Honours Projects Offered 2011

Contents

9th March 2011

1. Project: Privacy and Disconnected Databases

Proposer: Sonia Berman

Abbreviation: Privacy

Brief Description: *This project is primarily an ICT4D project aimed at helping users manage private data such as medical records. In a developing world environment there are no centralised medical health records, and patients are often given responsibility for transporting and storing these records themselves. The first part of this project is therefore about exploring how patients' mobile phones might be used to store and transport medical information in a secure way that can by read by a health professional when the need arises; perhaps by synching the information on the mobile phone with a clinic database.*

The second part of the project, however, deals with more complex issues of trust around medical records that have resulted in working with NGOs dealing with rape cases. Often it is the case that the patient will need to share some information about their health with a particular official (e.g. showing an employer a TB certificate) but preserve the privacy of the rest of the data. In this part of the project, the goal is to develop a mobile application that is developed according to UCD principles, allowing users to have control over data on their handsets down to a fine granularity.

Computer Science Content: *ICT4D, distributed data sharing, data standards, mobile interaction design, mobile programming*

Specific Learning Outcomes: *Working with NGOs; dealing with sensitive data; working with end users*

Skills Required by Team as a Whole:

- **Theory:** *Distributed computing*

   Implementation: *For part 1, the difficulty will lie in understanding medical record standards and security algorithms, then adapting them to the mobile. For part 2, the difficulty is in presenting the information to the user in a way that allows them to make informed choices about the data they share and with whom they share it.*

FACILITIES NEEDED: *Mobile handsets and a medical database*

Supervision: *Co-supervisor will be Gary Marsden with input from the Simelela NGO and Shikoh Gitau, a PhD student in the department. Sonia is offering 3 projects but will supervise at most 2 projects.*

Number of Students: 2

2. Project: Location-aware Business information

Proposer: Sonia Berman

Abbreviation: ***BusLoc***

Brief Description: *A project offering location-aware business information on one's mobile device has been suggested by BSG. This will provide a personal guide to life in the business – areas of interest, people to connect with that have things in common with you, directions to make use of facilities (e.g. how to gain access to wireless networks) etc. This will involve*

determining what types of information and communication is required, and how to capture, store and exploit this in a location-aware mobile application. One team member will concentrate on end-user interaction, interface design and evaluation; the other with implementing the system on a mobile device using spatial data.

Computer Science Content: *distributed data sharing, databases, mobile interaction design, mobile programming*

Specific Learning Outcomes: *mobile programming, working with end users, working with spatial data*

Skills Required by Team as a Whole:

- **Theory:** *databases and HCI*

    Implementation: *For part 1 the difficulty will lie in understanding the business needs and opportunities and how best to capture and present this information in a location-aware system. For part 2 the difficulty will lie in working with spatial data in a mobile system.*

FACILITIES NEEDED: *MOBILE HANDSET*

Supervision: *Co-supervisor will be Gary Marsden with input from BSG. Sonia is offering 3 projects but will supervise at most 2 projects.*

Number of Students: 2

3. Project: Innovative m-Learning

Proposer: Sonia Berman

Abbreviation: ***mLearn***

Brief Description: *This project will produce a novel learning environment for a mobile device. It is based on a suggestion by SAP Research. The target market can range from primary school children to adults, and the content from material for educating the general public (e.g. about chronic diseases) to specific school or university topics such as poetry or SQL. The system can furthermore be targeted at the learners or the teachers, e.g. by creating a system to quickly and efficiently produce educational content like short video clips that can be viewed from a mobile phone. User-centred design will be important as will appropriate evaluation of the final product.*

Computer Science Content: *mobile databases, mobile interaction design, mobile programming*

Specific Learning Outcomes: *mobile programming, dealing with multimedia data; working with end users*

Skills Required by Team as a Whole:

- **Theory:** *Databases, HCI*

    Implementation: *The focus is on design, implementation and validation of software. Experimental design is also expected.*

FACILITIES NEEDED: *MOBILE HANDSET*

Supervision: *Co-supervisor will be Gary Marsden with input from SAP. Sonia is offering 3 projects but will supervise at most 2 projects.*

Number of Students: **2 or 3**

4. Project: CODECS and Interfaces for Mobile Video Communication in SASL

Proposer: Edwin Blake

Abbreviation: CIMVCS

Brief Description: This project builds on preliminary work done at UCT and UWC in Video Communication for Deaf people who use South African Sign Language (SASL). Your task will be to investigate efficient video encoding and/or build a video chat system on Android cell phones with good cameras. You will design and test a system, and you may first want to experiment on a computer-based simulator and then on real phones to allow some or all of the following:

- Effective video compression for Deaf communication in real-time and/or using store-and-forward. There are open source CODECs (see www.videolan.org/developers/x264.html) that can be adapted to emphasize regions of interest to SASL users. The psychology department has an eye tracker which could be used to identify such regions of interest.

- Good user interface design using a very simple gesture based interface. In a gesture based interface the users will make specific hand gestures to control the interface. We work closely with an NGO for the Deaf and you will be able to test designs with them.

- The best cameras are often at the back of the phone but that means that the display cannot be on the phone screen. The phone will on a stand and you can either try a mirror or TV as the main display.

The connection to the other phone can be via 3G, GPRS, or WiFi.

Computer Science Content: *Design for Interaction, Image processing, mobile computing, video CODECs.*

Specific Learning Outcomes: You will learn how to design a region of interest encoder. You will learn to build a complete mobile system and deploy it with real users.

Skills Required by Team as a Whole: This can be quite a large project depending on the size of the team. Skills needed include:

- **Theory:** Region of interest CODEC design. *Image processing, user-centred design*
- **Implementation:** *You will have to get to grips with Android, which probably one of the best entries into mobile programming.*
- **OTHER:** User Interface design and an interest in ICT 4 D issues.

Facilities needed: Android phones (Samsung) will be provided. You will have access to a SASL interpreter for your user studies. Possible use of eye tracking equipment. There is funding to cover incidental costs.

Supervision: Supervision via regular weekly meetings. Regular meetings with Deaf users to get to grips with requirements. There is the possibility of funding for students on the team.

Number of Students: 3 (2–4 possible)

5. Project: University Community Meshed Phone

Proposer: Edwin Blake

Abbreviation: UCMP

Brief Description: The Village Telco Organization (an international organization based in Cape Town) has produced a device called the "mesh potato" *(www.villagetelco.org/about/mesh-potato/mesh-potato-faq/).* The Mesh Potato (MP) is a device that acts as node on a meshed wireless (WiFi) network and allows the connection of a plain old phone or a computer via an Ethernet port. The MP can act as a WiFi infrastructure node and allow mobile phones to join the network as SIP (Session Initiation Protocol, for voice calls over IP). An Android mobile phone should also be able to act as a node on the network since it too can run the required mesh network protocol called BATMAN. We will be getting a number of Samsung Android phones before June for such projects.

We currently have a number of mesh potatoes (about 14 and can get more), this is enough to set up a well connected network on campus The purpose of this project is to design and implement a phone system for upper campus and investigate the use and obstacles to use. The possibility exists of extending the network with long distance connections to other MP networks at UWC and Bo-Kaap. While the initial system will be free it could be commercialized it in the longer term and the project could address the feasibility of this.

Computer Science Content: Wireless mesh networks, mobile phone application development. Also depends on where the group takes the project: it could include usability and user experience testing.

Specific Learning Outcomes: Meshed network protocols and adaptation. Open source design and development on mobile phones. User testing.

Skills Required by Team as a Whole:

- **Theory:** Mesh networks
- **Implementation:** Solid system implementation skills, willingness to learn about development on Android mobile phones (probably one of the best ways to learn about mobile programming).
- **OTHER**: User testing.

Facilities needed: This project will require mesh potato devices (already purchased) and Android mobile phones (which are expected in May). Funding is available to purchase other requirements.

Supervision: Co-supervised by Dr Hanh Le. The group will have regular weekly meetings, and a project website will be set up for coordination.

Number of Students: 2 (possibly 3)

6. Project: Collecting User Generated Video Stories in SASL

Proposer: Edwin Blake

Abbreviation: VidStory

Brief Description: There is a need for user generated content from the Deaf community. As pointed out above Deaf people prefer to communicate using video in South African Sign Language (SASL). The idea is to allow Deaf users to tell their own stories about whatever

interests them or to allow them to share important information about using facilities (e.g., how to use the Computers at the NGO we work with, or what to do at a Police station if you have to report a theft). The project would comprise two aspects:

1. An interface for capturing and editing content (think of how to add signing captions and commentary.

2. An interface for distributing content. Here we are inspired by Gary Marsden's work on Big Board (see www.hastac.org/blogs/melissa-brough/bluetooth-big-boards-digital-storytelling for an outsider's perspective). However the bandwidth offered by Bluetooth might not be sufficient and we should look at WiFi based solutions.

All of this has to be developed in collaboration with the Deaf community (there is funding to pay for a SASL interpreter). You will be expected to use user centred design techniques and will be assisted with the undertaking a contextual enquiry and the use of technology probes. The target platform will be PCs and Android mobile phones. You may use a large screen display for disseminating the information.

Computer Science Content: User centred design, usability testing, mobile design and implementation.

Specific Learning Outcomes: You will learn to build a complete mobile system and deploy it with real users.

Skills Required by Team as a Whole:

- **Theory:** Some background and willingness to learn about user centred design.
- **Implementation:** The whole system should ideally run on mobile devices, so you will have to learn to work with them and design interfaces on them.
- **OTHER**: User testing.

Facilities needed: Samsung Android mobile phones and large screen display.

Supervision: Supervision via regular weekly meetings. Regular meetings with Deaf users to get to grips with requirements. There is the possibility of funding for students on the team.

Number of Students: 2 or 3

7.   Project: A Location-based Mobile Gaming Platform

Proposer: James Gain

Abbreviation: MobiLoc

Brief Description:

Many modern cell-phones come equipped with GPS, which enables the location of the cell phone to be determined with reasonable accuracy. When combined with rich map data sources, such as OpenStreetMap and Google Maps, which provide detailed street maps of much of the world, this enables a class of location-based cell-phone application. A typical example is providing tourists with information on (and possibly directions to) nearby sites of interest.

Given a cell-phone with camera and tilt-detection it is also possible to create Augmented Reality applications that overlay real-world images from a cell-phone camera with digital

location-based information. One example of this is Google Goggles, which can overlay information about landmarks based on a photo search.

This project will involve creating a system for multi-player Augmented Reality gaming application on cell-phones. The system will use a central server to track player locations, manage game state and provide appropriately filtered views from OpenStreetMap. The implementation should be general enough that it can be used for different games. The final system will be evaluated both through performance experiments but also using a multi-player game to be developed over the course of the project.

Computer Science Content: Human-Computer Interaction (augmented reality, playability testing), Computer Games (game engine design and development), Mobile Development (client-server optimization, location-awareness)

Specific Learning Outcomes: Iterative system development, play-testing and system experiments and optimization

Skills Required by Team as a Whole:

- **Theory:** easy to moderate [augmented reality techniques, latency hiding, playability]

- **Implementation:** difficult [android development, client-server architecture, OpenStreetMap integration, multi-player gaming]

Facilities needed: At least two (but preferably more) Samsung Galaxy or equivalent high-end cell-phones. Android development environment.

Supervision: James Gain. Weekly meetings with supervisor expected, occasional attendance and presentation at research group meetings may also be required**.**

Number of Students: 3 (4 allowed but not encouraged)

8.   Project: A Sketch-based Interface for Modelling Trees and Plants
Proposer: James Gain

Abbreviation: TreeDraw

Brief Description:

Lindenmayer systems (or L-systems) are a grammar-based method for creating procedural computer graphics content. Most commonly this involves creating the geometry of trees and plants for games and Visual Effects. Each L-system rule set encodes a particular species of plant and can be used to generate a potentially wide range of individual trees representative of that species.

Unfortunately, creating a set of L-system rules by hand is a time consuming and complicated endeavour not well suited to untrained users. This project will involve developing a sketching interface, in which a user draws a 2D representation of a tree or plant, and from which corresponding L-system rules will be derived. The user will be able to visualize the results by running the L-system thereby enabling a cycle of refinement of the original sketch and rule-set. As part of this project an existing L-system parser and interpreter will be provided.

Reference – Prusinkiewicz, P. and Lindenmayer, A. The Algorithmic Beauty of Plants. Springer Verlag. http://algorithmicbotany.org/papers/#abop

Computer Science Content: Computer Graphics (procedural methods, visualization**)**, Image Processing (stroke recognition), Grammars (L-system parsing and interpretation)

Specific Learning Outcomes:

Skills Required by Team as a Whole:

- **Theory:** difficult [advanced computer graphics]
- **Implementation:** moderate [stroke recognition, tree rendering with uncertainty visualization, deriving L-system rules]

Facilities needed: no special facilities needed (beyond a standard PC and C++ compiler).

Supervision: James Gain and Rudolph Neeser. Weekly meetings with supervisor expected, occasional attendance and presentation with larger research group (including Julian Kenwood and Patrick Marais) may also be required**.**

Number of Students: 2 (possibly 3)

9.   Project: Touch-enabled Visualization of Heritage Data

Proposer: James Gain

Abbreviation: TouchViz

Brief Description:

In computer-based museum displays it is important that visitors be able to quickly master how the display is navigated so that they can begin to absorb what is being displayed. Recent developments in large surface multi-touch devices (such as the Microsoft Surface) offer the potential for a particularly intuitive interaction mechanism that does away with peripherals such as the mouse and keyboard.

This project will involve developing a collaborative museum-style visualization of African heritage sites, such as the stone churches in Lalibela, Ethiopia. It will be based around multi-touch interaction to control virtual walkthroughs of the site, cutaways to interior views and displaying annotations of the data on demand. In addition the project will involve researching ways to support multiple collaborating users.

Development will be done in collaboration with the Geomatics Department at UCT, which will provide real-world data from heritage sites in Africa.

Computer Science Content: Human-Computer Interaction (touch- and gesture-based interaction), Visualization (rendering of large point-based data-sets)

Specific Learning Outcomes: Visualization and Interaction design and development. Iterative experimentation-based research.

Skills Required by Team as a Whole:

- **Theory:** Moderate [gesture recognition, level of detail rendering, multimedia databases]
- **Implementation:** Moderate [computer graphics and interface implementation]

Facilities needed: Geomatics datasets, Touch-enabled display surface

Supervision: James Gain and Patrick Marais. Weekly meetings with supervisor expected, occasional presentations to the research group of Prof. Heinz Rüther in Geomatics may also be required**.**

Number of Students: 3 (4 allowed but not encouraged)

10. Project: Using Mobile Phone Capabilities (voice, sms, photo, video) to report crime activities or law infringements anonymously

Proposer: Anne Kayem

Abbreviation: Help Me

Brief Description: Crime is a problem that has arguably become a normal aspect of daily life in many parts of the world. For Africa, crime and corruption has become a major hindrance to economic development and so it makes sense to find ways of addressing this issue. Efforts in South Africa include "702 Radio" (www.702.co.za/press/blowingwhistle.asp) and "South African Police Service Crime stop line" (www.saps.gov.za/_dynamicModules/internetsite/crimestop.asp) that are aimed at encouraging citizens to report criminal activities anonymously. Yet, in spite of the popularity of mobile phones and increased access to the internet that make communication a matter of "clicking a button", this idea has failed to result in meaningful change.

In this project, we are interested in discovering the challenges and concerns, from an information security perspective, that users face in anonymously reporting crime activities or law infringements via mobile phone. In order to do this, two aspects need to be addressed, namely:

1. The security challenges users face in using mobile devices to make anonymous reports (e.g. fear of their cell phone numbers being associated with the message, need for encryption to enhance message privacy, exasperation with having to insert passwords repeatedly and/or delays in transmission, ...).

   ** The expectation is that the team member in charge of this will formulate a questionnaire that will be used to gather the data. The data analysis will then be based on a data mining technique that the team member will choose.

2. How to design a framework and implement a prototype to overcome the challenges of anonymous crime and/or law infringement reporting (e.g. secure data gathering and message translation into a common format, techniques/algorithms to anonymize messages, information analysis and extraction...).

   ** In this case, we will model the general framework to integrate the functionalities mentioned above and then implement one or two of the functionalities (depending on time).

For more information please email me at akayem@cs.uct.ac.za.

Computer Science Content:

- Information Security
  - Data Privacy and Message Anonymity
  - Data Mining

Specific Learning Outcomes:

- Data Gathering and Analysis (Create a website or application to collect data in addition to field data collection)

- Design of a framework to anonymize and translate messages (e.g. from different languages or formats) that are transmitted from mobile phones

- Prototype implementation of the framework and evaluation (in terms of cost, scalability, throughput ...) with respect to existing solutions e.g.

Skills Required by Team as a Whole:

- **Theory:** Software Modelling and Design; Data Mining; knowledge of some machine learning technique(s) might be helpful.

- **Implementation:** Good Programming Skills; Weka and/or Matlab (Data Analysis)
- **OTHER:** Ability to work in a team. Work will be split into two on the basis of two criteria, namely – "Field study and data analysis" and "Framework design and prototype implementation".
  ** Experience with questionnaire formulation is a plus (but not required).

Facilities needed: Mobile Phones, and Desktop Computers, Internet access; Java; Weka; and Matlab

Supervision: One on one meeting with supervisor – 1X/week; Group meetings (2x/month); Monthly presentation (progress status) and consultation with SAP (1X/month).

Number of Students: 2

11. Project: Integrating Cryptographic Operations on SafeNet's Hardware Security Modules: Case Study – E-Payments

Proposer: Anne Kayem

Abbreviation: SNet-HSM

Brief Description: Securing payments originating from various hardware devices and software processes is a key concern for companies and/or individuals wishing to do business over the Internet or via various electronic/mobile devices. In this project, we want to use – as a case study – the S1 Corporation's SafeNet Hardware Security Modules (HSM) payment platform, to study the theoretical and practical concerns of supporting this platform with cryptography. The SafeNet HSM is a particular brand of an HSM device that is popular in Electronic Funds Transfer (EFT) markets.

The S1 Corporation which is based in Cape Town, South Africa, provides e-payments services to over 300 clients located in 50 countries. Currently, S1 uses two platforms to ensure that these services are provided in a way that optimises performance and flexibility in addition to saving costs. The first payment platform provides support for devices like bank cards that run cryptographic operations while the second provides support for devices like ATM machines that contain HSMs. HSMs are typically physically secured to be tamper-proof, and contain all the processors, memory and storage required to perform cryptographic operations at a high level of throughput, securely, and store the secret keys required for accessibility to payment information.

The aim of this project is to create a framework that implements cryptographic support for the SafeNet HSM and then compare the capabilities of the framework on other HSM devices. An analysis based on metrics like cost, transaction time, throughput, and scalability will serve as a

basis for the comparison and a feasibility study to decide whether combining SafeNet HSMs with cryptographic operations is a viable solution for EFTs.

For more information please email me at akayem@cs.uct.ac.za.

Computer Science Content:

- Information Security
    - Applied Cryptography

Specific Learning Outcomes:

- Design a security framework to integrate cryptographic operations (like encryption, etc) on to an HSM platform (e.g. SafeNet platform)

- Implement the integrated platform (using Java)

- Evaluate the scalability of the proposed solution (in terms of cost, scalability, throughput ...) with respect to existing solutions that the S1 Corporation provides namely cryptographic operations and HSMs.

Skills Required by Team as a Whole:

- **Theory:** Discrete Mathematics, Cryptographic key management and Encryption Algorithms (DES and 3DES encryption)

- **Implementation:** Good Java Programming Skills
- **OTHER:** Ability to work in a team

Facilities needed: Mobile Phones, Desktop Computers, and SafeNet HSM (-- provided by S1 Corporation) Internet access, Java

Supervision: One on one meetings with supervisor – 1X/week; Group meetings (2x/month); Monthly presentation (progress status); Practical and/or research consultations with S1 Corporation possible.

Number of Students: 2

12. Project: Social Networks as a backbone for Small and Medium Sized E-Business: Privacy Considerations

Proposer: Anne Kayem

Abbreviation: SME-PRI

Brief Description: Social networks have become a popular platform for exchanging information seamlessly. With social networks like Facebook, and MySpace, one has the impression that there are no boundaries. Increasingly, small and medium sized E-business (SME) is beginning to give serious consideration to the business potential of using social networks as a method growing the size of their clientele. The advantage of this is that it removes the cost of advertising on popular media channels like the radio and television. However, news reports like the one involving Facebook in October of 2010 (www.pcworld.com/article/208058/facebook_privacy_fail_apps_leak_private_info_report.html), raise privacy concerns that need to be addressed if SMEs are going to "trust" social networks enough to use them as a backbone for growing their businesses and handling online transactions.

In this project we are interested in addressing in finding answers to the following questions:

1. What are the privacy considerations that SMEs need to take into consideration in using social networks as a backbone? (Can they interact with large organisations? How do they handle situations involving conflicting security requirements?)
2. What sorts of SMEs are interested in support from social networks and why? (use case scenarios)
3. How do we design a privacy mechanism that adapts intelligently to changes in network performance without compromising privacy?

For more information please email me at akayem@cs.uct.ac.za.

Computer Science Content:

- Information Security
  - Data Sharing and Privacy

Specific Learning Outcomes:

- Survey Paper : Evaluating the privacy considerations in using social networks as a backbone for SMEs

- Prototype Design, Implementation and Testing

Skills Required by Team as a Whole:

- **Theory:** Data privacy considerations for SMEs wanting to use social networks as a backbone; Software Modelling and Design; knowledge of some machine learning technique(s) might be helpful (but not necessary) in designing/creating the prototype.

- **Implementation:** Create a prototype application or plug-in to facilitate connectivity to a social network and enforce privacy
- **OTHER:** Field work – data gathering and prototype testing (online and offline);

Facilities needed: Desktop Computers, Mobile Phones, Internet Access...

Supervision: One on one meeting with supervisor – 1X/week; Group meetings (bi-weekly); 1 presentation per month (progress status) and consultation with SAP.

Number of Students: 2

13. Project: 3D Molecule Lego

Proposer: Michelle Kuttel

Abbreviation: *MOLLEGO*

Brief Description: *The task in this project is to design a suitable, intuitive molecule builder so that your average 6-year old can successfully build a 3D model of a carbohydrate, DNA or a protein. You don't have to know anything about chemistry – the idea is to treat molecules as lego-like bricks which stick together according to certain defined rules. There is also potential to develop this into a game of "who can build the best structure", along the lines of a recent paper in Nature (Predicting protein structures with a multiplayer online game, Cooper et al., NATURE| Vol 466,5 August 2010) or else develop an iPad version of the interface.*

Computer Science Content: *Algorithm development and open-source software engineering.*

Specific Learning Outcomes: *You will learn about software design and engineering. You will have experience with direct contact with the "clients" for requirements specification (Göran Widmalm and his group at the University of Stockholm, Sweden).*

Skills Required by Team as a Whole:

- **Theory:** *Absolutely no prior experience with chemistry is required. However, you will have to be willing to learn the basics of molecular structure (which is useful knowledge!).*
- **Implementation:** *Implementation will be of average difficulty for an Honours project. The emphasis will be on an interactive design process to obtain a really useful and user-friendly product.*

Facilities needed: *Standard PC/laptop or an iPad if that is the focus.*

Supervision: *We are very excited about this project, which has the potential to create a very useful tool. You will have weekly meetings with Michelle, together with remote Co-supervision by Göran Widmalm (University of Stockholm, Sweden).*

Number of Students: *2, 3 or 4*

14. Project: Scalable multi-threaded tool for visualization of radio astronomy data cubes.

Proposer: Michelle Kuttel

Abbreviation: *ASTROVIS*

Brief Description: *The South African bid for hosting the Square Kilometre Array (SKA), which will be the largest radio telescope in the world, has vastly increased the focus on astronomical research in our country. As part of the bid, a new large South African radio telescope is being built in the Karoo ("MeerKAT"), and scheduled to come online in 2015. As smaller prototype called KAT-7 is already being commissioned.   The size and complexity of the MeerKAT telescope (not to mention the future SKA) will vastly increase the radio astronomical data output. We have a collaboration with the Astronomy Department at UCT to build software tools to assist with processing and analysing the increased volume of data. For example, current tools used to visualize radio astronomy data (such as Karma) will not be able to handle the new much larger data cubes. In this project, you will develop a new scalable, multithreaded system for visualizing radio astronomy data cubes.*

Computer Science Content: *Parallel computing and visualization, multi-threading, 3D –data visualization.*

Specific Learning Outcomes: *You will learn about how to build scalable applications to handle large dataset, parallel multithreaded computing, and visualization algorithms.*

Skills Required by Team as a Whole:

- **Theory:** *No prior experience with Astronomy required, but a strong interest in developing computational tools for Astronomy. Must not be afraid of a challenge!*
- **Implementation:** *Challenging, but very interesting!*

Facilities needed: *Multicore CPU, reasonable GPU, access to astronomical data cubes.*

Supervision: *Weekly meetings with Michelle, Meetings with Astronomy supervisor Erwin de Blok as necessary, fortnightly meetings with the postgraduate students working in the DARC Astronomical Research Computing (DARC) group.*

Number of Students: *2 or 3*

15. Project: Can you create a MANET amongst students on campus?

Proposer: **Dr Hanh Le**

Abbreviation: *MANET*

Brief Description:

Many students have mobile phones that have network capabilities but cannot access network applications at low or zero cost on campus. Can you create a Mobile Ad hoc Network (MANET) amongst them so that useful applications can be realized?

Possible outputs are 1) a file sharing application amongst our students without the need of PCs, laptops or even wireless access points; 2) movement patterns of the students (nodes) for future research.

Computer Science Content: Networking, Programming

Specific Learning Outcomes: Wireless communications

Skills Required by Team as a Whole:

- **Theory:** *Networking*
- **Implementation:** Programming for mobile phones

Facilities needed: Some mobile phones can be provided for testing but it would be better if your software works with existing students' phones

Supervision: Weekly meeting

Number of Students: *3 (or 4 or 2 if needed)*

16. Project: An intelligent WSN based on agents.

Proposer: **Dr Hanh Le**

Abbreviation: **WSN**

Brief Description:

Wireless Sensor Networks (WSNs) involve a high number of small sensors to perceive information about the environment such as temperature, humidity, etc. The type and capability of sensors varies depending on their roles and applications. We propose a framework that allows a node to construct its functionality and software network architecture using agents to best suited to its need. The main benefit of the framework is to avoid overloading sensors with unnecessary features and to enable sensors with re-configurability. This project entails developing mobile agents (e.g. routing and encryption functions/agents) as a part of the framework and then deploying the framework onto SunSPOT sensors.

Computer Science Content: Artificial Intelligent, Networking and Programming

Specific Learning Outcomes: AI and WSN

Skills Required by Team as a Whole:

- **Theory:** WSN, AI
- **Implementation:** Programming for wireless sensors (e.g. Sun SPOT)

Facilities needed: Sun SPOTs are provided

Supervision: Weekly meeting and co-supervised by Dr. Audrey Mbogho

Number of Students: *3 (or 4 or 2 if needed)*

17. Project: The use of Social Networks for Electronic healthcare

Proposer: Dr Hanh Le

Abbreviation: *E-health*

Brief Description:

Social networks involve a high number of users and help people stay updated at relatively low cost. Electronic healthcare applications are supposed to help patients to manage their medical condition better. This project investigates the ability to use social networks for an electronic healthcare application. For example, people may want to share information about new drugs or publish medical advices. Specifically a "Diabetes Management Software" will be built. Students are required to develop interfaces between the software and a social network, and study the behaviour of the users on both systems.

Computer Science Content: Networking, Programming

Specific Learning Outcomes: Social Network

Skills Required by Team as a Whole:

- **Theory:** *Networking*
- **Implementation:** Programming for mobile phones

Facilities needed: Some mobile phones can be provided for testing but it would be better if your software works with users' phones

Supervision: Weekly meeting

Number of Students: *3 (or 4 or 2 if needed)*

18. Project: Compression of Radio Astronomy data sets

Proposer: Patrick Marais

Abbreviation: ASTCOMP

Brief Description: *The data sets produced by radio-astronomy surveys are huge, and will grow even larger with the advent of large-scale radio telescopes like MeerKAT. The data that streams from the sensors is often represented as a 'data cube', in which each 2D image corresponds to information across the sky in a portion of the radio spectrum. Scientists are interested in analysing these data cubes, to evaluate current cosmological models, among other applications, and also need techniques which will allow this data to be efficiently compressed. Currently, simple generic compression schemes are used to shrink the data set sizes – but these take no account of the properties of the data cube itself.*

The purpose of this project is to evaluate existing image compression methods, which accommodate prior knowledge about image content, and to assess the usefulness of these methods in this context. An important design goal for any new algorithm is to avoid the need to decompress the entire data set in order to examine only part of the data. An enhanced algorithm, based on existing techniques, which is fast and outperforms naïve entropy coders will be hugely beneficial to the radio astronomy community. It may also be possible to adapt existing algorithms to run on a GPU, which would further enhance performance gains.

Computer Science Content: *Data compression; image compression; data structures and algorithms (possibly GPU alg. design, depending on student interest)*

Specific Learning Outcomes: *Design, implement and test algorithms and data structures based on a problem spec.*

Skills Required by Team as a Whole: *Several compression algorithms will need to be understood, implemented and evaluated. They will also need to be modified to meet the design goals states above (efficiency, partial data decompression). More specific information on project components is listed below:*

- **Theory:** *This project will involve understanding a number of image/data compression techniques – this maybe be somewhat challenging. Someone with an interest in algorithm design would have a distinct advantage.*
- **Implementation:** *The implementation will require coding up some existing schemes and modifying them to take account of the characteristics of data cubes. If the project evolves in that direction, familiarity with GOU coding would also be useful.*
- **Evaluation***: A comprehensive evaluation will need to be conducted for each developed method.*

Facilities needed: *Standard hardware will suffice; data sets will be provided.*

Supervision: *I will provide input on image/data compression; The UCT astronomy department (Prof De Blok) will provide data sets and expertise in radio astronomy.*

Number of Students: *2 or 3*

19. Project: Automated Counting of Cape Fur Seal Pups on Digital Aerial Photographs

Proposer: Patrick Marais

Abbreviation: *SEALS*

Brief Description: In order to manage and monitor the Cape fur seal population, seals must be counted on a regular basis. Traditional techniques relied on manual counting, which is obviously labour intensive and expensive. More recently, aerial surveys have become popular since these provide high resolution images which can be analyzed by experts away from the colony sites at a convenient time. Unfortunately, such manual scrutiny is still time consuming and prone to error. The solution is to develop an automated image processing system which can scan an image and identify seals of the appropriate age category, and thus count them.

Your task is to develop a system that can identify juvenile seals – pups – by using ideas from image segmentation. Since there are many algorithms that one can attempt, this project can

scale to accommodate more than two people. A common code base will have to be developed, and then a series of separate algorithms will need to be implemented, tweaked and analysed.

Computer Science Content: *This project will require techniques from image processing and computer vision. Specifically, those algorithms dealing with object recognition/segmentation will need to be explored in some depth to develop a feasible solution.*

Specific Learning Outcomes: Software design; algorithm design; validation

Skills Required by Team as a Whole: *This project will require students with a strong programming background and an interest in image processing/manipulation. A fair amount of reading will also be required to gain understanding of the basic techniques used in image processing and segmentation.*

- **Theory:** *The theory behind object recognition can be quite complex. The specific features of the images (resolution, terrain changes, occlusion of seals) will make this very challenging.*
- **Implementation:** *The implementation will require image processing tools to be developed (perhaps a library can be used), as well as object recognition algorithms and data structures.*

Facilities needed: The computer hardware in the honours lab should be adequate; open source software/libraries can be used for some parts; data will be provided by the client.
Supervision: Dr Audrey Mbogho will serve as co-supervisor, and Mr Mduduzi Seakamele from Oceans and Coasts Research is the client. Audrey and Patrick will provide help with image processing and segmentation techniques, and Mduduzi will provide expertise on seal classification and prior work.

Number of Students: *2 or 3*

20. Project: Reinventing the Mobile Interface

Proposer: Gary Marsden

Abbreviation: *iMobile*

Brief Description: *Current smartphone interfaces are based on the notion of applications. Our interaction is based around what app provides the information and functionality we require. I (and many other researchers) believe this model has outlived it usefulness. This project is focussed on creating the next generation of mobile interface.*

One part of the project will be to implement the 'lifestreams' interface on a mobile architecture such as WM7 or Android. Lifestreams is a document-based interface metaphor that visualises your interactions as a series of messages. To date, it is has only existed as a desktop system but lends itself to mobile interaction.

The second part of the project will be to investigate other metaphors and design new ones using high-fidelity prototypes. Here the student will be required to design and then test those designs with groups of users.

Computer Science Content: *Generally, mobile computing. Specifically mobile interaction design and mobile interface design.*

Specific Learning Outcomes: *Interaction design, mobile programming, interface programming and mobile prototyping*

Skills Required by Team as a Whole:

- **Theory:** *None in the classic sense. Just need to have completed MID course.*
- **Implementation:** *For one person, the difficulty will lie in wrapping a new interface over an existing platform; coming to grips with how the mobile platform works.*
- **OTHER:** *For the other person, the difficulty lies in designing prototypes and synthesising research ideas and results.*

Facilities needed: *Mobile handsets will be provided.*

Supervision: *I will be available for weekly meetings, along with two postgraduate students working in this area.*

Number of Students: *2*

21. Project: Asynchronous Mobile Training

Proposer: Gary Marsden

Abbreviation: *mTraining*

Brief Description: *This project is about continuing the highly successful Big Board project from Microsoft. This project is also Microsoft funded and it seeks to create a system to distribute video-based training materials to semi-literate health workers. The system works by registering the Bluetooth ID's of health workers' handsets and sending them training videos over Bluetooth. Whenever the worker next comes within range of the system, the system checks to see what video that have watched and automatically sends them new material.*

There are two aspects to this project.

The first is to implement the Bluetooth file exchange system. The code for this has been largely finished, but on Windows Mobile 6.5. We need the system ported to Android and then extended to keep track of which Bluetooth ID has watched which videos.

The second part of the project is to work with midwives to design an interface which facilitates them uploading and checking on material. Midwife training does not include a lot of ICT, so these interfaces have to be very carefully designed using techniques such as PD, prototyping etc.

Alternatively, the second part of the project could be purely technical about marrying Bluetooth technology to Mule networks, so that information is spread in a peer-to-peer fashion, rather than from a central point.

Computer Science Content: *Generally, mobile computing. Specifically mobile interaction design and mobile interface design.*

Specific Learning Outcomes: *Interaction design, mobile programming, interface programming and mobile prototyping*

Skills Required by Team as a Whole:

- **Theory:** *None in the classic sense. Just need to have completed MID course.*
- **Implementation:** *For one person, the difficulty will lie porting code to a completely new platform, then adding functionality to that code.*
- **OTHER:** *For the other person, the difficulty lies in designing prototypes and synthesising research ideas and results.*

Facilities needed: *Handsets and access to health professionals will be provided*

Supervision: *This project is currently funded by Microsoft research using a maternity hospital in Sierra Leone as a testbed for a general system to distribute training materials. There are many groups across the developing world who need such a system and there is much interest in what can be produced.*

Number of Students: *2*

22. Project: Spaza Shop Mobile Management

Proposer: Gary Marsden

Abbreviation: *iSpaza*

Brief Description: *The idea for this project comes from two sources. Firstly, my research into book keeping systems for informal traders – we have worked with an NGO that has a paper-based system that we are converting to run on Android. Secondly, a commercial company, S1, that has a secure mobile payments platform that would allow informal traders to conduct cashless payments.*

There are a number of ways that this project could go. If you are interested in any of the following topics on a mobile platform, then the project could be constructed to incorporate those interests: secure transactions; mobile interface design; stock management and accountancy systems; image processing and OCR.

Computer Science Content: *Mobile platforms*

Specific Learning Outcomes: *Implementing commercial applications on a mobile platform – could include HCI, security or databases.*

Skills Required by Team as a Whole:

- **OTHER:** Hard to say at this point.

Facilities needed: *Mobile handsets will be provided*

Supervision: *I will have weekly meetings and work on this project with a postgrad student who has a lot of Android and mobile payment experience. S1 will offer a liaison person and information regarding their platform.*

Number of Students: *2-3*

23. Project: RoboCup Rescue Robot Project

Proposer: Audrey Mbogho

Abbreviation: *ROBOCUP*

Brief Description: *The intention of the RoboCup Rescue project is to promote research and development in Artificial Intelligence and Robotics (See www.robocuprescue.org/).*

This project will involve the software development for a rescue robot that is developed by the Robotics and Agents Research Laboratory, Department of Mechanical Engineering, UCT.

Computer Science Content: *Robot Control, Image Processing, Speech Recognition, Human Computer Interfaces*

Specific Learning Outcomes: *Fostering the learning in artificial intelligence and robotics, overcoming operator-interaction challenges*

Skills Required by Team as a Whole:

Student 1: Robot Control

A control interface to operate the different functions of the Robot

Selection of an appropriate interface for the user as well as testing what skill level/ training is needed to operate the robot.

Main systems that need to be controlled-

Robot Base - this will be the control of the motion of the robot- forward , back, turn, as well as the flipper positioning. This will include that speed that the robot moves at.

Robot Arm - this will be the control of the position of the arm and the operation of the manipulator.

Robot Sensor Payload - this will be the control and selection for the different sensors.

Student 2: Image Processing

Image processing of all the video streams to help the operator navigate and find victims. This will be for the optical cameras as well as the thermal camera. This will include face detection, Hazmat sighs detection and identification, detection of the rolling E set.

Generate a 3D map of the world around the robot. The map can then be used for navigation.

Student 3: Speech recognition

Processing to the audio to detect repetitive pattern and speech.

Student 4: Human Computer Interface

The development of a user- friendly interface that is intuitive and does not subject the user to sensory overload.

The human-computer interface must take a minimalistic approach and only display the selected video streams and what is core to operating the robot. It must only bring in other data if requested or if required i.e. Motor overload. Intelligence in the system is needed - to think for the user to simplify the operation of the robot.

- **Theory:** *Image Processing, Speech Recognition, Artificial Intelligence*
- **Implementation:** *IMPLEMENTATION DIFFICULTY - MODERATE*

Facilities needed: *rescue robot to be supplied by Robotics and Agents lab. Data Includes:*

· 	*4 video streams*

· 	*Thermal image video stream*

· 	*CO_2 sensor*

· 	*GPS*

· 	*Inertial measurement unit (IMU)*

· 	*Audio stream (sending and receiving)*

·   *Laser 3D mapper*

Supervision: Audrey Mbogho, Anet Potgieter and Stephen Marais: *Speech Recognition, Image Processing, HCI, AI, development of software, meetings and presentations at the Robotics and Agents Research Lab, Mech Eng*

Number of Students: *4 (or 3)*

24. Project: SimplyCT Heritage

Proposer: Hussein Suleman

Abbreviation: ***SimplyCT***

Brief Description: *Digital heritage collections are emerging in many countries/regions as a means to record and disseminate various forms of heritage (culture, language, history, etc.). While the systems for managing these collections are often custom-developed, it is clear that there are many common requirements. Thus, configurable reusable software for the management of heritage collections should be feasible.*

The aim of this project is to develop a set of Web-based tools to manage heritage collections and make them accessible to end-users. Curators needs specific tools for management, such as the ability to upload objects, organise into categories and edit metadata. End-users need typical search and browse functions. The simplyCT framework that defines simple data stores and common component layouts must be used.

The project is focused on three desirable criteria:

1. *Reconfigurability of the system – how easily can the system be redeployed for a different community/collection?*

2. *Scalability – how well can the system operate with very large collections?*

3.   *Preservation – what guarantee do we have that the digital objects and their organisation will be readable in the distant future?*

This project can have a substantial impact if it can be demonstrated in the context of new collections and new communities. Our partners include organisations such as the Centre for Curating the Archive at UCT (that is interested in periodically adding new collections), the Indira Gandhi National Centre for the Arts in New Delhi (that is interested in very large manuscript collections) and the District Six Museum in Cape Town (that is interested in an existing solution that can be reconfigured for their needs).

Computer Science Content: *Digital Libraries, Web technology, cultural heritage preservation, Web 2.0 techniques, information retrieval*

Specific Learning Outcomes: *System implementation; research methodology; experimental evaluation.*

Skills Required by Team as a Whole:

> **Theory:** *Nothing particular.*
> **Implementation:** *Knowledge of Web technology and XML will be useful. Some knowledge of information retrieval will be useful for aspects of the project, but these will be covered in the WWW course.*
> **Other:** *Excitement about contributing to the preservation of endangered cultures!*

Facilities needed: *Server and data storage space will be provided.*

Supervision: *Hussein Suleman, with input from various partners. This project will be hosted within the Digital Libraries Laboratory – students will be encouraged to attend DL activities when relevant or to get input/assistance from senior research students.*

Number of Students: *2, 3 or 4*

25. Project: Superimposed Bushman Information

Proposer: Hussein Suleman

Abbreviation: *SIBush*

Brief Description: *The Bleek and Lloyd collection of Bushman stories, drawings and dictionaries are world-famous as the last documentary record of the culture of the Bushmen of this region.*

Over a period of 5 years, this collection has been digitised and carefully organised into online Web-accessible collections. It is now possible to make use of the collection in teaching, research, performances, exhibitions, etc.

The aim of this project is to develop a set of Web 2.0 tools to reuse the content and assemble it in interesting ways, both automatically and manually, implementing the emerging theory of superimposed information for layered and separable archives. A typical automatic assembly of the content could be the illustration of the Bushman stories based purely on analysis of the corresponding word patterns/statistics. A typical manual assembly would be a tool that allows authoring of Web pages (or PDFs or other documents) with embedded content from the B&L collections, thus allowing reuse and the creation of new forms of expression that can be contributed back into the community.

This project can have a substantial impact in how we appreciate and assimilate the culture of the Bushmen in a modern context.

See http://lloydbleekcollection.cs.uct.ac.za/ and http://lloydbleekcollection.cs.uct.ac.za/dictionaries/.

Computer Science Content: *Digital Libraries, Web technology, cultural heritage preservation, Web 2.0 techniques, information retrieval*

Specific Learning Outcomes: *System implementation; research methodology; experimental evaluation.*

Skills Required by Team as a Whole:

>   **Theory:** *Nothing particular.*
>   **Implementation:** *Knowledge of Web technology and XML will be useful. Some knowledge of information retrieval will be useful for aspects of the project, but these will be covered in the WWW course.*
>   **Other:** *Excitement about contributing to the preservation of endangered cultures!*

Facilities needed: *Server and data storage space will be provided.*

Supervision: *Hussein Suleman, with input from the Centre for Curating the Archive (UCT Fine Arts). This project will be hosted within the Digital Libraries Laboratory – students will be*

encouraged to attend DL activities when relevant or to get input/assistance from senior research students.

Number of Students: *2 or 3*

26. Project: Online Meetings in Africa

Proposer: Hussein Suleman

Abbreviation: AfriMeet

Brief Description: *Hosting a meeting with remote participants is often a nightmare when using South African Internet connections, notorious for unstable and low bandwidth. Commercial and open source tools all work to varying degrees, but most fail at some point as they were all designed with the assumption of fast and stable connections. Commercial software acquired by UCT last year failed to deal with the low bandwidth connections.*

This project is about the design and development of a developing-country-aware application to host online meetings where multiple participants can share audio, video and presentations.

In a low-bandwidth meeting environment, the emphasis is on a different set of criteria, such as:

- *pre-fetching of static data*

- *prioritisation of audio*

- *clear meeting procedure encoding (e.g., virtual hand-raising)*

- *video keyframing*

- *minimalism in messaging protocols*

- *graceful degradation over unstable connections*

This project can demonstrate how to build better conferencing applications that work in all parts of the world, not just the northern hemisphere.

Computer Science Content: *Web technology, multimedia interfacing, Web 2.0 techniques, network protocols*

Specific Learning Outcomes: *System implementation; research methodology; experimental evaluation.*

Skills Required by Team as a Whole:

      Theory: *Nothing particular.*
      Implementation: *Knowledge of Web technology and XML will be useful. An ability to interact with multimedia and multimedia devices will be useful, but can be learnt.*
      Other: *Excitement about changing perceptions on software development for developing countries.*

Facilities needed: *Server and data storage space, if required, will be provided. Any additional hardware (such as cameras), if required, will be provided.*

Supervision: *Hussein Suleman. This project will be hosted within the Digital Libraries Laboratory – students will be encouraged to attend DL activities when relevant or to get input/assistance from senior research students.*

Number of Students: 2 or 3