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Micromouse Maze Solving

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***Abstract*— Micromouse is a device that applied the principles of optical, mechanical, electronic, and integration of hardware and software technology. This paper describes the structure of micromouse and maze; and then using wall following algorithm defines a maze search problem. It is to solve the problem of maze by using wall following algorithm. It is need to be designed negotiate a path to the target of a maze. The aim of this research is to find the path from the starting point to the exit of maze without an intervention from a human operator. Detection of walls and opening in the maze were done using ultrasonic sensors by reducing the collision. This paper also includes some results of tests.**

***Index Terms*— wall following algorithm, obstacle avoidance, micromouse, maze, sensing system.**

I. Introduction

A robot is a mechanical device which can execute various tasks, either manually by direct human supervision or autonomously by a predefined program or some guidelines set by human [1]. A mobile robot is a category of robot that is capable to move in a given environment and executes tasks with some degrees of flexibility.

In the most of mobile robots, robots should move and find their paths, for example robots that are used in industrial and domestic plays a more important role in the human life. The complete robotic system is a synthesis of mechanical design, motor control, sensory input systems, electrical design and software development system [2].

Maze solving problem is one of the most common problems and to solve this problem an autonomous robot is used. Autonomous robots are robots that can perform tasks intelligently depending on themselves, without any human assistance. Maze Solving Robot, which is also called "Micro-Mouse Robot", is one of the most popular autonomous robots [3]. It is a small self-reliant robot that can solve a maze from a known starting position to the target area of the maze. There are many algorithms and techniques have been discovered and used to solve the maze.

In this system design, micromouse that consist obstacle avoidance ultrasonic sensors and then ultrasonic sensors detect the wall. Thus, this micromouse will apply the wall following routine such as left or right hand rule to solve the maze. If the choose right wall following algorithm, the micromouse will firstly decide right wall presence or not. As if choose left wall following algorithm, the micromouse will firstly decide left wall presence or not. Then, the micromouse will secondly decide front have wall or front have no wall. Thirdly, it will be decided the other sides of the wall presence or not.

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II. System Block Diagram and Operation of the Control Circuits of Micromouse

In this thesis, the arduino programmable board is the heart of the control system. This system composed with two brush dc motors, three ultrasonic sensors detectors and one arduino control board. For the balance of the rpm of both wheels, the analog output is used to adjust the variable speed of the motors. The ultrasonic sensors detectors are used for the wall detecting and favorite the right turning to the mobile robot in the maze. First, the mobile robot is placed the specification point of the maze and sense the distance of the left/right wall of the maze for the straight line robot driving. The two brush DC motors are connected by the L298 module (motor driver IC). The arduino control board will also be controlled this L298 module for driving the mobile robot through the maze. In the first position, the two ultrasonic sensors detectors (left and right) are closed to wall and generate the output data. The front ultrasonic sensor generate the free output data because it far from the wall. According to these data, the mobile robot move toward the front by adjusting the left and right distance. If the mobile robot is sensing the right ultrasonic sensor is far from the wall, the robot is turning the right maze path and moving toward the front. Left turn is same to the right. If mobile robot will have the both detection of left and right data, the arduino control board is decided to turn the right by the right favorite method by programming. By the way, the robot gets the all wall closed sensing data from all detectors and then the robot turn to 180 degree and backward to the maze and all detectors are sense again by the program. The overall block diagram showing the interaction between the components is shown Fig.1.

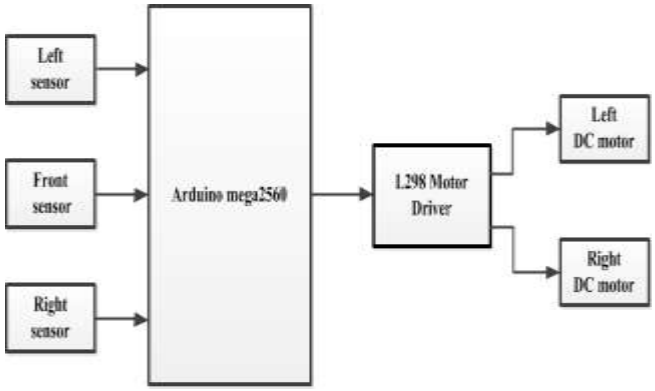

Fig.1. Overall Block Diagram of the System

III. Circuit Operation of The System

All the motors are driven by the command signal received from the sensor. The Arduino Mega is also used as the main microcontroller to interface with other devices by receiving the data from three sensors. The robot is moved to direction with the help of two DC motors driven by L298. DC motors are used to turn the robot right/left or forward/backward and stop. The circuit diagram is shown in fig.2.

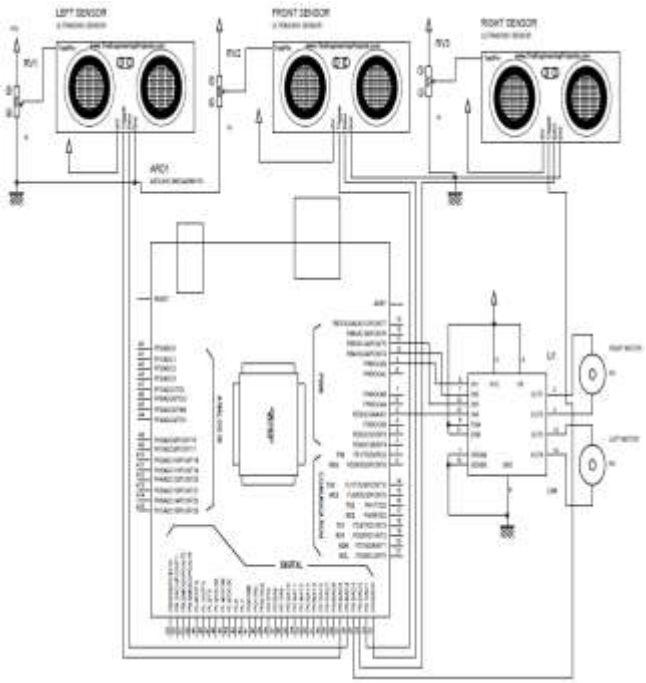

Fig.2. Overall Circuit Diagram of the System

III. Structure of The Maze

Micromouse is an event where small robot to solve 8x8 mazes. In this research, micromouse maze is composed of 8 × 8 square cells, each square cell whose size is 228.6mm × 228.6mm. Maze wall height is 101.6mm, thickness is 2mm and wall color is white. Maze's "starting point" in the corner of the maze, "starting point" of the maze have right and left two of the walls. The "end" of the maze have right wall. The dimension of maze is shown in Fig.3 and Fig.4 shows the whole maze structure.

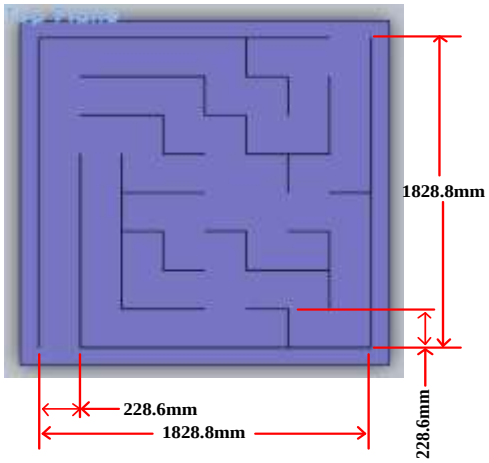

Fig.3. Dimension of maze

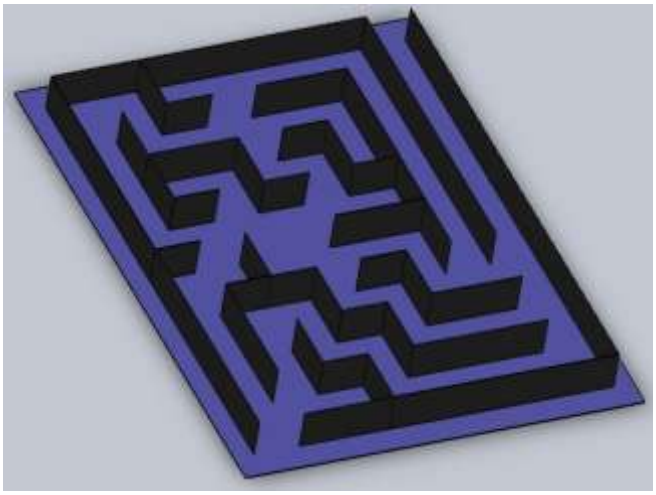

Fig.4. Structure of 8x8 maze grid cell

IV. Configuration of Micromouse Model

When making the model of micromouse, the important things are the mechanical design that should be consider as a major fact. In this model of micromouse, the main purpose of the chassis of the micromouse is to move smoothly and clearly between the paths of maze without collapse. The mouse's size is restricted by the maze's wall distance, smaller and especially lighter mice have the advantage of higher acceleration/deceleration and therefore higher speed. A robot is not larger either in length or in width than wall of maze. And then, the weight and height of the micromouse are unlimited.

In this research, the base frame of the robot is constructed out of a circular disk. The circular base only needs to turn in place. And the smaller amount of surface space that the circular base contains, the components will be mounted in a layered support system. This will provide a way for subsystems to be mounted and removed easily without interfering with the other systems. A layered mounting system provides a way to easily add and remove subsystems independently. The structure of the robot is built with plastic sheets in order to decrease the overall weight of the robot.

A robot with a circular base needs to have at most a diameter of 152.4 mm. This system aims the size of the robot to a minimum to obtain better mobility and to avoid collision with the walls. One caster wheel is attached at the rear of the platform to provide balance of the chassis of micromouse system. The plastic sheets make the necessary holes and cuts in order to connect the parts to each other and to keep the actuators tightly. Moreover, the sensor board, which is containing of reflective sensors located on the right, straight and left has been attached at the front of the robot to sensing the maze walls. It has to depend on simple and small and low power sensors such as infrared sensors. The platform includes the robot body, two wheels and two motors. In mobile robot application, the two-wheel differential drives are the most basic drive. For the case of 90 degree turning and 180 degree spinning of the micromouse while moving in the maze, the differential drive wheel is placed at each side of the center of the bottom layer of the platform to avoid the collapse the wall of maze. The main processing unit used in this micromouse system is Arduino MEGA 2560, a

microcontroller based on the ATmega2560. The typical of micromouse is shown in Fig.7.

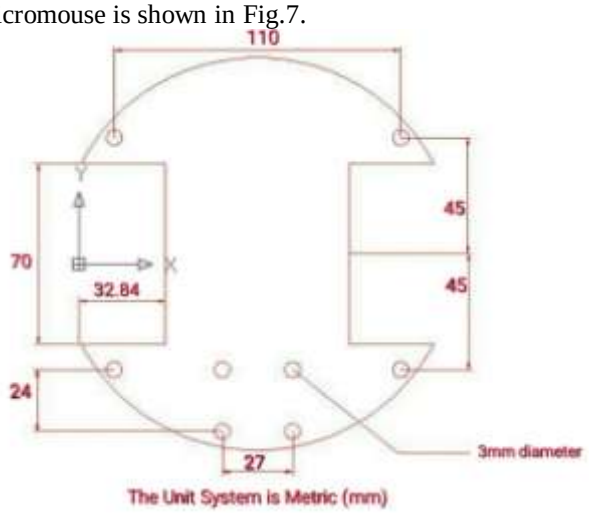

Fig.5. Micromouse platform of bottom layer

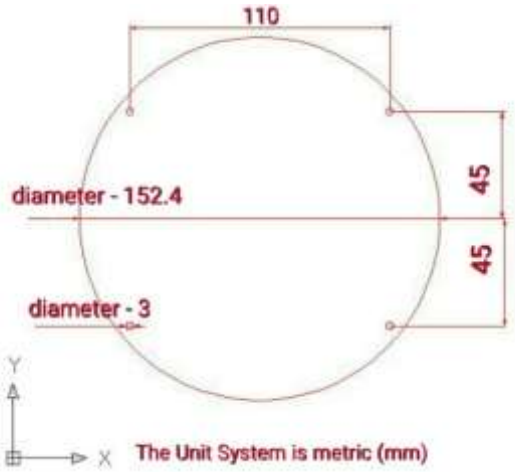

Fig.6. Micromouse platform of upper layer

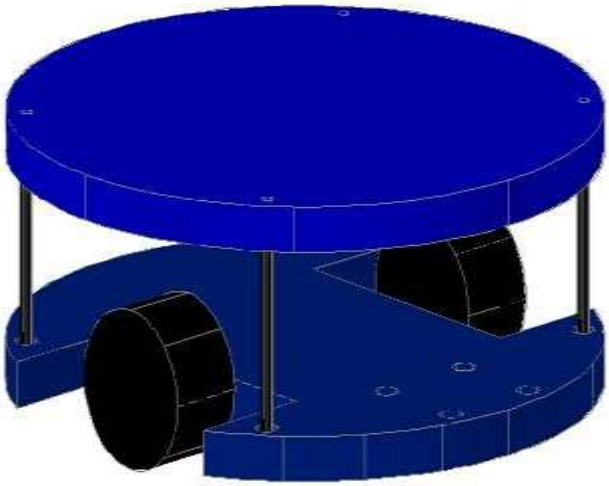

Fig.7. The typical of micromouse

V. Wall Following Algorithm

In this system, the wall following algorithm can be used to solve a maze. The robot will take its direction by following either left or right wall. Whenever the robot reaches a junction, it will sense for the opening walls and select it direction giving the algorithm to the selected wall.

The right hand wall has been selected, because implementing wall following algorithm required selecting either left or right wall to be followed. The micromouse will start the current position of the mouse (or robot), and print the first step. If the robot dose not reaches the goal, the sensor will detect the maze walls and take the suitable direction. The priority in right hand wall is in the following orders: right, straight, left, or u-turn. After that, the operation steps will print over and over with showing the mouse steps until it reaches to the target of the maze. Fig.8 shows the flowchart of right hand rule.

Otherwise, this algorithm will use left-hand following. If a robot comes to an intersection with several open sides, it follows the leftmost path. If left side has wall and front and right have not separated by walls, the mouse will choose to go forward. If the left and front directions are blocked, it will try to drive right. Else if the left, right and front directions are blocked, the mouse will go back return. Fig.9 shows the flowchart for left hand rule.

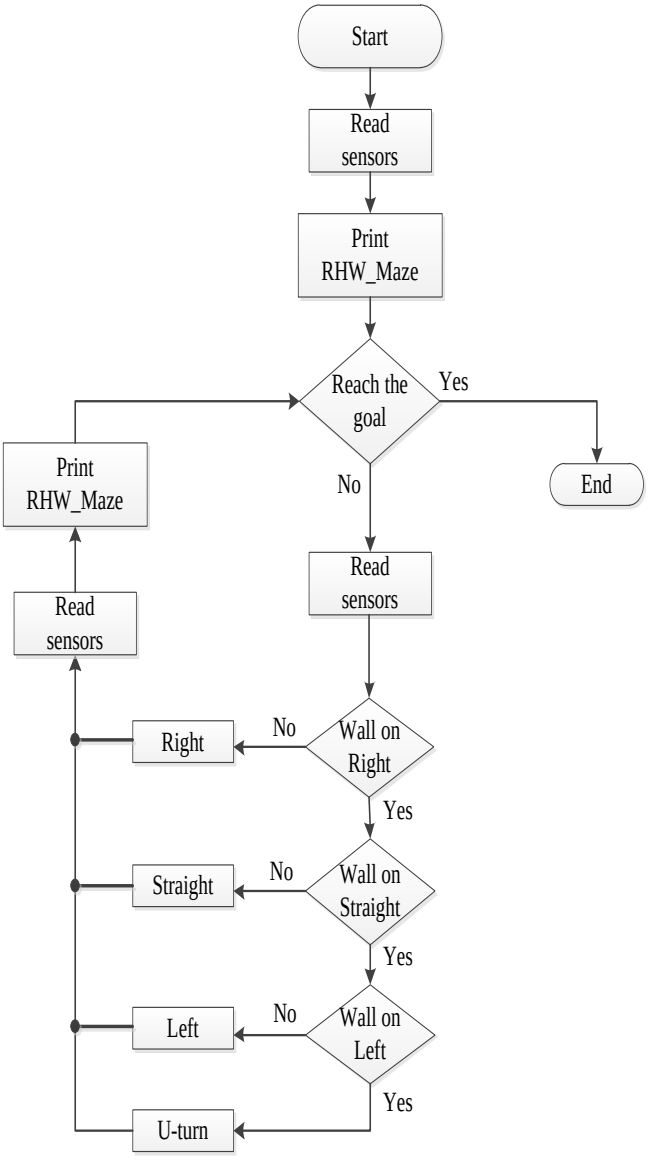

Fig.8. Flowchart for right hand rule

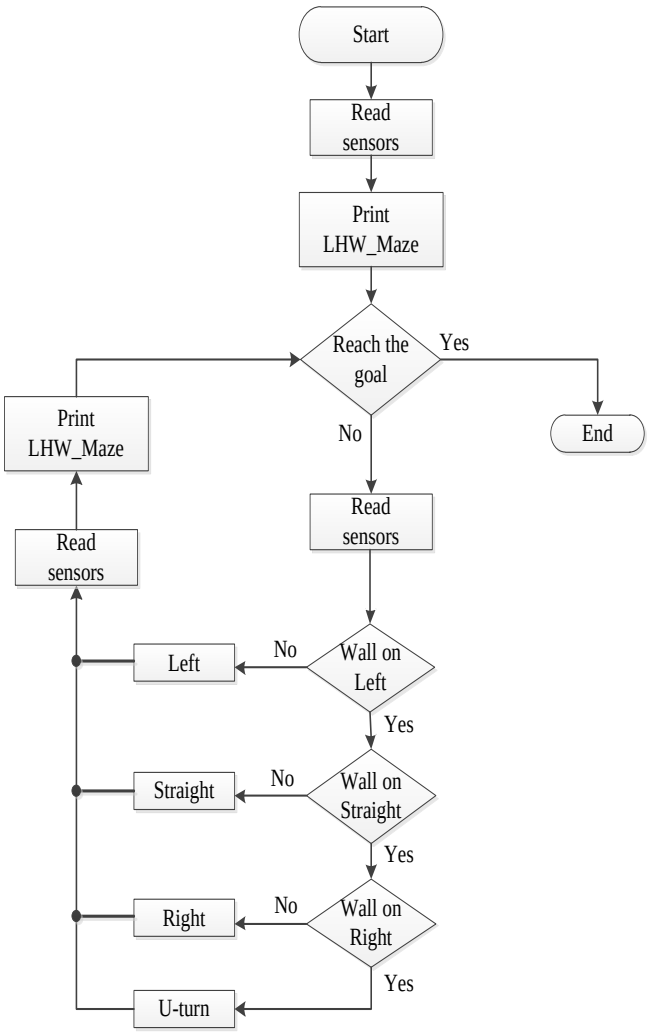

Fig.9. Flowchart for left hand rule

VI. Test And Results

This program should be tested with software simulation before it is tested with hardware. Arduino microcontroller controls the driving motors and obstacles detection system. When the motor needs to turn run, the sensor decide the direction that the motor turn run. Arduino microcontroller receives the decision from the sensor. Then, arduino will send the signal to the motor. If so, the motor will turn run. If the motor turn the right, the left wheel is accelerated and the right wheel is decelerated. If the motor turn the left, the right wheel is accelerated and the left wheel is decelerated.

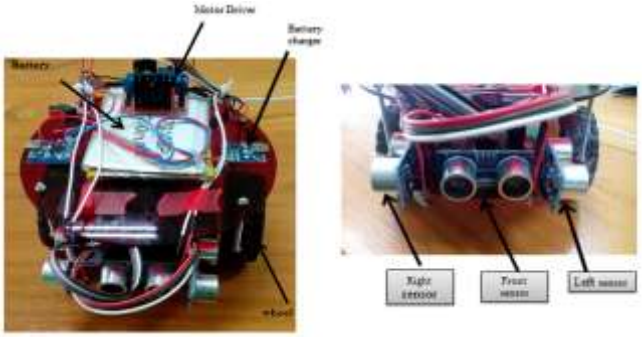

Fig.10. Hardware structure design of micromouse

Fig.11. Testing of micromouse in straight path

Fig.12. Testing of micromouse in 90 degree turn right

Fig.13. Testing of micromouse in maze

VII. Conclusion

In conclusion, this paper describes the micromouse solve the maze using right wall following algorithm. The design

and implementation of this control system is used on the arduino C microcontroller. DC motor can be controlled by an operator safety and efficiently by using PWM technique. A wall follower algorithm with selectable left-hand or right-hand rule can provide more flexibility and intelligence for unknown maze. In future, this system may also include other types of small sensors to improve the ability of the robot to detect its surrounding more accurately.

In this paper, we have studied and analyze various sensors, motors and arduino and find out the most suitable one for designing the micromouse according to our problem statement.

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