

## SPRING 2014 – CS 490 PROJECTS

### *Flockbots as a Multi-Robotics Research Platform - Multi-Body Systems and Emergent Behaviors*

The objective of this experiment was to use multiple Flockbots to solve sokoban puzzles in parallel (a multi-body simulation with a central planner). The simulation takes place on an 8x7 grid that we constructed. Each grid space has a QR code in it for localization. There are three main components to solving the problem: the centralized planner, which finds a solution to the puzzle and coordinates Flockbot movements, the bird's eye camera, which tracks the location of boxes, obstacles, and goals, and the Flockbots themselves, which push boxes and use QR codes for localization.

### *Sequence Motif RNA Classifier*

The RNA Classification project is a project that started at the beginning of the Summer of 2013 with a hiatus in the Fall semester and concluding at the end of the Spring semester. This project's goal was to accurately classify RNA strings with the limited resources available to me. To compare RNA strings I broke them down into sequence motifs with which I could actually compare different RNA strings even when they were different lengths. Most of the project was finding effective ways of storing the sequence motifs in order to save the most important information while still maintaining high accuracy classifying RNA strings. It was a constant challenge balancing between memory, performance, and accuracy classifying.

### *Autonomous Pick and Place Behavior with a Robotic Manipulator*

Investigation and implementation of a method to perform pick and place behavior using a redundant robotic manipulator. The process involved researching methods for mathematical modeling, kinematics formula derivation, motion planning, system design, and hardware/software communication. A simulator was created to represent the physical environment where a collision-free path was found and sent via serial to a microcontroller which managed the hardware.

### *Man-In-The-Middle Attack on a Web Server with HTTPS*

My project involves implementing a Man-In-The-Middle attack on a web server with HTTPS. This differentiates itself from a standard MITM in that it is performed on a web server with a secure encrypted connection. This encryption makes active eavesdropping impossible unless you can circumvent or crack the encryption to listen in on the unencrypted traffic. The goal of my project is precisely that, to establish a MITM attack between a victim viewing a website through a web browser using an HTTPS connection with a website. The method used to sidestep SSL is called SSL stripping. SSL stripping involves parsing the payloads relayed between the victim and server stripping and reattaching secure links. This keeps the connection between the attacker and server encrypted, but the connection between the attacker and victim unencrypted. This project was implemented on a local area network with both the server, attacker, and victim on the same network. Although the server doesn't have to be on the same network, just the victim and attacker.

## *Indoor Location Applications*

With the ubiquitous computing concept arose from the need for more easily interacting with the computer by user in normal life, the wearable computers have received much attention. Google Glass, a wearable computer with an optical head-mounted display (OHMD) developed by Google, is one of the high-profile devices. Professor Jana <Kosecka> and I recently get the Google Glass; I decided to use the basic functions of the Android smart Phone and Google Glass to develop the applications to locate our indoor position by reading the QR Code.

## *Exploring deeper security through a browser extension*

Modern web applications often require users to trust them with their information. PGP uses a style of encryption which circumvents the need to trust a web-service; before routing a piece of information through an untrusted server, PGP encrypts it such that only the intended recipients are capable of decrypting it. This project explores the possibility of incorporating PGP-style encryption into general web- applications. It implements a Google Chrome extension which allows certain HTML elements to be flagged as “encrypted” so they can be securely decrypted and displayed for the user. And inversely, it allows a user to encrypt text inputted into HTML form elements in the manner of PGP.

## *Event Services Portal*

The Event Services Portal is a web application to solve a problem in the event industry related to information sharing. The event industry suffers from a lack of coordination when relaying information. The primary cause is the lack of a devoted software application for the event industry. There are many software applications that address problems that are faced in the event industry, however the use of multiple systems can cause more inaccurate or lost information when sharing between clients, departments, and companies. The Event Services Portal solves the information sharing problem, and is a platform for creating new features geared towards analyzing all data harnessed by one system. The web application is written in Groovy utilizing the Grails framework.

## SPRING 2015 PROJECTS

### *Improving the Vision and Localization System of a DarwinOP for RoboCup Competition*

At this years RoboCup competition rule changes have been put into effect which make color-based methods of object detection impractical. The lines on the field, the goal posts, and the soccer ball are all white in this year's rule set which presents the problem of distinguishing these items which are critical to the game. This project's objective is to identify the goalposts and balls of arbitrary color on a soccer field. To achieve this objective we will be using existing algorithms such as flood fills, Hough transforms, and linear regressions in an attempt to remove the dependence on color as the method for identification of an object. Once objects have been identified object state information, such as positions and heights in the global frame, will be passed into the probabilistic reasoning system enabling the robots to localize themselves on the soccer field.

### *Exploring Programmable Gaming Engines*

Game designer Shigeru Miyamoto (famous for creating many beloved Nintendo characters) often looks to his childhood and hobbies he enjoys when searching for inspiration to design a new game. I have often considered what it would be like to combine the concept of something I enjoy with gaming software as well. Programming is an activity that I believe is quite a fun and expressive activity for myself and many others, and the addition of user- accessible programming interfaces in game software has the potential to add an interesting layer of depth on top of traditional gaming mechanics. So for this project I have explored adding elements of programming into a game.

### *Network Management System*

Simple Network Management Protocol is a basic protocol used to obtain network data of a network device, and manage network devices. In previous research, SNMP is used along with support vector machine (SVM) or other classification tools such as decision making tree in detecting ARP spoofing, an old yet effective man-in-the-middle attack. In this paper, I develop a network management system with the help of SNMP, monitoring the network devices in a Local Area Network (LAN), finding out an alternative way to detect ARP spoofing. Key words: SNMP, ARP spoofing, LAN

### *Developing Direct DarwinOP Motion Controls for RoboCup*

This project's objective is to create and tune motion sets for the DarwinOP to provide better stability on an artificial turf soccer field and to provide new motions for the robot to perform. The new motions will be achieved using preexisting software created for development of the DarwinOP. Additionally, the current motion control system will be restructured to provide more direct control of the DarwinOP's motion by higher level behaviors. This will allow the custom motion sets to be called upon, giving the robot access to a greater range of movement during the RoboCup competition.

## *GPGPU Accelerated Fractal Image Compression: Addressing Computational Complexity with a Massively Parallel Solution*

Fractal image compression has the potential to revolutionize image compression by providing superior image quality and compression ratios for large complex images. Actual adoption of fractal image compression technology has been nearly non-existent however due an open problem in finding optimal or even visually acceptable encoding algorithms. Finding an optimal solution to the encoding problem remains a problem due to the sheer variety of possible transformations that exist to store fractal information. Such a problem is well suited to the high level of parallelism present on modern GPGPUs. This paper seeks to examine the use of a GPGPU driven solution to fractal image encoding.

## *Developing a Computational Pipeline for Metagenomic State Classification with Feature Engineering*

Microbes exist everywhere on earth, from the most extreme environments to the human body, where they outnumber human cells 10 to 1. Metagenomics is the process of determining microbial genomes by directly sampling from co-existing microbial communities. This process has the potential to yield a lot of extremely important information on the microbes and how they affect their environmental or human host. However, metagenomic sampling also results in massive amounts of data that needs to be traversed and understood using bioinformatics techniques. One such process involves the use of machine learning techniques to parse metagenomic data and determine the state of the sample. For instance, we might want to determine whether or not a person has a given disease based on metagenomic samples gathered from the patient. In this work, we develop a computational pipeline that allows for the classification of metagenomic data into clinical phenotypic states or environmental states. Specifically, we evaluate the use of different state-of-the-art clustering techniques for generating features from obtained metagenomic sequence data. Using the generated features, a classifier is developed using support vector machines. We also engineer the features that result from the clustering algorithms to improve the performance of the classifier. As part of this project, we attempt to maximize and assess the success of the feature engineering process and compare the success of each different clustering algorithm that is tested.

## *Contact Grabber: An Android Based Information Acquisition and Analysis System*

This project involves the creation of an Android application to gather contact information from android devices, a PHP database system to store and retrieve contacts, and a JavaScript/HTML5 webpage to display the contact connections graphically and analyze them based on their connections. Through this, this project attempts to quantify the privacy risks from leaking contact and related information from mobile devices and to show to the utility of the generation of a large dataset of contacts for analytic study. The data this project is concerned with is contact and personal information which can be obtained from Android devices. As a result of this research, a system was successfully built to collect contact information, store it, analyze it, and display it to the user. All assessment specifications were met, with preliminary results from the generated set. From these results and the generated dataset, the project was able to show that not only a user's privacy, but the privacy of their associates can be put greatly at risk. Further, we can tentatively conclude that having a dataset of contact information and known associations provides useful information about a user, but experiments on a larger dataset are needed to confirm this assertion.

## *Unsupervised academic curricula evaluation through topic modeling*

Identifying the concepts covered in a university course based on a high level description is a necessary step in the evaluation of a university's program of study. To this end, data describing university courses is readily available on the Internet in vast quantities. However, understanding natural language course descriptions requires manual inspection and, often, implicit knowledge of the subject area. Additionally, a holistic approach to curricular evaluation involves analysis of the prerequisite structure within a department, specifically the conceptual overlap between courses in a prerequisite chain. In this work we apply existing topic modeling techniques to sets of course descriptions extracted from publicly available university course catalogs. The inferred topic models correspond to concepts taught in the described courses. The inference process is unsupervised and generates topics without the need for manual inspection. We present an application framework for data ingestion and processing, along with a user-facing web-based application for inferred topic presentation. The software provides tools to view the inferred topics for a university's courses, quickly compare departments by their topic composition, and visually analyze conceptual overlap in departmental prerequisite structures.

## *OpenClick: An Open Source Clicker Implementation*

The question we asked ourselves was if we could create a system that rivaled other interactive classroom quizzing systems such as iclicker and Top Hat Monocle. Our implementation would need to be free, accessible, customizable, and benefit the student more so than the other systems. The benefits aim to include promoting positive interaction between the students and the classroom, increase the amount of learning done by keeping the students attention focused on the work, and by not costing them a penny. What we ultimately landed on was the idea of OpenClick. The aim of OpenClick is to provide teachers and students with an easily accessible and usable way of live classroom quizzing at an extremely low cost. OpenClick is completely open source and customizable to the teacher, student, or institution. By being customizable, this would allow for a greater variety of question types including multiple choice, short answer, true and false, essay, and more. The benefits of having a larger variety of question types compared to other implementations would ultimately allow for more feedback to be given to the students from the teachers, resulting in more engagement and increased learning. The following pages will detail our thought process on how to go about creating OpenClick, the problems we faced, how we overcame these specific problems, and the results and conclusion of our efforts.