
# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## DEVELOPMENT OF PLC BASED NAVIGATION SYSTEM FOR MOBILE ROBOT

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Robotics and Automation) (Hons.)

by

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2014

# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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TAJUK: Development of a PLC Based Navigation System for Mobile Robot

SESI PENGAJIAN: 2013/14 Semester 2

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# APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotics and Automation) (Hons). The member of the supervisory committee is as follow:

…….

(Dr. Fairul Azni bin Jafar)

# ABSTRAK

Sebuah mesin yang diprogramkan digelar robot mudah alih mempunyai kemahiran bergerak dalam mana-mana persekitaran yang ditetapkan. Robot mudah alih juga tidak tetap kepada satu lokasi fizikal seperti robot industri yang biasa. Kebanyakan robot mudah alih yang dicipta sebelum ini menggunakan sistem kawalan PID dan Fuzzy untuk mengawal pergerakan mereka. Walaupun PID dikenali sebagai sistem kawalan yang terbaik untuk robot mudah alih, kesukaran menggunakannya serta menulis program di dalamnya membawa perhatian untuk mengkaji system kawalan yang lebih mudah seperti PLC.

Lebih-lebih lagi, masih kurang robot mudah alih yang bergerak dengan menggunakan PLC sebagai kawalan sistem dan ia tidak mustahil untuk mencipta robot mudah alih yang mudah dan fleksibel dengan aplikasi PLC sistem navigasi. Disebabkan kekurangan robot mudah alih menggunakan sistem PLC yang telah mendorong projek ini dilakukan. Oleh itu, projek ini cuba untuk memhasilkan sistem navigasi PLC untuk robot mudah alih, dan sistem algoritma serta menganalisis prestasi navigasi robot mudah alih. Semua maklumat yang diperlukan adalah mengenai robot mudah alih, sistem kawalan dan penggunaan PLC dalam system navigasi robot bergerak. Kaedah-kaedah untuk menyiapkan projek ini bermula dengan mereka bentuk pengaturcaraan dalam perisian PLC, pemasangan PLC ke dalam robot mudah alih dengan pendawaian litar lengkap dan analisis projek.

Untuk menganalisis projek, eksperimen navigasi dilakukan dengan 2 laluan yang berbeza dan setiap laluan diulang sehingga 5 kali percubaan. Hasil eksperimen akan dipersembahkan menggunakan “Line graph” untuk mengetahui keberkesanan pergerakan robot mudah alih menggunakan sistem PLC. Hasilnya menunjukkan beberapa kesilapan semasa ekxperimen tetapi ia mengeluarkan keputusan yang baik kerana robot dapat mengikuti garisan seperti yang diharapkan dengan menggunakan sistem PLC. Akhir sekali, kesimpulannya dapatan penting dalam projek ini membuktikan bahawa sistem PLC dapat digunakan sebagai garis mengikuti sistem kawalan robot bergerak.

# ABSTRACT

A programmed machine called mobile robot has a skilled of movement in any controlled environment. It has the capabilities to move around in environments and does not fixed to one physical location as categorized as fixed robot. Most of the mobile robots developed before are based on PID and fuzzy control system to control their navigation. Although PID is known as the best controller for mobile robot, the difficulties of applying the PID as well as writing the program in it bring the attention of researches to look for easier controller such as PLC.

Yet, it is still very few mobile robots which used PLC as the navigation controller and based on some reviews, it is believe that creating a simple and flexible mobile robot based on PLC navigation system is possible. This project is motivated by this situation, with a consideration to develop the types of mobile robot which is controlled by Programmable Logic Controller (PLC) because of the lack of mobile robot developed under control by PLC. For some people, PIC is very hard to be understood compared to PLC. Therefore, this project is trying to develop a PLC based navigation system for mobile robot, by developing the algorithm and analyze the performance of the mobile robot. All related works with comprised information about mobile robot, controller system and application of PLC in mobile robot navigation system are reviewed. The method to complete this project is starting with designing the program using PLC software, apply the commissioning of the PLC into the mobile robot with complete circuit wiring and analyze the project.

To analyze the project, a navigation experiment is done under 2 different paths and each path is repeated for 5 times for both experiments. The experiment results will be represented using line graph in order to know the effectiveness of the mobile robot movement using PLC system. The result shows a few errors during all experiments but it is still a good result because the mobile robot able to follow the line as expected. Lastly, as a conclusion, the significant finding in this project is proven that PLC system able to be applied as line following mobile robot control system.

# DEDICATION

Specially dedicated to my beloved parents, Saffar bin Paidin and Fatimah binti Suradi and to my supervisor, Dr.Fairul Azni bin Jafar, and all my friends who have encouraged, guided, and inspired me throughout the study process.

# ACKNOWLEDGEMENT

Bismillahirrahmanirrahim,

Alhamdulillah, thanks to Allah SWT, who with his willing giving me the opportunity to complete this Final Year Project (FYP).

Firstly, I would like to express my deepest gratitude to my project supervisor, Dr.Fairul Azni bin Jafar who had guided me to complete this project successfully. I would like to express an appreciation for his ideas, guidance, encouragement and professionally giving constant support in ensuring this project possible and run smoothly as per planning schedule.

I also truly grateful to those lecturers and staff in Faculty of Manufacturing Engineering, UTeM especially in Department if Robotics and Automation, that willing to help me in many ways. Sincerely thanks to them for their excellent corporation, supports and inspiration during this project.

Also, thanks to all my friends, those who have been contributed by supporting my work, giving ideas and help me during this project started till it is fully completed.

Last but not least, deepest thanks and appreciation to my family for giving me encouragement and for their good-natured forbearance with me during completion of this project.

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| | | |
|---|---|---|
| AGV | - | Automated Guided Vehicle |
| CPU | - | Central Processing Unit |
| DC | - | Direct Current |
| FKP | - | Fakulti Kejuruteraan Pembuatan |
| FYP | - | Final Year Project |
| LED | - | Light Emitted Diode |
| PC | - | Personal Computer |
| PIC | - | Peripheral Interface Controller |
| PID | - | Proportional-Integral-Derivative |
| PLC | - | Programmable Logic Controller |
| SFC | - | Sequential Functional Chart |
| SMS | - | Short Message Service |
| WMR | - | Wheeled Mobile Robot |
| DC | - | Direct Current |

# CHAPTER 1
# INTRODUCTION

This chapter presents the problem statement, the objectives, the scopes and the report configuration of the project entitled "Development of PLC Based Navigation System for Mobile Robot".

## 1.1 Background

A robot is an Electro-Mechanical device that can accomplish autonomous or preprogrammed tasks (Girme *et al.*, 2007). Robot may be used to achieve jobs that are too hazardous for human to implement directly or may be used to automate repetitive jobs that can be performed with more precise then human. There are fears about the growing use of robots and their part in society. Robots are accused for rising unemployment as they replace workers in some functions. Despite that robots are actually contributing more with their skills in helping human to complete much kind of jobs. In general robot can be classified into two categories which are fixed robot and mobile robot. While most of the fixed robots can be found in manufacturing environment, robot with mobility function gave a lot advantages in helping humans in environment such as agriculture land, hospital, hazardous field, household as well as manufacturing environment.

Mobile robot is defined as a programmed machine that is skilled of movement in any specified surroundings. They have capabilities to move around in their environments

and are not fixed to one physical location as categorized as fixed robot. Mobile robot can be classified by a few characteristics which are: the environment; the device or tools they used to move.

In order for mobile robot to work successfully in human living environment, they need to have skills which allow them to perform tasks similar to the human being. One of the skills which could be considered as most important for mobile robot is navigation. Navigation is ability of the robot to move in an environment. There are many types of mobile robot navigation, example like:
Manual remote, mobile robot is under control of a driver with joystick or other control devices. Example of ANATROLLER ARI-100 and ARI-50 as shown in Figure 1.1.

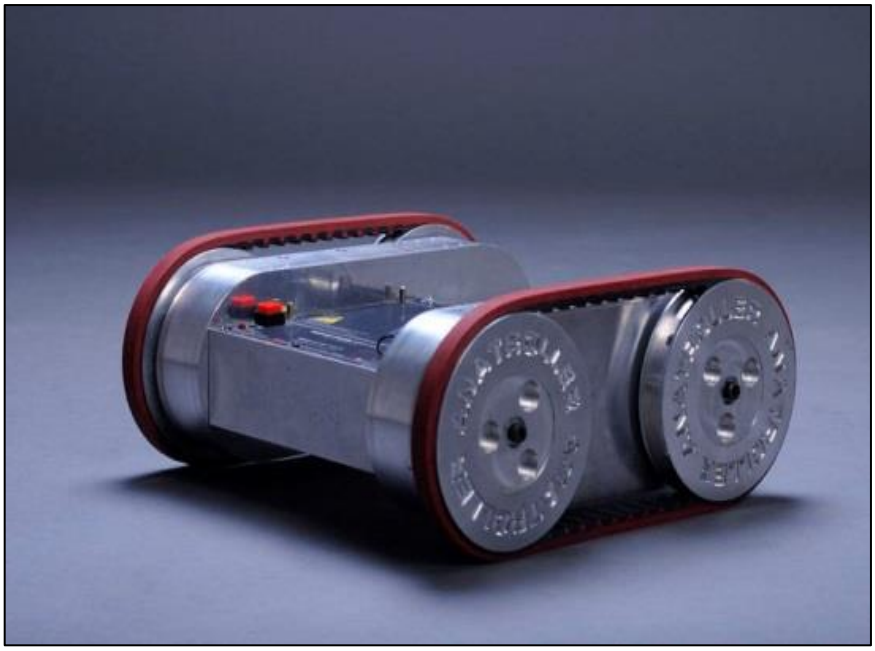

Figure 1.1: Mobile robot of ANATROLLER ARI-100.

(Source: < http://www.directindustry.com/prod/robotics-design-inc/robotic-crawlers-57161-1176337. > 22/10/13)

Line-following robots, as shown in Figure 1.2, Automated Guided Vehicles (AGVs) are the best example of mobile robot that used line following navigation system. They trail a visual line painted or embedded in the floor.

Figure 1.2 : Example of Automated Guided Vehicle.

(Source: <http://www.jbtc-agv.com/en/Solutions/Products/Forked-Automatic-Guided-Vehicles-AGVs. > 22/10/13)

Autonomous guided robot, the robot knows at least some information about where it is and how to reach various goals.

## 1.2 Motivation

For centuries, the revolution in technology undoubtedly is the robot. Starting from dream of a man to be free of the drudgery of manual labor using automatic device until currently in 21st century where robot has been applied to almost all types of labor industries. Every day a growth of robot can be seen with increasing human like capabilities, such as recognizing objects and moving around independent of human control (Girme *et al.*, 2007). Furthermore, there has been much interest on achieving educational and research goals by the use of mobile robots (Greenwald and Kopena, 2003). Thus, a low cost robot platform is commonly used and frequently controlled by some kind of microcontrollers PC with interface cards together with the growth of mobile robot. There are less mobile robots with industrial based system being

developed. Thus, it motivates to do a project in developing the types of mobile robot with a controller of Programmable Logic Controller (PLC).

## 1.3 Problem statement

There are two ways that can be used in mobile robot development. First way is to build up an embedded system, the second is to use 'ready to use' industrial components. Using Peripheral Interface Controller (PIC) as a microcontroller of mobile robot is a common application used by engineers or researchers in developing mobile robot. With embedded system where engineer can build their own system according to what they want and program it according to their hardware, thus it make PIC is much favorable among engineers. But, for some people who want a system that's ready-made and simple, PLC will be the answer.

Nowadays, with the expansion of industrial mobile robot, there are lots of components available in market that can be used to create a complete control and sensor system of a mobile robot. Thus, by using these components, electrical hardware development is not necessary, which will speed up the development time and decrease the cost. Using PLC on board, what left is only constructing the program and engineers can concentrate on the algorithms, rather than developing the hardware. Furthermore, PLC is very suitable for manufacturing industries because it's more simple compare to PIC (e.g. C Language). But yet, it's still very less mobile robot which used PLC as the navigation controller and it's not impossible to create a simple and flexible mobile robot based on PLC navigation system.

Therefore, this project is trying to develop a PLC based navigation system for mobile robot, and study the algorithm and analyze the performance of the mobile robot.