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| School of Computing  Faculty of Engineering |

Control System (AI) for Wrestling Robot

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Submitted in accordance with the requirements for the degree of  
MSc Advanced Computer Science (AI)

**Session 2019/2020**

The candidate confirms that the following have been submitted*:*

*<As an example>*

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| **Items** | **Format** | **Recipient(s) and Date** |
| *Deliverables 1* | *Report* | *SSO (xx/xx/xx)* |
| *Deliverables 2* | *Code and URL* | *SSO (xx/xx/xx)* |
| *Deliverable 3* | *Youtube video URL* | *Supervisor, assessor (xx/xx/xx)* |
| *Deliverable 5* | *User manuals* | *Client, supervisor (xx/xx/xx)* |

Type of Project: Exploratory Software

The candidate confirms that the work submitted is their own and the appropriate credit has been given where reference has been made to the work of others.

I understand that failure to attribute material which is obtained from another source may be considered as plagiarism.

(Signature of student)

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# Summary

*<Concise statement of the problem you intended to solve and main achievements (no more than one A4 page)>*

***<Reminder about basic requirements of layout and format:***

***The report must be in typescript, sequentially page numbered, on A4, single or double-sided, with 1in margins. Point size 11 and one-and-a-half line spacing should be used.***

***Page Numbering: The pages preceding the body of the text, i.e. from "Summary" to "Contents" inclusive, should be sequentially numbered in Roman numerals. All the remaining pages should be numbered in a single sequence of Arabic numerals.***

***Length: The main body of a 60 credit project report must be no longer than 60 pages (i.e. excluding appendices and references). The limit for 40-credit projects is 50 pages.>***

# Acknowledgements

*<This page should contain any acknowledgements to those who have assisted with your work. Where you have worked as part of a team, you should, where appropriate, reference to any contribution made by others to the project.*

*Note that it is not acceptable to solicit assistance on ‘proof reading’ which is defined as “the systematic checking and identification of errors in spelling, punctuation, grammar and sentence construction, formatting and layout in the text”; see* [*http://www.leeds.ac.uk/qat/documents/policy/Proof-reading-policy.pdf*](http://www.leeds.ac.uk/qat/documents/policy/Proof-reading-policy.pdf)*. >*

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BEAST Bio-inspired Evolutionary Agent Simulation Toolkit

# Chapter 1 Introduction

## Project Aim

The aim of this project is to design a fine robot high-level control system, which is the ‘brain’ of the Zumo robot. The control system would have it’s own strategy, and drive the robot’s movement during the competition. As for the strategy, it can be assigned with specific movement in different cases or the robot can develop it’s own strategies, which may related to evolutionary algorithm. And this will be discussed later in the report.

The main goal of this project is to make the Zumo robot be competitive and perform well in the Sumo robot competition. In addition, this project will find out if the idea of control system can be applied to a wider range of different robot, such as other robot competition or the robot service in daily life.

Sumo robot league is a very popular international robot wrestling competition, which is two robots attempt to push each other out of the ring. The last stand robot in the ring is the winner.

This project is going to use the Zumo 32U4 robot, which is a complete, versatile robot controlled by an Arduino-compatible Atmega32U4 microcontroller. Therefore, extra hardware structure and improvement is not considered in the project. The Zumo robot has two motors, one Atmega32U4 chip as the brain and a variety of sensors, including proximity sensors, line sensors and accelerometer. So the Zumo robot can detect the opponent and run towards or away from it, which satisfy every requirement of a robot in the Sumo league.



Figure 1.1: Main features of the Zumo 32U4 robot

### Objectives:

* To get familiar with the hardware functions of Zumo robot.
* Conduct a theory study to compare different control system in the wrestling case.
* Implement two or more different control system and compare it’s advantages and disadvantages.
* Create wrestling simulation environment. (Due to the lockdown policy, it’s hard to find the opponent in the real world)
* Evaluate the results with it’s performance in different simulation cases.

#### Deliverables

1. A software product that can simulate the Sumo robot wrestling. Built using BEAST.
2. A Github repository that contains the source code of the system.
3. A developer documentation that provides:

* An overview of the simulation, algorithm used, programming languages and style.
* Instructions for setting up the project in a local development environment. (Provide VM for Mac or Windows user)

1. The MSc project report.

#### Ethical, legal, and social issues

No Ethical, legal and social issues related to this project.

# Chapter 2 Background Research

## 2.1 Literature Survey

There are pretty much studies in Sumo robot control, and even more research on the general intelligence control system. And there are also different aspects of these project. Some are fucus on the low-level development, some are meant to design the hardware or the construction of the Sumo robot. And this project is going to focus on the high-level design.

One study is to develop the Neuro-Fuzzy (NF) hybrid system as the control system (Hamit, 2011). In other word, it use two system, which is ANN and Fuzzy Inference System (FIS). FIS is for detecting and tracking the opponent, which relates sensor output (IR sensor) to motor control pulses. ANN is used for rule extraction and tuning the FIS parameters. And the result shows that this control system can improve the robot responses during competition. This is a good thought to develop a good control system. It’s pettery much the low-level development. It’s just like human work out to improve physical strength, but I would focus on the brain development. However, the wrestling environment is uncertain and the data is non-linear. Thus, the method that using ANN to improve the fuzzy control is a good thought for high-level control as well.

Simularly, many other papers use the same fuzzy idea. For example, a project used fuzzy logical control, it use three IR sharp sensors for target detection. Then the fuzzy controller fuses the sensor data and provide the control signal to the motor for driving the robot toward the opponent (Erlan et al., 2013).

# List of References

Erdem, H. 2011. Application of Neuro-Fuzzy Controller for Sumo Robot control. *Expert Systems with Applications*. **38**(8), pp.9752–9760.

‌ Erlan, C., Lima, O., Almeida De Araújo, F., Bibiano Da, M., Júnior, S., Edson, A., Filho, R., De Andrade, R., Rabêlo, L., Allisson, T., Da Silva, R., Jose, A. and Alves, O. 2013. *An Enhancement in Conventional Potential Field Using a Fuzzy System for Navigation of a Sumo Robot*.

# Appendix A External Materials

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# Appendix B Ethical Issues Addressed

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