<table>
<thead>
<tr>
<th>Project Title</th>
<th>Status: Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto-Tuning of Difficult Dynamic Systems</td>
<td>Assoc Prof Cai Wenjian; email: <a href="mailto:ewjcai@ntu.edu.sg">ewjcai@ntu.edu.sg</a></td>
</tr>
<tr>
<td>Project Title: Controller Hardware Design for COD Sensor</td>
<td>Assoc Prof Cai Wenjian; email: <a href="mailto:ewjcai@ntu.edu.sg">ewjcai@ntu.edu.sg</a></td>
</tr>
<tr>
<td>Development of PID Auto-Tuning Software Package</td>
<td>Assoc Prof Cai Wenjian; email: <a href="mailto:ewjcai@ntu.edu.sg">ewjcai@ntu.edu.sg</a></td>
</tr>
<tr>
<td>Predictive Control of Air Handling Unit of HVAC System</td>
<td>Assoc Prof Cai Wenjian; email: <a href="mailto:ewjcai@ntu.edu.sg">ewjcai@ntu.edu.sg</a></td>
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<td>Software Development For COD Sensor</td>
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<tr>
<td>Study of Process Control of Air Handler Unit</td>
<td>Assoc Prof Cai Wenjian; email: <a href="mailto:ewjcai@ntu.edu.sg">ewjcai@ntu.edu.sg</a></td>
</tr>
<tr>
<td>Spline Interpolation</td>
<td>Assoc Prof Chua Chin Seng; email: <a href="mailto:ecschua@ntu.edu.sg">ecschua@ntu.edu.sg</a></td>
</tr>
<tr>
<td>Dynamic obstacle avoidance for Robots</td>
<td>Asst Prof Hu Guoqiang; email: <a href="mailto:GQHu@ntu.edu.sg">GQHu@ntu.edu.sg</a></td>
</tr>
<tr>
<td>Multimodal Robot Localization in GPS Challenged Environment</td>
<td>Asst Prof Hu Guoqiang; email: <a href="mailto:GQHu@ntu.edu.sg">GQHu@ntu.edu.sg</a></td>
</tr>
</tbody>
</table>

**Summary:**

- **Project 7:** The objective of this project is to automatically extract both 3D range data and 2D intensity image from a stripe-light range camera. By texture mapping the two data formats, a realistic 3D textured view of the imaged object can be obtained. Usually the 3D range data contains a significant level of noise (both random and impulse noises) which have to be culled away before the data can be useful. In addition, there will also be many missing data points which have to be recovered through interpolation. In this respect, the candidate should be firmly grounded in mathematical concepts of splines (cubic, bezier curves, NURBS) as well as a good working knowledge on Visual C/C++ programming.

- **Project 8:** This project aims to design a dynamic obstacle detection and avoidance module for an autonomous robot so that it can detect and avoid dynamic obstacles intelligently. The scope of the project includes: 1) Develop approaches to effectively and efficiently detect dynamic obstacles using images and laser measurements in dynamic environments. The dynamic obstacles include moving human beings, robots, and vehicles. 2) Develop motion control strategies and algorithms for the robots to avoid dynamic obstacles. 3) Implement the above approaches and algorithms using C++ or C. 4) Test the developed obstacle avoidance module using mobile robots.
Project Title: Networked Autonomous Robot - Design and Implementation
Supervisor: Asst Prof Hu Guoqi; email: GQHu@ntu.edu.sg
Summary: This project aims at designing a networked autonomous robot. Different from traditional autonomous robots, the sensing, perception, and computing components of the robotic system may not be directly connected via cables, but may be connected via wireless networked communication. The scope of the project includes: 1) Design a networked visual servo control approach, which will be a key technology to realize the networked autonomous robot; 2) Design a networked autonomous robot navigation and control architecture; 3) Build a networked autonomous robot test platform.

Project Title: Vision-based Fast 3D Modeling
Supervisor: Asst Prof Hu Guoqi; email: GQHu@ntu.edu.sg
Summary: Industrial robots have been widely used in manufacturing tasks such as welding, surface painting, coating, and polishing. Robot path teaching and planning is a key step towards the successful completion of these manufacturing tasks. Most of the existing methods rely on the CAD models of the parts, which may not be available, especially for the old parts. It is also tedious to construct CAD models, especially for low-volume high-mix production. This project aims at developing 3D object reconstruction methods to quickly and accurately reconstruct the 3D model of an object using images, with an intention to transform the old parts to automated manufacturing. The scope of the project includes: 1) Develop an approach to reconstruct the 3D model of an object using images; 2) Develop a method to facilitate the 3D modeling; 3) Implement the modeling approach and evaluate its effectiveness.

Project Title: Vision-based localization of a moving target
Supervisor: Asst Prof Hu Guoqi; email: GQHu@ntu.edu.sg
Summary: Current ground and aerial vehicles and outdoor robots all highly rely on global positioning system (GPS) or inertial measurement units (IMU) for navigation and control. However, IMUs can drift and accumulate errors over time and GPS may not be available in GPS challenged or denied environments. Given recent advances in machine vision and image processing technology, computational technology, and control theory, an interesting approach to solve the pose measurement, navigation, and control problems is to utilize a vision system. This project aims at developing vision-based solution for localization of a moving target. Specifically, algorithms will be designed and tested to find the location of a moving target using images taken by a camera. The scope of the project includes: 1) Design a vision-based algorithm to localize a target moving on a 2D motion space (e.g., a mobile robot) 2) Modify the algorithm to localize a target moving in a 3D motion space (e.g., a micro aerial vehicle) 3) Implement and test the localization algorithms. The programming tools include C++, Matlab, and OpenCV. The test platforms include a mobile robot and a quadcopter.

Project Title: Vision-Guided Navigation and Autonomous Flight of Unmanned Rotorcrafts
Supervisor: Asst Prof Hu Guoqi; email: GQHu@ntu.edu.sg
Summary: This project aims at providing vision-based solution for navigation and autonomous flight of small unmanned rotorcrafts. For an autonomous rotorcraft, its position and orientation is typically required for autonomous navigation and control. Often such information is determined by a global positioning system (GPS) or an inertial measurement unit (IMU). However, IMUs can drift and accumulate errors over time and GPS may not be available in GPS challenged or denied environments. Given recent advances in machine vision and image processing technology, computational technology, and control theory, an interesting approach to solve the pose measurement, navigation, and control problems is to utilize a vision system. To enable vision-based navigation and autonomous flight of small unmanned rotorcrafts, one key challenge is to enable precise and reliable localization and attitude estimation using jittered and noisy airborne images. Another challenge is to provide the solution using limited onboard resources on the small rotorcraft. Based on the above two challenges, the scope of the project includes: 1) Design image processing methods to enable real-time processing of the airborne images; 2) Design information acquisition methods including state estimation and mapping methods; 3) Design vision-based navigation and control methods for the rotorcraft; 4) Design a small-size embedded vision system. To implement the above algorithms; 5) Adopt and modify a small-size embedded control system to implement the above navigation and control algorithms; 6) Design and prototype a rotorcraft platform to verify the proposed methods and design.

Project Title: Analysis of X-SAT Images
Supervisor: Asst Prof Hu Guoqi; email: GQHu@ntu.edu.sg
Summary: Current ground and aerial vehicles and outdoor robots all highly rely on global positioning system (GPS) or inertial measurement units (IMU) for navigation and control. However, IMUs can drift and accumulate errors over time and GPS may not be available in GPS challenged or denied environments. This project aims to design a precise and robust multimodal robot localization module for an autonomous robot to localize itself in GPS challenged environment (i.e., GPS signals may be partially available or intermittently available). The sensors that can be used for localization include GPS, monocular camera, stereo camera, and laser ranging finder. However, not all of them are always available during the operation of the robot. The scope of the project includes: 1) Develop a multimodal approach to localize a robot using cameras and laser. 2) Implement the above approaches and algorithms using C++ or C. 3) Test the developed localization module using a mobile robot.
**Project Title:** Android Apps for Smart Wheelchairs
**Status:** Available

**Supervisor:** Asst Prof Justin Dauwels; email: JDAUWELS@ntu.edu.sg

**Summary:** Due to the growing ageing population and the disabled in Singapore, the demand of the wheelchairs and better wheelchairs features has been increasing. There is a need for the innovation and creation of wheelchairs with more and better features. The focus of this project is to create an Android application to control the movements of the wheelchair, to detect the location of the wheelchair user through the GPS and to send out notifications to the guardian if the wheelchair user is in distress. The project is supported by the NTU Innovation Center. This project is expected to lead to a research publication with the student as co-author.

**Project Title:** Compressive sensing for advanced radar technologies (in collaboration with Temasek Labs)
**Status:** Available

**Supervisor:** Asst Prof Justin Dauwels; email: JDAUWELS@ntu.edu.sg

**Summary:** Radar systems try to detect targets hidden in strong noise and clutter. We will develop novel signal processing methods to detect those targets. We will use the theory of compressive sensing, which has become tremendously popular in recent years due to its many successful applications. The project is conducted in collaboration with Temasek Labs.

**Project Title:** Detecting mental states from EEG (in collaboration with DSO)
**Status:** Available

**Supervisor:** Asst Prof Justin Dauwels; email: JDAUWELS@ntu.edu.sg

**Summary:** In collaboration with DSO, we are studying how we can objectively mental states from electroencephalogram (EEG) signals. We will analyze EEG data recorded from subjects who perform certain memory tasks, of varying difficulty. We will try to infer the level of difficulty from the EEG signals. This project is expected to lead to a research publication with the student as co-author.

**Project Title:** Discovering mental states from epileptic EEG: Hierarchical Bayesian non-parametric approach — in collaboration with MIT (USA) and Harvard Medical School
**Status:** Available

**Supervisor:** Asst Prof Justin Dauwels; email: JDAUWELS@ntu.edu.sg

**Summary:** Hierarchical Bayesian non-parametric models allow to automatically segment signals in different regimes. The underlying hypothesis is that the signals are generated by switching linear systems, where the coefficients of the systems are unknown and the number of systems is unknown as well. This new powerful class of models allows us to analyze brain signals from an interesting angle: we can automatically infer distinct mental state. The objective of this project is to analyze EEG data of epileptic patients with this new technology. The outcome of our approach will be interpreted and evaluated by neurologists from Harvard Medical School (Cambridge, MA). This project is expected to lead to a research publication with the student as co-author.

**Project Title:** Growing Artificial Tissue (in collaboration with MIT)
**Status:** Available

**Supervisor:** Asst Prof Justin Dauwels; email: JDAUWELS@ntu.edu.sg

**Summary:** Image that one could grow new tissue, for instance, for people who're suffering from damaged skin. Wouldn't that be wonderful? To some, that may sound like science fiction. However, recently, scientists have made substantial progress in this direction. Currently, it is possible to grow simple biological tissues by applying principles from control engineering. In this project, the student will develop methods to quantitatively analyze growing tissues, with the aim of explore the underlying key principles of tissue regeneration. Plenty of experimental data is available. This project is conducted in collaboration with MIT and SMART (Singapore-MIT Alliance for Research and Technology). This project is expected to lead to a research publication with the student as co-author.
Project Title: Guiding neurosurgery for epileptic patients through signal processing --- in collaboration with Harvard Medical School

Summary: For approximately 30% of epilepsy patients, seizures are poorly controlled with medications alone. Those patients may be successfully treated by surgically removing the brain area where the seizures originate; it is obviously crucial to accurately localize the seizure onset zone. Currently, the seizure focus is determined from cortical recordings during seizures. Since seizures occur infrequently, patients often need to stay several weeks in the hospital, till sufficient seizures have been recorded; this procedure is uncomfortable and costly. We hope to be able to determine the seizure focus from short invasive recordings in the operating room, made before resection of the seizure focus. In this UROP project, we will explore the feasibility of this idea. We will apply advanced signal processing techniques to interictal cortical recordings, with the aim of localizing the seizure focus. This project is in collaboration with neurologists and neurosurgeons at Harvard Medical School. This project is expected to lead to a research publication with the student as co-author.

Supervisor: Asst Prof Justin Dauwels; email: JDAUWELS@ntu.edu.sg

Status: Available

Project Title: How can we avoid traffic jams? Design of on-demand traffic guidance systems - -- in collaboration with MIT (USA)

Summary: In most large cities, traffic jams are quite common, especially at rush hour. By appropriately guiding drivers, traffic jams may potentially be avoided or at least limited. In order to develop effective on-demand route guidance, we need to be able to track and predict the traffic flow in real-time. Indeed, if we can accurately predict how the traffic will evolve, we may be able to forecast potential traffic jams, and determine route guidance schemes to avoid them. We aim to develop practical algorithms for tracking and predicting traffic flow in dynamic urban transportation networks in real-time, using heterogeneous data sources such as video sensors, radar detectors, and GPS enabled mobile devices. The objective of this project is to develop and explore basic traffic models, and apply them to actual data. This project is expected to lead to a research publication with the student as co-author.

Supervisor: Asst Prof Justin Dauwels; email: JDAUWELS@ntu.edu.sg

Status: Available

Project Title: How does priming influence people's decision? Quantitative analysis of EEG and eye movement --- in collaboration with RIKEN Brain Science Institute (Japan)

Summary: We aim to examine how priming can influence consumers' perception of printed advertisement (ad) cognitively and affectively. To this end, we plan to record and analyze event-related brain potentials (ERPs) and eye movements. Priming has shown to strongly influence consumers' attitudes and purchase intentions. However, so far, only behavioral studies of priming have been conducted, using questionnaires; responses to questionnaires are subjective, and may not correspond to the ground truth. As an alternative, we will investigate the effect of priming on a more objective basis, by analyzing its effect on brain signals and eye movement. This project is conducted in collaboration with RIKEN Brain Science Institute (Japan). This project is expected to lead to a research publication with the student as co-author.

Supervisor: Asst Prof Justin Dauwels; email: JDAUWELS@ntu.edu.sg

Status: Available

Project Title: Joint analysis of EEG and fMRI data: an exciting machine learning challenge --- in collaboration with RIKEN Brain Science Institute in Japan

Summary: We have recorded EEG and fMRI while subjects are watching flickering stimuli. The latter induce oscillations in the brain, which can be detected both in the EEG and fMRI. The objective of this project is to leverage the excellent temporal resolution of EEG with the fine spatial resolution of fMRI. By combining both brain imaging technologies, we hope to gain more insight in the human visual system. This project is conducted in collaboration with the RIKEN Brain Science Institute. This project is expected to lead to a research publication with the student as co-author.

Supervisor: Asst Prof Justin Dauwels; email: JDAUWELS@ntu.edu.sg

Status: Available

Project Title: Learning networks from data using copula theory: application to social and genetic networks --- in collaboration with MIT (USA)

Summary: One of the current hot topics in signal processing and applied mathematics network inference. For examples, given a large collection of Facebook profiles, how can we generate meaningful friend networks, and what information can we extract from such network? Likewise, given genetic data of cancer patient, how can we infer what genes are involved in the disease, if any? How do those genes interact? Most common models for network inference are based on Gaussian graphical models. Such models have the advantage to be tractable, however, often data is non-Gaussian. The objective of this project is to go beyond Gaussian models, and develop new powerful network models based on copula theory. Those models will then be applied to several real-world data sets, including micro-array data and social network data. We are currently looking for motivated students with interest in applied mathematics, who are excited by working on real-world problems. This project is conducted in collaboration with MIT (Cambridge, MA). This project is expected to lead to a research publication with the student as co-author.

Supervisor: Asst Prof Justin Dauwels; email: JDAUWELS@ntu.edu.sg

Status: Available
25 Project Title: Mathematical models of extreme events — in collaboration with MIT (USA) and Royal Dutch Shell
Supervisor: Asst Prof Justin Dauwels; email: JDAUWELS@ntu.edu.sg
Summary: Risk analysis is an important topic in insurance, statistics, finance, and operations management. Reliable prediction of catastrophic events like hurricanes or earthquakes can save people's lives and avoid chaos and destruction. In this project, we will extend standard risk analysis in an exciting and novel way; we will develop graphical models that consist of Pareto distributions. Graphical models allow to model complex large-scale systems; on the other hand, Pareto distributions are commonly used to describe exceptional events. Therefore, Pareto graphical models seem very promising to model and predict catastrophic events in real-life scenarios; however, they have not been explored so far. We are currently looking for motivated students with interest in applied mathematics, who are excited by working on real-world problems. This project is conducted in collaboration with MIT (Cambridge, MA). This project is expected to lead to a research publication with the student as co-author.

26 Project Title: Modeling and controlling epileptic seizures: A mathematical modeling approach — in collaboration with MIT (USA) and Harvard Medical School
Supervisor: Asst Prof Justin Dauwels; email: JDAUWELS@ntu.edu.sg
Summary: A variety of models have been proposed to describe epileptic seizures. Many of them try to capture the onset of a seizure but not the further evolution and ending. Most modeling approaches are detailed biophysical models, from which it is very hard to deduct general mechanisms of seizure genesis. We wish to develop generic network models of epileptic seizures that try to reproduce certain aspects of seizure onset as well as endings. The models are generic in a sense that they do not attempt to describe the underlying electrophysiology or biochemistry of seizures; instead they allow us to identify general mechanisms in networks that may provoke and disrupt seizure-like dynamics. The parameters in the model will be fit by means of actual ictal EEG data from epileptic patients. In later work, we will map those generic mechanisms into concrete electrophysiological and/or biochemical processes. In the long term, such approach may lead to novel insights in the phenomenology of seizures, and potentially, to novel treatments of epilepsy. We are now looking for motivated students to join us in this exciting exploration. This project is in collaboration with neurologists at Massachusetts General Hospital and Harvard Medical School, and applied mathematicians at MIT. This project is expected to lead to a research publication with the student as co-author.

27 Project Title: Monitoring of Group Discussions: a Socio-Engineering Approach (in collaboration with Nanyang Business School)
Supervisor: Asst Prof Justin Dauwels; email: JDAUWELS@ntu.edu.sg
Summary: Human group interaction is very complex and rich. Monitoring any group can be done using non-verbal (facial expressions, body languages, gestures, etc.) or verbal (voice tone, voice pitch, etc.) signals. Despite the impressive advancements in video-audio signal processing, analyzing different aspects of human interaction as empathy, hostility, (dis-)agreement, flirting, dominance, superiority, inferiority, etc. remains very challenging. Investigating these aspects is crucial for building intelligent robots that can participate in conversations in a natural way, or to fulfill certain social responsibilities in our life. As our ultimate goal is to improve the current computer systems and social robots that suffer from a lack of social skills, we will explore the social signals and social behaviors, including social interactions (like turn taking), social attitude (like alliance), and social relations/roles to build more socially intelligent model for robots. More specifically, we have the following three aims: - Analyze social signals (audio-video signals) collected simultaneously from different candidates in a group interaction. - Develop a real-time automated system to annotate the measured signals based on the features discussed above. - Build a model for social judgment and dominance based on verbal signals (voice tone-pitch) that can socialize the current computer systems and robots. The project is conducted in collaboration with the Nanyang Business School. This project is expected to lead to a research publication with the student as co-author.

28 Project Title: Real-time Phase Imaging (in collaboration with MIT and SMART)
Supervisor: Asst Prof Justin Dauwels; email: JDAUWELS@ntu.edu.sg
Summary: When light passes through objects, the intensity and phase of the light wave change. In phase imaging, one tries to reconstruct the phase shift from intensity images. There are plenty of applications for phase imaging. For instance, biological cells are transparent, and therefore, they do not show up on intensity images. However, they can easily be visualized by phase imaging. Current phase imaging technologies are often bulky and sensitive to noise. At NTU, we have developed a new phase imaging technology that is much more practical and far less sensitive to noise. In this project, the student will further refine this technology, and test it extensively under various imaging conditions. This project is conducted in collaboration with MIT and SMART (Singapore-MIT Alliance for Research and Technology). This project is expected to lead to a research publication with the student as co-author.

29 Project Title: Virtual-reality representation of brain waves I --- in collaboration with RIKEN Brain Science Institute in Japan
Supervisor: Asst Prof Justin Dauwels; email: JDAUWELS@ntu.edu.sg
Summary: Nowadays various technologies exist to record brain waves, e.g., electroencephalograms (EEG) and functional MRI (fMRI). Those brain imaging tools allow researchers to gain understanding of the complex
inner mechanisms of the brain. On the other hand, abnormal brain waves have shown to be associated with particular brain disorders (e.g., Alzheimer’s disease and epilepsy). Therefore, the analysis of brain waves plays an important role in clinical diagnosis as well. Despite the impressive advancements in brain imaging, interpreting brain waves remains an enormous challenge: brain imaging data are often complex and vast. We wish to represent brain waves in a more tangible fashion; we will explore the use of sound, music, computer graphics, haptics, and combinations thereof, as a means of representing and analyzing multichannel brain waves. Such virtual-reality (VR) representation of brain waves has several applications of high potential: (1) it may help to detect abnormalities in brain waves, and to diagnose brain disorders; (2) it may be used for therapeutics, for example, to treat sleeping and attention deficits disorders; it would provide real-time multi-modal feedback to patients about their brain waves, which may allow them to better control their cognitive states; (3) we can use it to investigate the changes in brain waves during different mental tasks (e.g., working-memory tasks) and conditions (e.g., meditation, fatigue, stress, happiness, fear), which may lead to further insight in the phenomenology of cognition.

The objective of this student project is to start developing the virtual-reality system. Initial tests of the system will be conducted on actual EEG recordings, e.g., EEG data of Alzheimer’s disease patients, or EEG signals recorded during meditation. This project is conducted in collaboration with the RIKEN Brain Science Institute in Japan. This project is expected to lead to a research publication with the student as co-author.
lead to a research publication with the student as co-author.

33 Project Title: Active Contours for Image Segmentation
Supervisor: Assoc Prof Koh Tong San; email: etskoh@ntu.edu.sg
Summary: Active contour models are physics-based deformable models used to model the appearance and behavior of a physical object being imaged, or to simulate some image analysis task. Using a Lagrangian formulation of the energy functional, active contour models can be adopted for image segmentation by the design of appropriate energy terms and the subsequent minimization of the total energy. The aim of this project is to develop and implement appropriate active contour schemes for the segmentation of noisy images. An appreciation of Matlab and numerical computation skills would be desirable.

34 Project Title: Electric Field Tuning of Excitonic States in Quantum Discs
Supervisor: Assoc Prof Koh Tong San; email: etskoh@ntu.edu.sg
Summary: na

35 Project Title: A Literature Survey Cooperative Distributed Constrained Optimisation
Supervisor: Assoc Prof Ling Keck Voon; email: ekvling@ntu.edu.sg
Summary: As the title suggests, the student will be tasked to carry out the required literature survey. Thereafter, implement a promising algorithm based on the result of the survey.

36 Project Title: Attitude Control of Nano-Satellite Using Model Predictive Control
Supervisor: Assoc Prof Ling Keck Voon; email: ekvling@ntu.edu.sg
Summary: This project is part of the NTU's Satellite Programme whose aim is to develop and launch nanosatellites, with typical mass less than 10kg. The aim of this project is to carry out a controller design study, using Model Predictive Control (MPC), for the attitude control system of the NTU nanosatellite. Matlab skills for control system simulation will be needed. Full-time, and mathematically inclined student preferred.

37 Project Title: Development of a Matlab-based Control System Laboratory
Supervisor: Assoc Prof Ling Keck Voon; email: ekvling@ntu.edu.sg
Summary: The aim of this project is to develop a Computer Aided Control System Design (CASCD) environment that are typically utilised in an undergraduate controls laboratory. Due to their popularity and availability, MATLAB, SIMULINK and the Real-Time Workshop toolbox are chosen as the prototyping environment. The following issues should be addressed:

1. Standardisation: a consistent hardware interface to various laboratory apparatus and a consistent user interface, for the following task: modelling, control design, data collection, parameter estimation, and real-time experiment.
2. Control experiment via Internet: While the local real-time control could be extended for remote control via the Internet, there will be some issues that are peculiar to Internet lab, e.g. all Internet experiments need to be self-resetting. In addition, safety, security and user flexibility are issues that need to be addressed.

As this project requires the use of laboratory facilities, it is only suitable for full-time MSc student.

38 Project Title: Development of Re-Usable Learning Objects for Topics in Control and Automation
Supervisor: Assoc Prof Ling Keck Voon; email: ekvling@ntu.edu.sg
Summary: na

39 Project Title: Intelligent Supervisory Control for a Complex Automated Material Handling System
Supervisor: Assoc Prof Ling Keck Voon; email: ekvling@ntu.edu.sg
Summary: Guaranteeing an efficient material handling is of crucial importance in facilities such as warehouses, distribution centers, production plants and transshipment terminals. It has been estimated that material handling can represent up to 70% of the cost of a product. Automated material handling systems today have increasingly critical requirements in terms of performance and safety. This in turn causes a considerable growth of the complexity of the control systems. In this project, a case study of a real airfreight terminal is considered. The student will be introduced to discrete-event systems and the modeling, analysis and control schemes of such systems. Due to its scale and complexity, the current implementation in the real airfreight terminal is based entirely on heuristics. The student can therefore
take up the challenge of coming up with a systematic control design for the system.

40 Project Title: Intelligent Supervisory Control for Microelectronics Fabrication
Supervisor: Assoc Prof Ling Keck Voon; email: ekvling@ntu.edu.sg
Summary: The quality of microelectronics circuits and components, such as those manufactured from a semiconductor wafer, is directly dependent on the consistency of the processes used in its fabrication. In a typical scenario, the manufacturing process exhibits slow drifts that change the batch-to-batch properties of the product. Additionally, minor variations in the way in which an individual tool responds to the recipe parameters to execute the process can drastically affect the resulting product performance.

41 Project Title: Intelligent Watchdog
Supervisor: Assoc Prof Ling Keck Voon; email: ekvling@ntu.edu.sg
Summary: To design robust Signal Processing algorithms and develop efficient Real-time DSP software for optimized implementation in embedded systems. This is a joint project with SIMTech and the student must have a GPA of at least 4.0.

42 Project Title: Investigation of FPGA Technology for Embedded Control
Supervisor: Assoc Prof Ling Keck Voon; email: ekvling@ntu.edu.sg
Summary: na

43 Project Title: Labview for Control and Automation
Supervisor: Assoc Prof Ling Keck Voon; email: ekvling@ntu.edu.sg
Summary: na

44 Project Title: Model Predictive Control (MPC) on a Chip
Supervisor: Assoc Prof Ling Keck Voon; email: ekvling@ntu.edu.sg
Summary: The project aims to accelerate computation of model predictive control algorithms (a form of constrained optimization to be carried out online and in real-time) on special purpose hardware, such as a Field-Programmable Gate Array (FPGA), or a Graphics Processor Unit (GPU). Experience in digital circuit and system design and MATLAB would be useful.

45 Project Title: Model Predictive Control of Large-Scale Manufacturing Systems
Supervisor: Assoc Prof Ling Keck Voon; email: ekvling@ntu.edu.sg
Summary: This is a joint project with SIMTech. The main aim of the project is to investigate the application of Model Predictive Control techniques to large-scale manufacturing systems. Pre-requisite • Student must have a CGPA of 4 out of 5 or better • Student should have good knowledge of mathematic • Student with some background of software language C#, .net and matlab will be preferred • Full-time MSc students preferred

46 Project Title: MPC on a Chip
Supervisor: Assoc Prof Ling Keck Voon; email: ekvling@ntu.edu.sg
Summary: Model Predictive Control (MPC) has become an established control technology in the petrochemical industry. Its use is currently being pioneered in an increasingly wide range of high bandwidth applications, such as ships, aerospace, road vehicles and “Lab-on-Chip” devices. MPC outperforms other control strategies through its ability to deal with constraints. This requires on-line optimization, hence computational complexity can become an issue when applying MPC to complex systems with fast response times or to embedded applications where computational resource may be a major constraints. We are seeking students with suitable background and interest to help us realize the vision of ”MPC on a Chip”, which is also an ASTAR research programme. There are several projects along this line of research: 1. To develop a scalable and modular Matlab/Simulink model of constrained MPC algorithm 2. To develop a C model of (1) based on the interior point method 3. To develop a C model of (1) based on the active set method 4. To implement (2) and (3) on a suitable embedded processor or FPGA platform. 5. To exploit parallelism and/or multiple date width model to achieve area-time efficient FPGA implementation. Students who wish to be considered for the above projects should have good programming expertise and are interested in mathematical algorithms. Experiences with embedded control or FPGA would be an advantage.
47 Project Title: Multivariable Model Predictive Control of a Distillation Column  
Supervisor: Assoc Prof Ling Keck Voon; email: ekvling@ntu.edu.sg  
Summary: In this project, the student is required to apply model predictive control on a distillation column. First, computer simulation using Matlab will be carried out. Then, experimentation on the actual lab-scaled distillation will be carried out to check the performance of the controller.

48 Project Title: Object Oriented Optimisation Toolbox  
Supervisor: Assoc Prof Ling Keck Voon; email: ekvling@ntu.edu.sg  
Summary: To use object oriented programming tools (e.g. MATLAB, YAPMIP, CVX) to create the required toolbox, so that other users could use the toolbox to set up generic convex optimisation problem without bogged down by the details of programming.

49 Project Title: Remote tracking system for Aerospace Industry  
Supervisor: Assoc Prof Ling Keck Voon; email: ekvling@ntu.edu.sg  
Summary: The student will be explored and developed a remote tracking solutions for aerospace industry with mobile assets located in remote parts of the airport. This is a joint project with SIMTech and the student must have a GPA of at least 4.0.

50 Project Title: Two-Way Ranging based Positioning System  
Supervisor: Assoc Prof Ling Keck Voon; email: ekvling@ntu.edu.sg and LIU WEI (A*STAR SIMTECH)  
Summary: In this project will enable student to learn and develop Two-Way Ranging (TWR) based low cost and scalable Real Time Locating System. The student will develop positioning algorithms based on integration of RSSI and TWR methodologies. The student will have opportunities to apply their results to the MNC and local companies in Singapore so that can have better understanding of industry operation. Guidance and hands-on training will be given. Student taking up this project should be proficient in C programming and micro-controller, and be willing to carry out experimental work.

51 Project Title: Website Development for Online Control System Laboratory  
Supervisor: Assoc Prof Ling Keck Voon; email: ekvling@ntu.edu.sg  
Summary: na

52 Project Title: Analysis of LDPC Codes  
Supervisor: Assoc Prof Low Kay Soon; email: ekslow@ntu.edu.sg and Guan Yong Liang  
Summary: Currently many Satellite missions use the concatenated Reed-Solomon and convolutional coding technique for space to ground links. While this standard has served space agencies well in the past it is bandwidth inefficient. This is particularly a problem for high data rate links in the X-Band which is band limited to 375 MHz, with data rates demands going to 800 Mbps and higher. Quasi-cyclic (QC) low-density parity-check (LDPC) codes form an important subclass of LDPC codes. These codes have encoding advantage over other types of LDPC codes. This project concentrates on the issues of efficient encoding of QC-LDPC codes. The project aims to analyze the Quasi cyclic LDPC code in Matlab and propose the best way of implementing the LDPC code on FPGA.

53 Project Title: Fast Image Synthesis of 2D Infrared Facial Images  
Supervisor: Assoc Prof Mao Kezhi; email: ekzmao@ntu.edu.sg  
Summary: Pose determination of human faces plays an important role in face recognition. The traditional way of dealing with pose-variation is to use a number of representative images in different poses. In this project, we will synthesize virtual images at different pose using few reference images in the pose space. Fast methods to find correspondence between reference images will be explored. To deal with the intensity variation of IR images among individuals and to further deduce computation, modeling method will be adopted. The synthesized IR images can be used to interpolate virtual views between real views to provide more "samples" or to produce a standard frontal view for recognition.

54 Project Title: Neural Network based Color Image Segmentation  
Supervisor: Assoc Prof Mao Kezhi; email: ekzmao@ntu.edu.sg  
Summary: Breast cancer is the most common cancer among women, and is the second leading cause of cancer deaths in women today. Basically, the diagnosis procedure of breast cancer consists of two steps: (1) mammography based breast abnormality detection; (2) biopsy based diagnosis. Biopsy is the only
definitive way to determine whether cancer is present. In this project, biopsy color image segmentation based on neural networks will be studied. The objective of breast biopsy image segmentation is to segment cells and blood vessels in the image.

As the second part of the project, color image segmentation software will be developed.

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55 Project Title: Embedded System Project: Portable Fluorescence Detection System

**Supervisor:** Assoc Prof Soh Cheong Boon; email: ecbsoh@ntu.edu.sg

**Summary:** Integration of Micropump, Microfluidic Card, Optical Detection and Data Acquisition. The objective of this project is to construct a prototype of portable fluorescence detection system for microfluidic chip. It involves the integration of a micropump, microfluidic chip, optical detection, one-dimensional scanning system, and data acquisition. Micropump and scanning system will be controlled by a PC, laptop or microcontroller. The output of optical detection will be amplified, stored in memory, processed and displayed. Micropump and microfluidic chip will be made from polymeric materials. Photodiode or avalanche photodiode will be used as optical detector. Required background knowledge: Photonics and electronics, particularly data acquisition and controlling either using PC or microcontroller. Please contact Dr Rudi Irawan (erirawan@ntu.edu.sg) to discuss if you are interested.

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56 Project Title: Iterative Multipath Interference Cancellation

**Supervisor:** Assoc Prof Soh Cheong Boon; email: ecbsoh@ntu.edu.sg

**Summary:** na

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57 Project Title: System Prototype for Personal Mobile Health Monitoring

**Supervisor:** Assoc Prof Soh Cheong Boon; email: ecbsoh@ntu.edu.sg

**Summary:** Infocommunication technology has been employed in health care for many years with good success. However, the upgrade of existing medical instruments and the design of new medical applications as a result of continuous advances in information technology should not lead to a neglect of the practical needs of patients and physicians. Although significant progress has been made with respect to the development of these instruments in operational information systems where all the devices can be integrated into a single framework of health-care resources, it should be observed that this aspect is particularly critical since different medical devices and hospital data bases using different protocols and data representations may be unable to interact automatically, thus failing to provide efficient diagnostic support. Although the current technologies offer the necessary means to support this type of health care, it should be possible to integrate selected health care devices offering a continuous, cooperative health care system and tools for personalized health monitoring. This project focuses on the development of a versatile system prototype for personal mobile health monitoring on mobile phones operating on Symbian OS, including the use of open standards such as Bluetooth, GPRS, etc. The aim is to achieve an optimized system design for efficient data acquisition and online analysis for a 3-stage distributed mobile system that consists of the front-end integrated biosensor, the personal mobile phone and the back-end server. The primary goal will be on the data storage and processing of ECG and PCG signals. Requirements: Wireless Communications, Embedded Systems, Programming (Symbian OS, C++). This project is more suitable for a Full Time MSc student. There is scope for several MSc projects under the Home Health Monitoring. MSc candidates are encouraged to contact SUWA research staff Goh Keng Wee (ekwgoh@ntu.edu.sg) to define the scope of a project within Home Health Monitoring.

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58 Project Title: Information Data Clustering in Kernel Space

**Supervisor:** Assoc Prof Song Qing; email: eqsong@ntu.edu.sg

**Summary:** na

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59 Project Title: Discrete-event based vehicle dispatching and scheduling in multicommodity transportation

**Supervisor:** Asst Prof Su Rong; email: Ru@ntu.edu.sg

**Summary:** The transportation problem of a commodity deals with a set of source sites, and a set of destinations. The task is to satisfy all the demands of the destinations and utilize all the supply of source sites with minimum transportation cost or time. This is the basis of much more complicated problem classes, like supply chain allocation and distribution. In this project we shall explore to model a multicommodity transportation system as a weighted discrete-event system and solve the vehicle dispatching and scheduling problem as a supervisor synthesis problem. The potential advantage of using discrete-event model is that it provides effective means to capture many desirable requirements such as task precedence, mutual exclusion, deadlock/livelock free etc, while allowing advanced model abstraction techniques to reduce computational complexity.
60 Project Title: Distributed scheduling and control for achieving minimum makespan in a large-scale material handling system
Supervisor: Asst Prof Su Rong; email: Rsu@ntu.edu.sg
Summary: Material handling systems (MHS) are used widely in almost every industrial system. They are responsible for transferring and storing materials. In a mega MHS commonly seen in, e.g., a seaport container terminal or an airport terminal warehouse, there are typically hundreds of moving equipment in various types, e.g., stacker cranes, forklifts, primary movers, dolly trucks or rail guided vehicles. They are used to move cargos usually packed in containers from one location to another for either a processing purpose such as repackaging, or a simple storage purpose. Each container has a specific destination and may require a specific processing procedure. The daily volume of containers to be processed in such a mega MHS is measured in thousands. To make the situation even worse, unexpected delays or early arrivals and non-regular transportation jobs put extra operational pressures on operators. In this project we will develop a distributed scheduling and control strategy for a large material handling system for the sake of minimizing an overall makespan of a given set of tasks.

61 Project Title: Dynamic resource allocation and scheduling for multi-location coverage search
Supervisor: Asst Prof Su Rong; email: Rsu@ntu.edu.sg
Summary: Multi-location coverage search has many applications in both civil and military operations, e.g., for rescue or surveillance. The basic problem is to allocate and dispatch a finite number of search devices (usually UGVs or UAVs) to a given set of areas so that the overall time of scanning through all areas shall be minimized under the constraints of functionalities and maneuverability of search devices in each area. Due to dynamic changing environment, an allocation/dispatching/scheduling strategy needs to be frequently updated. In this project we will investigate how to model such a problem in a discrete-event formalism and solve it as a dynamic time-optimal control problem accordingly.

62 Project Title: Protocol design for a multi-agent system consisting of identical agents
Supervisor: Asst Prof Su Rong; email: Rsu@ntu.edu.sg
Summary: Informally speaking, a protocol is a collection of if-then rules, which provides guidance for concerned parties to avoid possible conflicts and improve performance. For example, we use protocols when exchanging information through communication networks, to avoid traffic accidents on a road, or to avoid deadlock and meet deadlines in manufacturing/logistic systems. A protocol can be treated as a template of a special type of distributed controllers for a class of systems, where each agent in a system instance carries a local controller, instantiated from the protocol. In the current practice, a protocol is usually designed based on intuition and experience of the designer through an informal manner and lots of simulation-based trial-and-error steps. A few formal frameworks have been introduced within different engineering communities to address the protocol analysis problem. But they can rarely be used for design. In this project we shall investigate how to systematically design a protocol for a specific application problem by using discrete-event modeling, analysis and synthesis theories.

63 Project Title: An Ant-Colony Approach to Intelligent Self-Recovery in Manufacturing
Supervisor: Assoc Prof Sugathan, Ponnuthurai N.; email: epnsugan@ntu.edu.sg
Summary: Splice site identification is an important task in the process of understanding human genome and how it expresses. The splice site is defined as the boundary between exons and introns in the messenger ribonucleic acid. In this project, the student is expected to apply feature analysis and pattern classification techniques to classify the gene sequences into intron-exon boundary or exon-intron boundary or non-boundary sequence.

64 Project Title: Hierarchical K-Winner Machines with Fuzzy Memberships
Supervisor: Assoc Prof Sugathan, Ponnuthurai N.; email: epnsugan@ntu.edu.sg
Summary: The aim of this project is to develop a hierarchical K-winner machine classification system with fuzzy memberships in the highest level. The K-winner machine makes use of supervised and unsupervised learning techniques. The hierarchical approach allows us to improve the classification speed during the application stage and at the same time finely partitions the pattern space in the highest levels. In order to further improve the performance of the hierarchical K-winner machine, we introduce the fuzzy membership assignment to the prototype vectors. The developed system will be tested on some standard datasets and its performance will be compared against competing approaches.

65 Project Title: Splice Site Identification using Pattern Recognition Techniques
Supervisor: Assoc Prof Sugathan, Ponnuthurai N.; email: epnsugan@ntu.edu.sg
Summary: Splice site identification is an important task in the process of understanding human genome and how it expresses. The splice site is defined as the boundary between exons and introns in the messenger ribonucleic acid. In this project, the student is expected to apply feature analysis and pattern classification techniques to classify the gene sequences into intron-exon boundary or exon-intron boundary or non-boundary sequence.

66 Project Title: Investigation of an Additive LDA on its Performance on various Databases
Supervisor: Assoc Prof Sung, Eric; email: eericsung@ntu.edu.sg
Summary: This project is to implement an additive form of LDA using either C++ or Matlab and to train it on various databases. Comparative performance experiments will be thoroughly investigated on this proposed algorithm versus the conventional quotient LDA. Some of the investigations will include varying of a parameter known as beta, of the feature dimensions used and on the size of the training data. A full analysis of the results is required.

67 Project Title: Investigation of the Sequential LDA Accelerator for Pattern Recognition
Supervisor: Assoc Prof Sung, Eric; email: eericsung@ntu.edu.sg
Summary: In machine learning methods, when the input data becomes extremely large, the current direct methods require too large learning times and memory. This project investigates one sequential method to overcome this problem. It is quite a simple method to implement and is tested using the well-known LDA classifier. The student will try various investigations on different very large data sets and to measure their computational complexities. It has been shown that this sequential method is very fast and only need a small subset of the large data set to complete the learning.

68 Project Title: Adaboost For Gender Recognition From Image Silhouettes
Supervisor: Assoc Prof Sung, Eric; email: eericsung@ntu.edu.sg
Summary: Humans can quite successfully recognize the gender of a person from his/her body shape. This project attempts to do that by learning from examples. These training examples are used to train an Adaboost classifier. The trained classifier is then tested on testing examples and a performance analysis is to be conducted. Initially, the student will obtain silhouettes of a couple of hundred persons. To assist in the segmentation of the human silhouette, photos of persons will be taken with a blue background.

69 Project Title: Investigation of the Sequential Accelerator on LDA for Pattern Recognition
Supervisor: Assoc Prof Sung, Eric; email: eericsung@ntu.edu.sg
Summary: In machine learning methods, when the input data becomes extremely large, the current direct methods require too large learning times and memory. This project investigates one sequential method to overcome this problem. It is quite a simple method to implement and is tested using the well-known LDA classifier. The student will try various investigations on different very large data sets and to measure their computational complexities. It has been shown that this sequential method is very fast and only need a small subset of the large data set to complete the learning.

70 Project Title: Investigation of the Sequential Accelerator on the Perceptron for Pattern Recognition
Supervisor: Assoc Prof Sung, Eric; email: eericsung@ntu.edu.sg
Summary: In machine learning methods, when the input data becomes extremely large, the current direct methods require too large learning times and memory. This project investigates one sequential method to overcome this problem. It is quite a simple method to implement and is tested using the Perceptron as the base classifier. The perceptron converges very slowly. So it will be interesting to find out if the proposed accelerator can improve significantly the computational times of this simple classifier. The student will try various investigations on different very large data sets and to measure their computational complexities. It has been shown that this sequential method is very fast and only need a small subset of the large data set to complete the learning.

71 Project Title: Bayesian Network Based Event Management Model
Supervisor: Prof Wang Dan Wei; email: edwwang@ntu.edu.sg
Summary: The objective of this project is to develop a Bayesian network model of an event management system for monitoring and analysis of real-time organization operation events. The system will provide support to make intelligent decisions as to the type and severity of events, the possible root cause of failure event and corrective actions to be taken to recover operations or provide suggestions for repair action. The project will be based on a prototype of an interactive web-based platform to develop the event management system and focus on the development of a rule inference engine integrating with a Web-based graphical GUI. The Web-based GUI is to manage the various events in the system, including adding, removing diagnosis rules into/from the system, display health status of a specified system, etc. Students will have a chance to working with C#, or .net programming and other computing and network skills in this project. This is a joint project of NTU and SIMTech.

72 Project Title: Computational Intelligence Approach For Discrete Data Pattern Extraction
Supervisor: Prof Wang Dan Wei; email: edwwang@ntu.edu.sg
Summary: This project is to develop an algorithm of extracting discrete data pattern based on Mata-heuristics for abnormal event detection. This project focus is on the research of an automated approach for data pre-processing and algorithm parameter setting for the algorithm to achieve better performance for associate rule mining. An in-depth study on related computational intelligence techniques needs to be carried out.
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<tr>
<th>Project Title</th>
<th>Status: Available</th>
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<tbody>
<tr>
<td><strong>73 Project Title:</strong> Fault Detection and Diagnosis in Condition Based Maintenance</td>
<td>Supervisor: Prof Wang Dan Wei; email: <a href="mailto:edwwang@ntu.edu.sg">edwwang@ntu.edu.sg</a> and Zhou Junhong (SIMTech)</td>
</tr>
<tr>
<td><strong>Summary:</strong></td>
<td>1. Objective Critical machine failures are costly and result in significant process down time. The early detection of degradation and faults will not only improve its reliability, it would also enable maintenance to be carried out only when necessary; hence reducing the costs of outage time and repairs. Ultimately, it can enable a near zero loss for potential failures. Real time/online machine fault detection and prognostic monitoring by using machine learning is a new technological development for critical machinery facility maintenance. This project will focus on the research in the fault detection and diagnosis techniques. Different sensors will be used and set up for construct the system. Diagnosing feature will be extracted from the sensors signals. Information fusion technology will be used to obtain better diagnosis results. A test bed of hydraulic pump will use in this study. 2. SCOPE OF WORK The scope of work is described as below: a. State-of-art survey of equipment fault diagnosis b. Develop a self-learning and rule based method for fault mode classification. c. Carry out a case study by using the developed method. d. Verify the method through real industrial data. 3. Pre-requirement a. Basic knowledge of signal processing b. Basic knowledge of artificial intelligence</td>
</tr>
<tr>
<td><strong>74 Project Title:</strong> Fault Diagnosis for three phase inverters</td>
<td>Supervisor: Prof Wang Dan Wei; email: <a href="mailto:edwwang@ntu.edu.sg">edwwang@ntu.edu.sg</a></td>
</tr>
<tr>
<td><strong>Summary:</strong></td>
<td>Three phase inverters are almost found in every renewable electrical energy systems such as wind farms, solar plants, and smart grids. The power electronic inverters consist of many semiconductor switches like IGBTs and MOSFETs. Solid state faults in electrical systems can lead to fatal consequences and catastrophic failure and dangerous situations. Increasing demands for system reliability and availability request applicable fault diagnostic and prognostic algorithms to detect, isolate, and predict the electrical component faults fast enough to prevent catastrophic failures. Proper fault tolerant control strategies need to be applied to ensure maximum system efficiency and safety in present of faults. FDI algorithms with minimum number of sensors are necessary for power electronic systems in automotive, aerospace, marine vessel and space power systems where the power electronic system is mobile or hard to access for schedule monitoring.</td>
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<td><strong>75 Project Title:</strong> Optimizing RFID-based Tracking for Efficient Inventory Management</td>
<td>Supervisor: Prof Wang Dan Wei; email: <a href="mailto:edwwang@ntu.edu.sg">edwwang@ntu.edu.sg</a></td>
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<td><strong>Summary:</strong></td>
<td>In this project, the problem of RFID-based tracking will be studied. Specifically, students will investigate the effects of environment on RFID tracking reliability, and optimize RFID reading zones for various application scenarios. Students will also be reviewing related literatures, conducting RF measurement experiments and developing methods for fault tolerant tracking. All works will be carried out in Singapore Institute of Manufacturing Technology. Two students will be needed: One student with background in radio engineering will focus on RFID experimentation. Another with background in network design and data modeling will focus on tracking algorithm.</td>
</tr>
<tr>
<td><strong>76 Project Title:</strong> Real Time Locating System Application Design</td>
<td>Supervisor: Prof Wang Dan Wei; email: <a href="mailto:edwwang@ntu.edu.sg">edwwang@ntu.edu.sg</a> and LIU WEI (A*STAR SIMTECH)</td>
</tr>
<tr>
<td><strong>Summary:</strong></td>
<td>The highlight of the indoor-based real-time location system (RTLS) market is that it will grow to global revenue of more than $1.6 billion by the year 2010. In this project will enable student to learn and develop both hardware and software for industrial application using RTLS. Through the project with NTU/ SIMTech, the student will learn basic principle and the techniques of wireless communication. The student will also benefit from building architecture &amp; application to apply technology to the industrial needs. Guidance and hands-on training will be given by a very strong team of professor, research scientists and industrial engineers. The supervisors will guide the students to write research paper for international conference.</td>
</tr>
<tr>
<td><strong>77 Project Title:</strong> RFID Smart Shelf System Design</td>
<td>Supervisor: Prof Wang Dan Wei; email: <a href="mailto:edwwang@ntu.edu.sg">edwwang@ntu.edu.sg</a> and LIU WEI (A*STAR SIMTECH)</td>
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| **Summary:** | This project is about bringing RFID technology developed by SIMTech to the industry through product design and development process. In this project will enable student to learn and develop both hardware and software system for industrial application using RFID technology. Through the project with SIMTech, the student will learn basic principle and the techniques of antenna and RFID system design. The student will also benefit from building architecture & algorithm to improve RFID reliability and to apply technology to the industrial needs. Guidance and hands-on training will be given by a very strong team of research scientists and industrial engineers. The supervisors will guide the students to write research paper for
78 Project Title: RFID Smart Shelf System Design
Supervisor: Prof Wang Dan Wei; email: edwwang@ntu.edu.sg
and LIU WEI (A*STAR SIMTECH)
Summary: This project is about bringing RFID technology developed by SIMTech to the industry through product
design and development process. Through the project with SIMTech, the students will learn basic
principle and the techniques of antenna and RFID system design. The student will have opportunities to
apply their results to the MNC and local companies in Singapore so that can have better understanding
of industry operation. Guidance and hands-on training will be given by a very strong team of research
scientists and industrial engineers. The supervisors will guide the students to write research paper for
international conference.

79 Project Title: Simulation Study of Power Electronics Systems: Bond Graph Model Approach
Supervisor: Prof Wang Dan Wei; email: edwwang@ntu.edu.sg
Summary: Power Electronics systems, including inverters, converters and rectifiers, are critical and integrated part
of energy systems. During operation, faults in such systems need to be identified and isolated online and
in time to avoid power shut down and economic loss. These systems are highly complex and hybrid
systems with continuous dynamics and discrete events. To develop effective fault detection and isolation
(FDI) algorithms of such systems, the first thing is to understand the behaviors under the normal
operation and in the presence of faults. In this project, a model based approach is used to build for such
power electronics systems. These models in SIMULINK are used to study the behavior of these power
electronics systems. Both normal operations and faulty modes are simulated and analyzed. These results
will be used for the developments of FDI for complex and hybrid power electronics systems. The student
should have some knowledge of power electronics. This is a joint project of NTU and SIMTech.

80 Project Title: Statistical Model For Optimal Equipment Maintenance Decision
Supervisor: Prof Wang Dan Wei; email: edwwang@ntu.edu.sg
Summary: The analysis of event patterns contained in the operation event sequence data is becoming increasingly
importance in the system design and maintenance. This project is to develop a systematic approach and
algorithms to build a statistical model for prediction of equipment fault event based on event/data patterns
extracted from log files. The Cox proportional hazard model (CPHM), which is widely used in biomedical
survival analysis, can be adapted in this project to provide a statistically rigorous prediction of system
faults based on identified event patterns. The event patterns can be used to define significant covariates
for making optimal decision on the schedule of maintenance. This is a joint project of NTU and SIMTech.

81 Project Title: Study of friction estimation for robot vehicles
Supervisor: Prof Wang Dan Wei; email: edwwang@ntu.edu.sg
Summary: Friction between ground and tyres of a robotic vehicle is an important parameter that affects the vehicle
motion in outdoor terrains. Such terrains can be concrete, grass patches, rocks, soils or sands. Vehicle
will experience different frictions in different ground surface conditions. This project aims to review papers
on the techniques, algorithms and results for online identification and estimation of this friction coefficient.
The student needs to search for relevant papers and summarize findings in a proper way. Analysis and
comparisons are to be carried out for advantages and disadvantanges.

82 Project Title: Terminal Iterative Learning Control for Run-To-Run Control
Supervisor: Prof Wang Dan Wei; email: edwwang@ntu.edu.sg
Summary: The Nitride Process is one of the critical processes wafer production line. The wafer quality is highly
sensitive to variation of the temperatures and deposition time. The deposition time and temperature
currently are tuned and controlled manually based on engineers’ experience and a more automatic
approach is desirable. Terminal Iterative Learning Control (TILC) is a cycle-to-cycle control approach that
can be used on a thermoforming oven. TILC can be used for automatically tuning the heater temperature
set points so that the temperature tracks a desired temperature profile. Although TILC has been studied
for more than 10 years, but industrial thermoforming ovens can have a large number of temperature
sensors (inputs) and heaters (outputs), which makes TILC design difficult. In this research, students will
conduct the researches using both TILC and artificial neural network (ANN) approaches. The designed
control algorithms will be verified using both simulations and industry case studies. This is a joint project
between SIMTech and NTU.

83 Project Title: UWB Real Time Location System
Supervisor: Prof Wang Dan Wei; email: edwwang@ntu.edu.sg
and LIU WEI (A*STAR SIMTECH)
Summary: In this project will enable student to learn and develop both hardware and software skills for industrial
application using UWB RTLS, The students will also benefit from building architecture & application to apply technology for real industrial needs (nursing home). Guidance and hands-on training will be given by a very strong team of professor, research scientists and industrial engineers. The supervisors will guide the students to write research paper for international conference.

84 Project Title: 3D Object Tracking
Supervisor: Assoc Prof Wang Han; email: hw@ntu.edu.sg
Summary: Tracking 3D objects using model based approach. A frame work has been built by previous research students. We wish to expand the scope of tracking to track more complex objects.

85 Project Title: Digital Interface Conversion of a Mobile Robot
Supervisor: Assoc Prof Wang Han; email: hw@ntu.edu.sg
Summary: This is a practical project in which hardware knowledge about motors are required. A mobile robot needs upgrading its drive system with a new computer. The robot also has its own odometry sensors such as speed and turning rate. I am looking for a person who is interested in robotics to rebuild the whole system.

86 Project Title: E-toy: Learn to React in Diverse Environment (Two Students Needed)
Supervisor: Assoc Prof Wang Han; email: hw@ntu.edu.sg
Summary: na

87 Project Title: Internet based Surveillance
Supervisor: Assoc Prof Wang Han; email: hw@ntu.edu.sg
Summary: The objective is to replace traditional CCTV camera with digital cameras using advanced compression techniques such as wavelet.

88 Project Title: Development of Computer Graphics for Aircraft Landing
Supervisor: Assoc Prof Wang Jianliang; email: ejlwang@ntu.edu.sg
Summary: Pre-requisite: The student MUST be familiar and have worked on similar computer graphics projects. In this project, the student will help develop the computer graphics of the aircraft landing phase of an aircraft flight simulation software package. The student MUST be familiar with computer graphics and animation, and must have experience working on similar computer graphics development projects.

89 Project Title: Development of Real-time Rendering Control System
Supervisor: Assoc Prof Wang Jianliang; email: ejlwang@ntu.edu.sg
Summary: Background: This project involves the usage of principles from Control Theory usually adapted in mechanical systems on computer software, particularly real-time computer graphics. From a broader perspective, this allows computer software to be controlled in a meaningful way to yield predictable results consistently. Objective: The objective of this project is to develop software modules to support a real-time control system for rendering software. The software modules include network communication, PID control functionality and low level triangulation and vertex handling of 3D objects. The modules will be integrated into a cohesive Plant and Controller system in which the Plant is the rendering software. The possible subjects to be used as the Plant could be computer graphics programs such as a virtual reality software, computer game or scientific data visualization application. Requirements: The interested student should possess very good skills and knowledge in software development with at least proficiency in .Net language or C++. Background or experience in 3D computer graphics will be preferred, for those interested in working with real-time rendering software.

90 Project Title: Dynamic Inversion based Semi-Active Control for Seismically Excited Nonlinear Civil Structures
Supervisor: Assoc Prof Wang Jianliang; email: ejlwang@ntu.edu.sg
Summary: This project addresses development of vibration suppression of nonlinear base-isolated buildings excited by unknown earthquake disturbances. Since, some of the states are not measurable and the nonlinearity is severe (like frictional), dynamic inversion or feedback linearization concepts should be explored to handle the hysteric/frictional nonlinearity present in the structure. The controller should be implemented in MATLAB and the performance of the controller is evaluated on a full-scale nonlinear three-dimensional base-isolated benchmark structure incorporating lateral-torsion superstructure behavior and biaxial interaction of nonlinear bearings.
91 Project Title: Real-time Rendering of Complex 3D Models
Status: Available
Supervisor: Assoc Prof Wang Jianliang; email: ejlwang@ntu.edu.sg
Summary: Background: As the power of computer hardware scales non-linearly, users of many interactive computer graphics applications often demand high quality visualization that conveys very detailed information close to the real world. Complex 3D models are used in industries such as Computer-aided Design/Manufacturing and Medical Visualization but they scale beyond the capacity of the processor and memory hardware regularly. Consequently, real-time rendering of such models is a challenge under heterogeneous platforms. Objective: The objective of this project is to develop a software that is able to be generically adopted in real-time rendering applications for performance tracking. This involves the design and programming of a low level library that intercepts rendering tasks sent to the graphics hardware for pre-processing before the information is converted to pixels to be displayed. Requirements: The interested student should possess good knowledge of either DirectX or OpenGL. Prior experience developing interactive applications using these APIs directly would be necessary and preferred. In addition, the student should be conversant in C++/.Net technology for deployment reasons on the Windows platform.

92 Project Title: Unknown Disturbance Rejection in a Nonlinear System using Output Feedback Neural Controller
Status: Available
Supervisor: Assoc Prof Wang Jianliang; email: ejlwang@ntu.edu.sg
Summary: Neural networks with different architectures are successfully used in identification and control of nonlinear system. The problem of input disturbance rejection in such nonlinear system is gaining importance. For example, vibration suppression in civil structural building is a typical example. The unknown nonlinearity present in the base-isolation system and unknown seismic vibration introduces complexity in vibration suppression in civil structures. The idea here is to model the uncertain disturbance using nonlinear enforced system and determine the control law which minimizes the effect of disturbance at the output. The controller should be implemented in MATLAB and the performance of the controller is evaluated on a full-scale nonlinear three-dimensional base-isolated benchmark structure incorporating lateral-torsion superstructure behavior and biaxial interaction of nonlinear bearings.

93 Project Title: Error Bounds for Quintic Spline Interpolation II
Status: Available
Supervisor: Assoc Prof Wong Jia Yiing, Patricia; email: ejywong@ntu.edu.sg
Summary: We begin with quintic Hermite interpolation. This is followed by the definition, existence, uniqueness and construction of the quintic spline interpolate $S$ of an $n$ times continuous function $f$. We then proceed to the main objective namely to find explicit bounds for the sup norm of the $k$th derivative of $(f - S)$, $k = 0, 1, \ldots, n-1$. Having discussed one-dimension spline interpolation, we shall generalize the results to two-dimensional case. An important feature of this project is the inclusion of numerical illustration which justifies the established results.

94 Project Title: Error Inequalities for Discrete Hermite and Spline Interpolation
Status: Available
Supervisor: Assoc Prof Wong Jia Yiing, Patricia; email: ejywong@ntu.edu.sg
Summary: We shall develop a class of discrete Hermite and spline interpolates in one and two independent variables. Explicit error bounds in $l_{\infty}$ norm for both cubic and bicubic discrete Hermite and spline interpolates will be established.

95 Project Title: Error Inequalities for Discrete Hermite and Spline Interpolation II
Status: Available
Supervisor: Assoc Prof Wong Jia Yiing, Patricia; email: ejywong@ntu.edu.sg
Summary: na

96 Project Title: Pricing and Hedging Asian Options
Status: Available
Supervisor: Assoc Prof Wong Jia Yiing, Patricia; email: ejywong@ntu.edu.sg
Summary: An Asian option is a security whose payoff depends on the price average of the underlying asset. It remains a challenge to be able to price an Asian option quickly and accurately, since no explicit pricing formula exists even for most European-style Asian options. One suggestion is that of recursive numerical integration for pricing European-style Asian options, for which early exercise is not allowed. The price average is written in such a way as to allow the evaluation of its density through a recursive sequence of one-dimensional integrals involving the univariate normal distribution. However, as recursive numerical integration can prove to be computationally intensive with a large number of fixings, an alternative should be offered to circumvent this difficulty.

97 Project Title: Controller Design and Implementation for a Smart Structure System
Status: Available
### Project Title: Development of A Simulation Platform for a Networked UAV System

**Status:** Available

**Supervisor:** Prof Xie Lihua; email: elhxie@ntu.edu.sg

**Summary:** The aim of this project is to provide a multi-level infrastructure of interconnected simulator based on OMNet++ (or NS2) and MATLAB for UAV (unmanned aerial vehicle)-oriented large-scale wireless sensor networks for research purposes, pursuing an interdisciplinary approach that integrates the aspects of software development, topology control and consensus algorithms, data fusion and partially hardware. The topology construction and maintenance strategies will be coded and tested using OMNet++. A middleware, which hides the differences of UAVs, operating systems and communication protocols, maintains QoS and reflects real-time changes of the environment and networks, should be developed. The OMNet++-based WSN will then be embedded into high-level application of UAV mission simulated by MATLAB via the aid of the middleware. A student with good programming skill is required.

### Project Title: Outdoor Localization of Autonomous Vehicle

**Status:** Available

**Supervisor:** Prof Xie Lihua; email: elhxie@ntu.edu.sg

**Summary:** This project is concerned with an electric autonomous vehicle operating outdoors and connected to the Internet. It will be equipped with GPS, IMU, wheel encoders, lidar/camera system, and a wireless communication unit. The autonomous vehicle will be able to follow another similar vehicle closely in a leader-follower configuration and be able to perform some degree of autonomous navigation with the aid of the Internet. The student will be expected to contribute in the areas of sensor integration, path planning, and localization using lidar and/or a camera system.

### Project Title: Analysis of the quality of fingerprint image features

**Status:** Available

**Supervisor:** Asst Prof Yau Wei Yun; email: ewyyau@ntu.edu.sg

**Summary:** The most popular fingerprint feature used for matching is the feature points, called minutiae. Several approaches have been proposed which in a way, involves detecting the skeleton image to locate the minutiae. Subsequently, the geometrical and other information are extracted and used to match the minutiae. However, the performance of the minutiae extraction varies. Problem arises when there is noise or the fingerprint image is not clear. This could cause the introduction of false minutiae or the omission of valid minutiae. In this project, the main aim is to devise methods to analyse the quality of the minutiae so that the overall matching is improved. This will involve analysing the property of the minutiae to provide suitable confidence level and providing consistent information that can be extracted from the minutiae. Good knowledge in C/C++ or Matlab programming is essential for this project.

### Project Title: Automated Camera Network Coordination

**Status:** Available

**Supervisor:** Asst Prof Yau Wei Yun; email: ewyyau@ntu.edu.sg

**Summary:** The analysis and understanding of video events are important for various exciting applications including surveillance and monitoring, vision-based human-computer interaction, content-based video archiving and retrieval etc. This will usually require a large camera network (or camera array). However, the images obtained from the cameras may vary due to the intrinsic property of the camera. For example, for a white object, the color obtained from each camera may not be of the same value. The project aims to devise methods to calibrate the camera network automatically from the scene and coordinate the camera output. Good knowledge in C/C++ programming is essential for this project.

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