Sensors Enable Revolutions
ST VISION

We aim at becoming the undisputed leader in **Sense** & Power applications and in **Multimedia Convergence**, dedicating significant resources to product innovation and increasingly becoming a **solution provider**.
Motion Sensor (~MEMS) Leadership

Top Suppliers of Consumer and Mobile MEMS in 2010

- Consumer and Mobile MEMS revenue-2009
- Consumer and Mobile MEMS revenue-2010

Source: IHS Suppli – March 2011
ST – Sensor Leadership

**Motion**
Accelerometer, Gyroscope, Compass

**Touch**
Resistive, Capacitive, Multi-Touch, Haptic

**Sound**
Microphone, Speaker

**Light / Sight**
Ambient, Imaging, Pico-Projector

**Pressure**
Absolute, differential

**Temperature**
Ambient

Connecting the *Outside* world for greater *User Experience*

*courtesy of Huawei*
MOTION
MEMS Extreme Analog Products

- MEMS takes advantage of the electrical and mechanical properties of silicon:
  - an Advanced Analog Chip with embedded smart functionalities
  - Micron-sized Transducer realized through a specific process called Micro-Machining
- Dedicated package and calibration features

3 Axis Gyroscope
In the picture: The capacitive heart of a 3-Axis Accelerometer
Latest 3-axis Accelerometer: LIS3DH

Advanced power management
- Wide supply voltage down to 1.8V
- Ultra low current

High versatility
- Extended FS range (2/4/8/16g)
- Multiple configurable interrupt sources

Embedded features
- Programmable FIFO (32 levels)
- 3 auxiliary ADC channels
- Package 3x3 mm

100x less power
Gyroscopes
Digital 3-axis Gyroscope (L3G4200D)

3-axis Gyro with a Single-die driving Mass
3 axis single die mechanical sensor

Drive mode

Yaw mode

Roll mode

Pitch mode

➢ our beating heart
**Single die – what for ?**

<table>
<thead>
<tr>
<th><strong>Silicon Structure</strong></th>
<th><strong>ST</strong></th>
<th><strong>Alternatives</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Robustness to Temperature</td>
<td>Zero-rate level</td>
<td>&lt; 0.04 dps/° C</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>± 2%</td>
<td>± 10%</td>
</tr>
<tr>
<td>Hysteresis</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>External mechanical stress</td>
<td>&gt;3kG</td>
<td>&lt;&lt;1kG</td>
</tr>
<tr>
<td>Cross-axis density</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Analog ASIC</strong></th>
<th><strong>ST</strong></th>
<th><strong>Alternatives</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Consumption</td>
<td>6.1mA</td>
<td>6.5mA</td>
</tr>
<tr>
<td>Turn-on Time</td>
<td>1.25ms</td>
<td>50ms</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Large scale manufacturing machine</strong></th>
<th><strong>ST</strong></th>
<th><strong>Alternatives</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Common technology process</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Yield and Volume</td>
<td>High (1Bu)</td>
<td>?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Sensor + Processor Partitioning</strong></th>
<th><strong>ST</strong></th>
<th><strong>Alternatives</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Component connection</td>
<td>Simple</td>
<td>Complex</td>
</tr>
<tr>
<td>Sensor fusion IP</td>
<td>Yes</td>
<td>?</td>
</tr>
</tbody>
</table>

➤ **Robustness, Stability, High-yield / high volume**
Compass Module

Accelometer

Geo-Magnetic Sensor

6-axis Integration
6-axis integration (Accelerometer + Gyroscope) - Re-use of existing mass-production devices

Guarantee: Robustness, Stability, High-yield / high volume
The New Frontier: Sensor Modules

Compass (3A+3M)
- LSM303DLM: 5x5x1 mm³
- LSM303DLHC: 3x5x1 mm³
- Nano Compass: 3x3x1 mm³

Inertial modules (3A+3G)
- LSM330DL: 7x5x1 mm³
- LSM330DLC: 4x5x1 mm³
- LSM330DLHC: 4x4x1 mm³

STMicroelectronics
PRESSURE
Pressure Sensors

Sensing Element

IC

Altimeter

20cm resolution

LGA-16 (3x3x1 mm)

LPS331AP

Mass Production

Barometer
ST Motion - Solution Provider

3-axis Accelerometer
3-axis Gyroscope
3-axis Magnetometer
1-axis Pressure Sensor

iNEMO

10 Degrees of Freedom

iNEMO Engine

ST Microelectronics
Enabling emerging applications
Future of iNEMO
ST – Sensor Leadership

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# iNEMO project proposals 2012

<table>
<thead>
<tr>
<th>S/N</th>
<th>Proj Title</th>
<th>Description</th>
<th>Supervisor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>iNEMO: Wearable Vital Signs Monitoring System</td>
<td>Vital signs provide essential indications to the basic condition of our body functions. It is important to measure vital signs not only for time-critical medical operations but also for regular health condition monitoring for healthy subjects. The objective of this project is to develop a wearable vital signs monitoring system using the iNEMO solution. The system is designed to be wearable in that the power consumption is expected to be low enough for long duration operation. The iNEMO low-power MCU controller will be put to test on this function. The vital signs to be measured for this project include the heart (or pulse) rate, blood pressure, and respiratory rate. The measurements will involve the use of iNEMO’s magnetometer, accelerometer and gyroscope (for heart and respiratory rate), and iNEMO’s pressure sensor (for blood pressure). If time permits, a fusion algorithm on information recorded from these sensors will also be developed to provide an integrated overview of the health condition of the wearer. The student will be required to study the iNEMO solutions and work with another student on the development of the system using the iNEMO solutions.</td>
<td>Ser Wee</td>
</tr>
<tr>
<td>2.</td>
<td>iNEMO: “Health Enhancement”</td>
<td>This project requires the students to conceptualize, develop, design and build a demonstrable “Health, Fitness or Wellness Enhancement” application using the STMicroelectronics iNemo integrated smart sensor platform. Possible sensor functions to incorporate could include one or more of the following – pressure sensor (for various parts of the anatomy), mobility tracking, motion tracking, activity tracking, location tracking, fall detection, impact detection. Students can also propose some creative ideas and develop something interesting based on iNemo as long as it is related to healthcare.</td>
<td>Huang Guangbin</td>
</tr>
<tr>
<td>3.</td>
<td>iNemo for interactive digital media</td>
<td>In this project, the FYP student will work with iNemo evaluation board and develop applications in the field of interactive digital media. Students interested in developing the next generation gaming applications is highly encouraged to apply for this project. The student should be comfortable in C programming language.</td>
<td>Andy Khong Wai Hoong</td>
</tr>
<tr>
<td>4.</td>
<td>iNEMO: with LEGO NXT</td>
<td>ST’s iNEMO inertial-module product family (<a href="http://www.st.com/internet/analog/subclass/1448.jsp">http://www.st.com/internet/analog/subclass/1448.jsp</a>, see also <a href="http://www.youtube.com/watch?v=HBXDwmI1R6A">http://www.youtube.com/watch?v=HBXDwmI1R6A</a>), designed for enhanced multiple degrees of freedom for motion detection, delivers multi-sensing integration to reduce system architecture size and BOM, and to improve accuracy. The iNEMO inertial module include a system-in-packages (SiP) that integrates accelerometer and gyroscope in a unique package to deliver 6 degrees of freedom sensing. Lego Mindstorm NXT (<a href="http://en.wikipedia.org/wiki/Lego_Mindstorms_NXT">http://en.wikipedia.org/wiki/Lego_Mindstorms_NXT</a>, see also youtube) is a robotic kit that has revolutionised robotics (as well as</td>
<td>Ling Keck Voon</td>
</tr>
</tbody>
</table>
science and technology) education and experimentations. The main component in the kit is a brick-shaped computer called the NXT Intelligent Brick which can take input from up to four sensors and control up to three motors.

We are looking for students interested in developing a Lego-NXT sensor based on the iNEMO inertial module which will enable NXT robots to perform even more impressive tasks.

Two students are sought for this FYP. They will work in pair and to participate in the STMicroelectronics iNEMO Innovation Challenge. The incentives and Support from ST are:
(a) Attractive prizes, (b) Materials sponsorship, up to SGD 1,000 to purchase 3rd party materials to build a demonstrable prototype; and (3) Technical support from ST engineers

5. **iNEMO: A Multi-Sensor Real-time Human Activity Monitoring System**

In this project, we aim to develop a real-time human activity monitoring system based on iNEMO, an image sensor and a laptop PC. The system can real-time monitor the internal environment and the occupant's activities, therefore to provide new context aware service.

The sensor node will be composed of the ST iNEMO and a low power Zigbee transmitter. The receiver includes a laptop PC and a 256x 256 image sensor, which is mounted on a PCB board and attached to a credit-card-sized Opal-Kelly XEM 3010 FPGA board. The computer receives image, accelerometer, gyroscope data and runs signal processing algorithm:
1) Object segmentation and tracking: based on image data, to find out how many motion objects in the scene
2) Object localization: using accelerometer and gyroscope data, to identify the object of interest
3) Posture recognition: to recognize the human’s activity.

The project will be based on the previous work on human posture recognition. A demonstration can be found in the following link, http://www3.ntu.edu.sg/home/eechenss/Research/2008-recog/recog-sim-1.swf.

Chen Shoushun
STMicroelectronics iNEMO Innovation Challenge

Proposal
STMicroelectronics iNEMO Innovation Challenge

- Concept
  - A university-level competition sponsored by ST
  - Opened to 6 teams each from NUS and NTU
  - Participating teams must use the iNEMO* solution to develop application ideas for a specific area (healthcare for example) and build a demonstrable prototype.
    [* iNemo is an integrated module comprising 4 MEMS chips – gyroscope, accelerometer, compass and pressure sensor together with an MCU controller.]
  - Judging criteria for the competition will include:
    - Creativity and innovation
    - Practicality and commercial viability
    - Technical execution
STMicroelectronics iNEMO Innovation Challenge

- **Mechanics**
  - To ensure full commitment by students – the competition is tied to their final year project
  - 2 students to a team will complete the project for submission as their university final year project
  - Same project is then submitted as entry into an ST organized competition which will be judged by an external panel – totally unrelated to grading of final year project.
  - Competition is launched via open invitation to entire final year engineering cohort of the 2 universities (limited to the School of EEE, NTU, this time).
  - The 12 teams (6 from each university) will compete as individual teams - not inter or intra university.
  - To attract the best students, ST is offering prize incentives and sponsorship support.
Incentives and Support from ST

Prizes
- 1st prize - SGD 10,000 ($2,000 - supervisor, $8,000 - students)
- 2nd prize - SGD 5,000 ($1,000 - supervisor, $4,000 - students)
- 3rd prize - SGD 3,000 ($500 - supervisor, $2,500 - students)

Materials sponsorship
- Each team will be sponsored SGD 1,000 to purchase 3rd party materials to build a demonstrable prototype.

Technical support
- iNEMO modules
- Software kits, documentation, etc
- Consultation with ST engineer