Use of Motion Sensors for Improved Headset User Interface

Wei Qin; Zhaowei Wang

The use of ear-worn devices (e.g. headsets, headphones) has become more popular over the years. Ear-worn devices are widely used for longer periods in various activities. With the advent of miniaturised MEM sensors, multiple sensors can be integrated into ear-worn devices to capture a range of information from the wearer and surrounding environment. This project aims to capture data from multiple sensors in/on the ear during a wide range of situations. It will use sensor fusion technology to detect/track head movement and head gestures. It will also analyse the data and explore 3D sound rendering algorithms to create new types of user interfaces.

Effective and Safe Medication Infusion in Critically Ill Newborns

Ying Lu; Melanie Chan

Multiple drugs are often co-administered intravenously to critically ill neonates through a common infusion line, due to limitations in access sites. However, in the course of drug delivery, several assumptions clinicians adopt deviate from actual occurrences, increasing the risk of clinically adverse events. Through the use of a laboratory infusion model simulating clinical scenarios, a range of parameters influencing the effectiveness of drug delivery can be investigated. In conjunction with experimental methods, computational analysis will be performed to better appreciate the fundamental causes for the observed deviations. As such, this project aims to characterise and develop reliable predictive models, and improve efficiency of the drug delivery system for better clinical outcomes.

Classification of Lower Limb Movements from Electroencephalography

Ruwan Devasurendra; Hans Dharma

This project will computationally identify joint and muscle movements of the lower limb. Given a set of initial ‘training’ data, future limb movements will be identified as being similar or dissimilar to the initial set. Using EEG, EMG and motion tracking of the legs and torso this information will assist in the development of a brain machine interface (BMI), which is a device or software that enables brain and muscle control of an external device, such as an exoskeleton. The classifications from this project can be used to enhance the capabilities of these devices.

Automated Measurement of Blood Vessels Implanted with Minimally-Invasive Brain Machine Interfaces

Siming Lin; HuaKun Xin

Stentrode™ is implanted into a cerebral blood vessel to record neural signals. Implantation results in tissue growth around the implanted Stentrode™. This endothelialisation is assessed using angiography, by manually measuring the blood vessel diameter, which is time consuming and often varies based on assessors. To address this issue, this project aims to develop an automated image processing toolkit to assist vessel segmentation and evaluate the change in vessel morphology with the Stentrode™. Ultimately, this project will contribute to the development and safety assessment of minimal invasive brain-machine interface and allow direct brain control of external interfaces.
<table>
<thead>
<tr>
<th>Project Name</th>
<th>Authors</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Wireless Stethoscope</td>
<td>Chris Wright; Victoria Tang</td>
<td>In some cases, risk of infection restricts healthcare professionals from accessing affected patients and making informed decisions about their care. Obtaining as much information as possible while maintaining physical isolation from the patient is necessary to contain the transmission of infectious disease. This project aims to provide a method for auscultation without exposure to infection. The primary goal is the reproduction of traditional acoustic stethoscope performance using wireless transmission to an external speaker. Compatibility with sterilisation procedures will be explored to ensure safety in the working environment.</td>
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<td>Surgical Implant for Reconstructing ribs</td>
<td>Geoffrey Yam; Arathi Ramesh</td>
<td>Costal-Sternal reconstruction can be required after the spread of cancer, infection or necrosis to the sternum. Anatomical recreation is a challenge and many methods have been explored, custom 3D-printed titanium implants being one. There have been a limited number of cases and there is no mechanical data on the implant. This project aims to optimise the current designs through software finite element analysis. Each major component will undergo force simulation using Autodesk Inventor. The findings will then be used to design a novel ‘off-the-shelf’ kit in the hopes of eliminating long lead times and increasing market competitiveness.</td>
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<td>Construction of a Cognitive Map Using the Neural Engineering Framework</td>
<td>Hannah Burrage; Amanda Mach</td>
<td>The Neural Engineering Framework (NEF) is a computational framework for modelling functions of complex neurobiological systems, such as the brain and central nervous system. This increases our understanding of mental functioning, especially with regard to neurological disorders. Problems with spatial memory and navigation are considered early indicators of Alzheimer’s disease. This project aims to develop an NEF model that simulates the behaviour of place cells, specialised cells in the brain that allow determination of allocentric location. In response to environmental stimuli, specific place cells fire indicating the individual’s position in their neural map.</td>
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<td>Cartilage Replacement Biomaterial Characterisation</td>
<td>Emily Liu; Irene Yu</td>
<td>Osteoarthritis is one of the most predominant and costly geriatric diseases today. Currently, there is no effective long-term solution for cartilage replacement, sparking great interest in tissue engineering research to provide a solution. This project aims to characterise and refine a suitable hydrogel biomaterial for cartilage regrowth and determine the effectiveness of a new novel applicator, the 3D printer BioPen. This project will involve conducting comprehensive mechanical tests, first to characterise the material and scaffold production methods, then to determine cell compatibility and integration in chondrocyte seeded material.</td>
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### Automatic Cat Food Dispenser

**Jameer Asif Shahul Hameed; Anuprasan Alampoondi Rajagopalan**

When studied under behavioural testing experiments, cats are usually subjected to negative reinforcements like electric shocks, restraints and food deprivation. But these negative reinforcement techniques increase stress among cats, which depreciates their performance during behavioural studies. Behavioural studies are important in the field of Medical Bionics to test the effects of cochlear implants in deafened or partially deafened cats.

### Osseointegration with PoreStar® Implants

**Abigail Roseona Lutherine Augustine Jeyaseelan Raj**

Patients who have traumatic craniofacial injuries may have damaged facial and/or skull bones, which need reconstructive procedures that use craniofacial implants. As these implants are considered to be long-term and permanent, bone ingrowth is desired to stabilise the implant and help restore the appearance of the face. This project will study the interaction of PoreStar® craniofacial implants with bone, in collaboration with Anatomics®, a Melbourne-based medical device manufacturer. PoreStar® implants are used globally by surgeons and this study can provide information to increase the use of PoreStar® in patients where bone integration is desired.

### Realisation of a Single-Source Single-Detector fNIRS System

**Bolog Liu**

Functional near-infrared spectroscopy (fNIRS) is an optical imaging technology. The near-infrared light (670-900nm) is mainly absorbed by oxygenated haemoglobin (HbO2) and deoxygenated haemoglobin (Hb) in cerebral blood. Thus, the change of light attenuation from a baseline state at dual-wavelength represents the concentration change of HbO2 and Hb. Hemodynamic changes of brain are tightly coupled with neuronal activation. This project aims to build a fNIRS system that uses dual-wavelength light, emitting diodes for direct skin illumination and photodiodes for signal detection, and to develop signal processing techniques on the amplified received signal in order to infer oxygenation changes in blood.

### Determination of the Effect of Cyanide on Oxygen Saturation Measurement

**Malini Shiv Kumar**

A case study is proposed to assess some of the side effects of ingesting apricot kernels as an alternative treatment for cancer. A preliminary study was conducted on a patient at the Alfred Hospital who was known to be taking apricot kernel extract after successful surgical removal of prostate cancer. His blood showed a higher than normal level of cyanide as well as a low pulse oximetry reading. However, alternative indicators of blood oxygen saturation were normal. To commence the case study, tests will be conducted on a variety of pulse oximeter models to determine whether the cyanide level affects the efficacy of pulse oximetry in measuring blood oxygen saturation. This project aims to create awareness among the medical community as well as the general public about the harmful effects of consuming apricot kernels and misinterpretation of pulse oximetry in cyanide diagnosis.
# Neonatal Physiological Parameter Progression

**Samantha Sirur; Chantelle Muller; Branka Potkonjak**

Bedside patient monitors measure and store physiological parameters for 24 hours on a large central database, which trends information graphically for 12 hours. The limitation of this system is that clinicians cannot select specific segments of data for comparison and further examination. ixTrend is a software that allows long-term acquisition of data from these monitors for further investigations and analysis. This project aims to develop an algorithm that: (i) tracks the dynamics of pre-saved patient data from ixTrend to (ii) flag possible physiological events and (iii) allows for time separation - the selection and comparison of data from different time segments. This will assist clinicians to better evaluate the effectiveness of treatment therapies and identify critical changes in patients’ health.

# Biodegradable Materials for Electrospinning: A Medical Application

**Li Ma; ShanShan Chen**

Cardiovascular disease affects the heart and blood vessels. Bare metal stents are commonly used to treat the patients, but they have the risks of thrombosis, inflammation, tissue growth and other problems for long-term implants. This project uses the electrospinning technique to produce a biodegradable cardiovascular drug-embedded stent. Ideal solvent, polymer and drugs will be determined using an experimental approach. Existing biodegradable stents are not visible under angiography, thus this project aims to increase the stent’s radiopacity. Electrospinning the product causes it to dry immediately upon contact with collector plate, minimising processing. This technique can be used for customising the stent and can also be extended to other applications.

# 3D Modelling of Airways

**Thuy Nguyegn**

3D printing has become an increasingly attractive field in medical research. At the Royal Melbourne Hospital, 3D printing technology has been applied to model patients’ airways. Respiratory scientists have developed a method to efficiently produce structurally accurate 3D printing airways for medical training. Unfortunately, the material of the 3D printed model is too rigid, thus unsuitable to represent flexible characteristics of airways. Therefore, this project explores different materials and methods that could be used to model airways. The aim of this endeavour is to produce a fast, simple, inexpensive and accurate model to mimic airway models.

# Nasogastric Tubes

**Sarah Fink, Edward Green, Wei-Shen Mak, Andrew Davey, David McAllister**

Nasogastric tubes (NGT’s) are used to drain and supply food to the stomach. Each year, nine million NGTs are used globally. However, NGTs are reported to be misplaced in 20 - 50% of placement attempts. If left undetected, misplaced NGTs may lead to severe harm or death. This project involved developing a medical device to improve the detection of NGT placement, along with a business plan for its potential commercialisation.
Neuro Rehabilitation: An Exercise Quality Control Device  
William Abbott, Evelyn Loveband, Gerdus Buitendag, Nicola Ingram
A stroke is the death of brain cells caused by inadequate blood flow to localised regions of the brain. With 1 in 6 people being affected by stroke at some stage in their lifetime, the need for optimum post-stroke rehabilitation and management is undeniable. This project explores the use of motion capture and analysis to assess and improve the quality of individual rehabilitation exercises. Intended as a companion device for an existing individual rehabilitation program, this project will provide a solution that allows for a greater level of independence in a rehabilitation program, without the compromise of poor exercise quality.

Catheter Placement & Extravasation Monitor  
Tim Allison-Walker, Chen Chen, Derek Sheen, Megan Kong
Peripheral intravenous line placement and monitoring is thought of as a routine procedure. In neonatal populations, however, it is fraught with difficulty and danger, often leading to both short and long-term complications and discomfort. Better methods and equipment are needed to improve outcomes. This project aims to iterate on existing catheter-needle insertion devices with simple electronic sensor circuitry. This is achieved with a two-stage combination that provides feedback on the relative position of the needle and the cannula. Allowing the physician to make informed decisions during insertion will reduce procedure time and complexity, rates of bruising, and later extravasation that results from less-than-ideal line placement.

Improving Successful Placement of Umbilical Venous Catheters  
Shing Yue Sheung, Mubin Yousuf, Alexander Newton, Bradley Bergmann, Wei Sue
For over 60 years, umbilical venous catheters (UVCs) have been placed in critically ill new-born babies to provide a vital pathway for drug delivery. Despite frequent and widespread use, UVC insertions are performed "blind", with no guarantee of correct placement during the procedure, potentially putting the patient’s safety at risk. This project aims to create a device that identifies the UVC tip location to ensure correct placement, along with a novel business plan for commercialisation. Development of this device not only reduces the time, resource and materials currently required for UVC insertions, but above all improves clinical outcomes for the patients.

PELT Phototherapy Device  
BoQu Lin, Vanessa Pang, Samuel Ellis, Edward Tyndall
Neonatal jaundice is a common disease in newborns. Newborns are treated with phototherapy to reduce a component, called Bilirubin, in their bloodstreams. Current phototherapy devices use optical fibre and are stiff and bulky, limiting parent-child interactions while treatment is underway. A potential solution to enhancing parent-child interaction is through providing more flexibility and portability to current phototherapy devices. The prototype aims to address these needs with light emitting diode (LED) technologies and battery alternatives. A business model was constructed to show the pathway from prototype to commercialisation.