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| Supervisor | Project | Description | Research Notes: |
| Bastiaan Kleijn | Distributed Processing Visualization | An exciting new research area that is growing rapidly and has many applications is distributed processing. In distributed processing nodes of a network perform computations together.  Distributed processing can handle unlimited amounts of data (just add nodes) and it is robust to failure. At Victoria we are working on distributed algorithms that can be applied to sensor networks: the data are observed by the sensors and then jointly processed by processors placed in the sensors.  Each sensor only talks to its nearby neighbors. Our networks can contain any number of nodes but yet the algorithms are formulated such that answers will always be delivered in finite time. The idea is that a user requests a task from a network at a "query node", the network then performs the task and it finally delivers the answer to that same query node. A concrete example is an acoustic beam forrmer where the sensors (microphones) together extract the signal produced by one sound source (for example a talker) out of a cluttered acoustic environment with many sound sources.  We have recordings for a setup with 64 microphones and your task is to build a  demonstration system that visualiizes the processing by the various distributed algorithms. You will work with the team (a postdoc, a PhD student, and the supervisor) to implement or adapt distributed algorithms and to design and implement a visualization of the processing, showing the pathways of the information and the accuracy of any signal estimates available at various points within the network. The demonstraition system will provide the user with the ability to listen to processed signals at various locations within the network.The project requires a solid background in mathematics. | * Multiple systems minimises the computational overhead if split effectively * Can see the amount of cross correlation – power spectral density * This project is constrained to visualisation of it |
| Christopher Hollitt | High Speed Vision for Cricket Ball Tracking | Tracking of a fast moving object is a challenging machine vision task. Using active vision to ``intelligently'' gather information is expected to improve the performance of a tracking application when compared to a traditional approach that collects (and processes) large amounts of extraneous information.  In this project you will build a system that collects visual data in an attempt to infer the motion of a cricket ball. The system will use a pair of fixed high speed cameras that have the capacity to selectively gather images from only part of their field of view. The system will need to collect as many images as possible during the ball's flight as this will enable better inference about the ball's trajectory. The cameras will need to be synchronised with appropriate hardware to ensure that their images can be combined correctly.  This project could take a couple of different flavours depending on the background and interests of the student. Full inference of the ball's motion could be studied by those having knowledge of Kalman filters. This would lead to a system not unlike the commercial Hawk-Eye (TM) system, but would have the additional capacity to display uncertainty about ball trajectory. Alternatively, the project could focus on the computational challenges of best collecting the image data and determining three dimensional position. Some capacity to bowl a cricket ball is likely to prove useful for this project. | * High speed requires high computation power * Capacity in gathering uncertainty and position information * Established technology in sports stadiums – need to find a new path to make it novel * Deal with the determinism, make it computationally cheaper for operation * Use 2 cameras, try to derive a 6 camera positional information * Currently very expensive |
| Christopher Hollitt | Control System Redundancy for Fault Tolerance | Redundancy can be used to improve the reliability of control systems used in safety critical systems. As an example, the space shuttle used five independent control computers, four of which were expected to ``agree'' on all actions via a voting system. There was also a fifth system ready to take over if four primary systems malfunctioned. Similar systems are used throughout the aviation industry today.  In this project you will build a redundant control system that is capable of detecting and diagnosing faults. The constituent control systems could be either analog or digital controllers (or a mixture of both). Rather unusually, your controllers will need to be able to exhibit common fault types so that you can test the behaviour of your fault detection system. | * What’s new with this? We already have flight redundancy control systems, what’s different? |
| James Quilty | Fluid Control with Ferrier Institute |  |  |
| NIWA, Paul Teal | Detection / Classification of underwater sounds **(Industrial Project)** | **Background:**  NIWA is interested in developing in house technology for marine passive acoustics monitoring, and has already invested funds to collect acoustics data, and have 1 year of data from 7 locations in the Cook Strait (~ 28 TB of acoustic recordings).  **Project:**  NIWA is looking for possible collaborations with New Zealand Universities to develop algorithms for the detection and classification of marine mammals and anthropogenic sounds in the ocean. The project will require the development of signal processing algorithms for the detection and classification of different sources of sound in the ocean.  **Ideal Skill Set:**  A good knowledge of signal processing, programming, software and electrical engineering is preferred.  **Objectives**  1. Identification of different underwater sounds (marine mammals, vessels, seismic surveys etc…)  2. Development of algorithm for the detection and classification of target sounds  3. Assess the performance of the algorithm in terms of accuracy in the classification  **Deliverables**  1. The algorithms developed  2. A report about the project | * **Private classification of larger** * **Significant amount of background information in detection – need to specialize it to cook channel sounds – often built in the concept of population technologies** |
| Paul Teal, Robin Dykstra | Bayesian estimation of bound fluid fraction from NMR relaxation | The relative proportions of bound and free fluids in porous materials reveals a great deal of information about the material in a range of applications including brain imaging and mineral exploration.  Classically an entire distribution (1D or 2D) of relaxation times is estimated, and the relaxation times above and below a certain threshold are considered to correspond to free and bound fluids respectively.  But estimating the entire distribution is an ill posed problem, particularly when, as is often the case, the signal to noise ratio is low.  It is also unnecessary if the bound fraction is the only required information.  In some situations, prior information regarding the distribution is available, and this information can be utilised to enhance the accuracy of the estimation process.  This project will implement, refine and evaluate a proposed Bayesian method of found fluid fraction estimation.  An basic understanding of signal processing, Bayesian statistics are required, and Matlab or Python programming.  This work is of interest to Schlumberger Doll Research. | * Looks v new https://faculty.engr.utexas.edu/sites/default/files/torresverdin/files/tv5.pdf |
| Paul Teal | Separation of Reflection and Distortion Otoacoustic Emission Components | Otoacoustic emissions are sounds made by the mammalian ear, which reveal a great deal about the inner processes of the ear.  Distortion product otoacoustic emissions (DPOAEs) offer a particuarly convenient method of assessing hearing health, and are routinely used, particularly in infant screening programmes.  The diagnostic value of DPOAEs can be considerably enhanced if they can be separated into distortion and reflection components.  Several signal processing methods have been proposed for performing this separation.  This project will implement several of these methods, including a new method, which will be refined and compare with the other methods.  No prior knowledge of the physiology of hearing is required, although a willingness to learn about it certainly is required.  A basic knowledge of signal processing is required, as is programming in Matlab or Python.  This work is of interest to collaborators at University of Southern California | <http://asa.scitation.org/doi/abs/10.1121/1.1903846> |