BEB801/2 projects for 2015

From Sem 2 2015 forward, BE801/2 projects are advertised and allocated through the inplace system

https://inplace.qut.edu.au/

Some of you may have encountered problems login to InPlace to add BEB801 project. A very common problem could be that you are not listed as InPlace user. For this reason, and any other problem you may encounter, please contact: sef.wil@qut.edu.au or call ext. 80499 to sort it out.

BEB 801/2 projects

<table>
<thead>
<tr>
<th>Final year projects Pizza evening</th>
<th>Tuesday, February 24, 17:30, in S-Block, Level 12, OJW Room</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>We will be holding a Special Event, for all the 4th year students (and other interested students), where you can meet the supervisors and discuss the projects first hand! and there will be free pizza 😊</td>
</tr>
</tbody>
</table>

We have a great range of projects in mechatronics, robotics and computer vision. Please directly contact the supervisors associated with the projects.

- From Sem 2 2015 forward, BE801/2 projects are advertised and allocated through the inplace system
- BEB 801/2 projects
- Tuesday, February 24, 17:30, in S-Block, Level 12, OJW Room
- Peter Corke's Projects.
- Michael Milford's Undergraduate Projects.
- Ben Upcroft's Projects
- Jonathan Roberts' Projects
- Chris Lehnert's Projects
- Feras Dayoub's Projects
- Chris McCool's Projects.
- David Ball's Projects
- Jason Ford's Projects
- Frederic Maires's Projects
- Ruth Schuilz's Projects
- Matthew Dunbabin's Projects
- Thierry Peynot's Projects
- Projects in collaboration with Navinda Kottege (QCAT, CSIRO)
- Tristan Perez's Projects 2015
- Juxi Leitner's Projects
- Donald Dansereau's Projects 2015
- Markus Eich's Projects 2015
- Real-Time Collision Avoidance and Smooth Trajectory Planning Based on Wide Angle Camera Images
- Semantic Perception Based on Spatial Ontologies and Scene Description
- Troy Bruggemann's Projects 2015
- Duncan Campbell's Projects
- Peter Corke's Projects.
About Peter. If you email me please be sure to put “BEB801 project” in the subject line, that way I’ll notice it.

1: A camera array for advanced imaging

| Description | We want to create a camera array, something like shown above, with a 2x2, 3x3 or maybe even 4x4 grid of cameras. We need to select cameras and associated computers (Odroid, Raspberry Pi class) that can receive all that image data, synchronised, aggregate it, and send it over a network to server where it can be stored and processed. An array of cameras has many potential advantages including: high dynamic range, high resolution color, low-light imaging, recovery of 3D structure, post-capture focussing and into other computational photography algorithms. |
| Skills | Self-motivated and good engineering skills. Evaluation of key components (cameras and computers) and tradeoffs for quality, cost and convenience. Mechanical design and 3D printing of the array base. Software on the computer array to synchronise clocks and camera shutters, acquire images and send to the server, written in C++/Python language in a Linux environment. |
| No. of Students | 1 |
| Other | This project is associated with the Australian Centre for Robotic Vision and a scholarship is available for high GPA students. The project could potentially lead to interesting PhD research in the area of light-field photography. |

2: Build a Frankencamera

| Description | The Frankencamera was developed in the Stanford University graphics lab (see [http://graphics.stanford.edu/projects/camera-2.0](http://graphics.stanford.edu/projects/camera-2.0)) to exploit the latent capability of camera sensor and signal processing inside modern mobile phones, but which is generally accessible to the average user of the phone. That is, phone cameras are capable of much more than what they are allowed to do. The Stanford project is winding down, I’d like to wind it up again at QUT. |
| Skills | Good knowledge of embedded systems and hardware-level computing concepts. Ability to program in C/C++ in an Android/Linux environment. |
| No. of Students | 1 |
| Other | This project is associated with the Australian Centre for Robotic Vision and a scholarship is available for high GPA students. The project could potentially lead to interesting PhD research in the area of novel vision sensors for robots. |

Michael Milford's Undergraduate Projects.

I have a range of final year / vacation projects. All of these projects have been funded by the [Australian Research Council](https://www.arc.gov.au) or industry such as Microsoft, meaning they can lead into exciting PhD projects as well where you would have a significant head start. Details are deliberately kept high level and brief - feel free to contact me to discuss in more detail. The projects vary from applied to theoretical.

About Michael.
Superfast GPU-based Visual Navigation Algorithms

Modern GPUs offer amazing parallel computing capability. This project concerns implementing some relatively straightforward state of the art visual navigation algorithms on a high end GPU. Doing so will enable us to do cool things like making a camera-based GPS system that scans millions or even billions of images in a second and tells you where in the entire world you are located.

| Description | • Using C/C++ and CUDA / OpenCLI  
|             | • Implement algorithms on a GPU |
| Skills     | C or C++ programming, GPU-based programming desirable |
| No. of Students | 1 |

Phone-based Visual GPS

Modern smart phones have incredible computing power. This project concerns porting some relatively straightforward visual navigation algorithms onto a phone to create a publicly appealing navigation app which uses images from the camera's phone to tell the user where they are in the world, day or night, indoors or outdoors, in the car and on the footpath.

| Description | • Using C/C++ and Java / NDK  
|             | • Implement algorithms on a smartphone efficiently to enable real-time operation  
|             | • Design a software-hardware system to provide live navigation instructions to a human wandering around QUT and the Botanic Gardens.  
|             | • Mock up a sexy tech demo |
| Skills     | C or C++ programming, Java / NDK programming, hardware, software, C++, Matlab, human interaction design skills |
| No. of Students | 1 |

Solving the Infinite Memory Holy Grail

Our unique biologically-inspired mapping and navigation algorithms offer the potential for implementing a memory system in software with effectively unlimited memory potential. This blue sky project will require a self-driven, open-minded, laterally thinking student to pursue possible avenues of investigation in attempting to solve this extremely challenging problem.

| Description | • Using C/C++ and Matlab |
| Skills     | • Using C/C++ and Matlab |
| No. of Students | 1 |

The Robot Wanderer
Using ROS (Robot Operating System) develop movement behaviours for a new Pioneer robot and/or Robotnik robot so that it can randomly wander the hallways in a safe manner using its sensors (laser, Kinect, camera, sonar) to avoid hitting things. Log all sensor data in a usable format.

Skills
robot electrical and electronics hardware, C or C++ programming, experience using external software packages such as OpenCV, RoS.

No. of Students
1

Brain-based Algorithms for Navigation

In Matlab and C++, develop and test computational models of some of the most recent theories of how animals use their brains to navigate.

Skills
Neural networks, strong math, C or C++ programming, experience using external software packages such as OpenCV and ROS.

No. of Students
1

Android Long Exposure Maximum Gain Continuous Photos Software

Need a photo/video app that can:

Take continuous photos of at least 2 MP with ISO ratings of 2500+ and (settable) exposure times of up to 2 seconds.

So if I set it at an exposure duration of 500 ms, I would want it taking photos at least every 1 second, and hopefully closer to every 500 ms.

It is perfectly acceptable that the resultant images are a) very noisy and b) very blurred if the camera moves during capture. Appropriate image exposure is the priority, image quality comes a distant second. Output images can be grayscale.

Capture must be able to be continued for at least an hour (given enough memory).

- Would prefer not to have to root the phone.
• Using stock apps I can already grab 1 second interval photos at ISO1600 and exposure 500 ms, so needs to be significantly better than that.
• Apps that scrape the screen over time are not acceptable.
• Post processing software pixel binning is not acceptable (I can already do that, and that's how I generated the attached photo).

I have attached an example of the sort of image that is acceptable (the one on the right). Ideally I'd want it much better exposed than the example one.

Ben Upcroft's Projects

About Ben

3D mapping with a mobile phone

Description
The aim of this project would be to implement an online mapping algorithm for 3D reconstructions in computer vision on a mobile phone.

The scope of the project would be to initially fuse the inertial measurement unit (IMU) and camera information from a mobile phone to track and simultaneously map the world in real-time. This has recently been demonstrated in international conferences, and the next step would be to build 3D reconstructions using only the phone.

Skills
C or C++ programming

No. of Students
1 to 2

High quality images from a simple webcam for UAVs
### Project 1

Recently, it has been shown that very high quality images can be obtained from poor lenses. For example, see High quality computational imaging through simple lenses at the University of British Columbia.

This project would involve reimplementing this work and attempting to build a real-time system for correction on incoming video streams. These videos would come from robotics platforms such as an unmanned aerial vehicle (UAV) or submarine.

**Project 2:** This project will develop localisation techniques for high speed fixed wing UAVs travelling through urban canyons.

### GetMyCoffee Robot

This project aims to localise a robot in a place it’s never been using vision and information from the internet.

### Agricultural automation in Third World countries

<table>
<thead>
<tr>
<th>Description</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>C or C++ programming</td>
<td>1 to 2</td>
</tr>
</tbody>
</table>
According to the Gates Foundation Agricultural Development initiative:

‘...population growth, rising incomes, dwindling natural resources, and a changing climate have caused food prices to rise and agricultural productivity has once again become strained. Many of those affected are smallholder farmers. Three-quarters of the world's poorest people get their food and income by farming small plots of land about the size of a football field. Most of them barely get by—struggling with unproductive soil, plant diseases, pests, and drought... Helping farming families increase production in a sustainable way, and sell more crops, is the most effective way to reduce hunger and poverty over the long term.'

The goal of this project is to use mobile phone technology to build effective visual detection and identification of diseases and weeds, and automatically suggest methods for defending against these problems. The idea is for it to be like an online doctor that looks at symptoms and suggests a 'cure'.

<table>
<thead>
<tr>
<th><strong>Skills</strong></th>
<th>C/C++ Programming</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No. of Students</strong></td>
<td>1 to 2</td>
</tr>
</tbody>
</table>

**Removing blur from poor quality images**

The goal of this project is to use known motion of a camera to remove blur from images similarly to http://helpx.adobe.com/photoshop/using/reduce-camera-shake-induced-blurring.html.

The goal of this project is to compute the pose of a moving camera even in poor lighting. This has large implications in robotics and mobile phone applications ranging from UAV navigation to removing camera shake from an image.

<table>
<thead>
<tr>
<th><strong>Skills</strong></th>
<th>C++ programming, Maths</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No. of Students</strong></td>
<td>1</td>
</tr>
</tbody>
</table>

**Visual weed identification for agricultural applications**
This project will use state of the art computer vision algorithms to identify weeds in the presence of poor lighting and occlusions. The end goal of this project is to detect and destroy weeds using dedicated robotic platforms in broadacre agriculture. This is part of an exciting new $3M Agricultural Robotics Centre at QUT aimed at developing new lightweight farm platforms to address current and future agricultural challenges.

<table>
<thead>
<tr>
<th>Description</th>
<th>C++ programming, Maths</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Students</td>
<td>1</td>
</tr>
</tbody>
</table>

**AgBot 2D and 3D Simulator**

<table>
<thead>
<tr>
<th>Description</th>
<th>Develop 2D and 3D simulator with physics engine for an autonomous weed spraying robot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skills</td>
<td>C++ programming, computer graphics</td>
</tr>
<tr>
<td>No. of Students</td>
<td>1</td>
</tr>
</tbody>
</table>

**Agricultural Robotic Platform Design**
This project will aid in the development of a new robotic platform that will form part of a robotic coordinated team to address agricultural challenges such as weed resistance and increasing crop yield. The end goal of this project is to aid in developing a modular platform for commercialisation purposes. This is part of an exciting new $3M Agricultural Robotics Centre at QUT aimed at developing new lightweight farm platforms to address current and future agricultural challenges.

**Skills**
- CAD, electrical/mechanical design

**No. of Students**
- 1

### Novel Methods for Destroying Weeds

The aim of this project is to investigate novel methods (mechanical, electrical, microwave, etc) for destroying weeds. The end goal of this project is to aid in developing technologies that address the increasingly detrimental problem of herbicide resistance in weeds. This is part of an exciting new $3M Agricultural Robotics Centre at QUT aimed at developing new lightweight farm platforms to address current and future agricultural challenges.

**Skills**
- CAD, electrical/mechanical design

**No. of Students**
- 1

### Robotic Ethics and Legalities

The aim of this project is to investigate ethical and legal issues in deploying robotic platforms in the agricultural domain - how does this effect the work force?, the users?, and what are the safety requirements? The end goal of this project is to aid in developing policies for robotic use in agriculture and horticulture. This is part of an exciting new $3M Agricultural Robotics Centre at QUT aimed at developing new lightweight farm platforms to address current and future agricultural challenges.

**Skills**
- Ethics, robot interests, law

**No. of Students**
- 1

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**Jonathan Roberts' Projects**

**About Jon**

email: jonathan.roberts@qut.edu.au

**Robot rescuer**
This project will investigate how a person sustaining traumatic injury with subsequent incapacitation in an inaccessible, austere or dangerous location, can be assessed and potentially retrieved by a robot with remote medical oversight and diagnostics. The project will investigate how a patient can be assessed using robotic vision including various types of sensors such as visible spectrum and infrared cameras, hyperspectral imagers and any other sensors that may give biometric feedback in a non-contact or light-touch way.

Skills
An interest in robot vision, robot design and embedded C++/Python programming.

No. of students
1

Remote Ultrasound using a robotic device

This project will develop a technique required to perform remote ultrasound diagnostic capabilities by an expert located remotely from the patient. The clinical settings would include rural, remote, regional and austere environments. The technological basis of the project is a lightweight robotic system for remote tele-operation of an ultrasound probe, which is able to work in a human environment. The research challenge is to adequately sense the patient’s body and safely manipulate the transducer in a medical environment with a patient and medical staff in close proximity.

Skills
An interest in robot vision, robot design and embedded C++/Python programming.

No. of students
1

Robotic Ethics and Legalities for Medical Robots

The aim of this project is to investigate ethical and legal issues in deploying robotic platforms in the medical and healthcare domains - how does this effect the doctors and healthcare professionals and of course the patients? And what are the safety requirements? The end goal of this project is to aid in developing policies for robotic use in medical and healthcare robotics. This is part of an exciting new Medical and Health Robotics Program at QUT aimed at developing new cost-effective robotics for the world.

Skills
Ethics, robot interests, law
Robot circus performers

QUT is hosting a number of robotics events where the main audience will be the general public. We want to show the general public what robots can do and get them to think about robots doing all sorts of amazing things. As part of this engagement with the public, QUT will develop some robot shows. We need some robot circus performers! We have a general concept for our robot performers that they must be able to morph into and out of a cube. That is the only constraint. It is up to the student to come up with a concept for a circus performance robot and implement a prototype. They might create a cube that unfolds and crawls, a cube that spins and dances, a cube that can skip a rope, a cube that can climb a ladder.

Skills
Robot design, mechanical design and construction, embedded C++/Python programming, a love of performance!

No. of students
Up to 3

Chris Lehnert's Projects

About Chris
email: c.lehnert@qut.edu.au

Design of a Novel Omnidirectional Spherical Wheel
We have developed a continuous isotropic spherical omnidirectional drive mechanism that is efficient in its mechanical simplicity and use of volume. Spherical omnidirectional mechanisms allow isotropic motion, although many are limited from achieving true isotropic motion by practical mechanical design considerations. A prototype platform was built using a combination of machining and 3D plastic printing and is illustrated in the images above. This project aims to develop the next prototype improving the performance and addressing some flaws in the design.

Skills (not all required)
- Electro-mechanical Design
- Math
- Dynamics
- Control Theory

No. of Students
1 or 2
Can a robot learn to pick fruit?

<table>
<thead>
<tr>
<th>Description</th>
<th>This project aims to develop an algorithm that gives a robot the ability to learn how to pick fruit. There has been a lot of recent interest in machine learning and in particular reinforcement learning which has the potential to enable robots to learn to do complex tasks that are hard to program directly. The project will involve designing and testing ideas using simulation and real hardware, in particular on our dual arm Baxter Research Robot.</th>
</tr>
</thead>
</table>
| Skills (not all required)                                                                 | • Math  
• Dynamics  
• Control Theory  
• Machine Learning |
| No. of Students | 1 |

Design of a Manipulator for Robotic Horticulture

<table>
<thead>
<tr>
<th>Description</th>
<th>This project aims to design a robotic manipulator for autonomously harvesting crops, for the new agricultural robot being developed at QUT. The project will involve designing and testing ideas using simulation and real hardware. Testing could include a 6 DoF manipulator or a recently purchased dual arm Baxter Research Robot.</th>
</tr>
</thead>
</table>
| Skills (not all required)                                                                 | • Electro-mechanical Design  
• Math  
• Dynamics  
• Control Theory |
### Improving robot control by learning nonlinear models

**Description**

This project aims to use machine learning to give a robot the ability to improve its control performance. There has been a lot of recent interest in machine learning and in particular supervised learning techniques which are very useful to estimate nonlinear models and are computationally efficient. Our recently purchased dual arm Baxter research robot is flexible and human safe but as a consequence has slower performance and less precision. This is where machine learning can be used to improve robots and the aim of this project is to use supervised learning methods on a real robot in order to improve its control performance.

**Skills (not all required)**

- Math
- Dynamics
- Control Theory
- Machine Learning

**No. of Students**

1

### Smart weed sprayer for a lightweight agricultural robot

**Description**

This project aims to develop a prototype of an intelligent weed spraying system that uses a novel actuated spraying nozzle combined with computer vision to be used on the QUT agbot to perform autonomous weed management. This project will involve designing electro-mechanical systems and using computer vision algorithms to close the loop on a smart weed sprayer.

**Skills (not all required)**

- Math
- Computer Vision
- Mechatronics

**No. of Students**

1

### µAV (µUAV) - Open Source Palm Sized Quadrotor Version 2

![µAV (µUAV) - Open Source Palm Sized Quadrotor Version 2](image)
The aim of this project is to develop an open source micro unmanned aerial vehicle that is capable of autonomously navigating within an indoor environment, which also fits in the palm of your hand. The goal is to develop and test the next version of the platform. The scope of the project is flexible, such as focus could be on developing the flight control system or testing and designing an on board vision system.

### Skills (not all required)
- Embedded Design
- Electrical Design
- C programming
- Math
- Control Theory

| No. of Students | 1 or 2 |

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## Feras Dayoub's Projects

email: feras.dayoub@qut.edu.au

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### 1- The Sympathetic Robot

#### Project Description:
Mobile robot companions should be able to recognize human facial expression and respond accordingly. This project will teach you about face detection algorithms and give you the chance to implement a machine learning algorithm for facial expression recognition. At the end of the project, the robot should detect faces using its cameras and then response by changing its facial expression to match the human. The photo above shows the robot with its smiley face, another expression this face can express is angry, sad, bored, confused...

Working on this project will give you the opportunity to interact with a real mobile robot and to learn how to interface with ROS (the robotics operating systems) which is used widely in the robotics community.

#### Project Type:
Individual or group.

#### Eligibility:
Students with strong programming skills (ideally in C++ or/and Python).
Students with background in computer vision are preferable.

#### Deliverables
A short report
A working system implemented on a mobile robot (the robot is provided).

#### Inquiries:
Please contact Dr. Feras Dayoub directly, ph: 3138 9972, email: Feras.dayoub@qut.edu.au

### 2- The smart librarian assistant robot

#### Project Description:
We are looking for a student who is comfortable in programming using C++/Python and wants to enable our mobile robot to interact with the students in the QUT library. The robot has a touch screen which can be used for interaction with the students. The project goal is to enable the robot to receive a book location inquiry from the user and then guide the user to the location of that book. The robot should also be able to greet the visitors of the library and offer to give them a tour showing where are the different book sections located inside the library.

Working on this project will give you the opportunity to interact with a real mobile robot and to learn how to use ROS (the robotics operating systems) which is used widely for programming robots.

#### Project Type:
Individual or group.
Eligibility:
Students with strong programming skills (ideally in C++ or/and Python).
Students with background in computer vision are preferable.

Deliverables:
A short report
A working system implemented on a mobile robot (the robot is provided).

Inquiries:
Please contact Dr. Feras Dayoub directly, ph: 3138 9972, email: Feras.dayoub@qut.edu.au

Chris McCool's Projects.

About Chris. Email: c.mccool@qut.edu.au

I have a range of projects available in Computer Vision and Machine Learning in an applied setting. Many of these projects are being driven by active research and so have the potential to lead into exciting PhD projects, giving motivated students a considerable head start. Please feel free to contact me to discuss any of these projects in more detail.

1. PlantSnap: Recognition of Plants using a Mobile Phone

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>This project will develop a mobile phone application that will recognise different species of plants based on images taken with a smartphone. The student(s) will also be responsible for writing some of the recognition algorithms and so will gain exposure to practical computer vision algorithms.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>C/C++, Android/iPhone programming, Computer Vision</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 3</td>
</tr>
</tbody>
</table>

2. Weed Detection for a Farm Robot: applied Computer Vision and Machine Learning

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detecting and dealing with weeds in an Agricultural setting is a critically important problem. This project will explore ways of detecting weeds automatically using computer vision and machine learning techniques.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Python, C/C++, Computer Vision</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 2</td>
</tr>
</tbody>
</table>

Crop identification for fruit and veg picking

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>This project will use state of the art computer vision algorithms to identify crops such as pineapples and bananas in the presence of poor lighting and occlusions. The end goal of this project is to detect and pick the crop using dedicated robotic platforms for horticultural applications. This is part of an exciting new $3M Agricultural Robotics Centre at QUT aimed at developing new lightweight farm platforms to address current and future agricultural and horticultural challenges.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>C++ programming, computer graphics</td>
</tr>
</tbody>
</table>
3. FishSnap: recognition of Fish using a Mobile Phone

<table>
<thead>
<tr>
<th>Description</th>
<th>This project will develop a mobile phone application that will recognise different species of plants based on images taken with a smartphone. The student(s) will also be responsible for writing some of the recognition algorithms and so will gain exposure to practical computer vision algorithms.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skills</td>
<td>C/C++, Android/iPhone programming, Computer Vision</td>
</tr>
<tr>
<td>No. of Students</td>
<td>1 to 2</td>
</tr>
</tbody>
</table>

David Ball's Projects

About David and contact details.

Optimise visual obstacle detection

<table>
<thead>
<tr>
<th>Description</th>
<th>The aim of this project is to investigate techniques to improve the performance of our vision algorithms, eg such as using a GPU.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desirable skills</td>
<td>C/C++ programming, ROS, computer vision</td>
</tr>
<tr>
<td>No. of Students</td>
<td>1</td>
</tr>
</tbody>
</table>

Navigation on a smartphone

<table>
<thead>
<tr>
<th>Description</th>
<th>Run navigation algorithms on your smartphone. Last year looked at indoor navigation. This year will investigate outdoor navigation techniques. This project also has the potential to develop practicals suitable for undergraduate student projects.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desirable skills</td>
<td>Android programming, C++ programming, Java, ROS, OpenCV</td>
</tr>
<tr>
<td>No. of Students</td>
<td>1</td>
</tr>
</tbody>
</table>

Comparison of camera sensors and hardware

<table>
<thead>
<tr>
<th>Description</th>
<th>There are a variety of lost cost camera sensors and hardware that are commercially available. The goal of this project is to mount a variety of sensors and test their performance on different hardware.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desirable skills</td>
<td>C++ programming, ROS, embedded programming</td>
</tr>
<tr>
<td>No. of Students</td>
<td>1</td>
</tr>
</tbody>
</table>
# Jason Ford's Projects

Jason teaches into the Electrical Engineering and Aerospace Avionics course programs.

All projects are for 1 person (maybe 2).

Contact Jason at j2.ford@qut.edu.au (or x82207). Subject line: “BEB801/2 projects”.

<table>
<thead>
<tr>
<th>Title</th>
<th>Description</th>
<th>Comments/more information</th>
</tr>
</thead>
</table>

| *NEW* Automating Advanced vision-based collision for changing detection environments. | The use of aviation automation technology, including un-manned aircraft systems (UASs) is expected to rapidly increase over the next few years. However, under the limitations of current UAS technology, any increased use will lead to corresponding increase of collision risk, and hence led to increasing importance been placed on the development of reliable automated aircraft mid-air collision warning and avoidance technology, or sense-and-avoid technology (especially for small UAVs)[1]. Recently, spot dim target detection techniques coupled with tracking filters have been extensively investigated as vision based solutions for the detection part of this problem (in particular, for detection from sky-regions rather than detection from ground clutter) [2]. Unfortunately, achieving reliable operation in a range of lighting conditions, and against a range of backgrounds remains difficult and these limitations motivate the investigation of new detection techniques. This project proposes to extend current state-of-art for vision based mid-air collision detection approaches in two ways by investigating extension of the current state-of-the-art "sky-region" aircraft detection technology [2] to automate detection in changing lighting conditions. | Background references: [1] Wainwright, Alexander Lloyd & Ford, Jason J. (2012) Fusion of morphological images for airborne target detection. In 15th International Conference on Information Fusion (Fusion 2012), 9 - 12 July 2012, Raffles City Convention Centre, Singapore. [2] Lai, John, Ford, Jason J., Mejias, Luis, & O’Shea, Peter (2013) Characterization of sky-region morphological-temporal airborne collision detection. *Journal of Field Robotics*, 30(2), pp. 171-193. [3] S. Cho, S. Huh, D. Shim, and H. Choi, "Vision-Based detection and tracking of airborne obstacles in a cluttered environment." *Journal of Intelligent & Robotic Systems*, vol. 69, no. 1-4, pp. 475-488, Aug. 2013. [Online]. Available: [http://dx.doi.org/10.1007/s10846-012-9702-9](http://dx.doi.org/10.1007/s10846-012-9702-9) |
| **NEW** Robust change detection in dynamics | Safe and efficient operation in a dynamic uncertain real-world environment requires access to a range of sophisticated detection and decision making capabilities. In fact, many decades of statistical decision and control system theory effort has been motivated by the desire to automate decision making well beyond human sensing and cognitive limits. Yet some aspects of the real-world continue to evade appropriate and useful representation, particularly in a range of situations requiring good decisions that are made with an appreciation of the uncertainty being faced. Change detection is a signal processing problem in which the decision objective is to detect a substantial behavioural change in a monitored dynamic system.

This project will investigate sophisticated decision and estimation tools to help achieve better real world automation in rapidly changing environments. It will involve simulating and evaluating new mathematical tools and concepts. |
| **NEW** Memory efficient Compressed sensing vision | One of the main hurdles to use of compressed sensing ideas in image processing relates to memory and computational requirements. In this project, we will investigate the use of (Scrambled) Block Hadamard compression matrices rather than Gaussian compression matrices. This project will involve working with GPU and related software aspects. 

Background reference:
| Compressed sensing and image quality estimation | Over the last few years, sparse signal ideas have emerged that allow recovery of signals below sub-Shannon Limits (i.e. in situations that seem to violate well-respected signal processing performance limits). These sparse signal recovery ideas have lead to compressed sensing ideas (such as the single pixel camera, see link to the left).

In this project, these new ideas will be used to develop new computational algorithms to quickly generate estimates the amount of information present in a provided image. Understanding the "information content" of an image helps build new technology. This project involves signal processing, matlab, and other languages. This project contains a research or investigation component.

An updated list of projects ranging from deep neural network applications to humanoid robots can be found on this separate page.

Ruth Schulz's Projects

About Ruth
Email: ruth.schulz@qut.edu.au
Phone: 3138 5107

My projects, outlined below, are part of the ARC Discovery project:

**Human Cues for Robot Navigation**

The world has many navigational cues for the benefit of humans: sign posts, maps and the wealth of information on the internet. Yet, to date, robotic navigation has made little use of this abundant symbolic information as a resource. This project will develop a robot navigation system that can navigate using information beyond the robot's range sensors by incorporating knowledge gained by reading room labels, following human route directions or interpreting maps found on the web. We will demonstrate the robot's navigation ability by comparing its performance with a human as it learns to find its way around campus by asking for directions, reading signs and maps, and searching the internet for clues.

The aim of the larger project is to create and demonstrate a new framework that integrates information intended for humans into a navigation resource that can be used for autonomous navigation in urban spaces. There are several student projects that could be undertaken and related topics will also be considered. Contact me to discuss options in more detail.

1. Using sketch maps
   This project will involve the development of a system for goal-directed navigation in a simulation world. The robot will determine the best path to the goal using sketch maps with different orientations, different scales, and possible errors. (ROS / Matlab)

2. Following directions
   This project will involve the development of a system for goal-directed navigation in a simulation world. The robot will determine the best path to the goal using written or verbal directions with different frames of reference, different landmarks, and possible errors. (ROS / Matlab)

3. Finding relevant text
   This project will involve the development of a system for determining whether text in the world is relevant for a given task. There are two parts for this project. The first involves implementing a text detection algorithm using existing methods. The second is processing the text for relevance to a navigation or search task. (ROS / Matlab / Java)

4. Autonomous map reading
   This project will extend work on autonomous map reading for robot navigation. A complete system would be able to read floor plans, campus maps, street maps, sketch maps, and topological maps at a variety of scales and resolutions. (ROS / Matlab)

5. Human navigation
   This project will involve a human study investigating how humans navigate around built environments, how people request directions from others, and how people give directions to other humans or robots in a built environment. The result will be strategies that a robot should use in navigating built environments, and directions that can be used by humans or robots.

6. Grounding game
   This project will involve the development of a game to help roboticists (and others) understand what grounding is and why it needs to be considered for their robots. While the game may initially be paper-based, an app or web-based game could be developed as part of this project. Grounding is a term used to refer to how words can have meaning in experiences. The game would involve a small group of people developing new meanings and establishing shared words to complete a task. (Mobile App / Web)

7. Robot Language Tutorials
   This project will draw on my previous work on the *Lingodroids* project, designing a set of tutorials for understanding grounding and artificial languages. The tutorials, targeted at robotics researchers, will involve artificial agents exploring a grid world and interacting with each other to form languages for locations and relationships between locations. (Matlab)

Matthew Dunbabin's Projects

About Matthew
Greenhouse Gas Sampling using Robotic Boats

Environmental science is often limited by the ability to collect data at large spatial scales. The goal of this project is to assist researchers studying Greenhouse Gas emissions from inland waterways using robotic technology. Specifically, this project will develop and implement real-time path planning algorithms to simultaneously coordinate four robotic boats recently developed at QUT which are capable of collecting greenhouse gas measurements from across entire water storages. This will involve consideration of both the usual robot problems of operating in natural environments, as well as the sampling requirements for environmental scientists.

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Environmental science is often limited by the ability to collect data at large spatial scales. The goal of this project is to assist researchers studying Greenhouse Gas emissions from inland waterways using robotic technology. Specifically, this project will develop and implement real-time path planning algorithms to simultaneously coordinate four robotic boats recently developed at QUT which are capable of collecting greenhouse gas measurements from across entire water storages. This will involve consideration of both the usual robot problems of operating in natural environments, as well as the sampling requirements for environmental scientists.</td>
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<table>
<thead>
<tr>
<th>Skills</th>
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<tbody>
<tr>
<td>Math</td>
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<tr>
<td>Matlab</td>
</tr>
<tr>
<td>C/C++ and/or Python programming</td>
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<tr>
<td>Research</td>
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<table>
<thead>
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<th>No. of Students</th>
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Stereo Vision Obstacle Avoidance for Autonomous Underwater Vehicles
**Description**

This project involves the upgrade of the on-board real-time stereo vision obstacle avoidance software for the Starbug Autonomous Underwater Vehicle (AUV) using OpenCV. Upcoming missions in the Great Barrier Reef will require the AUV to navigate within complex environments at low altitude where there is a risk of entanglement with the seafloor. Therefore, a robust obstacle avoidance system is required. The Starbug AUV has two stereo camera pairs with the forward pair used for obstacle avoidance. With a recent upgrade of the AUV and a new on-board computer, the image processing algorithms can now exploit the latest OpenCV libraries. Specifically the student will interface with and calibrate the forward stereo cameras and upgrade the current obstacle avoidance strategy from the original custom code base to one using OpenCV. Finally, the student will experimentally evaluate the upgraded system against the original system in the field.

**Skills**

- Computer vision
- C++ programming, OpenCV
- Linux

**No. of Students**

1

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**Formation control of multiple robotic boats**

This project will develop and apply path-planning algorithms on multiple robotic boats (e.g. the QUT WAM-V pictured) to conduct coordinated survey. Survey scenarios include search and rescue, and bathymetric survey in the ocean. This will involve the development of a simulator in Matlab for evaluating different path planning algorithms that take into account obstacles, shallow water, energy availability, currents and the maximum speed of multiple robotic boats. The best algorithms will then be converted to the Robotic Operating System (ROS) and evaluated in the field on the actual boats.

**Skills**

- Math
- Matlab
- C/C++ and/or Python programming
- ROS
- Research

**No. of Students**

1
Environmental Acoustic Sampling for Stealthy Robots

Environmental sounds (acoustics) have been identified as a potential means to measure biodiversity and monitor wildlife behaviour. However, covering large areas or tracking moving wildlife is difficult and time-consuming - a perfect task for autonomous systems. This project will conduct both field and laboratory work to assess different microphone configurations in their capacity to measure and localise environmental sounds as well as their ability to be incorporated onto a moving robotic platform for stealthy tracking of animals.

Skills
- Strong Math / Signal processing
- Matlab
- Research
- Embedded programming

No. of Students 1

Hyperspectral Image Classification of Vegetation
QUT has recently acquired a small hyperspectral camera suitable for mounting on terrestrial and airborne robotic vehicles. This camera has the potential to allow classification of vegetation and terrain to assist with path-planning as well as species identification for smart agriculture and forestry. This project involves the algorithm development and software for processing the images from the hyperspectral camera to allow autonomous classification of the scene for future use on robotic platforms.

Skills
- Computer Vision
- Research
- Matlab
- C/C++ programming

No. of Students 1

**Interacting with Robots to Conduct Large-scale Environmental Research**

Robotic platforms are revolutionizing the way in which the environment is monitored. Whist capable of collecting large and unique data-sets which scientists and managers can use to assess the state of the environment, they still require a relatively skilled engineer to successfully operate in natural environments. This limits the overall scientific and managerial efficiency potential. To realise a greater adoption of environmental robots by the wider community, the ease of operation and interoperation requires a simplification. Current interfaces lack intuitive functions for planning and control, and are unable to scale with increasing number of robots as well as to visualise current and historic data streams. Using a variety of techniques the group will engineer a complete information flow process based around a generic mobile device interface to allow seamless and simultaneous planning and control of multiple robotic assets with the ability to retrieve and view instantaneous and historically collected data.

Skills
- Android programming
- C++ programming, Java, ROS
- Research

No. of Students 1-2

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**Thierry Peynot's Projects**

**About Thierry**

email: t.peynot@qut.edu.au

**Characterisation of Radar Sensor for Robotic Applications: Seeing through smoke/dust, vegetation or walls.**
### Description

The RAS group at QUT owns 2 radar sensors. The first one is an automotive radar that was designed for obstacle detection in all-weather conditions. The second one is a low-frequency UWB Radar that can see through some material such as (some amount of) vegetation or thin walls. The purpose of this project is to thoroughly characterise those sensors for use in robotics applications. As such, the project will have a strong experimental component. Upon successful completion of the sensors characterisation, the second phase of the project will concern the implementation of proofs of concept of robotics applications exploiting the properties of the radar sensors (in combination with vision). Potential applications include: obstacle detection for an outdoor mobile robot in all-weather conditions, robust navigation in vegetated environments (mostly for agriculture robotics), early detection of dynamic obstacles through walls (for an indoor robot).

### Skills

**Required:**

- Basic Signal Processing
- Matlab and/or C/C++ programming

**Desired (would be a plus):**

- Computer Vision
- Knowledge of range sensors
- Basic knowledge of Robotics

### No. of Students

1 or 2

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### Towards an Autonomous Astrobiologist Rover

*(Automatic Stromatolite Recognition)*

Astrobiologists look for signs of life on other planets, such as Mars. In particular, they hope to find stromatolites, i.e. rock structures that were formed by a biogenic process. The end goal of this project is to give a planetary rover the ability to help astrobiologists with this mission, by autonomously detecting stromatolites using computer vision. In this component of the project, the student(s) will investigate, develop and test algorithms that can detect and recognise characteristics associated with biogenicity (can you do it on the picture above?).

This project is in collaboration with the Astrobiology Centre at UNSW.
Skills

- Computer Vision
- Solid Matlab or C/C++ programming
- Knowledge of the Image Processing Toolbox (Matlab) or OpenCV

No. of Students

1 or 2

Reliable Terrain Traversability Estimation in Vegetated Environments

Description

Operating safely and efficiently in vegetated environments is a major challenge for autonomous mobile robots. Vegetation may appear like a dangerous obstacle geometrically, although a robot may be able to drive through it safely. On the other hand, it may be relatively easy to classify vegetation using vision, but there may be a stone hidden behind it that constitutes a real obstacle for the robot. This project concerns the development of novel methods for terrain traversability estimation that are reliable in vegetated environments, using a combination of camera/laser and radar data.

Skills

- Computer Vision and/or knowledge of range sensors (such as laser range finders and/or radars)
- Matlab or C/C++ programming

No. of Students

1

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Projects in collaboration with Navinda Kottege (QCAT, CSIRO)

Hexapod robot terrain perception using acoustics
### Bio-inspired Vision Based Navigation for Field Robots

**Supervisors**
Navinda Kottege (CSIRO) & Michael Milford (QUT)

QUT contact email: michael.milford@qut.edu.au

**Description**
Vision based navigation is successfully used by many animals in nature to walk, fly, crawl through very complex environments. We need your expertise to enable our small highly agile mobile robots with bio-inspired vision based navigation capabilities.

- Design and implement wideangle stereo vision system using off the shelf components.
- Implement bio-inspired vision based navigation algorithms to accurately perceive complex environments.
- Conduct experiments with small agile robots in unstructured terrain using developed navigation system.

This project will be hosted in part at QUT and at CSIRO's Autonomous Systems lab located at QCAT (Queensland Centre for Advanced Technologies), Pullenvale, QLD 4069.

**Skills**
- GPA > 5.5
- Computer vision/OpenCV experience,
- Programming experience in C/C++ or Python
- ROS experience (desirable)

**No. of Students**
1 or 2
### Acoustic localisation using mobile phones

**Supervisors**
Navinda Kottege (CSIRO) & Michael Milford (QUT)

**QUT contact email:** michael.milford@qut.edu.au

**Description**
Use the ever present acoustic cues in our surroundings (both transient and salient) to discern additional information about the surroundings by way of localising ‘sounds of interest’, tracking sound sources, mapping the ambient soundscapes and aligning them with a 3D point cloud to identify ‘hot spots’.

- Perform signal processing to extract sounds of interest
- Autonomously build a soundscape map with semantic information
- Develop graphical interface to display soundscape hotspots and events of interest

This project will be hosted in part at QUT and at CSIRO’s Autonomous Systems lab located at QCAT (Queensland Centre for Advanced Technologies), Pullenvale, QLD 4069

**Skills**
- GPA > 5.5
- Good mathematics knowledge
- Good signal processing knowledge
- Programming experience in C/C++ or Python
- ROS experience (desirable)

**No. of Students**
1 or 2

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### Polarimetric perception for field robots

**Supervisors**
Navinda Kottege (CSIRO) & Thierry Peynot (QUT)

**QUT contact email:** t.peynot@qut.edu.au

**Description**
Use polarization of light by non-metallic surfaces such as water to extract information about the environment to aid robotic navigation, control and gather additional information about the environment allowing rich perception of the robot’s surroundings.

- Design and implement polarimetric perception system using off the shelf components.
- Implement image processing algorithms for salient feature extraction from polar images.
- Conduct experiments with mobile robots in unstructured terrain using polarimetric perception system.

This project will be hosted in part at QUT and at CSIRO’s Autonomous Systems lab located at QCAT (Queensland Centre for Advanced Technologies), Pullenvale, QLD 4069

**Skills**
- GPA > 5.5
- Computer vision/OpenCV experience
- Programming experience in C/C++ or Python
- ROS experience (desirable)

**No. of Students**
1 or 2

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### Acoustic localisation using mobile phones

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Navinda Kottege (CSIRO) & Thierry Peynot (QUT)

**QUT contact email:** t.peynot@qut.edu.au

**Description**
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**Skills**
- GPA > 5.5
- Good mathematics knowledge
- Good signal processing knowledge
- Programming experience in C/C++ or Python
- ROS experience (desirable)

**No. of Students**
1 or 2
## Description

Given the ubiquitous nature of mobile phones capable of significant processing power with a suite of sensors makes it possible to use these devices to derive rich contextual information from its surroundings. Indoor localisation is a challenging problem and is an active research area. Location identification and activity detection using acoustics with mobile phones have been studied in the literature with varying degrees of success [1]. The published work attempts to identify which room a device is located using the ambient acoustic signature of that particular room. In this project, you will attempt to increase the accuracy of the localisation compared to work by Tarzia et al [1], as well as increase the resolution of the system to try and identify which area of the room the phone is located in. An additional extension would be to add activity detection capability to the system as described by Lu et al [2].

**References:**


This project will be hosted in part at QUT and at CSIRO's Autonomous Systems lab located at QCAT (Queensland Centre for Advanced Technologies), Pullenvale, QLD 4069.

## Skills

- GPA > 5.5
- Android programming,
- Familiarity with machine learning,
- Signal Processing knowledge

## No. of Students

1 or 2

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**Tristan Perez's Projects 2015**

**About Tristan**

Email : tristan.perez@qut.edu.au

<table>
<thead>
<tr>
<th>Title</th>
<th>Robot Trusted Autonomy</th>
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<tr>
<td><strong>Description</strong></td>
<td>As we continue to develop field and service robots with increasing levels of autonomy, their operation in spaces shared by humans and human operated machinery poses a challenge - robot autonomy needs to be trusted. The issue of assessing autonomy is a topic of increasing importance and a key enabling factor in the uptake of robot technology. This project will look at implementing a framework for assessing autonomy using probabilistic methods and decision theory.</td>
</tr>
</tbody>
</table>
| **Knowledge to be acquired by doing the project** | • Bayesian analysis  
• Artificial intelligence  
• Hypothesis testing and parameter estimation  
• Decisions under uncertainty  
• System reliability including sensors and actuators  
• Process in the loop simulation |
| **Skills required** | • Programming skills in Matlab and C.  
• Willingness to learn new things |
| **No. of Students** | 1 or 2 |

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<table>
<thead>
<tr>
<th>Title</th>
<th>Experimental Modelling of Marine Vehicles Dynamics</th>
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<tr>
<td><strong>Description</strong></td>
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<tr>
<td><strong>Knowledge to be acquired by doing the project</strong></td>
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<td><strong>Skills required</strong></td>
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<td><strong>No. of Students</strong></td>
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<td><strong>Title</strong></td>
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The design of motion control systems of underwater vehicles requires the designer to consider information about the vehicle dynamic response. This information is captured by a mathematical model. Mathematical models for underwater vehicles can be obtained from a combination of analytical and experimental methods. These methods require the design of optimal experiments to collect data with enough information to infer both the structure and parameters of the model. This project seeks to develop a methodology for optimal experiment design and model inference for marine vehicles based on information theory. That is design the most informative experiment for given model structure. The project will incorporate experiments on either an underwater vehicle or on an unmanned surface vehicle.

### Knowledge to be acquired by doing the project

- Mathematical modelling of vehicle dynamics (marine, aerospace)
- System identification and experiment design
- Bayesian data analysis
- Parameter estimation
- Optimisation
- Uncertainty and information theory

### Skills required

- Matlab and C
- Willingness to learn new things

### No. of Students

1

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<table>
<thead>
<tr>
<th>Title</th>
<th>Dynamics and Control of Crops for Automated Farm Management</th>
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<td>Description</td>
<td>Coming Soon</td>
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<tr>
<td>Skills</td>
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<td>No. of Students</td>
<td>1</td>
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<tr>
<th>Title</th>
<th>Fault-tolerant Motion Control for AgBot II</th>
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<tr>
<td>Description</td>
<td>The AgBot II (short for agricultural robot) has been designed at QUT to conduct autonomous operations for weed and crop management in farms. The chosen configuration for drive train is based on the use of differential driving of two traction wheels. This project seeks to develop a motion control strategy and control allocation for this class of robot. The project will require the implementation of motion control. In addition, the project will seek to design a fault diagnosis system to detect, isolate, and identify faults in the drive train and re-configure the control allocation function to enable fault tolerant operations.</td>
</tr>
</tbody>
</table>
| Knowledge to be acquired by doing the project | - Dynamics of mechanical systems  
- Motion control of non-holonomic robots  
- Optimisation  
- Implementation of real control systems  
- Fault diagnosis and fault-tolerant control  
- Decisions under uncertainty |
| Skills required | - Matlab and C  
- Control systems  
- Willingness to learn new things |
| No. of Students | 1 or 2 |

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Juxi Leitner's Projects

To find out more about me and my research projects, have a look at [http://Juxi.net](http://Juxi.net)
Generally my interest in making robots more adaptive and autonomous, focussing on how to integrate perception with the action side of things (see Vision and Action in the ACRV).

Email: j.leitner@qut.edu.au

<table>
<thead>
<tr>
<th>Title</th>
<th>Design and Development of a Robotic Lunar Payload</th>
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<tbody>
<tr>
<td>Description</td>
<td>The Google Lunar XPrize team offers the opportunity to send a small Cubesat sized payload to the moon. The idea of this project is to design and develop a functioning integrated system in a 10x10x10cm cube with less than 1.3kg to perform some measurements/science operations, based on the ArduSat platform. <a href="http://www.ardusat.com">http://www.ardusat.com</a> <a href="http://ptscientists.com/go/space">http://ptscientists.com/go/space</a></td>
</tr>
<tr>
<td>Skills</td>
<td>Mechanics, Electronics, Programming, Maths</td>
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<tr>
<td>Students</td>
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<thead>
<tr>
<th>Title</th>
<th>Multi-Robot Cooperative Visual Sensing</th>
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<tr>
<td>Description</td>
<td>Multi robot setups are considered in more and more applications, from agriculture to space exploration. One of the issues to tackle is how to cooperatively observe the environment. While each robot can observe only a limited part of the scene, together they are able to create a global view which allows for better navigation and planning. An exciting student project could be focussing on the RoboCup robot soccer.</td>
</tr>
<tr>
<td>Skills</td>
<td>Programming, Maths, preferably knowledge of either OpenCV, Robot Operating System, or multi-agent systems</td>
</tr>
<tr>
<td>Students</td>
<td>1-2</td>
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<thead>
<tr>
<th>Title</th>
<th>Building an External Camera Rig for Precise Localization of Robot End-Effectors</th>
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<tbody>
<tr>
<td>Description</td>
<td>The idea is to build a small and cheap visual localization systems, similar to a VICON system. The system will allow the precise detection and position estimation for a robotic manipulator arm. Consist of multiple cameras (and/or Kinects) it will be used for providing precise localization for our robotic arms and Baxter.</td>
</tr>
<tr>
<td>Skills</td>
<td>Programming, Maths, OpenCv</td>
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<tr>
<td>Students</td>
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<thead>
<tr>
<th>Title</th>
<th>Evolving Visual Object Detectors From Small Datasets (Video, Video 2)</th>
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<tbody>
<tr>
<td>Description</td>
<td>While the current trend in Computer Vision is to train deep networks with very, very large datasets, we recently looked at how to use small datasets to learn object representations. One of the application areas is robotic systems, where we previously used Genetic Programming to evolve simple object detection filters on small datasets. The idea here is to systematically test the performance of such a system and/or use it in robotics applications. (Reference)</td>
</tr>
<tr>
<td>Skills</td>
<td>Programming, Maths, preferably knowledge of either OpenCV or Machine Learning</td>
</tr>
<tr>
<td>Students</td>
<td>1-2</td>
</tr>
<tr>
<td>Title</td>
<td>Toward Human Avatar Robots by Fusing (Bio)Sensors (Video)</td>
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<tr>
<td>Description</td>
<td>Recently novel and affordable sensors that read bio-signals have become available. Each of these are provide not necessarily very reliable data (due to the fact that humans are different and the systems are in a very early/prototype stage), yet by combing multiple sensor it seems reasonable that a reliable (tele-)operation of complex (humanoid) robots can be achieved. The video shows the use of the LEAP motion sensor, a MYO sensor is also available.</td>
</tr>
<tr>
<td>Skills</td>
<td>Programming, Maths, preferably knowledge of either OpenC, Machine Learning or Sensor Fusion</td>
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<td>Students</td>
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<thead>
<tr>
<th>Title</th>
<th>Improving Manipulation Skills by Using Visual Feedback</th>
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<tr>
<td>Description</td>
<td>This project will focus on improving the manipulation skills of Baxter. It will involve visually detecting the objects (and possibly the gripper) to then servo the gripper in a good position for a successful grasp. More advanced manipulation could be addressed afterwards, such as, bi-manual manipulation (opening a bottle, pouring cereal in a bowl, ...). Update: Amazon is currently running a Challenge for robotics team to enter.</td>
</tr>
<tr>
<td>Skills</td>
<td>Programming, Maths, preferably knowledge of either OpenCV or Control</td>
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<tr>
<td>Students</td>
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<thead>
<tr>
<th>Title</th>
<th>Evolving Robust Neuro-Controllers for Vehicles</th>
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<tbody>
<tr>
<td>Description</td>
<td>Artificial Neural Networks have previously been used to control vehicles from spacecraft to flying robots. The goal of this project is to develop robust strategies for controlling vehicles from visual feedback using a neural network. The input of the network will be visual information, the images might at first come from a simulated car racing games (e.g. TORCS). The aim is to make a mobile robot (or Frosty's Ferrari) drive around a track using visual information.</td>
</tr>
<tr>
<td>Skills</td>
<td>Programming, Maths, preferably knowledge of either OpenCV or Control</td>
</tr>
<tr>
<td>Students</td>
<td>1-2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Title</th>
<th>Detection of Stars/Mountain Peaks/Landmarks for Augmented Reality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>There are a few applications already available that allow you to find constellations and stars in the sky. These systems are based on GPS, compass and gyroscopes, they are not using any visual information to overlap what you see (or the camera sees) with a digital map of the sky. The idea is to visually detect constellations or planets in an image and increase the accuracy of these systems by doing so.</td>
</tr>
<tr>
<td>Skills</td>
<td>Programming, Maths, preferably knowledge of OpenCV or smartphone programming</td>
</tr>
<tr>
<td>Students</td>
<td>1-2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Title</th>
<th>Obstacle Avoidance for Aerial Robots</th>
</tr>
</thead>
</table>
This would build on a previous project aiming to provide a robust method to do obstacle avoidance for a drone, using only on-board computational power (e.g. using a raspberry pi or odroid). It heavily relies on previous work on SLAM systems based on Extended Kalman Filter that use data from a monocular camera. This method is able to estimate the 3d position of the drone and a small number of features. The features are used to build a surface that represents the depth map of what lies in front of the drone. Knowing the distance of the objects with respect to the drone, a virtual force field is used to prevent the collision.

Skills
Programming, Maths, preferably knowledge of OpenCV or ROS

Students

Donald Dansereau's Projects 2015

About Donald. As I am presently out of email contact, please contact Peter Corke regarding these projects; include "BEB801 project" in all emails.

I have several projects that work with light field cameras, like the Lytro cameras www.lytro.com. These have something like a bee's eye view of the world, and it turns out this opens a lot of opportunities in computer vision. Also called "plenoptic" cameras, these devices give us images that encode both 3D shape and texture, but we need intelligent tools to extract and make use of this extra information.

Bullet time: Smooth motion rendering with a single light field camera

Description
Methods for rendering novel views from a single light field image exist, but what happens when we have a series of light field images taken from different angles? This project will explore ways of rendering views between the cameras, allowing a smooth bullet-time-like effect to be created.

Skills
Matlab, image processing, geometry; Desirable: experience with image registration, raytracing.

No. of Students
1

Computational camera design tool

Description
Light field cameras fit into a broader class of computational cameras along with the Frankencamera (http://graphics.stanford.edu/projects/camera-2.0), flutter shutter (http://web.media.mit.edu/~raskar/deblur/) and focal sweep (http://www.cs.columbia.edu/CAVE/projects/local_sweep_camera/). Finding the best camera for a given job is a complex problem, which this project helps address by creating an interactive optics simulator for exploring the computational camera design space. The simulator will determine the salient performance metrics of a user-specified camera, e.g. depth of field, resolution, field of view, light gathering, etc. For a larger group or a particularly motivated student, there is an opportunity to design and build a low-cost computational imaging prototype to validate the simulation tool.

Skills
Interactive application/web development, optics systems and analysis, geometry, signal processing; Desirable: experience with image quality analysis; For building a prototype: good engineering skills especially for working with optical hardware, cameras and their interfaces, capture software.

No. of Students
1-3
GPU-accelerated light field processing

**Description**
Some problems become simpler when you have a light field camera, e.g. visual odometry: telling where a robot moves from what it sees; change detection: in complex 3D scenes, telling what's moving from what's not, even though the camera itself is moving; and depth filtering: the basis for Lytro's refocusing ability, depth filtering is useful for removing noise and focusing on the important elements of the scene. All of these methods have significant parallel components, and stand to benefit from GPU implementation. In this project you'll be implementing one or more of these methods on GPU hardware, creating a realtime demonstration.

**Skills**
C/C++ or Matlab GPU programming, linear systems, signal processing; Desirable: CUDA or OpenCL

**No. of Students**
1

Motion deblurring light field imagery

**Description**
Moving cameras are often resolution-limited by motion blur as much as by pixel size. Deblurring 3D scenes is a hard problem that might become simpler when you have a light field camera. In this project you will extend existing 2D deblurring methods, build on bleeding-edge light field deblurring research, or develop your own light field deblurring method from scratch.

**Skills**
Matlab, image processing; Desirable: experience with optimization, deconvolution, 2D deblurring.

**No. of Students**
1

Release the Robots! RGBD from light field cameras

**Description**
Kinect sensors have shaken up the robotics world by offering co-registered RGB colour and depth (RGBD) in the same sensor. If you've ever tried to use one outside, though, you know that these sensors have serious limitations. Robots want to be free, and this project will have you turning a commercially available light field camera like the Lytro into an RGBD sensor. The main task is deriving a useful RGBD point cloud from the 4D light field structure. For larger teams or particularly driven individuals, validate the results by replacing the Kinect or laser input to an open-source project like RGBD SLAM, PCL, ROS, or similar (https://www.youtube.com/watch?v=AMLwjo80Wzl, https://www.youtube.com/watch?v=17W8dkzkvWA).

**Skills**
Matlab, image processing; Desirable: experience with RGBD sensors or point clouds; Desirable for larger groups: familiarity with open-source SLAM frameworks/tools/languages (C/C++, Python, ROS, PCL, ...).

**No. of Students**
1-3

Interactive light field tools
| **Description** | Contribute to the open-source MATLAB Light Field Toolbox by adding new functionality and awesome demos. Light field cameras like the Lytro give us rich information, but we need intelligent processing to make full use of the imagery. Add features like depth estimation, interactive refocusing, 3D rendering, depth filtering, motion detection, segmentation, image synthesis and rendering... driven individuals can draw from the literature or bring their own ideas. |
| **Skills** | Matlab, image processing, geometry; Desirable: experience with filtering, raytracing, interactive Matlab, multidimensional geometry. |
| **No. of Students** | 1 |

**High dynamic range (HDR) from light field cameras**

| **Description** | Light field cameras like the Lytro show significant vignetting, the darkening of images near their edges. Because of the way these cameras are built, like a bee's eye, and the redundancy in the light field, this vignetting can be used for high-dynamic-range (HDR) imaging. For this project you'll explore methods for exploiting this extra information in the light field. Excellent solutions will be considered for inclusion in the open-source Light Field Toolbox. |
| **Skills** | Matlab, image processing, geometry; Desirable: experience with HDR imaging, devignetting, debayering. |
| **No. of Students** | 1 |

**Machine learning and computer vision with light field cameras**

| **Description** | Machine learning is shaking up the computer vision community [http://www.nytimes.com/2014/11/18/science/researchers-announce-breakthrough-in-content-recognition-software.html?_r=0](http://www.nytimes.com/2014/11/18/science/researchers-announce-breakthrough-in-content-recognition-software.html?_r=0) How can existing techniques like deep learning benefit from light field imagery, like we get from the Lytro? In this project you'll apply existing machine learning techniques to data you collect using a Lytro. Can you beat state of the art 2D techniques? What can we learn from what the machine has learned? Can it validate existing light field processing methods, or motivate new ones? |
| **Skills** | Matlab, machine learning, image processing; Desirable: multidimensional geometry. |
| **No. of Students** | 1-2 |

**Seeing Better in Low Light using Camera Arrays**

| **Description** | An array of cameras gathers more light than a single camera, but intelligent software is needed to take advantage of the redundant imagery it collects. This project makes use of a newly completed 16-camera array, exploring techniques for seeing better in low light and in other challenging conditions, like through fog, rain or other partial occluders. There is also an opportunity for hardware work, enhancing the hardware as well as the algorithms that use it. |
| **Skills** | Matlab, image processing; Desirable: multiview geometry, filtering. |
| **No. of Students** | 1-2 |
### Real-Time Collision Avoidance and Smooth Trajectory Planning Based on Wide Angle Camera Images

**Description**

Fast collision avoidance is an important feature for any type of fast moving robots or autonomous cars. During the last few years, several breakthroughs have been noticed in the area of autonomous driving. Laserscanners are usually quite expensive and slow or do not provide enough information about the environment. The idea of the project is to use only wide angle images (provided by a small inexpensive camera) to estimate egomotion, position and direction of objects and to calculate an optimal smooth trajectory around objects.

**Skills**

C++, openCV, image processing, trajectory planning

**No. of Students**

1-2

### Semantic Perception Based on Spatial Ontologies and Scene Description

**Description**

"I tell you what it looks like and you tell me what it is". Many "things" we use and perceive in a typical, human made (indoor) environment can be described by their shape, the structure and the spatial relation. This knowledge about shape and structure is learned but can also be represented in a knowledge base language, such as OWL (Web Ontology Language). A table can be described as a thing which is planar, has a certain size and is always parallel to the ground floor. Once a table is identified, chairs can be described as the things near a table which consists of a planar seat part and an optional back rest and an optional arm rest. The things described in a knowledge based (we will deal with a close world assumption here) can be linked to what a robot sees. To classify shape and structure a Microsoft Kinect 2 sensor will be used. A knowledge based about the environment can be set up using e.g. Protege. To reason about shape and structures, existing reasoners such as FaCT++, FuzzyDL or Pellet can be used.

**Skills**

C++, Point Cloud Library

**No. of Students**

1
**Title**  
Range Estimation with Low-cost Radios for UAV swarming

**Description**  
The project will design and test range estimation with low-cost radios and its application to a swarm of UAVs. The project involves characterizing measurements of received signal strength then designing filtering strategies to estimate the range. Then implementing the strategy onboard UAV flight computers or autopilots and flight testing.

**Skills**  
Mathematics, embedded linux computing, MATLAB and C++ programming and some electronic prototyping.

**No. of Students**  
1

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**Duncan Campbell's Projects**

**About Duncan**

Email: da.campbell@qut.edu.au

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**Title**  
MAVLINK OPC Bridge

**Description**  
The project is to write an OPC bridge for Mavlink suitable for hosting on both a desktop PC or a small embedded Linux system such as a Raspberry Pi or a Beaglebone. Mavlink is a protocol to control multiple UAVs and is support by several autopilots/flight management systems. OPC is an industrial automation protocol which is platform independent and is highly developed for process control including hmi/SCADA systems. The objective of this project is to create an OPC/Mavlink bridge to leverage the two systems, particularly for remote/distributed command and control of multiple UAVS. This project is is based at QUT's ARCAA facility.

**Skills**  
The project involves software, embedded linux system, C++ and Java programming.

**No. of Students**  
1 or 2

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**Title**  
Haptic Control of UAV Swarm

**Description**  
The aim of the project is to develop a haptic interface for a single human operator to control multiple multi-rotor UAVs. The project will investigate how to control fleet behaviour via a haptic interface. The haptic feedback could provide the operator with tactile/force feedback based on group proximity to nearby structures. This project is is based at QUT's ARCAA facility and is cosupervised by Dr Troy Bruggemann.

**Skills**  
The project involves software development and indoor flight experimentation.

**No. of Students**  
1 or 2