambulatory trails with or without visual-auditory biofeedback was performed by the amputee subjects. Experimental results show that the improvement of all four dynamic gait performance indices (double support time, stance/swing time ratio, constant time cadence, and sound side single support time index) in amputees were verified. The improvement ratio of four gait performance indices across subjects resulted in a 7.89% in DSP (affected side), 8.59% in CTC, 16.67% in SSP (sound side), 45.30% in SSR (sound side), and 40.30% in SSR (affected side) respectively. These findings suggest that visual-auditory biofeedback rehabilitation strategy may be effective in compensating sensory loss and improving dynamic ambulation performance for amputees.

---

## Author Index

---

### A

Abbott D ..... A3.4  
 Acharya U R..... E2.1, E2.2, E2.3, E2.4,  
 ..... F2.1, F2.2, F2.5  
 Agarwal R..... C2.2  
 Aissaoui R ..... A5.2  
 Akiyama Y ..... C3.4, D3.1  
 Akutsu T ..... B2.4, B2.5  
 An K N ..... F4.5, F5.1  
 Ando N..... H1.2  
 Ao H R ..... E5.2  
 Aoki T ..... B2.3  
 Arai N ..... H4.2  
 Audenaert A ..... H2.1, H2.2  
 Audenaert E..... H2.1, H2.2

### B

Balachandran S ..... C2.1  
 Banakh I ..... E4.2  
 Basker R ..... D3.3  
 Bayrak C ..... C1.3  
 Begg R..... E4.1  
 Belletti L..... H3.1, H3.2  
 Belmonte G ..... H3.1, H3.2  
 Bersenev V ..... H3.1  
 Blondeel P N ..... B1.3  
 Blyakhman F A ..... C2.3  
 Bovin K ..... A5.2  
 Breglia D ..... H2.4  
 Burdet E..... B3.2

### C

Cai N ..... H5.1  
 Cai N ..... H5.2  
 Casino D ..... H2.3  
 Chaichanyut M ..... A4.1, C4.1, C4.2  
 Chan C C H..... F1.2  
 Chan H..... F2.4  
 Chan R W ..... G5.3  
 Chan S M ..... A1.3  
 Chan V..... H5.1  
 Chan W K ..... J3.2  
 Chandran V ..... E2.4, F2.1, F2.2  
 Chang C H..... A2.2, J2.3  
 Chang G L ..... D5.3, F4.5, F5.2, F5.3  
 Chang H C..... C1.2  
 Chang H W ..... F4.2  
 Chang J H..... F4.3  
 Chang J Y ..... A2.2, D5.3  
 Chang Y H..... D1.3  
 Cheah W K ..... G4.4  
 Chee C..... E2.3  
 Chee J ..... F2.4  
 Chen C Y P ..... A4.4, B4.1  
 Chen D F..... G4.4  
 Chen S B..... F4.2  
 Chen Y C..... F4.2  
 Chen Z G..... E4.3  
 Cheng H..... F1.5  
 Chern J S ..... F5.6  
 Cherng R J..... C3.2

Cherng R J..... F4.1  
 Chew C M ..... A4.4  
 Chew C M ..... B4.1  
 Chia S J ..... G3.3  
 Chian K S ..... H5.1  
 Chiang I T J ..... F1.5  
 Chiu H Y ..... F4.3  
 Chiu Y H ..... A2.2, C5.1  
 Choi D Y ..... E1.1  
 Choi J S..... F4.7  
 Choo K W ..... C5.2, D4.1, D4.2  
 Chou S Y ..... F5.5  
 Chow J Y ..... F2.3  
 Chua K C ..... E2.1, E2.2, E2.3,  
 ..... E2.4, F2.1, F2.2, F2.5  
 Chua L P..... C2.4, D2.1, D2.2, G4.5  
 Chung K C ..... D5.1, D5.2, D5.3  
 Chung S C ..... F4.7  
 Corazza I..... H2.3  
 Cui F S ..... D3.4  
 Czempinska-Switalska Z ..... D1.4

### D

Davis G M ..... J1.3  
 De Guise J A ..... A5.2  
 De Wilde L ..... H2.2  
 Dhakshinamoorthy P ..... D3.2, D3.3  
 Dhandapany P S ..... B2.2  
 Di Bartolo C ..... B1.3  
 Doi Y..... C3.4, D3.1  
 Du H J..... G4.4  
 Du T H ..... B3.2  
 Dunstan C..... D4.3  
 Dzgmuhadze E S ..... C2.3

### E

Eng A K H..... C5.2  
 Eng S T ..... A4.2  
 Eom G M ..... F4.7

### F

Fan L J ..... B1.1  
 Faust O ..... E2.2  
 Feeney S J ..... E4.2  
 Fok S C ..... C5.3  
 Fragrance Latha V..... B2.2  
 Fu C L ..... D5.1  
 Fukasaku K ..... H4.2  
 Fuss F K ..... H1.4, H1.5  
 Futohashi T..... G1.1

### G

Ganesan V ..... B2.2  
 Gardiner B S ..... C4.4, D4.3  
 Ghista D N ..... C2.4, D2.1, E1.2  
 Giovanni P ..... H3.1, H3.2  
 Goh C H J ..... B4.2  
 Goh E..... E2.1  
 Gonez L J..... E4.2

Goroso D G.....J1.2  
 Goulernas J Y.....F1.1  
 Gunawardana U ..... B3.1

## H

Haari K .....G5.1  
 Hagemeister N ..... A5.2  
 Halic T ..... C1.3  
 Hamzaid N A.....J1.3  
 Harrison L C..... E4.2  
 Hase K..... G1.1, H1.3  
 Hashizume M ..... C3.1  
 Hassan M R ..... E4.1  
 Hayasaka T..... C5.4  
 He X M..... B1.2  
 Higaki H .....G1.2  
 Himeno T ..... A2.4  
 Ho H N..... A4.4, B3.2, B4.1  
 Horiguchi H ..... A2.3  
 Hou C J .....F3.1  
 Howard D .....F1.1  
 Hsiao R L..... D5.2  
 Hsieh L F..... D5.4  
 Hsu A..... J2.2  
 Hsu A T..... F4.5, J2.3  
 Hsu H Y..... F4.3  
 Hsu Y F..... F1.5  
 Hu D J J ..... A4.2  
 Huang C K..... C1.2  
 Huang T Y ..... F5.4, F5.5  
 Huang V C..... H3.3  
 Huang Z W ..... B4.2  
 Hung W C..... J2.3  
 Hunt J..... B1.3  
 Hunter P J ..... H2.5  
 Husse S ..... A5.2  
 Hussey A J..... E4.2  
 Hwang C K ..... D1.1, D1.2

## I

Igor S ..... H3.1, H3.2  
 Ilic V..... B3.1  
 Imai R..... B2.4  
 Imai Y..... B2.3, C5.4, G4.1, G4.2  
 Inoue S..... H4.5  
 Iqbal K.....C1.3, H1.1  
 Ishikawa T..... B2.3, G4.1, G4.2  
 Ivanov N ..... A3.1  
 Iwamoto Y..... G1.2  
 Izumi Y .....C3.4, D3.1, H4.3, H4.4, H4.5

## J

Jafari R ..... F3.3, J3.1  
 Jang Y J ..... C5.1  
 Jeyapalina S ..... A4.4, B4.1  
 Ji W F ..... D2.1  
 Jiang H Y..... E5.1, E5.2  
 Jothi Rajan M A ..... B2.2  
 Ju M S.....F1.3

## K

K Rappel J ..... B3.2  
 Kakuknai S ..... C1.4  
 Kaneko H..... C1.4  
 Kang Y H ..... H4.1  
 Kannathal N ..... E2.2  
 Kanzaki R ..... H1.2  
 Karalis T K ..... G2.1  
 Karino T ..... B1.1, B1.2  
 Katiyar V K ..... C2.2  
 Kato H..... J2.1  
 Katti S K..... A3.2  
 Kaufman K R..... F5.1  
 Kawabata N ..... G4.1, J2.1  
 Kawakami K ..... G1.1  
 Kelso R M ..... A3.4  
 Kenney L ..... F1.1  
 Khong P W ..... B5.1, B5.2, B5.3  
 Khoo L P..... C5.3  
 Kikuchi N ..... H4.2  
 Kim C H..... F4.7  
 Kimura H ..... C3.4, D3.1  
 Kishimoto M ..... C5.4  
 Kitajima Y..... G5.1  
 Knight K R ..... E4.2  
 Kobori T ..... H4.2  
 Kockara S ..... C1.3  
 Koh M ..... F2.3  
 Kolchanova S G ..... C2.3  
 Komiya A..... G3.2  
 Kon O L ..... C5.2  
 Kong W M ..... D4.1  
 Konishi K ..... C3.1  
 Konishi Y ..... H4.2  
 Kotajarvi B..... F5.1  
 Kremleva Y V ..... C2.3  
 Kuklik P..... A3.4  
 Kulish V V..... J3.2  
 Kumar M A..... A3.2  
 Kuo C H..... D1.3  
 Kuo F L..... D5.4  
 Kuo L C ..... F4.3  
 Kuo T Y ..... F5.4, F5.5  
 Kuo Y F ..... F4.1

## L

Le T T ..... E1.2  
 Lee B S ..... F4.7  
 Lee H P ..... D3.4  
 Lee J J..... C5.1  
 Lee J K Y ..... A4.2  
 Lee M Y ..... J1.4, J4.1, J4.2, J4.3  
 Lee N ..... F2.4  
 Lee W H ..... A1.1  
 Lemoyne R C..... F3.3, J3.1  
 Lertpasert P ..... C4.1, C4.2  
 Li C H..... F4.2  
 Li W H ..... G4.4  
 Liao K..... H5.1, H5.2  
 Lim B H ..... A4.4, B3.2, B4.1  
 Lim C M..... E2.1, E2.2, E2.3, E2.4,  
 ..... 2.1, F2.2, F2.5  
 Lim K H ..... A4.4, B4.1  
 Lim L W..... G3.5  
 Lim S Y E..... H4.1

Lim T M.....	D2.2, G4.5
Lin C C K.....	F1.3
Lin C F.....	J1.4, J4.1, J4.2, J4.3
Lin C J.....	F4.4
Lin C L.....	D1.3
Lin H C.....	C3.2
Lin H T.....	F4.5
Lin K B.....	D1.1, D1.2
Lin P C P.....	F5.1
Lin T Y.....	F5.4, F5.5
Lin Y H.....	D1.1, D1.2
Liu H L.....	D1.3
Liu K C.....	A2.2
Liu K P Y.....	F1.2
Liu Z F.....	D5.3
Liu Z J.....	D3.4
Liu Z Z.....	A1.2, A1.3
Liyana-Pathirana R.....	B3.1
Lo C C.....	J1.4
Lo H C.....	F5.2, F5.3
Lu C.....	D3.4
Lu N L.....	E5.2
Lu S C.....	F4.3
Lu S K.....	A1.1
Lum F T.....	E2.1
Lung C W.....	F5.6
Lynch K.....	E4.1

## M

Ma C B.....	E5.2
Ma G.....	H5.2
Ma G W.....	A1.4, H5.1
Ma X Y.....	A5.1, G1.3
Magalhaes F H.....	J1.2
Marcacci M.....	H2.3
Maria Grazia B.....	H3.1, H3.2
Marisa H.....	E1.3
Maruyama S.....	G3.2
Mathavan T.....	B2.2
Matsubara M.....	C3.1
Matsumoto T.....	G5.2
Mazumdar J.....	A3.4
Meenachi Sundram N.....	F2.3
Mehta B V.....	H2.4
Mezghani N.....	A5.2
Mhaisalkar P S.....	H5.1
Miao J M.....	C1.1, C1.2
Mironkov A B.....	C2.3
Mithraratne K.....	H2.5
Miura H.....	G1.2
Mizuno F.....	C5.4
Mo X M.....	E4.3
Mochizuki S.....	C1.1
Mohamed Junaid K A.....	B3.3, B3.4
Mohd Kairi M F.....	F2.3
Mori K.....	B2.5
Morita M.....	C1.4
Morsi Y S.....	B2.1, E4.1
Munisamy K M.....	C2.1
Murakami H.....	J2.1
Murakami T.....	G5.1

## N

Nagayama K.....	G5.2
-----------------	------

Naidich A M.....	C2.3
Nakamura H.....	C5.4
Nakanishi Y.....	G1.2
Nakayama A.....	G1.1, H1.3
Naktawan A.....	A4.1, C4.2
Ng E Y K.....	F2.5, G3.1, G3.3, G3.4, G3.5
Ng W K.....	G3.3, G3.4
Nishijima S.....	C3.4, D3.1, H4.3, H4.4, H4.5
Nishimura J.....	C1.4
Nizeki K.....	F4.6
Nowinski W L.....	A3.1

## O

Obinata G.....	G1.1, H1.3
Oda J.....	J2.1
Okajima J.....	G3.2
Okamoto T.....	G1.2
Ong F R.....	C3.3
Onishi K.....	G1.1
Ooi E H.....	G3.1
Owida A A.....	B2.1
Ozaki T.....	H4.4

## P

Pai Y C.....	H1.1
Paladini Molgora A.....	H2.3
Paolo P.....	H3.1, H3.2
Parihar R S.....	D3.2
Parihar R S.....	D3.3
Patronik N A.....	E1.1
Penington A J.....	E4.2
Perreault E J.....	F1.4
Phasukkit P.....	A4.3
Phonphruksa P.....	A4.1, C4.1
Pivonka P.....	C4.4, D4.3
Png A E H.....	C5.2
Poh C K.....	G3.4
Potjanasaja I.....	A4.1
Pradhan P.....	C2.2
Pragya.....	D3.3

## R

Rajini A.....	D3.3
Ramakrishnan S.....	F3.2
Rani H P.....	G2.2
Rasana K.....	D3.3
Ravindran G.....	B3.3, B3.4
Ren R M.....	B5.3
Riviere C N.....	E1.1
Rodriguez M.....	G5.3
Rowe R.....	C1.3

## S

Saito J.....	B2.4, B2.5
Sakai E.....	A2.4
Sakamoto J.....	J2.1
Sakamoto T.....	C1.4
Sanada T.....	G5.1
Sanders P.....	A3.4
Sangworasil M.....	A4.3
Sano S.....	H4.3
Sarayu Parimal A.....	A3.1

Sawae Y	G5.1
Settle K	F1.4
Sharma J	D3.2
Shen X Y	G1.3
Sher Y J S	D5.1, D5.2
Sheu T W H	G2.2, H3.3
Shi W L	A5.1, G1.3
Shivamurthy P M	A3.2
Shu D W	A1.4
Sim M R Z	A4.2
Singh S	D3.3
Slawomirski M R	D1.4
Smith D W	C4.4, D4.3
Smith R M	J1.3
Sokolov S Y	C2.3
Song G L	D2.2
Soon K S	J4.1, J4.2, J4.3
Stelzer M	J1.1
Stillaert F B	B1.3
Su B Y	G4.5
Su F C	F4.1, F4.2, F4.3, F4.4, F5.1
Subbaraman R	A4.2
Subbhuraam V S	B5.1, B5.2
Sugino S	G5.1
Sun M T	D1.3
Suri J	E2.1, E2.2, F2.5
Suzuki T	B2.4, B2.5

## T

Tack G R	F4.7
Taenaka Y	A2.3
Tai K	G3.4
Takashima T	G1.2
Takayama S	G4.3
Takeda S I	C3.4, D3.1, H4.3, H4.4, H4.5
Tan B K	D3.4
Tan M A	H1.4
Tan P H	E2.1, F2.3
Tan R S	E1.2
Tan S C W	H5.2
Tan X N S	F2.3
Tan Y K	G3.3
Tan Y S	C2.4, D2.1
Tawara D	J2.1
Teh E	E2.1
Teh S K	B4.2
Teo C L	A4.4, B3.2, B4.1
Terada T	H4.3, H4.4, H4.5
Thaddeus A	B2.2
Thakur M S	A3.2
Tham L W M	C5.2
Thies S	F1.1
Tian T Y	A1.1
Tkakura Y	H4.2
Toh H J	A4.2
Tomita K	J2.1
Torii S	C4.3
Tortal E	B3.1
Tresadern P	F1.1
Tsai K H	F5.2, F5.3
Tsai M S	A2.2, D5.3, F3.1
Tsai S F	G2.2
Tsai Y A	F1.5
Tseng C C	F3.1
Tsubota K	B2.3, G4.1, G4.2

Tsubta K I	C5.4
Tsujimoto Y	A2.3
Tsukiya T	A2.3
Tung E	J2.2
Tung W L	F4.2
Tungjitkusolmun S	A4.1, A4.3, C4.1, C4.2
Turcot K	A5.2

## U

Uesaka C	J2.1
Umapathy S	B2.2
Umeda S	E3.1

## V

Veezhinathan M	F3.2
Venkatesh Y V	E2.3
Verdonk R	H2.2
Vivekanandam T S	B2.2
Von Stryk O	J1.1

## W

Wada S	G4.2
Wang H	H1.2
Wang H C	C5.1
Wang J L	A3.3
Wang L H	F4.4
Wang Y	E5.1
Watanabe K	F4.6
Watanabe M	C3.1, G5.1
Watanabe S	C3.1
Watanabe T	A2.4
Weber H J	E4.3
Wei W	E5.2
Wong C H	D3.4
Wong C S	B2.1
Wong K K L	A3.4
Wong L Y	E2.3, F2.5
Wong W K	C5.2
Worthley S G	A3.4
Wu Z W	F1.3

## X

Xiang Y	B3.1
Xu Y Q	A4.2

## Y

Yamaguchi S	C3.1
Yamaguchi T	B2.3, G4.1, G4.2
Yamamoto Y	C3.4, D3.1
Yan G L	F3.1
Yanagihara S	G5.2
Yang B D	A3.3
Yang B S	F1.4
Yang C C	J1.4
Yang C L	A3.3
Yang H K	E5.1
Yang S W	D5.4, F5.6
Yang W	B2.1
Yang W J	C1.1, C1.2, C4.3, E3.1
Yeh C Y	F5.2, F5.3
Yeh H I	A1.1



Yeo S Y .....	E1.2
Yeung K .....	A1.2, A1.3
Yi J H .....	F4.7
Yokota H .....	J2.2
Yoshida T .....	C5.4
Yoshizawa Y .....	F4.6
Yu C F .....	B4.2
Yu C M S .....	G4.5
Yusoff M Z .....	C2.1
Yuyama K .....	B2.4

## **Z**

Zaffagnini S .....	H2.3
Zampagni M L .....	H2.3
Zannoli R .....	H2.3
Zhang J M .....	C2.4
Zhang L H .....	C4.4
Zheng W .....	B4.2
Zhong L .....	E1.2
Zhou T M .....	D2.2
Zvonareva O .....	H3.2