UNIVERSITI TEKNOLOGI MARA

A MODEL-BASED APPROACH FOR STRATEGY PLANNING OF COLLABORATIVE HUMANOID SOCCER ROBOT

NORHELIENA BINTI AZIZ

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any other degree or qualification.

I, hereby, acknowledge that I have complied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

Name of Student	:	Norheliena binti Aziz
Student I.D. No.	:	2011890268
Programme	:	Masters of Science (EM 780)
Faculty	:	Mechanical Engineering
Thesis Title	:	A Model-Based Approach for Strategy Planning of Collaborative Humanoid Soccer Robot
Signature of Student	:	.....
Date	:	August 2015

ABSTRACT

Collaborative multi-robot system has drawn a great attention in the past decades. With recent advances in hardware and software, such system has become more versatile and applicable in various fields. One of the best research platforms for research in multi robot system is robotic soccer and the most known event promoting robotic soccer is RoboCup. In RoboCup, Standard Platform League (SPL) requires all participants to use the same hardware which is NAO humanoid robot with no modification allowed. Therefore, winning chance is fully depended on the software development of the team. Many teams have developed a more or less operative system with locomotion and image processing capabilities. However, most of the teams still do not take the advantage of collaboration between players. Because of the increasing size of teams, team coordination will be the distinctive factor in the success of a team in the coming years. In order to design a system with good coordination, it requires operation robustness, behavior optimality under dynamic environments, and agility in order to response to any changes. The development of such system is a challenge, especially during the conceptual design phase. Therefore, the aim of this study is to presents a model-based approach for strategy planning of humanoid soccer robot team based on a principal solution which defines the coordination concepts for the collaborative robotic soccer players. The principal solution is the foundation of the first analysis, verification and validation on the system level. In order to construct the requirements of such system, a specification technique is designed in order to describe the principal solution. Therefore, all the aspects needed has been identified such functions, environments, active structure, behavior and application scenarios. These aspects are represented by partial models which related to each other, thus creating a principal solution. To ensure effective communication during the process, a specification technique called "Conceptual Design Specification Technique for the Engineering of Complex Systems (CONSENS) has been applied. By using this method, a strategy for collaborative humanoid robot soccer has been proposed. Such model provides a lucid interface and also facilitates the development process whether for simulation or field test. Furthermore, it was designed to ease any modification since the structure has been organized into several parts.

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CHAPTER ONE
INTRODUCTION

1.1 RESEARCH BACKGROUND

Research on collaborative multi-robot systems has drawn a great attention in the recent decades. Before 1990's, research on robotics mainly focused on designing of single robot that are capable to handle given tasks successfully. Even though there are some industries using multiple robots, they were pre-programmed with certain task without any sense of intelligence. Then, inspired by behaviour of insect community, spark the bloom of research in multiple robot system and distributed artificial intelligence. Since then, research on multi robot system expanded rapidly, especially through RoboCup events which attract various fields of robotics and Artificial Intelligence (AI) researchers. These kinds of systems will play an important role in the near future as the fact that a number of practical tasks cannot be effectively accomplished by single-robot systems. Research in robotic soccer is complex and interdisciplinary, however the results of this research can be applied to numerous applications and fields such as mechatronics, robotics and artificial intelligence. Furthermore, this kind of system is very useful especially in search and rescue field where the need of autonomous robot system is crucial.

The RoboCup Standard Platform League (SPL) [1] as shown in Figure 1.1 provides a platform for advancing the development of collaborative humanoid soccer robots. In the SPL, it is interesting to observe how a humanoid soccer robot can shoot, pass, dribble, localize, and search a ball. With new functionalities of software and hardware, they are becoming more versatile, robust and agile in response to the changes in the environment under dynamic conditions. Particularly, researches have been trying to improve the coordination of the team. For example, a coordination model using fuzzy reinforcement learning [2], cooperative behaviors through implicit communication [3], emergent cooperative behaviors [4], coordination via communication [5], and coordination through role distribution [6-7] have been introduced.