THE UNIVERSITY of ADELAIDE

Summer Research Scholarships

School of Electrical and Electronic Engineering

Project Titles 2017/18

Algorithms for Measuring Sleep Health
Description: Sleep performs important restorative functions for brain and body. Since we spent about 1/3rd of our lives asleep, sleep disturbance can seriously affect emotional wellbeing, cognitive performance and cardiovascular health. It is therefore important to monitor sleep if issues are suspected. Multichannel sleep recordings, performed at home or hospital, acquire a number of physiological signals throughout the night, creating large volumes of biological data. Automated algorithms are required to process these signals and deliver diagnostic information to aid clinical decision making. In this project, we will analyze nasal airflow signals obtained during a large, international randomized trial involving >2,000 patients to create a robust algorithm for detecting airflow limitations. This project will develop students' skills in biomedical signal processing using Matlab and background knowledge in sleep physiology.
Supervisors: A/Prof Mathias Baumert and Dr Dominik Linz

Developing Artificially Intelligent Control for a Robot Soccer Table
Description: This project provides an opportunity to contribute to the development of an autonomous robot soccer table. There is flexibility in the project for the participant to choose an aspect of the research that is of most interest to them. The hardware is substantially complete but there is scope to experiment and improve upon it. The existing software uses a modular structure with separate modules for image processing, artificial intelligence, and position control. Different modules can be developed so that different approaches can be tried and compared. At present, only very simple modules have been written to test the hardware. The project will involve writing new, more advanced modules. For example, the participant may choose to build an AI for the robot using a deep-learning machine intelligence approach, or by using a rule-based approach based on a cognitive architecture.
Supervisor: Dr Braden Phillips

Classifying Network Traffic Flows with Deep-Learning
Description: Deep-learning or Deep Neural Networks has gained prominence in recent years in a range of application areas, including image classification, speech recognition, self-driving cars, and was successfully adopted by IBM and Google for their artificial intelligence projects in winning competitions such as Chess and Go. This project involves developing deep learning techniques for classifying internet communications traffic for monitoring and management of networks and their infrastructure. Malicious attacks against computer networks of businesses, government agencies and the wider Internet infrastructure is another critical area of concern due to their increasing frequency and resultant damage.

This project expands upon current network classification R&D projects sponsored by the Defence Science & Technology Group since 2014. The goal of this project is to extend existing research and techniques for classification of sparsely labelled network data. In discussion with the successful student(s), this includes expanding the deep-learning approach with graph theoretic methods, self-taught or transfer-learning concepts.
The project provides students with the opportunity to:

- Gain knowledge within the data sciences domain, specifically deep-learning technologies
- Develop and adapt machine-learning techniques for application to network traffic flows
- Gain experience in utilising the university's super computing platform (HPC) to deploy traffic classifiers and conduct experiments
- Collaborate and write a research paper to capture the research work undertaken

Supervisors: Dr Hong-Gunn Chew and Dr Adriel Cheng

Efficient Implementation of Neural Networks in Hardware

Description: Deep learning neural networks have recently brought about major advances in areas such as automatic speech recognition, image recognition, natural language processing, and user recommendation systems. While neural networks are usually implemented on CPUs and/or GPUs, either singly or in clusters, neural networks have also previously been implemented in both FPGAs and proprietary ASICs. In almost all implementations, the most expensive processes for a neural network (in terms of speed, power usage, and physical size in hardware implementations) are the calculations of the neural activation function from weighted-sums of the neurons input. This project will explore a novel, efficient implementation of neural networks in hardware that minimises the expense of the neural activation function calculations while retaining the applicability of training the neural network to general test cases.
Supervisor: Dr Braden Phillips

Improving Usability and User Interaction with KALDI Open- Source Speech Recogniser

Aim: To enable users to access functionalities of KALDI (http://kaldi.sourceforge.net/about.html) without the knowledge of scripting, a language like Bash, or detailed knowledge of the internal algorithms of KALDI. Furthermore attempts will be made to transcribe live audio speech continuously.
Project Proposals: The proposal consists of two parts. For the first part is focused on improving usability and User Interaction with KALDI through a GUI that has the following features:

- Availability of a microphone soft ON and OFF switch
- Minimal scripting knowledge or commands to operate.
- Provide users the ability to select acoustic and language models of their choice. This can be done by allowing the users either to select one of the pre-trained models or to perform their own acoustic and language model training in order to subsequently use those models.
- Allow the user to select transcribing from continuous live speech input or from recorded audio. Recording audio from the speaker during live input allows the audio to be played back in order to correct errors in the transcript.
- Isolating Utterance/Speaker ID and Speaker ID/Utterance pairs from decoded results for later analysis of recognition performance of each user. This process also allows plain transcript for each user to be produced that is free from labels and indices.
- A facility whereby a user can improve her/his recognition performance with KALDI through user adaptive training i.e. by saving changes to her/his acoustic model after each decoding session.

The second part is reporting the project outcomes through

- Documenting the developed graphical user interface design and functionality for KALDI including the processes for selecting acoustic and language models, and incorporating online decoding features.
- Documenting the results of evaluation studies related to the usability of the new GUI design.
- Presenting the work to interested staff in Intelligence Analytics Branch of DST Group.

Supervisors: Dr Said Al-Sarawi and Dr Ahmad Hashemi-Sakhtsari (DST Group)

Description: With this project you will join a group of leading researchers from academia and industry working toward the design of an ultra-low power, passive wireless sensors that present significant technical challenges and raise opportunities for innovative solutions. This is a multidisciplinary project and can accommodate students from mechanical engineering, electrical and electronic engineering and computer science disciplines. In case of mechanical engineering, the interest will be the design of miniaturised sensors such as accelerometers or gyro that can be integrated with electronic circuitry using microelectromechanical systems (MEMS), for the electrical and electronic engineering students the focus microelectronic side and integration off the shelf sensors with high performance microcontroller devices, while for computer science the focus is on the review and development of algorithms to predict and detect a fall.
Supervisor*:* Dr Said Al-Sarawi

High power, energy efficient RF System-on-Chip (RF SoC) dynamic power conditioning circuits

Description: The project will develop a compact, high power, energy efficient RF System-on-Chip (RF SoC) by inventing dynamic power conditioning circuits (power supply modulators) and closely integrating them with RF MMIC transceivers and necessary external control circuits. The program will add an additional stage of power conversion and conditioning layer to the typical RF transmitter system and realize significantly higher overall system efficiencies. The main emphasis of this proposal is on physical and design approaches that enable power levels and bandwidths suitable for airborne and space based applications. This project will investigate the implementation of an efficient high-speed power supply modulator to rapidly convert input DC bus voltage to any DC supply voltage required of the RF PA within a given operational range. This modulator will ultimately be integrated into the transceiver design to implement envelope tracking techniques.
Supervisors*:* Dr Said Al-Sarawi, Prof Derek Abbott, Dr Aaron Pereira, Prof Neil Weste and Petar Atanackovic (Silanna)