### 1. Laser light and white light interferometry for 3D shape reconstruction of micro-mechanical components

**Description / Objectives**
To get the student familiar with the physics of light interference, to understand how physics theory can be applied to various industrial applications, and to train the student to obtain basic and advanced level of skills to handle optical components as well as microscopes.

**Student tasks and responsibilities**
Conduct optical component assembly, record light interference images, understand the principle of the experiments and measure various test objects.

**Hours required per week**
5 - 7

**Number of students**
1

**Faculty supervisor**
Chen Lujie

**Research areas**
Optical metrology and computer vision

### 2. Object profile reconstruction by photos taken from different viewing angles

**Description / Objectives**
To get the student familiar with the computer vision and photometric research tools, to understand how 2D images can be used to retrieve 3D information of an object, to train the student to obtain advanced skills to handle digital camera, and possibly to expose the student to basic level of C++ programming.

**Student tasks and responsibilities**
Conduct computer vision and photometric experiments (involving taking photos of test objects under controlled illumination environment), process recorded images and reconstruct 3D profile, and develop basic data-filtering program to improve the visualisation of the results.

**Hours required per week**
5 – 7

**Number of students**
1

**Faculty supervisor**
Chen Lujie

**Research areas**
Optical metrology and computer vision

### 3. Simulating the heating-up of ultracold atoms with a Monte Carlo algorithm

**Description / Objectives**
Ultracold atoms, just like human beings, behave very differently when they are in large groups. In particular, they seem to be much more resistant to outside perturbations (such as heating by a laser) when they interact very strongly between themselves. The aim of this UROP is to better understand this dynamical behaviour by simulating it on a computer. The equations that describe this system are classical diffusion equations that we want to address with a Monte Carlo method. This programming method and this kind of equations are very commonly used in many areas of science and engineering.

**Student tasks and responsibilities**
(i) Be introduced to the fascinating world of ultracold (near 0 Kelvin) atoms in vacuum trapped by lasers.
(ii) Write a good code that implements the Kinetic Monte Carlo method adapted to this problem. This project is ideal for students with a passion in Physics and programming.

**Hours required per week**
2 - 4

**Number of students**
1

**Faculty supervisor**
Dario Poletti

**Research areas**
Complex Classical and Quantum Systems, Ultracold Atoms
### 4. Design, Analysis and Development of Electromagnetic Actuators and Devices

**Description / Objectives**

Any electromechanical system that converts electricity to mechanical motion utilises the electromagnetic forces (one of four fundamental forces in nature) between magnets and electromagnets for generation of controlled motion. Such systems are found in the aircraft launching systems of the Gerald R. Ford class aircraft carriers, the electric motor of the Toyota Prius hybrid and the Shanghai Maglev Train.

**Student tasks and responsibilities**

This project will encompass both mechanical and electrical design, an introduction to electromagnetism and applied magnetics, fabrication and prototyping aspects as well as understanding and implementing control systems. Students with background and strong interest in mechatronics, fabrication and prototyping preferred but not required. Passion and drive is a must!

**Hours required per week**

10

**Number of students**

2 - 4

**Faculty supervisor**

Foong Shaohui

**Research areas**

Mechatronics, Automation, Sensing and Control Systems, Medical Devices, Electromagnetic Actuators, Magnetic Tracking Systems

### 5. Developing an Intuitive Mobile Application (iOS/Android/Windows) for Controlling and Programming of Industrial 6-axis Articulated Robotic Arms

**Description / Objectives**

6-axis articulated robots are popular robots used in numerous industries and for various applications. This project seeks to develop an App that can run on mobile devices to allow an actual robot to be controlled wirelessly and intuitively by harnessing the touchscreen and onboard sensors (accelerometers, gyroscopes, magnetometers, microphone etc). As programming of robots are traditionally and normally done with a computer keyboard (text-based), a more interactive and efficient system is sought that is more natural to mobile devices.

**Student tasks and responsibilities**

Background experience in mobile applications development and/or robot control theory will be helpful but not necessary. Requires passion and drive!

**Hours required per week**

10

**Number of students**

2 - 3

**Faculty supervisor**

Foong Shaohui

**Research areas**

Mechatronics, Automation, Sensing and Control Systems, Medical Devices, Electromagnetic Actuators, Magnetic Tracking Systems

### 6. Sustainable development 1: Making plants and plant databases more accessible to designers, environmental engineers, urban planners and architects.

**Description / Objectives**

With the paradigm shift towards having more greenery incorporated in urban structures and during sustainable development planning/designing, designers-urban planners-architects often struggle to know which is a suitable plant or a group of plants for the planned design or project. We are in midst of producing a (massive plant encyclopedia) book and database for the tropics, and we welcome you to join the “Green” people at the “Green Solutions Laboratory@SUTD”.

**Student tasks and responsibilities**

Students will learn a lot about plants and how they can be used in the designing of architectural façade, green roofs, civil engineering projects, urban planning, water cleansing of water bodies, plantations, agriculture and reforestation. The students will assist the research staff and graduate students to organise the database, visits to the Singapore National herbarium (a place where all plants are kept in a national repository) and will help to take super-macro, macro and holistic photographs of plants. Training will be provided to students who lack the skills in carrying out professional biological photography and the handling of cameras, microscope-assisted photography.

**Hours required per week**

10

**Number of students**

2

**Faculty supervisor**
Jean (John) Yong

**Research areas**
Inter-disciplinary research area of Sustainable Development involving elements of Biology, Environmental Science, Information Technology, and Analytical Chemistry

### 7. Sustainable development 2: Bridging the knowledge gap between Organic bio-fertilizers and Synthetic fertilizers

**Description / Objectives**
This is the current SUTD-ZJU funded research at “Green Solutions Laboratory@SUTD”. As a result of the negative environmental effects associated with conventional synthetic fertilisers (e.g., urea), such as overfertilisation, nutrient leaching and subsequent ecological and farm land damages, crop growers have begun to turn to bio-fertilisers instead of synthetic fertilisers.

At present, most bio-fertilisers are environmentally friendly, but they may not be able to deliver a stable and predictable growth stimulation comparable to synthetic fertilisers. The main reason is that the chemical and biological properties of bio-fertilisers are not fully understood yet. Composting is an accelerated bio-oxidation process of organic matter, using micro-organisms such as bacteria, fungi, etc., to form useful homogenous and stabilized humus-like product. Vermicomposting is essentially the use of earthworm-microbial symbiotic relationship to enhance the process of organic waste (e.g. animal, plant, or urban wastes) biochemical conversion, with significant concomitant reduction in the volume and weight of initial raw materials. After vermicomposting, the end-product is vermicompost which is a type of biofertilisers with high growth-promotory efficacy.

The beneficial effects of bio-fertilisers not only come from the elevated nitrogen levels provided but also by the release of numerous growth-promoting substances. These substances play many important roles in plant growth and development. Furthermore, these organic compounds exhibit beneficial effect on soil recovery and enhancing soil microbial activities, which is important for sustainable and/or organic farming. In addition, the positive effect of bio-fertilisers on plant-mycorrhizal/microbial interaction is also essential as microorganisms can aid in nutrient uptake and produce plant growth-promoting substances, thus improving plant performance.

**Student tasks and responsibilities**
One design-centric student can focus on the design and fabrication aspect of this project. Designing a conducive “home” for the earthworms in order to keep the worms “happy”, and to facilitate the ease in placing suitable rubbish for vermicomposting, and collection of the vermicompost (ie, the earthworms’ excrement). The other student may focus more on animal husbandry (ie caring for earthworms; optimisation of earthworm feedstock and living conditions’ assessment) or on the analytical chemistry aspect of the vermicomposts using liquid chromatography-mass spectrometric (LCMS) analyses of the excrement.

**Hours required per week**
10

<table>
<thead>
<tr>
<th>Number of students</th>
<th>10</th>
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</thead>
<tbody>
<tr>
<td>Faculty supervisor</td>
<td>Jean (John) Yong</td>
</tr>
<tr>
<td>Research areas</td>
<td>Inter-disciplinary research area of Sustainable Development involving elements of Biology, Environmental Science, Information Technology, and Analytical Chemistry</td>
</tr>
</tbody>
</table>

### 8. Sustainable development 3: Urban water catchment pilot project at Sungei Buangkok, Punggol – improving the quality of canal water using aquatic plants

**Description / Objectives**
This is the current and externally (PUB) funded research at “Green Solutions Laboratory@SUTD”. This project follows the philosophy of PUB’s ABC (Active, Beautiful and Clean) Waters Masterplan in trying to achieve better water quality while maintaining the aesthetic aspects of GREEN Singapore.

This interdisciplinary project aims to be a comprehensive study on the direct applications of selected floating plants to remove macro-elements like Nitrogen (organic and inorganic) & Phosphorus, heavy metals (e.g. Cadmium), & metalloids (e.g. Arsenic) in local urban waterways, via the natural processes of plant growth and phytoremediation of excessive elements from the environment. Such plants would serve as “biofilters” or “biomops” to keep the levels of macro- & trace elements in local waterways at appropriate concentrations so as not to cause environmental pollution. The usage of plants as “biofilters” would therefore enable the maintenance of waterway water quality in a holistic & environmentally sustainable way, while providing an aesthetically-pleasing green environment.

The focus of this project is to utilise floating plants as a bioaccumulator of macro & trace elements in Buangkok Canal and Lower Peirce Reservoir. The primary plant choice will be the native Asian watergrass (Hygroryza aristata); in addition water hyacinth (Eichhornia crassipes) and water lettuce (Pistia stratiotes) will also be introduced to diversify plant phytoremediation ability. We have chosen the floating plants for on-site application in this project from our previous expertise based on extensive research on the investigation on the
phytoremediation ability of various plants in application to tropical waterbodies. Generally, fast growing species such as the water hyacinth, water lettuce and Asian watergrass have the potential to utilize macro-elements (N, P) and its associated compounds rapidly as the direct result of their inherent growth needs.

**Student tasks and responsibilities**

One design-centric student can focus on the design and fabrication aspect of this project. Designing an improved structure that carries more solid-state environmental sensors, more robust designs especially to cope with oil spills, in order to keep the plants “happy”, and to facilitate the ease in placing the watergrass (*Hygroryza aristata*) onto the floating structure and to facilitate the collection of the water for chemical analyses.

The other student may focus more on the ecological aspects (e.g., dragonflies and damselflies are good ecological indicators of good water quality – how have these parameters change since we put in the structure into the canal?) of the project or on the analytical chemistry aspect of the water quality using ICP (Inductively Coupled Plasma [ICP-OES and ICP-AES] from Perkin) or AA (Atomic absorption spectrophotometry). This student will also learn how to assess aquatic plant health using the portable photosynthesis system from Licor Inc, which is essentially an Open Gas Exchange system using a series of Infra-red gas analyzers (IRGA) measuring simultaneously both photosynthetic carbon gain/loss with concomitant water vapour sampling.

**Hours required per week**

10

**Number of students**

2

**Faculty supervisor**

Jean (John) Yong

**Research areas**

Inter-disciplinary research area of Sustainable Development involving elements of Biology, Environmental Science, Information Technology, and Analytical Chemistry

9. **Low cost self-assembled plasmonic nanoparticles**

**Description / Objectives**

When the size of metal particles is reduced to nanometre scale, very interesting phenomena occurs when the particles interact with light. The electrons in the metallic nanoparticles oscillate according to the varying electric field of the light wave. At a certain wavelength of the light, the oscillation will resonate with the frequency of the electric field. This will in term generate very large localised electric field. Plasmonics has a lot of applications in the area of sensing, imaging and nanophotonics.

In this project, the students will learn how to synthesise and characterise the nanoparticles. In the experiments, the students will explore the different factors affecting the growth of the nanoparticles. They will also design new methods to coat the nanoparticles.

**Student tasks and responsibilities**

To synthesise and characterise plasmonic nanoparticles
To develop self-assembled techniques for the nanoparticles

**Hours required per week**

3

**Number of students**

2

**Faculty supervisor**

Kwan Wei Lek

**Research areas**

Materials, Photonics

10. **Modeling of the dynamics of Singapore’s global water collection/treatment/distribution system**

**Description / Objectives**

• Biomimetic analysis based on an analogy with the bifurcated bronchial respiratory system
• Investigation of its adaptivity and control in the sense of complex systems

**Student tasks and responsibilities**

Contribute to the development of a global model of Singapore’s drinking water system using concepts borrowed from Complexity Science.

Initiate the implementation of the model.

**Hours required per week**

Flexible (up to 10h per week)

**Number of students**

2

**Faculty supervisor**

Roland Bouffanais

**Research areas**
11. **Probability Collectives Theory for the design of an artificial school of fish**

**Description / Objectives**
- Introduction to Complexity Science and Agent-based modelling
- Definition of a global utility function
- Influence of the ubiquitous presence of noise on the global control at the superorganism level

**Student tasks and responsibilities**
Contribute to the development of an Agent-based model using NetLogo to model the behaviour of an artificial school of fish. Initiate the implementation of the model and carry-on some simulations and observations.

**Hours required per week**
Flexible (up to 10h per week)

**Number of students**
2

**Faculty supervisor**
Roland Bouffanais

**Research areas**
Complexity Science

12. **Speak-ables**

**Description / Objectives**
A microcontroller based English speech learning system in the form of multiple display cubes. These cubes can be placed next to each other to form utterances of phoneme units. Phoneme units can be further combined to make actual words that will be read aloud to the user. The project is aimed at providing young children with an interactive and engaging method to develop spoken English language skills.

**Student tasks and responsibilities**
To implement the hardware and software components for the project.

**Hours required per week**
6 - 10

**Number of students**
2

**Faculty supervisor**
Suranga Nanayakkara

**Research areas**
Wearable technologies, Sensor Design, Assistive Devices

13. **Responsive ‘Stickers’**

**Description / Objectives**
The general idea is to build different type of wireless sensors that allows a person to turn everyday objects into something responsive. As a start we define 2 specific type of sensor that would help two groups of people – hearing impaired and visually impaired. The first type of sensor monitors for sound event and sends notifications to the hearing impaired wearing a device that could either have a visual or vibro-tactile alert. The second type of sensor is design to allow a visually impaired person to instrument everyday objects with audio capabilities such that they can respond to the person when called out to.

**Student tasks and responsibilities**
To implement the hardware and software components for the project.

**Hours required per week**
6 - 10

**Number of students**
4

**Faculty supervisor**
Suranga Nanayakkara

**Research areas**
Wearable technologies, Sensor Design, Assistive Devices

14. **Imaging of Inorganic Fluorescent Nanoparticles in a Simulated Tissue Matrix**

**Description / Objectives**
The key objective of this project is to create the platform that will be used to study the optical properties of fluorescent nanoprobes in a simulated tissue environment. Brightly-emitting, tissue-specific fluorescent nanoprobes are required to open new avenues in in vivo optical imaging for rapid disease screening and image-guided surgical interventions. New insights will be gained from studying the scattering effects of the matrix on the potential of using these probes as contrast agents for medical imaging.
15. **Inkjet Printing of Inorganics for Flexible Electronics**

**Description / Objectives**
The key objective of this project is to study and explore methods to print inorganic nanoparticles on a flexible polymer. Flexible electronics require a combination of printing and microelectronics to enable design of circuits on top of plastic materials in the same way that an inkjet printer transfers ink on paper. Advancements in flexible electronics will enhance product versatility; reduce costs and further innovation in product development. Examples of some technological applications include organic light-emitting displays, solar cells, radio frequency identification tag antennae, glucose test strips, eBook readers, and printed batteries.

**Student tasks and responsibilities**
- Students will learn and assist with the synthesis of inorganic nanoparticles
- Students will learn and assist with the printing of these inorganic nanoparticles on a flexible polymer

**Hours required per week**
5 - 10

**Number of students**
1

**Faculty supervisor**
Tan Mei Chee

**Research areas**
Engineering Nanocomposites for Biomedical Applications and Energy Efficient Devices

16. **Cloud Storage**

**Description / Objectives**
Design and implement next generation cloud storage system.

**Student tasks and responsibilities**
Develop programs for distributed storage system. Strong in mathematics or programming.

**Hours required per week**
10

**Number of students**
2

**Faculty supervisor**
Yuen Chau

**Research areas**
Wireless Communications, Smart Grid, Cloud Storage

17. **Wireless Video Transmission**

**Description / Objectives**
Investigate state of the art wireless communications techniques and customise for wireless video transmission.

**Student tasks and responsibilities**
Develop programs for wireless video transmission. Strong in mathematics or programming, especially for programming on mobile platform such as iPhone or Android.

**Hours required per week**
10

**Number of students**
2

**Faculty supervisor**
Yuen Chau

**Research areas**
Wireless Communications, Smart Grid, Cloud Storage
<table>
<thead>
<tr>
<th>18.</th>
<th><strong>Free space optical system</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description / Objectives</strong></td>
<td>Design and implement high speed wireless communications system based on visible light spectrum. Such free space optical system is attractive as it can support high data rate and create no interference to other system.</td>
</tr>
<tr>
<td><strong>Student tasks and responsibilities</strong></td>
<td>Students will need to build such communications system, both transmitter and receiver. Students with hands on electronic circuit design experience will be preferred.</td>
</tr>
<tr>
<td><strong>Hours required per week</strong></td>
<td>10</td>
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<tr>
<td><strong>Number of students</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Faculty supervisor</strong></td>
<td>Yuen Chau</td>
</tr>
<tr>
<td><strong>Research areas</strong></td>
<td>Wireless Communications, Smart Grid, Cloud Storage</td>
</tr>
</tbody>
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<thead>
<tr>
<th>19.</th>
<th>** Indoor Positioning**</th>
</tr>
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<tbody>
<tr>
<td><strong>Description / Objectives</strong></td>
<td>Design and implement an indoor positioning system.</td>
</tr>
<tr>
<td><strong>Student tasks and responsibilities</strong></td>
<td>Students will need to write programs and connect to various wireless transmission devices to enable accurate indoor positioning. Strong in programming and interfacing with hardware.</td>
</tr>
<tr>
<td><strong>Hours required per week</strong></td>
<td>10</td>
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<tr>
<td><strong>Number of students</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Faculty supervisor</strong></td>
<td>Yuen Chau</td>
</tr>
<tr>
<td><strong>Research areas</strong></td>
<td>Wireless Communications, Smart Grid, Cloud Storage</td>
</tr>
</tbody>
</table>

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<tr>
<th>20.</th>
<th><strong>Nanostructured titanium oxide coatings</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description / Objectives</strong></td>
<td>The objective of this project is to study the effect of processing parameters such as temperature and surface morphology on the formation of titanium oxide films. Titanium films will be formed using a wet oxidation technique. The student will have ample opportunities to be exposed to principles of materials science and engineering and methods for materials characterisation.</td>
</tr>
</tbody>
</table>
| **Student tasks and responsibilities** | Student will be given training on chemical preparation methods prior to performing tasks. The student will be involved in:  
- Fabricating coating using wet oxidation  
- Processing of coatings such as annealing, casting, etc  
- Characterising materials and analysing data |
| **Hours required per week** | 3 - 4 |
| **Number of students** | 1 |
| **Faculty supervisor** | Zuruzi Abu Samah |
| **Research areas** | Materials synthesis, processing and characterisation; Prototyping |

<table>
<thead>
<tr>
<th>21.</th>
<th><strong>Surface studies of materials</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description / Objectives</strong></td>
<td>This explorative project will study how surfaces affect the properties of materials. Various classes of materials will be studied. This project requires hands-on processing such as machining and is suitable for those who are open to manual operations and wants to be exposed to materials processing.</td>
</tr>
</tbody>
</table>
| **Student tasks and responsibilities** | Student will be given training prior to performing tasks. The student will be involved in:  
- Surface machining of materials using contact and non-contact machining  
- Processing of materials  
- Characterizing materials and analysing data |
<table>
<thead>
<tr>
<th><strong>Hours required per week</strong></th>
<th>3 - 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of students</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Faculty supervisor</strong></td>
<td>Zuruzi Abu Samah</td>
</tr>
<tr>
<td><strong>Research areas</strong></td>
<td>Materials synthesis, processing and characterisation; Prototyping</td>
</tr>
</tbody>
</table>

### 22. The Coffee Ring effect – Modifying it via external Magnetic or Electric Fields

**Description / Objectives**

When a drop of liquid dries on a solid surface, its suspended particulate matter is deposited in ring-like fashion. This phenomenon, known as the coffee-ring effect, is familiar to anyone who has observed a drop of coffee dry. This project will look at the effects of the application of an external field (magnetic/electric etc) on the deposition pattern of the magnetic/electrically charged solutes as the solvent evaporates.

**Student tasks and responsibilities**

To use an optical microscope with an attached digital video camera to observe, record and understand the drying process of droplets of various aqueous solutions as well as organic solvents with non-volatile solutes on various surfaces.

**Hours required per week**

5

**Number of students**

2

**Faculty supervisor**

Reginald Thio

**Research areas**

Colloid and Interface Science, Surface Chemistry, Water Remediation, Analytical chemical methods

### 23. Drawing on Cellulosic Paper for Functional Applications

**Description / Objectives**

We will explore the use of various inorganic and organic fillers in cellulosic paper for unique applications; such fillers will have (but are not limited to) magnetic, flame retardant, antibacterial, electrically conductive and anti-dust properties.

**Student tasks and responsibilities**

Deposit/write/incorporate various materials onto papers (writing papers, toilet/tissue paper) and observe the changes to the paper properties. Explore possible functional applications for such chemically modified papers.

**Hours required per week**

5

**Number of students**

2

**Faculty supervisor**

Reginald Thio

**Research areas**

Colloid and Interface Science, Surface Chemistry, Water Remediation, Analytical chemical methods

### 24. Identifying Energy Waste and Reduce Energy Consumption at SUTD

**Description / Objectives**

In this project, we’ll install sensor networks and smart plugs to monitor and identify the energy waste at SUTD campus and design effective solutions to reduce the energy consumption through technology.

**Student tasks and responsibilities**

The student will be in charge of planning and installing sensor networks, programming sensor nodes, collecting data, visualising data and analysing data.

**Hours required per week**

4 - 10

**Number of students**

2

**Faculty supervisor**

Jason Gu

**Research areas**

Cyber-Physical Systems, Mobile Computing
### 25. Novel Mobile Computing Applications

**Description / Objectives**
In this project, students will be involved in designing and implementing a wide range of novel applications with high research values as well as commercial values.

**Student tasks and responsibilities**
Students will assist in designing and implementing several mobile applications, such as smart objects tracking and searching, and privacy-enabled photo taking on the Google Android or Apple iOS platforms.

**Hours required per week**
4 - 10

**Number of students**
2

**Faculty supervisor**
Jason Gu

**Research areas**
Cyber-Physical Systems, Mobile Computing

### 26. Improving Verification of Real-time Systems with Ticks

**Description / Objectives**
The objective is to speed-up the existing algorithms on verifying real-time systems by designing and implementing new algorithms, heuristics, etc. Assume that a real-time system has been modelled in some form of state transition systems. A special transition label tick is used to represent the elapse of 1 time units. There might be many tick-transitions. It is an open system on how to reduce the tick-transitions while preserving interesting properties.

**Student tasks and responsibilities**
The task is to implement and experiment an improved algorithm in the PAT model checker and compare the performance with the existing approaches. The programming language is C#. Students are welcomed to design their own algorithms too.

**Hours required per week**
2

**Number of students**
1

**Faculty supervisor**
Sun Jun

**Research areas**
Computer Science, System Verification by Searching

### 27. Loss-sensitive training for word segmentation

**Description / Objectives**
To study the effect of loss-sensitive learning algorithms and compare their effect with the perceptron for word segmentation with beam search.

**Student tasks and responsibilities**
Performing experiments by running and evaluating a segmentation system with different loss functions.

**Hours required per week**
2 - 5

**Number of students**
1 - 2

**Faculty supervisor**
Yue Zhang

**Research areas**
Natural language processing, machine learning

### 28. Cross-domain word segmentation

**Description / Objectives**
To work towards a robust Chinese word segmentation system for all text domains.

1) evaluating the cross-domain performance of a Chinese word segmentation system; and
2) studying and comparing two domain-adaptation approaches.

**Student tasks and responsibilities**
(1) Performing experiments by running and evaluating a segmentation system;
(2) Manual annotation of unsegmented text.

**Hours required per week**
2 - 5

**Number of students**
<table>
<thead>
<tr>
<th>1 - 2</th>
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<tbody>
<tr>
<td><strong>Faculty supervisor</strong></td>
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<tr>
<td>Yue Zhang</td>
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<tr>
<td><strong>Research areas</strong></td>
</tr>
<tr>
<td>Natural language processing, machine learning</td>
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<thead>
<tr>
<th>29.</th>
<th><strong>SUTD iLab Remote Laboratory</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description / Objectives</strong></td>
<td></td>
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<tr>
<td>We hope to develop a sustainable and scalable lab with experimental set-ups that can be accessed by multiple users anytime and anywhere using a regular internet web browser.</td>
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<tr>
<td><strong>Student tasks and responsibilities</strong></td>
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<tr>
<td>Set up lab materials and test the system.</td>
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<td><strong>Hours required per week</strong></td>
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<tr>
<td><strong>Number of students</strong></td>
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<td>2</td>
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<tr>
<td><strong>Faculty supervisors</strong></td>
<td></td>
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<tr>
<td>Pey Kin Leong, Grace Sow, Allan Chan</td>
<td></td>
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<tr>
<td><strong>Research areas</strong></td>
<td></td>
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<tr>
<td>Remote Laboratory</td>
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<table>
<thead>
<tr>
<th>30.</th>
<th><strong>The Bagdad Battery: An Ancient Electrochemical Device</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description / Objectives</strong></td>
<td></td>
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<tr>
<td>There is emerging evidence that ancient civilisations had access to a series of technological tools and know-how which has been, for the most part, overlooked. In this particular project, we will focus on the Bagdad battery as an ancient invention, its past potential applications, and its adaptation as a lecture demonstration for the chemistry class at SUTD.</td>
<td></td>
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<tr>
<td><strong>Student tasks and responsibilities</strong></td>
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<tr>
<td>Student will carry out literature research on the Bagdad battery, design and fabricate various size replicas of the Bagdad Battery, and optimise voltage and measurements. In addition, the student will identify past potential, and current practical applications. Finally, the student will help in adapting the Bagdad battery as a “lecture demo” in the chemistry class at SUTD.</td>
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<tr>
<td><strong>Hours required per week</strong></td>
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<td><strong>Number of students</strong></td>
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<tr>
<td><strong>Faculty supervisor</strong></td>
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<td>Franklin Anariba</td>
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<tr>
<td><strong>Research areas</strong></td>
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<tr>
<td>Electrochemistry - Ancient Technologies, Aggregation-Induced Fluorescence</td>
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<table>
<thead>
<tr>
<th>31.</th>
<th><strong>UV-Vis and Fluorescence Studies of Organic Fluorescent Dyes</strong></th>
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<tbody>
<tr>
<td><strong>Description / Objectives</strong></td>
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<tr>
<td>Organic dyes displaying aggregation-induced emission (AIE) have found a wide range of applications in the field of biosensing and bioimaging. Of particular interest is the behaviour of these fluorescent dyes in the vicinity of DNA, metal cations, and anion species, including fluorescence response as a function of pH.</td>
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<td><strong>Student tasks and responsibilities</strong></td>
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<tr>
<td>The student will characterise the interaction of charge species in aqueous solvents (e.g., DNA and ions) with the fluorescent dyes via UV-Vis and Fluorescence measurements.</td>
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<td><strong>Hours required per week</strong></td>
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<td>5</td>
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<td><strong>Number of students</strong></td>
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<td><strong>Faculty supervisor</strong></td>
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<tr>
<td>Franklin Anariba</td>
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<thead>
<tr>
<th>32.</th>
<th><strong>Exploring military communication through simulation – a beginner tour</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description / Objectives</strong></td>
<td></td>
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<tr>
<td>We are focusing on carrying out a basic study about military communication through software simulation. This is a preparation for us to understand the military communication. By using existing software, we hope to improve the...</td>
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<tr>
<td>Project Number</td>
<td>Description / Objectives</td>
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<tr>
<td>33.</td>
<td>Exploring digital circuit design using C rather than HDL</td>
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<tr>
<td>34.</td>
<td>Nanomaterials based supercapacitor</td>
</tr>
<tr>
<td>35.</td>
<td>Metal oxide and carbon materials based anode materials for Li batteries</td>
</tr>
<tr>
<td>36.</td>
<td>Idea Bakery, a repository of half-baked ideas, inspirations and provocations for/by the SUTD community</td>
</tr>
</tbody>
</table>
(students, faculty, research, staff) have access to record, comment, build on and modify a repository of ideas. A number of systems and components need to be considered including criteria related to access, organisation, interaction, representation, confidentiality, etc. A pilot programme will include a trial period with a sample population. This project will contribute to the development of a systematic understanding of large-scale group ideation.

**Student tasks and responsibilities**
Ideally, students need to be interested in creativity research and practice. The set of abilities required include basic web-related coding/programming skills or willingness to learn (PHP, JavaScript, HTML, etc), as well as a flexible and open attitude to new ideas coupled with a hands-on experimental disposition to make decisions based on evidence.

**Hours required per week**
5 to 10 hours per week

**Number of students**
3

**Faculty supervisor**
Ricardo Sosa

**Research areas**
Social simulation of creativity and innovation; Rapid prototyping for creative design; Participatory design methods; Evolutionary design systems; Mass customization of designs

### 37. Design by Analogy: ideation and fabrication of innovative products using analogies from distant domains

**Description / Objectives**
This is a “maker” type project where students will be guided to conduct short-term design projects from ideation to prototyping/fabrication (typically two to three weeks each). The emphasis is on developing everyday use products that address present and future opportunities in the market. In order to provide some focus, the design process will be based on strategies of “design by analogy” — particularly from distant domains. The project’s aims include: to develop a design portfolio, to create teaching materials, to develop submissions for international design competitions, and ultimately to characterise the processes and strategies related to design by analogy and develop a relevant set of tools and techniques.

**Student tasks and responsibilities**
Students need a strong interest in product/industrial design practice and research. The set of relevant skills include: creative ideation, sketching, CAD software, rapid prototyping, and basic electronics (Arduino, Gadgeteer). Students need not have all these skills prior to joining this project, but they need to commit to learn and apply these skills rapidly.

**Hours required per week**
5 to 10 hours per week

**Number of students**
3 – 5

**Faculty supervisor**
Ricardo Sosa

**Research areas**
Social simulation of creativity and innovation; Rapid prototyping for creative design; Participatory design methods; Evolutionary design systems; Mass customization of designs

### 38. Development of an intelligent and autonomous multi-rotor flying drone

*(in collaboration with National Instruments [http://ni.com]*)

**Description / Objectives**
Unmanned aerial vehicles (UAVs) are used in a multitude of applications such as surveillance, photography, reconnaissance, rescue and even scientific research. Multi-rotor aircrafts are a class of UAVs that utilizes more than two fixed-pitch rotor-blades for aerial flight. Control of vehicle motion is achieved by varying the relative speed of each rotor to alter the resultant thrust and torque produced by each. However, without on-board sensors to measure the instantaneous inclination angles and velocities and a microprocessor for assistance, achieving stable flight is difficult. Here an NI Single-Board RIO system, with an embedded real-time processor and reconfigurable FPGA will be employed with an assortment of intelligent sensors to perform not just 3D flight stabilization but also achieve autonomy.

The students are tasked with the following objectives:

1. Show technical excellence with LabVIEW and LabVIEW FPGA
2. Develop a strong understanding of custom protocols using LabVIEW FPGA
3. Design and test an autonomous hex-copter (6 rotor multi-rotor craft)
   - Solid modelling and dynamic analysis/simulations
   - 3D flight dynamics and control algorithms
- Mechanical and electrical design, prototyping and fabrication
- Sensor (gyroscope, accelerometer, etc) integration and communication buses (PWM, I2C, SPI, etc)
- Real-time telemetry and information fusion
- Advanced programming, GUI (guided user interface) development and HMI (human machine interface) aspects
- Safety and fail-safe considerations (backup parachutes)

**Student tasks and responsibilities**
1. Perform self-paced training on NI LabVIEW and NI LabVIEW FPGA with the help of an NI Mentor
2. Take a CLAD (Certified LabVIEW Associate Developer) certification test (test will only be provided upon passing a mock CLAD test)
3. Understand the hardware and sensor communication protocols
4. Develop and test the control algorithm for hovering
5. Develop a 3D and control model to simulate flight using NI LabVIEW Control Design and Simulation Module
6. Implement the control model to perform a fully functional flight test
7. Design and implement autonomous path following functionality
8. Design for the second phase of development, which is fully autonomous mode using additional sensors

*Teamwork and dedication are crucial as students will need to work together closely to devise, build and program the multi-rotor aircraft to achieve autonomous flight.*

**Hours required per week**
Up to 10hrs

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<th><strong>Number of students</strong></th>
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<td>3 - 6</td>
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**Faculty supervisor**
Foong Shaohui

**Research areas**
Mechatronics, Automation, Sensing and Control Systems, Medical Devices, Electromagnetic Actuators, Magnetic Tracking Systems

### 39. Implicit theories and academic motivation

**Description / Objectives**
To study the impact of implicit theories in intelligence on language learning and motivation

**Student tasks and responsibilities**
Assist in the design and conduct of the study, including liaising with the relevant parties, recruiting participants, and running of the study.

**Hours required per week**
3 - 6

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<th><strong>Number of students</strong></th>
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**Faculty supervisor**
Wei Quin Yow

**Research areas**
Psychology – Bilingualism, Cognitive, Motivation

### 40. Bilingualism, communicative development, and cognitive control

**Description / Objectives**
To examine the impact of environmental influences, such as bilingualism on the development of social communicative skills and cognitive control

**Student tasks and responsibilities**
Assist in the design and conduct of the study, including liaising with the relevant parties, recruiting participants, and running of the study.

**Hours required per week**
3 - 6

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**Faculty supervisor**
Wei Quin Yow

**Research areas**
Psychology – Bilingualism, Cognitive, Motivation