# RoboCup Soccer Undergraduate Research Team

## Introduction

The summer project presented here is designed to establish the foundations for an exciting long-term research program in the computer science and engineering department that would engage undergraduates in some of the major research areas in robotics and artificial intelligence, while also providing a platform for original scholarly work for professors in the CSE department. I propose to create a UMHB team in the RoboCup Soccer Simulation league, a virtual environment for developing strategies, algorithms and control systems that enable robots to play soccer. The primary outcome of UMHB's participation in this league will be a unique undergraduate research experience that will inspire learning and teaching opportunities in a wide range of fields including robot control, image recognition, remote sensing and artificial intelligence.

## Project Description

The RoboCup Soccer Simulator[1] is a research and educational tool for multi-agent systems and artificial intelligence. It enables for two teams of 11 simulated autonomous robotic players to play soccer in a virtual environment. Without the necessity to maintain any robot hardware, the RoboCup Simulation League's focus comprises artificial intelligence and team strategy, with minimal required resources.

In the 2D Simulation League, two teams of eleven autonomous software programs (called agents) each play soccer in a two-dimensional soccer stadium represented by a central server, called SoccerServer. This server knows everything about the game, i.e. the current position of all players and the ball, the physics and so on. The game further relies on the communication between the server and each agent. Each player receives relative and noisy input of his virtual sensors (visual, acoustic and physical) and may perform some basic commands (like dashing, turning or kicking) in order to influence its environment. The big challenge in the Simulation League is to conclude from all possible world states (derived from the sensor input by calculating a sight on the world as absolute and noise-free as possible) to the best possible action to execute.

This system is a simplified analogy to many complex engineering problems. The determination of precise agent locations is a topic of great research effort in satellite control. The autonomous processing of sensor data into agent commands receives a great deal of attention in the defense community with applications in unmanned flying vehicles and "smart" vehicles of all other sorts.

My most recent research effort prior to joining the faculty of UMHB was the filtering of sensor data into position estimates and control commands in the missile interception scenario.[2] A successful implementation of the RoboCup team will enable an expansion of the research effort onto this platform and the production of original scholarly work, although this will not be completed in the summer time-frame.

The main project outcome will be the foundation for an ongoing research team to investigate rigorous solutions for the control of the Soccer-bots. This undergraduate team will gain unique experience in contemporary issues. For this project, I am requesting a $3,000 student stipend to aid in the development and serve as a student leader in the full research group.

## Research Tasks

The following tasks will be undertaken in the summer project, and are detailed below:

1. Install RoboCup server and client software on computers in the CSE lab.
2. Work with an undergraduate to diagram the flow of the control software, including inputs and outputs.
3. Create algorithms for the control of the agents based on heuristic strategies.
4. Develop algorithms to filter sensor data into ball and agent locations.

The first task will be to install the server and client software and set up the networking necessary for game simulations in the CSE lab. The software for this project is open source and available at no cost for academic use. The games are simulated by creating a host computer that runs server software, and the individual players (11 to a side) are agents that are running on separate machines. This network will be created on existing computers in the CSE lab, with no additional hardware requirements.

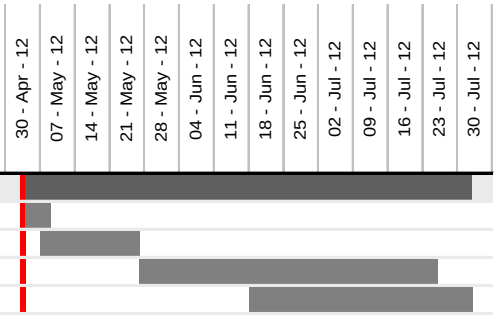
The second task will be to develop a diagram of the control software for the soccer-bots. The diagram will define how the inputs to the control software (sensor data, robot positions, etc.) will be transformed into commands to the agents. This process establishes the "flow" of the control and defines the control "blocks" that will need to be developed to achieve a running simulation. Examples of these blocks would be routines to take sensor data and determine the ball location, or a separate routine that would kick or pass commands based on the game situation.

The third task will be to implement strategies in each of the control blocks so that by the end of the summer we will have a functional simulation. With contributions from an undergraduate engineering and computer science student, we will create a basic control strategy for the individual players that will serve as the base for future research efforts. These strategies will be researched by the undergraduate team member, and decisions on implementation will be shared among the two of us.

The final task of this summer project will be to implement some of the routines from my previous research efforts into the problem of ball location. This task will eventually lead to original work that may later be published in technical journals or conferences.

## Schedule

| Tasks | Start | End | Duration (Days) | Working Days |
|---|---|---|---|---|
| **Summer Research** | 5/04/12 | 8/01/12 | 90 | 64 |
| Install Software | 5/04/12 | 5/08/12 | 5 | 3 |
| Diagram Control | 5/07/12 | 5/26/12 | 20 | 15 |
| Create Algorithms | 5/27/12 | 7/25/12 | 60 | 43 |
| Ball Postion Routine | 6/18/12 | 8/01/12 | 45 | 33 |




[1] http://wiki.robocup.org/wiki/Soccer_Simulation_League

[2] Paul R Griesemer, Joseph A Mueller, Michael A Paluszek, "Simulation Tool for the Missile-to-Missile Interception Scenario", MDA-SBIR Final Report, May 01, 2011.