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| **Project No:** | 13.5.1 | | |
| **Supervisor:** | Charayaphan Charoensak (Asst Prof) | **E-mail address:** | ecchara@ntu.edu.sg |
| **Candidature:** | PhD | | |
| **Research Programme:** | Statistical and Adaptive Signal Processing | | |
| **Research Area:** | Microphone Array Signal Processing | | |
| **Project Title:** | Application of Sigma-Delta Modulation in Signal Processing for Blind Source Separation | | |
| **Summary:** | A problem of separating individual speech from concurrent sounds, called "cocktail party", has been largely solved using many available blind source separation (BSS) techniques. Single or few bits, or Sigma-Delta, modulation allows multi-bit signal to be processed using only a few bits saving hardware circuitry. The purpose of this project is to combine Sigma-Delta techniques in the implementation of blind source separation of voice signal. Some comparative study between conventional multi-bit and the single-bit implementations will be carried out. This project involves algorithm simulations using MATLAB and C, and some preliminary study of FPGA (Field Programmable Gate Array). | | |

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| **Project No:** | 13.5.2 | | |
| **Supervisor:** | Henry Lew (Assoc Prof) | **E-mail address:** | ehlew@ntu.edu.sg |
| **Candidature:** | MEng / PhD | | |
| **Research Programme:** | Statistical and Adaptive Signal Processing | | |
| **Research Area:** | Microphone Array and Sensor Signal processing | | |
| **Project Title:** | Detection and Classification of Acoustic Transients | | |
| **Summary:** | In passive acoustic detection systems, especially those that operate in visually impaired or highly cluttered environments, transients (i.e., signals of short duration) which result from accidental events, such as the sudden release of pressure, can provide important clues regarding the presence and perhaps the identity of the target. This information can also be used to cue other sensor systems to track and localize the target in question. Therefore it is of interest to develop signal processing approaches that are robust to the signal's duration, form and source.<br>Keywords: Transients, detection, pattern classification, acoustics, microphone arrays, passive systems. | | |

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| **Project No:** | 13.5.3 | | |
| **Supervisor:** | Henry Lew (Assoc Prof) | **E-mail address:** | ehlew@ntu.edu.sg |
| **Candidature:** | MEng / PhD | | |
| **Research Programme:** | Statistical and Adaptive Signal Processing | | |
| **Research Area:** | Microphone Array Signal Processing | | |
| **Project Title:** | Robust Array Processing for e-textiles | | |
| **Summary:** | The embedding of acoustic sensors into textiles allows for the possibility of highly versatile and mobile acoustic arrays. However, the performance of the array processor can be significantly degraded when the sensor locations are perturbed from their design positions. This will especially be the case when the array of sensors is operating in a dynamic environment. Therefore, there is a need to develop array processing algorithms that are robust to sensor failure and perturbations to their positions.<br>Keywords: Array signal processing, beamforming, robustness constraints, acoustics, microphones, e-textiles. | | |

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| **Project No:** | 13.5.4 | | |
| **Supervisor:** | Yang Jun (Asst Prof) | **E-mail address:** | ejyang@ntu.edu.sg |
| **Candidature:** | MEng / PhD | | |
| **Research Programme:** | Statistical and Adaptive Signal Processing | | |
| **Research Area:** | Microphone Array Signal Processing | | |
| **Project Title:** | A Smart Microphone System for Source Localization | | |
| **Summary:** | Directional microphone arrays are spatial filters that can be designed to improve the sound quality of speech in audio telecommunication. Recently, there has been a large interest in adaptive microphone systems. This project will focus on adaptive source localization algorithms and novel microphone system design, being able to track a moving speaker in a changing acoustic environment. The first task is to choose an appropriate algorithm for acoustic source localization, and investigate the disadvantages/advantages of the chosen algorithm and of other algorithms. The second task is to design the smart microphone system and examine the accuracy and tracking capabilities of the system for different noise levels. | | |

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| **Project No:** | 13.5.5 | | |
| **Supervisor:** | Henry Lew (Assoc Prof) | **E-mail address:** | ehlew@ntu.edu.sg |
| **Candidature:** | MEng / PhD | | |
| **Research Programme:** | Statistical and Adaptive Signal Processing | | |
| **Research Area:** | Sensor Signal Processing | | |
| **Project Title:** | Detection and Classification of Range-spread Targets | | |
| **Summary:** | In echolocation systems, such as sonar and radar, many realistic targets of interest consist of multiple scatterers that are spread in range and are usually strongly aspect dependent. Consequently, two fundamental problems arise from this scenario. The first is how can the range-spread target response be best utilized to improve target detection in a variety of environments. The second is the problem of recognizing the target at different aspects and being able to distinguish it from other false targets, usually in highly variable environments.<br><br>Keywords: Detection theory, pattern classification, feature extraction, data reduction, target physics, extended targets, high-resolution signals, sonar, radar. | | |

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| **Project No:** | 13.5.6 | | |
| **Supervisor:** | Henry Lew (Assoc Prof) | **E-mail address:** | ehlew@ntu.edu.sg |
| **Candidature:** | MEng / PhD | | |
| **Research Programme:** | Statistical and Adaptive Signal Processing | | |
| **Research Area:** | Sensor Signal Processing | | |
| **Project Title:** | Detection of Slow Moving Low Cross Section Targets in Clutter | | |
| **Summary:** | An important problem in echolocation systems (e.g., sonar or radar) is the detection of slow moving low cross section targets in range and Doppler spread environments. The range spreading is often caused by multipath propagation of the channel resulting in multiple target responses. The Doppler spreading Is caused by the motion of the background scatterers and can obscure the target response in Doppler space.<br><br>Keywords: Detection theory, rough surface scattering, ambiguity functions, correlation processing, stochastic modeling of clutter/reverberation, sonar, radar. | | |

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| **Project No:** | 13.5.7 | | |
| **Supervisor:** | Henry Lew (Assoc Prof) | **E-mail address:** | ehlew@ntu.edu.sg |
| **Candidature:** | MEng / PhD | | |
| **Research Programme:** | Statistical and Adaptive Signal Processing | | |
| **Research Area:** | Sensor Signal Processing | | |
| **Project Title:** | Robust Detection and Estimation | | |
| **Summary:** | The environments in which many echolocation systems (e.g., sonar and radar) operate are time-varying and inhomogeneous. This implies that the detection threshold of such systems must be able to adapt or be at least reasonably robust to changes in the environment if consistent performance is to be maintained. Consequently, if the environment is characterized by a statistical parametric model, then the detection processing needs to be largely immune to variations in the model's parameters. One approach is to develop nonparametric detection algorithms. Another is to impose a constant false alarm probability constraint on the detection processor.<br><br>Keywords: Detection theory, nonparametric statistics, robust statistics, CFAR, sonar, radar. | | |

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| **Project No:** | 13.5.8 | | |
| **Supervisor:** | Henry Lew (Assoc Prof) | **E-mail address:** | ehlew@ntu.edu.sg |
| **Candidature:** | MEng / PhD | | |
| **Research Programme:** | Statistical and Adaptive Signal Processing | | |
| **Research Area:** | Sensor Signal Processing | | |
| **Project Title:** | The Physical Basis of Scatter Probability Distributions | | |
| **Summary:** | Effective signal processing for signal detection and estimation in scatter-dominated environments require the probability distributions of the scattered field. Traditionally, the approach has been to invoke the central limit theorem or to use parametric models without a physical basis. This has the advantage of mathematical tractability, but at the cost of being unrealistic in some cases of practical interest. With recent advances in computing, it should be possible (though challenging) to build probabilistic models of scattering based on the physics of scattering.<br><br>Keywords: Probabilistic models, scattering theory, non-Gaussian statistics, computational acoustics and electromagnetics, simulation. | | |

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| **Project No:** | 13.5.9 | | |
| **Supervisor:** | Henry Lew (Assoc Prof) | **E-mail address:** | ehlew@ntu.edu.sg |
| **Candidature:** | MEng / PhD | | |
| **Research Programme:** | Statistical and Adaptive Signal Processing | | |
| **Research Area:** | Sensor Signal Processing | | |
| **Project Title:** | Statistics of Fluctuating Targets with a Small Number of Scatterers | | |
| **Summary:** | Complex targets are often modeled as number of scatterers distributed across the spatial extent of the target. When the number of scatterers is large, the statistical distribution of the target response can be inferred from the central limit theorem. However, there are cases when the target only consists of a few principal scatterers. In the context of the detection problem, it is of interest to determine the statistical behaviour of targets with only a small number of scatterers.<br><br>Keywords: Detection theory, probability density function estimation, ambiguity functions, matched filtering, fluctuating targets, sonar, radar. | | |

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| **Project No:** | 13.5.10 | | |
| **Supervisor:** | Guan Yong Liang (Asst Prof) | **E-mail address:** | eylguan@ntu.edu.sg |
| **Candidature:** | PhD | | |
| **Research Programme:** | Statistical and Adaptive Signal Processing | | |
| **Research Area:** | Signal Processing for Communications | | |
| **Project Title:** | Non-Linear Signal Processing for Enhancing Digital Communication System Performance | | |
| **Summary:** | Digital communication systems of today have very demanding design goals and performance requirements. Intense research is conducted worldwide to enhance system performance without excessive hardware/computational complexity. Recently, a new non-linear frequency-domain signal processing technique has been found to show very promising results in enhancing some digital communication functions. Importantly, such performance improvement is achieved with lower computational complexity.<br>The aim of this project is to apply this new technique to other digital communication functions such as receiver synchronization, UWB (ultra-wideband) precision positioning, CDMA RAKE receivers and multi-carrier CDMA signal design. As the technique is fundamental and generic in nature, more of its applications may be discovered from this research. | | |

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| **Project No:** | 13.5.11 | | |
| **Supervisor:** | Patrick Ong Kian Seng (Assoc Prof) | **E-mail address:** | eksong@ntu.edu.sg |
| **Candidature:** | MEng | | |
| **Research Programme:** | Statistical and Adaptive Signal Processing | | |
| **Research Area:** | Signal Processing for Communications | | |
| **Project Title:** | Propagation Characteristics of Ultra-Wide Band Pulses in Various Media | | |
| **Summary:** | This project seeks to investigate the nature of ultra-wide band(UWB) pulse propagation in air and other common media e.g. concrete and to compare this with propagation of continuous radio waves(CW). There is some anecdotal evidence that such short (subnanosecond) pulses have different propagation and penetration characteristics to that of CW radiowaves. If so, such propagation behaviour may be exploited for potentially useful applications in communications. The research will include conducting some field experiments, and developing an appropriate mathematical model for the propagation characteristics | | |

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| **Project No:** | 13.5.12 | | |
| **Supervisor:** | Yap Kim Hui (Asst Prof) | **E-mail address:** | ekhyap@ntu.edu.sg |
| **Candidature:** | MEng | | |
| **Research Programme:** | Statistical and Adaptive Signal Processing | | |
| **Research Area:** | Signal Processing for Communications | | |
| **Project Title:** | Development of Blind Source Separation Algorithms in Digital Signal Processing | | |
| **Summary:** | The aim of blind source separation is to recover and separate the original signals from the multiple observed weighted mixtures. Blind source separation has many applications including wireless communication, geophysical exploration, and noninvasive biomedical diagnosis such as the separation of the heartbeats between the infant and the mother. The objective of this project is to develop blind source separation algorithms for different applications. These include the signal estimation of the desired users in code-division multiple-access (CDMA) systems, and audio signal extraction from the observed mixtures. The candidate will investigate independent component analysis, and employ them to perform blind source separation. | | |

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| **Project No:** | 13.5.13 | | |
| **Supervisor:** | Yang Jun (Asst Prof) | **E-mail address:** | ejyang@ntu.edu.sg |
| **Candidature:** | PhD | | |
| **Research Programme:** | Statistical and Adaptive Signal Processing | | |
| **Research Area:** | Transducer Signal Processing | | |
| **Project Title:** | Broadband Beamformer Design using the Eigenfilter Approach | | |
| **Summary:** | The eigenfilter method has been used to design a wide variety of filters and has recently received much attention. In this project, we focus on the design of far-filed and near field broadband beamformers with a given arbitrary spatial directivity pattern to a given arbitrary transducer (loudspeaker or microphone) array configuration. Several design procedures will be evaluated first, which are e.g. based on Least-Squares (LS) filter design, a maximumu energy array or non-linear optimization techniques. Unlike in the conventional eigenfilter technique a reference frequency-angle point is required, non-iterative design procedures will be considered and a low-complexity beamformer with FIR filter-and-sum structure will be investigated for improving performance. | | |