MOBILE ROBOT MULTIPLE SENSOR BEHAVIOUR
FOR OBSTACLE AVOIDANCE

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Bachelor of Electrical Engineering
(Power Industry)
May 2010
“I hereby declare that I have read through this report entitled “Mobile Robot Multiple Sensor Behavior for Obstacle Avoidance” and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)”

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MOBILE ROBOT MULTIPLE SENSOR BEHAVIOR FOR OBSTACLE AVOIDANCE

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A report submitted in partial fulfillment of the requirements for the degree of Electrical Engineering (Industrial Power)

Faculty of Electrical Engineering
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2009/2010
I declare that this report entitled “Mobile Robot Multiple Sensor Behavior for Obstacle Avoidance” is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ..............................................
Name : ..............................................
Date : ..............................................
ASSALAMUALIKUM WARAHMATULLAH WABARAKATUH.

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ABSTRACT

This project is about Mobile Robot with Multiple Sensor Behavior For Obstacle Avoidance. The mobile robot was designed to perform task to avoid an obstacle that blocking the robot way. A PIC16F877A, ultrasonic sensor and limit switch is used in this project for robot brain and sensing element. Different drive using relay control method is used in this project. When the sensor senses an object in front of the mobile robot or if a limit switch (bumper) is hit an object, a signal is send to the microcontroller to process. Through programming, the microcontroller moves the robot direction either in left or right movement. This mobile robot has the capability to move around in it environment and is not fixed to one physical location.
ABSTRAK

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CHAPTER 1

INTRODUCTION

1.1 Background

Mobile Robot can be classified into a few types based on the application and task given to complete. Mobile robot with multiple sensor behavior for obstacle avoidance is one of the autonomous mobile robot types. This robot can perform the tasks without any guidance from human and but limited to environment structured [1]. In the autonomous mobile robot designed, the most important is the position of the sensor attached to the robot. These sensors are act as an eye for alls mobile robot designed where it was used to decide the direction of the wheel and based on the task given.

However, autonomous mobile robot cannot operate smoothly with sensor only. It should have a controller that act as a heart where the controller will control the whole operation of the mobile robot based on program installed [2]. Basically, positioning of sensor is the most difficult part in autonomous mobile robot designed depends on sensors’ specifications and the sight where needs to give strictly attentions. If the research of the sensor ranges is studied, determination of the movement on left or right will totally affect to the whole operation of mobile robot [3].

1.2 Problem statement

Why we need the mobile robot? In this era of scientific and technological advance, people are inclining more and more towards using new devices and system to make sure all the work is easier and faster. With autonomous mobile robot the hazardous or dangerous task can be performed replace human for safety purposes.
The mobile robot also can transport material or tools over distances much larger than their own dimensions. Nowadays, mobile robot have been assigned to work in a certain or different environment that are often cluttered with lots of known and unknown, moving and immobile obstacles [4]. Figure 1.1 shows ones of the most applications of the mobile robot in the real life.

![Image](image_url)

Figure 1.1: Mobile robot application.

What important of sensors and sensors’ location in robot design? The number of sensor uses and its’ position in mobile robot designs is the major problem. Sensor should be place in a better location where the range of sense can be fully utilized. A robot’s surrounding and environment needs to analyses by measure the robot distance to other objects and obstacles and this is the most important source information that must know to avoid collapsed. In navigation and in unknown terrain exploration, the kind of control that is based on surrounding information processing is used commonly in robotics at the task planning level [5]. Else too many sensors used will increase the designed costs and no efficiency.
1.3 Objectives

This project was design based on the following objectives, which are:

1. To design a mobile robot that can avoid the obstacle.
2. To use a microcontroller as a main controller to control the movement of the robot.

1.4 Scope

In order to complete this project, the process is divided into few scopes as follows:

1. The work involves in this project is to design and to fabricate the mechanical and electronic hardware for a prototype of mobile robot. This task includes the design of robot structure/base, microcontroller and sensors circuit.
2. To study the sensor behavior and create an algorithm for the movement of mobile robot in applying the sensor behavior.
3. To use a PIC16F877A as a main controller or robot brain.
4. To use ultrasonic as distance sensor between robot and obstacle.
CHAPTER 2

LITERATURE REVIEW.

2.1 Mobile Robot

Mobile robot design is about art and individual skill to create the useful robot for human application. Each part of mechanical, electrical and software should be studies to make sure that the alls mobile robot application can run smoothly and can complete the task given. In mechanical part, each measurement of the mobile robot design must be details and fixed to make sure that the cost is not changes and affect to the whole process design. In electrical and software part also need research because the price is quite expensive and more sensitive if compare with the mechanical. Each equipment specification must be study details from it design, application and until the prices [9]. Figure 2.1 shows the example of mobile robot design with the range covered by sensor.

Figure 2.1: Example of Mobile Robot design.
Van-Quyet Nguyen et al studies about obstacle avoidance of mobile robot where is include about the design and the operation. On hardware design, they used the control software, out-case covers, aluminum beams and plastic connectors, scooter wheels, two stepper motors, and a power module, a battery (12V, 7A). On his paper stated that the design is most suitable on the application of their mobile robot. [1].

Jefri Efendi Mohd Salih et al. studies the designed of Omni-Directional Mobile Robot with Mecanum Wheel. They state that each of individual wheel direction and speed can be combined and will produces the bizarre results where is can allowed the freely movement in the direction without changing direction of the wheel [2]. Figure 2.2 shows the Omni wheel applied in mobile robot designed by Jefri Efendi Mohd Salih, which gives better turning either to right or left but robot movement a bit slower due to Omni wheel’s characteristic as shown in Figure 2.3.

![Figure 2.2: Omni wheel application.](image)

![Figure 2.3: Omni wheel design.](image)
MHA Hamid, AH Adom, NA Rahim, MHF Rahiman in studies about navigation of mobile robot using global positioning system (GPS) and obstacle avoidance system with commanded loop daisy chaining application method mobile robot for experiment utilized the use of remote control (RC) truck with the dimension of 50 cm in length, 25 cm in width and 15 cm in height. The RC truck include with four independent motor that can actuated individually which can skid steer to turn the mobile robot in immediate 360 degree turn. Equipped with seal lead acid battery, mobile robot increases the capability to move in longer time. Figure 2.4 show mobile robot structures integrated with GPS and sonar sensor [3].

![Mobile robot structures.](image)

Meng Joo Er and Chang Deng studies about obstacle avoidance of a mobile robot using hybrid learning stated that the Khepera robot used is cylindrical in shape, measuring 55 mm in diameter and 30 mm in height. Its weight is only 70 g. They also state that the small size allows experiments to be performed in a small work area [4].

Johns Hopkins on paper designing an autonomous robot vehicle stated that the body of the car contained two major parts which is the chassis and the arm. Their mobile robot design used entire vehicle fit into a 12 inch by 12 inch square that was no more 42 than 14 inches high. The chassis was made up of an upper stage and a lower stage. The upper stage was made of clear Plexiglas, which was cut to fit a 12 inch by 12 inch square [5].
2.2 Sensor

2.2.1 Ultrasonic sensor

William et al. had studies about implementation of a binaural sensory pod using an ultrasonic emitter and two receivers on a legged robot. A series of obstacle avoidance behavior is programmed onto a microcontroller that allows the robot to move both semi-autonomously and autonomously successfully programmed. From his studies, binaural ultrasonic sensor pod and programmed avoidance behavior has proven itself useful as a mobile robot navigation aid. By using the modular design implemented for these experiments, the sensor pods could be integrated with other mobile robots to provide non-contact sensing and navigation for them as well. [6].

J. Borenstein et al. on their paper about Mobile Robot Positioning & Sensors and Techniques had briefly described and defined that the seven categories for positioning systems where are Odometry, Inertial Navigation, Magnetic Compasses, Active Beacons, Global Positioning Systems, Landmark Navigation, and Model Matching. Each categories had their own characteristic and specialize like can make measurement of distance by the position, radius, x and y axis and more characteristic. [7].

Jarosław Majchrzak, Mateusz Michalski, and Grzegorz Wiczyn’skion Distance Estimation With a Long-Range Ultrasonic Sensor System had successfully identified a fundamental factor on the measuring error that always occurs on the mobile robot sensor that is because environmental conditions. To avoid this problem than occurred, a proposition of the distance measuring procedure with the chosen estimator is presented. The proposed measurement procedure could be useful when dealing with problems concerning the reliability of the measurement results obtained with ultrasonic sensors. It could be used as an alternative to other statistics-based methods. The proposed estimator chosen based on the of an error analysis for measurements performed in the range [8]. Figure 2.5 shows the design and dimension of the ultrasonic sensor.
2.2.2 Infrared sensor

Shadia Elgazzar and Timothy Welch stated that the sonar sensor can act and working as ultrasonic sensor application. It also can determine the distance between the sensors and object sharply and it also more cheaper compared to the ultrasonic sensor. Even it was cheaper and can operate similarly like an ultrasonic sensor, but the range coverage of infrared sensor only can reach until 3 meters maximum compare with ultrasonic where can reach until 6 meters. This showed that the infrared are most suitable in the small application of mobile robot than using ultrasonic sensor [9].

Shih-Jie Chang, and Wei Tong have identified the infrared sensor transmitter and receiver can use in two mobile robots with different application, which they had proposed a fuzzy target tracking control technique in their autonomous mobile robot. The first one can use as follower to the first mobile robot and another ones are use as a target tracking [10].
Jose Vazquez and Chris Malcolm in their studies mention that the maximum range of the infrared sensor is three meters with the beam width 450. The laser ranging is usually not used because the price is most expensive compared to infrared. In the research, the extract features from sonar sensors based on triangulation plus infrared sensing have been implemented successfully [11].

Heon-Hui Kim Yun-Su Ha Gang-Gyoo Jin on a studies about the Environmental Map Building for a Mobile Robot Using Infrared Range-finder Sensors stated that the sensor adopted for this work is infrared range-finder PB9-01 manufactured by HOKUYO AUTOMATIC, which uses an infrared LED modulated at 87 ohm for signal generation. It not only has compact size and light weight but also gets distant and directional information to an object for one time scanning [12].

Matijevics studied about Infrared Sensors Microcontroller Interface System for Mobile Robots stated that the IR sensor consists IR LED emitter and photo sensitive transistor Photo-transistor is in a plastic house with filter for daylight. LED is in series connection with resistor and controlled over the microcontroller out pin. There are two IR sensors in front of robot. The IR sensor is used with 980 nm wavelength light [13]. Figure 2.6 shows the IR sensor with its cover.

![IR LED with its cover](image.png)

Figure 2.6: The IR sensors with its cover.
2.3 Microcontroller

MHA Hamid et al. studied about Navigation of Mobile Robot Using Global Positioning System (GPS) and Obstacle Avoidance System with Commanded Loop Daisy Chaining Application Method stated the mobile robot for their project is suitable used micro controller in Basic stamp BS2 and BS2p. For BS2 it offer processor speed 20 MHz and it can execute approximately 4000 instruction per second. RAM size for BS2 is 32 bytes and 2K bytes memory for EEPROM about 500 instructions can be store in flash memory [13].

Chan Zhi Wei and Muhammad Nasiruddin Mahyuddin studied about Neuro-Fuzzy Algorithm for Obstacle Avoidance Mission of a Mobile Robot Using FPGA discussed that the designed obstacle avoidance program for mobile robot that incorporates a neuro-fuzzy algorithm using Altera Field Programmable Gate Array (FPGA) development board. Field Programmable Gate Array (FPGA) circuits provide suitable platform in realizing complex hardware system as well as implementing data intensive algorithm computation. The ability to easily reconfigure FPGA makes the design less expensive than pre-designed hardware. These features bring convenience to incorporating an artificial intelligence-based-program for mobile robot navigation and obstacle avoidance task or mission [3].

Johns Hopkins University studied on designing an autonomous robot vehicle stated that the microcontroller used as the central control system for the vehicle was the Motorola 68HC11. It has many features, including five I/O ports, five internal, independent timers that can be programmed to provide pulse width modulation and an on-board analog to digital converter. The 68HC11 can also be easily interfaced with different external circuits [5].