**RoboWars**

**Project Proposal**

**SYSC 4907  
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Project #34  
  
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Supervised by Cheryl Schramm**

# 1 – Introduction

This document is a proposal for the RoboWars fourth year engineering project. The project team consists of Alexander Craig, Alexander Dinardo, Steve Legere, and Mike Wright. The proposed project would be supervised by Cheryl Schramm and development would run from September 2010 to March 2011.

# 2 - Project Objectives

The RoboWars project has two primary objectives:

* The first project objective is to develop a robotics control system which is both intuitive to use and is implemented on a mobile platform that is widely available and used by the public. Specifically, the project targets mobile smartphones running the Android operating system as the client platform.
* The second project objective is to experiment with the combination of live video and virtually generated, overlaid imagery to enhance the ease of use and feature set of a robotics control system. This technology is commonly referred to as augmented reality.

To combine these objectives, the project aims to create a system which allows two remotely controlled robots to share and interact with a simple virtual world which will be rendered on to a live video feed and displayed to the remote operators. Users can connect to the system from smartphones anywhere where an internet connection is available, and use the robots to play simple virtual games supported by augmented reality overlays.

# 3 – Motivation and Background

## 3.1 – Android Operating System

Android is an operating system designed for use in mobile phones. It is developed by Google and the Open Handset Alliance, which is a consortium of companies whose purpose was to create open standards for mobile devices. Android saw its first public release on October 21st 2008. The OS is built upon GNU and the Linux Kernel. Android is an open-source platform with a wide and varied developer community. Android is packaged with numerous third party libraries which facilitate the rapid development of a wide variety of applications. In addition to the Java standard libraries, Android provides access to C libraries such as the GNU C library, SQLite, OpenGL ES 2.0, SGL graphics engine, OpenCore media framework, and SSL.

Android currently occupies the largest share of the mobile phone OS market, at 33 percent of all smartphone OS handsets in second quarter of 2010, followed by Blackberry OS and Apple’s iOS in third.

## 3.2 – Augmented Reality

Augmented reality was defined simply by Ronald Azuma in 1997 as a system which combines the real and the virtual interactively in real time, and uses imagery rendered in three dimensions. One way this is implemented is through live video feeds where computer generated graphics overlaid upon the video stream can give the viewer a clearer interpretation of the information that the broadcaster is trying to convey. A specific example of this would be in live sports broadcasts, where a line would be rendered on video which clearly denotes a line of scrimmage, or a 1st down, as in the case with football. Graphics can also be overlaid on what a person is actually seeing in front of them in real time, not just on a captured video stream. An example of that would be a heads up display in a fighter jet, which is integrated right in the windshield. Augmented reality can be a useful tool for someone to visually convey meaningful information to a user where a plain video feed would not be so meaningful or clear.

## 3.3 – Benefits and Potential Applications

Developing a robotics control system on a widely available mobile platform provides developers with greater accessibility and reduced development time. Using smartphones to remotely control devices, robotic or not, eliminates the need for extra time and development resources to be spent on designing and building a specialised hardware platform to run the control software on. Also, with smartphones already in widespread use by the public, it is simple and intuitive for a user to download, install, and immediately use the application to remotely control their device. This provides developers with a well established and easily accessible customer base.

When augmented reality is paired with remote control of robotics several interesting applications come to light. In any environment where human senses would be inadequate to determine threat or hazard, augmented reality can serve as a very effective interpreter between sophisticated robotic sensors and human eyes. An example of such a case would be bomb disposal robotics using specialised sensory equipment to detect sounds, odours, or image recognition to detect the threat of an explosive device. Augmented reality can aid in this practice by generating easily understood computer graphics in the video stream to the controller. Augmented reality also provides an effective and easily understood medium to display calculated or simulated information to a human operator.

# 4 – Technical Overview

The proposed system consists of three major components:

* Two wireless robots which will be remotely controlled and used in the virtually simulated games. The project is currently targeting Lego Mindstorm NXT 2.0 robots as these are effective budget kits which support wireless Bluetooth communication.
* A server that manages the virtual world simulation and live video feed which overlooks the robots. A suitable camera will need to be purchased, but the server software can run on a standard lab computer (such as those in AA507 or AA508).
* A mobile client implemented on the Android OS to allow any Android smartphone to connect to the server and remotely control the robots.

To implement remote operation both the robots and the Android client will connect to the central server. The robots will connect through a Bluetooth connection and therefore the robots must be physically located near to the central server (within about 10 meters). The Android client will connect to the server through standard internet protocols allowing any remote user to access the robotics control system. Once a user connects to the server and is paired to a robot, any commands from the user will be sent to the server, and propagated to the paired robot through the Bluetooth connection. Each robot will independently track their positions and notify the server of their current position whenever movement occurs.

Basic robot movement control will use the smartphone’s gyroscope and to provide a tilt based control system. Additional controls will be implemented primarily through the touch screen of the mobile smartphone.

Simple virtual world simulation will occur on the central server of the system. The server will track the positions of the robots at all times and use this information to include the robots as objects in simple virtual games. When appropriate, the server will send additional commands to the robots (such as lighting an LED or playing a sound) independent of the actions of the remote user to simulate events occurring in the virtual game.

Augmented reality overlays will be implemented through a camera connected to the server which overlooks the entire “arena” occupied by the robots. Although wireless cameras mounted on the robots would be ideal this approach is limited by budget concerns (especially since Bluetooth provides insufficient bandwidth for a live video steam). The central server will be responsible for receiving the live video feed from the camera and re-streaming the video feed to the remote clients. Either the server or the mobile client (depending on observed performance) will render additional game play elements using OpenGL on top of the received video feed, and this final combination will be viewed by the user when controlling the robots. Game play elements would include simple three dimensional items such as a ball for a soccer game mode, or projectiles in a tank simulation game mode. An entirely simulated first person view (showing only game play elements) will be provided using the OpenGL support of the mobile client.

# 5 – Development Process

To develop the system an incremental phased development lifecycle will be used. Requirements analysis and the bulk of the design work will occur in a design phase before implementation begins. Implementation of the system will occur in three distinct phases, each of which is followed by a round of integration of various components and rigorous testing before the next phase begins. To further complement the testing component unit testing will be employed during all stages of development. This method was selected because the project is self driven with little in the way of an external client, and therefore it is unlikely that significant requirements changes will occur midway through development. The proposed process ensures that testing is integrated into development at all stages of the process, and the incremental approach allows for flexibility when implementation issues arise. For more details please see the schedule outlined in appendix A.

# 6 - Required Equipment

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| **Equipment** | **Quantity** | **Price** | **Purchase Location** |
| LEGO Mindstorm NXT 2.0 Robotics Kit | 2 | (2 x $279.99 USD) + $12 Shipping = **$572 USD** | Amazon.com – International Shipping |
| D-Link DBT-120 (Mindstorm compatible Bluetooth dongle) | 1 | $23 USD + $2 Shipping = **$25 USD** | Amazon.com – International Shipping |
| HTC Desire Android Smartphone | 2 | Privately funded | Telus |
| Logitech Quickcam Pro 9000 | 1 | $82 CAD + $10 Shipping = **$92 CAD** | Newegg.ca |
| **Total Cost:** | | **$706 CAD** (at current exchange rate of 1 USD = 1.028 CAD) | |

Appendix A  
Development Schedule



Note: Phase 2 work is padded with an extra two weeks to account for delays due to exams and Christmas holidays.