UNIVERSITI TEKNOLOGI MARA

MODEL VERIFICATION IN FORAGING BEHAVIOR OF SWARM ROBOTICS USING SPIN MODEL CHECKER

NUR ATIQAH BINTI IBRAHIM

Dissertation submitted in fulfillment
of the requirements for the degree of
Master of Science in Computer Networking

Faculty of Computer and Mathematical Sciences

July 2015

ACKNOWLEDGEMENT

By the name of ALLAH, the Most Gracious and Most Merciful

First of all, I would like to express my gratitude to the all mighty, ALLAH S.W.T for the blessing, my parents and family members for their priceless support, encouragement, constant love, valuable advices and their understanding in completing this project. I also would like to extend my hearties gratitude to Encik Kamarul Ariffin Bin Abdul Basit, my respected supervisors for his guidance, knowledge, support, advices, experience and feedback throughout the process of completing this project. I also would like to thanks to my dissertation coordinator, Dr. Nor Shahniza Binti Kamal Bashah in always assisting on the writing of this dissertation report. Their kindness, valuable advice and useful feedback are really important and have contributed signifantly towards my research work.

Last but not least, a token of appreciation to all my colleagues for all the supports and cooperation during the development of this project. The support and assistance given from all parties involved in this project is highly appreciated. I sincerely would like to apologize for any unintentional mistakes throughout the completion of this project.

ABSTRACT

Swarm robotics systems normally consist of many homogeneous robots that operate autonomously without a global controller. It is inspired by swarms of insects cooperating to deliver food items that a single individual cannot move. An example of foraging behavior is in ant colonies that represent of how complex group behavior can arise from simple individuals. In the aspect of industrial and scientific settings, collaboration between robots and humans is crucial and increasingly as a compliment to human nowadays. Therefore, it is very significant for developing of robots in the industry development of robot helpers for more general use such as in the workplace, at home, and in health-care environments. However, before such robots can be fully utilized, a comprehensive analysis of their safety is necessary to check their deadlock and any violations occurred. Unfortunately, in real environment, these processes or activities have not been verified using model checker approach. Some researchers have studied and come out with the model based on PFSM of foraging behavior of swarm robotics. In short, their proposed process, activities or states model did not undergo a rigorous analysis based on model checking technique, hence the results could subject to failure or malfunction. Therefore, we have used formal verification in which one can verify the system and automatically checks whether a model meets its given specification. In this research, we apply a swarm robotics in food foraging problem in order to carry out the foraging task. The aim is to model foraging behavior in PROMELA code in order to verify their correctness properties in term of their safety by using SPIN model checker to avoid counterexample. The result of model checking then has been extended in order to be able to detect violations that occur in the model and also verify it by using assertion and never claim correctness properties. According to the result, it has been proved that SPIN model checker can be used to check the deadlock, counterexample and any violations occurred in the system in term of their safety and trustworthy. Hence, it is useful for software engineers to solve the problem the failure of software or malfunction in the system.

TABLE OF CONTENTS

CHAPTER 1
INTRODUCTION

1.0 Introduction

This chapter explains the overview of the research work starting from the background of the research. The problem statement discusses on some safety properties and how the system will be verified in term of their correctness properties. The objectives were extracted from the problem statement also been discussed. In addition, the scope of the research, significance of the research and the organization of research also explained in this chapter.

1.1 Background of Research

Swarm robotics is a new approach to the coordination of multi-robot systems which consist of large numbers of usually consists of simple physical robots. It is an interesting alternative to classical approaches to robotics because of some properties of problem-solving by social animals, which is flexible, robust, decentralized and self-organized (Jevtić, Gazi, Andina, & Jamshidi, 2010). It is a scientific discipline that emerged during the 90's and the intersection between two researches areas which are swarm intelligence and collective. From collective robotics, its main goal is to design control algorithms to coordinate the activity of a few of robots simultaneously. In an ideal world, this coordination should lead to the achievement of a global task that robot could not perform alone individually, at least in a given amount of time. In term of swarm intelligence perspective, swarm robotics gets the coordination principles that can serve as a basis to design the algorithms as stated above. These principles highlight local communications, distributed control and self-organization to generate collective behaviors that can be very complex, or solve problems that are far beyond the cognitive abilities of the single robots (Garnier, 2011). Swarm robotic systems typically comprise many homogeneous robots that operate autonomously without a global controller. Swarm