MOBILE ROBOT MONITORING SYSTEM USING LEGO MINDSTORMS

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This report is submitted in partial fulfillment of requirements for the Bachelor Degree of Electronic Engineering (Computer Engineering) with honours

Fakulti Kejuruteraan Elektronik & Kejuruteraan Komputer
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UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek	:	**Mobile Robot Monitoring System Using LEGO Mindstorms**
Sesi Pengajian	:	**06/07**

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"I hardly declare that this report is the result of my own work except for quotes as cited in the references"

Signature : _____

Author : Nik Rus Khuzaimah Binti Nik Azizan

Date : 27 APRIL 2007

"I hereby declare that I have read this report and in my opinion this report is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering (Computer Engineering) with honours."

Signature 

Supervisor's Name : En Nurulfajar Bin Abd Manap

Date : 27 APRIL 2007

Just For My Mom And My Dad

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ABSTRACT

The mobile robot monitoring system using LEGO Mindstorms tool is a mobile robot that has a behavior which is monitoring system. This robot will monitor and sense the object around them using camera Lego. This project highlights the hardware development and programming development. The hardware development of mobile robot monitoring system based on Lego while for programming development is used C language. This project programming needs other programming to display the image and make the camera as a sensor. The image data will be sent to the user computer using IR Tower. This IR Tower is interacting as interface between computer and the camera. In this project, two different methods programming Not Quite C and ROBOLAB is used which is able to move for Not Quite C and display the image for ROBOLAB using camera Lego through the user computer.

ABSTRAK

Projek *Mobile Robot Monitoring System using LEGO Mindstorms* adalah projek dimana robot yang mempunyai sistem pengawasan sebagai sifat robot itu. Robot ini akan mengawas dan sebagai pengesan pada objek disekelilingnya dengan menggunakan kamera yang disediakan oleh Lego Mindstorms. Projek ini mengetengahkan pembangunan *hardware* dan *software*. Bagi pembangunan *hardware* projek ini menggunakan kamera Lego sebagai komponen yang utama. Sementara itu, bagi pembangunan *software*, projek ini menggunakan bahasa C. Bagi projek ini, ia memerlukan satu lagi *software* untuk menjadikan kamera ini memaparkan gambarajah dan menjadikan kamera sebagai pengesan. Gambaran yang diperolehi oleh projek ini, akan di paparkan pada komputer pengguna melalui *IR Tower*. *IR Tower* ini dijadikan sebagai penghubung antara komputer penggna dengan kamera. Dalam projek ini, dua cara program yang berbeza iaitu *Not Quite C (NQC)* dan *ROBOLAB* digunakan dimana *Not Quite C* digunakan untuk pergerakan robot manakala *ROBOLAB* digunakan untuk memaparkan gambarajah dari kamera.

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CHAPTER I

INTRODUCTION

1.0 Background

Nowadays, there a lot of robot that has created to make an easy life for human. Some of robot is used at homc, as a research and the most using it at industry. Robot is a mechanical or virtual, artificial agent and usually an electro-mechanical system which by its appearance or movements conveys a sense that it has intent or agency of its own. Robot also can be define an automatically controlled reprogrammable, multipurpose, manipulator programmable in three or more axes, which may be either fixed in place or mobile for used in the industrial automation application.

A typical robot must not natural which is copy the creation from the previous. This robot can sense its environments and can manipulate things around it. All the intelligence of the robot is program by humans to make this robot have a degree of intelligence. This mean the robot can be programmable and controlled by computer. With the intelligence, they can move with one or more axes of rotation. There are two types of robot which are industry and mobile. An industrial robot is officially defined by ISO as an automatically controlled, reprogrammable, multipurpose manipulator programmable in three or more axes. The field of industrial robotics may be more practically defined as the study, design and use of robot systems for manufacturing.

Typical applications of industrial robots include welding, painting, ironing, assembly, pick and place, palletizing, product inspection, and testing, all accomplished with high endurance, speed, and precision [13].

A mobile robot is an automatic machine that is capable of movement in a given environment. It has the capability to move around in their environment and is not fixed to one physical location. In contrast, industrial robots usually consist of a jointed arm and gripper assembly that is attached to a fixed surface. Mobile robots may be classified by the environment in which they travel land robots, aerial robots, and underwater robots. Mobile robots are the focus of a great deal of current research. Mobile robots are also found in industry, military and security environments. The classification of the mobile robot needs the main behaviors of the robot which are navigation and monitoring.

The behaviors of the robot navigation and monitoring are related with each other. Monitoring need navigator to navigate the environment the robot. Otherwise, this robot cannot display or make a monitor around it because this robot cannot sense things around them.

1.1 Objectives

The purposes of doing this project are:

- To develop a mobile robot monitoring system using LEGO Mindstorm.
- To design a robot to capture an object image using Lego's camera.
- To developed RCX programming using NQC programming.

1.2 Scope of Works

The scope of this project is to design mobile robot monitoring system using LEGO MINDSTORM. This project have two part of designing which are design the hardware for the mobile robot while the other one is software for the mobile programming. The main device for this project is camera which is used to monitor and detect an object surround the robot. However, the camera cannot be detected by Not Quit C programming. Therefore, this robot will have two different programming in the RCX programmable. The movement of the robot will use sensor and camera to sense the object surround the robot to capture the image. The robots have to turn left or right or stop before it captures the objects.

1.3 Problem Statement

Nowadays, there are many of application of developing a robot such as using PIC, DSP Processor, RCX LEGO, etc. PIC, DSP and RCX all are the controller or main brain for the robot. They have same function which is for install the program into it. All the movement, behaviors and etc for the robot is in the brain. Between All of controller, the RCX is much easier then other because LEGO is available for a starting user which is available for children and adults.

In this project, I chose to design my robot using LEGO Mindstorm. LEGO Mindstorm is easy to develop a robot because it has a lot of brick that can be used to assemble the robot and already have their own controller which is called RCX Programmable. Although the cost of the LEGO is quite expensive, for the beginner it is available.

There are two behaviors for mobile robot which is monitoring and navigation. For this robot, I chose monitoring for my robot behavior. One of the greatest challenges in designing mobile robot monitoring system is dealing with camera. In LEGO Mindstorm, they have their own camera which is called Vision Command. This Vision Command has to connect to the computer to power it up. Vision Command also has the built-in USB port. Thus this project has a limited move with the camera. Besides that, the program needs to have an interface for the programming between Vision Command and RCX programming. In particular, it is very difficult for a developer to anticipate all possible contingencies in advance, much less decide how to capture the object image. The ultimate goal is to have the robot can monitor the entire situation and capture by user control, based on explicit models of the robot's sensors, behaviors and environment.

The requirements for this robot are:

- Camera (for capturing the image and being sensor).
- Light sensor (to detect the object).

The advantages of this robot:

- Can be monitored environment more accurate then CCTV or human.
- Can sense and capture the image of the object.

The disadvantages of this robot:

- Have limitation movement with the camera.
- Need more sensors to sense the object

1.4 Summary of Methodology

All the method that is used to achieve the objective of this project is based on the flow chart that has been designed from the beginning of this project. The detail explanation method of mobile robot will be in Chapter III.

Before the designing the prototype of the robot hardware, four model robots has been designed to make sure the robot is available for the monitoring system robot. This robot should be available used with camera because the core of this project is monitoring which mean it should has to use camera.

After the finished of the robot, the programming should be programmed in RCX which is as the robot brain. All the program will be download to the RCX. For this robot, the programming that has been used is ROBOLAB and Not Quit C. the using of two method of the programming will be explain more in Chapter III.

1.5 Thesis Outline

This thesis represent by five chapters. The following is the outline of the mobile robot monitoring system using LEGO Mindstorms project in chapter by chapter.

Chapter I: This chapter discuss about the brief overview about the project such as introduction, objectives, problem statement and scope of the project.

Chapter II: This chapter describe about the research and the information of the project. Every facts and information which found through journals or the other references will be compared and the better methods have been chosen for the project.

Chapter III: This chapter discuss about the project methodology used in this project such as software that have been used for the programming and the stages of designing the project until the last design. All these methodology will be the best result for the project.

Chapter IV: This chapter describes about the project finding such as results and the analysis.

Chapter V: This chapter is the conclusion of the project. The upgraded of this mobile robot is described in suggestion of this project. Discussion is described the problem is occurring went the project in progress.

CHAPTER II

LITERATURE REVIEW

2.0 Introduction

For this chapter, literature review will describe more about the component that will be used for this project. Literature review will give an idea about what component and design that will be used after all the suitable specification for this project have been studied. This specification is needed to know the suitable character that will be used so that this project is success in giving the right output.

This project will used LEGO Mindstorms features to design the robot. The entire components that have been used are all from LEGO Mindstorms. Lego Mindstorms is a line of Lego sets combining programmable bricks with electric motors, sensors, Lego bricks, and Lego Technic pieces (such as gears, axles, beams, and pneumatic parts) to build robots and other automated or interactive systems [9]. Lego Mindstorms may be used to build a model of an embedded system with computer-controlled electromechanical parts. Many kinds of real-life embedded systems, from elevator controllers to industrial robots modeled using Mindstorms.

LEGO Mindstorms has been nearly 15 years in the making. It comes through collaboration between LEGO and the Massachusetts Institute of Technology (MIT). Fred Martin, an MIT research scientist, helped develop much of the microprocessor technology ultimately used in MindStorms, and it was Dr. Seymour Papert's vision to stuff a computer inside a LEGO brick. Papert, a pioneer in artificial intelligence and the creator of the Logo programming language, worked with LEGO to put his Logo into LEGO bricks [7].

2.1 RCX Programmable Brick

The heart of the MindStorms kit is the Robotic Command Explorer (RCX). It is often called the "programmable brick," or "smart brick," because it resembles a standard Lego piece in many of its characteristics, through a great power hides within it [10]. The RCX is a microcomputer than interfaces with input and output devices. About the size of two decks of playing cards, the RCX uses sensors to take input from its environment, process the data, and signal up to three motors to turn on and off in forward or reverse at any one of 8 speeds. This "smart brick" can process over 1000 commands per second [7][10]. The RCX Programmable is shown in figure 2.1. The RCX serves as the brain of LEGO MINDSTORMS inventions. It uses sensors to take input from its environment, processes data, and signals output motors to turn on and off [6].

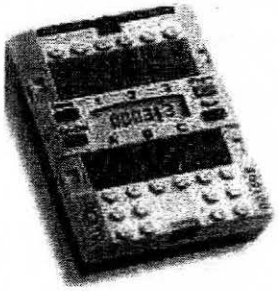

Figure 2.1: RCX

For the beginner, RCX and LEGO element will be used to build the robot. Then by using RCX Code, a simple programming language will be used to create the program. After that, the programs have to download to the RCX using a special infrared transmitter tower. Finally, the creation can be interacted with the environment, fully independent from the computer.

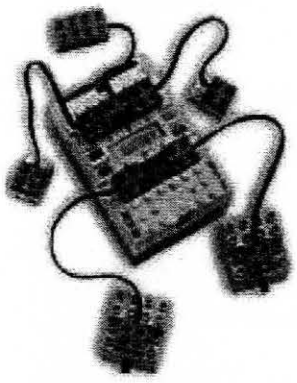

Figure 2.2: Connections RCX with Input & Output

2.2 RCX Features and Works

Version 1.0 RCX bricks feature a power adapter jack to allow continuous operation instead of the limited operation time when using batteries. In version 2.0, the power adapter jack was removed. Power adapter-equipped RCX bricks are popular for stationary robotics projects such as robot arms or for controlling Lego model trains. In the latter context, the RCX needs to be programmed with Digital Command Control (DCC) software required for automated model train operation [9].