Remote Controlled Lawn Mower using SK40C with PIC16F877A Microcontroller

Mohd.Ameerul Asyraf Bin Abdul Rahim
Faculty of Electrical Engineering
Universiti Teknologi MARA Malaysia
40450 Shah Alam, Selangor, Malaysia
e-mail: ameerul_asyraf1989@yahoo.com

Abstract— **A remote controlled lawnmower robot that uses a PIC16F877A microcontroller was presented in this project. The remote controlled lawnmower robot is designed to be able to follow the command given via a PlayStation 2 (PS2) controller joystick whether to move forward, backward, turn right and left to mow grass. The Remote Controlled Lawnmower's system principle is to remotely control a lawnmower by using a PS2 controller joystick. The microcontroller that will be used for this project is PIC16F877A. The remote controlled lawn mower can be separated into three main parts which is the input, the controller and the output. The input is the movement control by human via a remote control. User will control the lawnmower by using a remote control to which part of lawn to be mowed. The controller which is the brain of the system, will received the information signal that are send by the input to be processed and then send an output signal to the output part so that the output can perform its task. The output for this project is lawnmower's movement wheels that use two RC servo motor and the DC motor for cutting.**

Keywords- SK40C controller board; PIC16F877A microcontroller; RC servo motor; PS2 controller joystick;

I. INTRODUCTION

Grass mowing in field is considered by many to be a tedious chore, so there is a demand for methods to eliminate such problem. The traditional method of dealing with this unpleasant task is to hire someone to perform the task. Other option is the use of robots. At this point, robots are being introduced for lawn mowing.[1]

Remote controlled lawn mower offer user to do this tedious chore regardless of their physical capabilities except for handicapped personnel to mow their lawn at ease and safe distances.[2]

The remote controlled lawn mower is a robot that built with a sole purpose, to help humans to lawn their grass. The remote controlled lawn mower consist of two RC servo motors that are used as drive wheels and a dc motor that used a cutting mechanism. These motor were controlled by using a SK40C controller board that uses a microcontroller which is a PIC16F877A. A Playstation2 (PS2) joystick controller is used to control the movement direction and cutting action of the remote controlled lawn mower.

II. CONCEPT OF THE REMOTE CONTROLLED LAWN MOWER

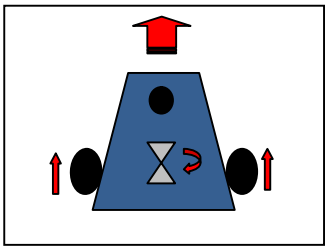


FIGURE 1 : THE REMOTE CONTROLLED LAWN MOWER BASE

The remote controlled lawn mower transmit one radio frequency signal for battery life and receive multiple signals from the PS2 controller for motor movement direction and cutting action.[3]

The movement direction of the two RC servo motor at the rear of the remote controlled lawn mower will determine the path way of the lawn mower. Table 1 shows movement direction of the remote controlled lawn mower.

TABLE 1 : RC SERVO MOTOR MOVEMENT DIRECTION.

RC SERVO MOTOR DIRECTION	ACTIONS
	MOVE FORWARD AND BACKWARD
	TURN SHARP LEFT AND RIGHT
	TURN LEFT AND RIGHT FORWARD
	TURN LEFT AND RIGHT BACKWARD

The movement of the remote controlled lawn mower was determined by the concept of times against angle of rotation of the RC servo motor as shown in Figure 1. Servos are controlled by sending them a pulse of variable width. Given the rotation constraints of the servo, neutral is defined to be the position where the servo has exactly the same amount of potential rotation in the clockwise direction as it does in the counter clockwise direction. The angle is determined by the duration of a pulse called Pulse Width Modulation (PWM).The distances of motor turns are determined based on the length of pulse given. [4]

FIGURE 2 : PS2 JOYSTICK.

Figure 2 shows buttons used on the PS2 joystick controller in order to control the remote controlled lawn mower. When an operator pressed both R1 and L1 or R2 and L2, both motor will begin to turn same direction whether forward or backward. If the operator pressed only R1, the left RC servo will rotate to forward direction so that the remote controlled lawn mower will turn right forward. While when the operator pressed only R2, the left RC servo motor will rotate to backward direction so that the remote controlled lawn mower will turn right backward.

If a combination of R1 and R2 are pressed, the left RC servo motor will rotate to forward direction while the right RC servo motor will rotate to backward direction, so that the remote controlled lawn mower will make a sharp right turn. Combination of L1 and L2 will make the remote controlled lawn mower will make a sharp left turn. Table 2 show the correspond action when buttons are pressed on the PS2 controller.

TABLE 2 : CONTROL BUTTONS

BUTTON(S) PRESSED	ACTIONS
R1	TURN RIGHT FORWARD
L1	TURN LEFT FORWARD
R2	TURN RIGHT BACKWARD
L2	TURN LEFT BACKWARD
R1+R2	TURN RIGHT SHARP
L1+L2	TURN LEFT SHARP
R1+L1	MOVE FORWARD
R2+L2	MOVE BACKWARD
X	ON CUTTER

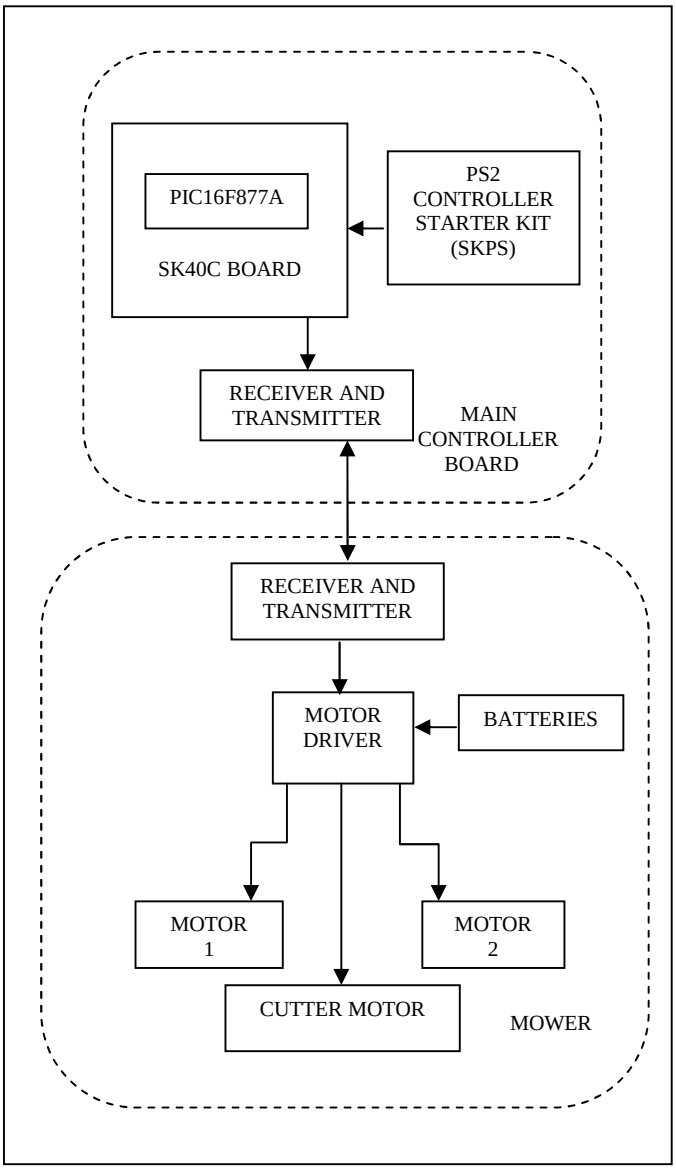


FIGURE 3 : SYSTEM BLOCK DIAGRAM.

Figure 3 shows the system block diagram of the remote controlled lawn mower. SK40C boards are used with a PIC16F877A microcontroller as a controller board which interfaces with a SKPS that offers a compact yet reliable PS2 Controller Converter[5]. Signals are being received and transmitted at port RC6 and RC7 of the PIC16F877A pins. Based on the signals received, the PIC16F877A will execute what actions had to be done by the remote controlled lawn mower whether to move forward, backward, turn right or left or to mow the grass.

III. METHODOLOGY

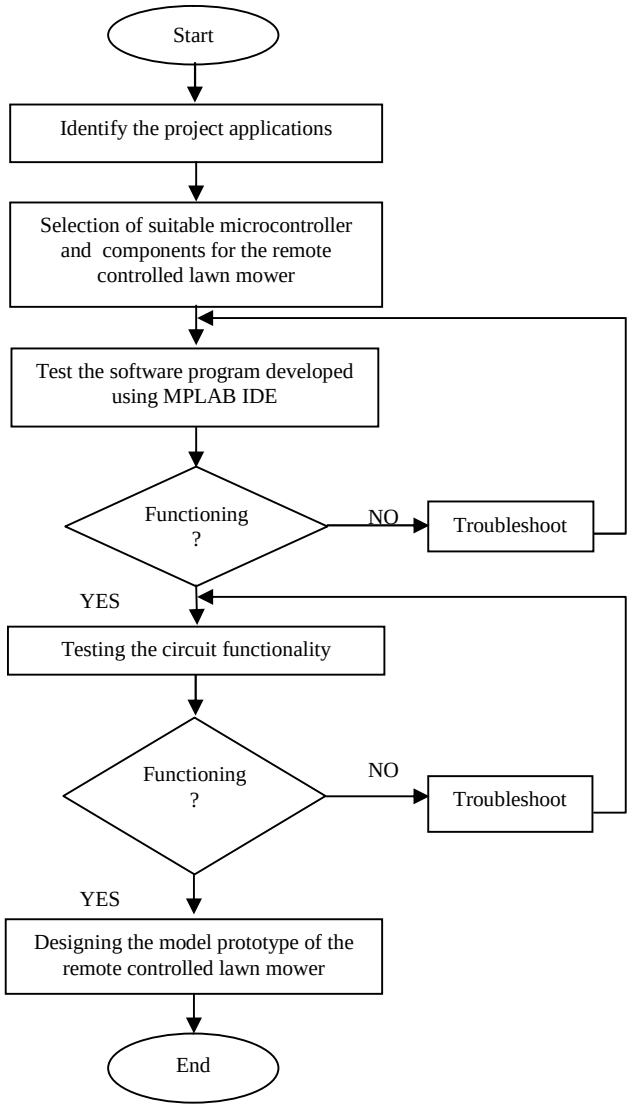


FIGURE 4 : Flow chart of the remote controlled lawn mower.

Figure 4 shows that this work included both hardware and software development. The development of the project is divided into two parts, the software which is the development of C language for the PIC16F877A on the SK40C using MPLAB IDE V8.33 software and the hardware which is the designing model prototype of the remote controlled lawn mower.

IV. SOFTWARE DEVELOPMENT

Before the remote controlled lawn mower can perform its task, which is to mow grass, all interface and program must be developed first. The programming for this remote controlled lawn mower was developed by using software called MPLAB IDE V8.33. The software uses C Programming language to program the PIC16F877A microcontroller. After a program is successfully built, the program must be sent into the PIC16F877A microcontroller by using USB ICSP PIC Programmer. Using the PWM signals that has been generated in the C programming language, the movement direction of RC servo motors was made.

V. HARDWARE DEVELOPMENT

A. SK40C Board and a PIC16F877A microcontroller.

A PIC16F877A microcontroller and a SK40C Enhance 40 pins Start Up Kits as shown in Figure 5 , are used as the main controller board for the remote controlled lawn mower. The SK40C were chosen to be used is because it is compact, powerful, flexible and robust start-up platform. It also provide ease of use to load the program that has been developed on the MPLAB IDE V8..33 by using an USB ICSP PIC Programmer[6].

Figure 5 : A SK40C board with a PIC16F877A

B. PS2 Controller Starter Kit (SKPS).

The PS2 Controller Starter Kit (SKPS) as shown in Figure 6 is used as PS2 controller converter because it is easy to be interfaced with the SK40C board and also very reliable. It used standard PS2 socket, therefore any PS2 controller in the market can be used whether wired or wireless type. The SK40C Board act as a host so that the SKPS can communicate with it via Universal Asynchronous Receiver/Transmitter (UART). The SKPS consist of 5 pins which is the 5 Volt power input pin, grounding pin, receiver pin, transmitter pin and a reset pin.

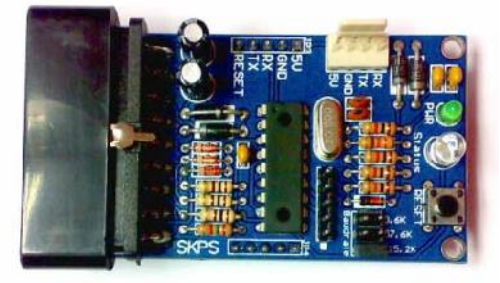


Figure 6 : PS2 Controller Starter Kit (SKPS).

C. Remote Controlled Lawn Mower prototype model.

Based on Figure 7, the remote controlled lawn mower is designed on a rectangular acrylic board with a thickness of 5mm as the base. On the top side of the base located the SK40C Board with PIC16F877A interface with the SKPS. The main controller board is powered by a 9 Volt battery while the power source used for two servo motor and the DC motor for cutting is 7.2 Volt.

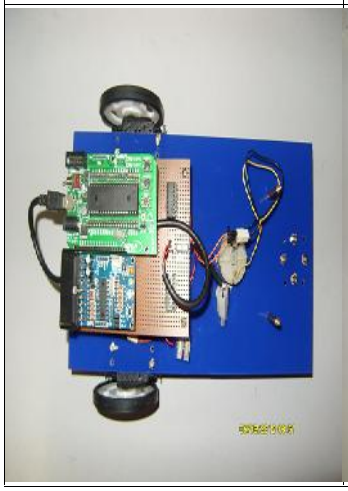
TOP VIEW	BOTTOM VIEW
	

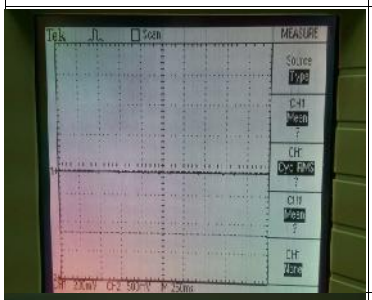
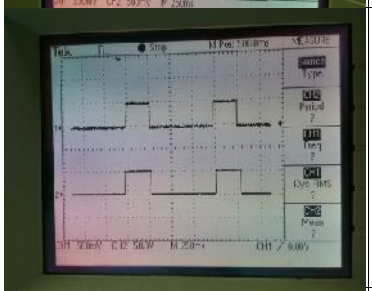
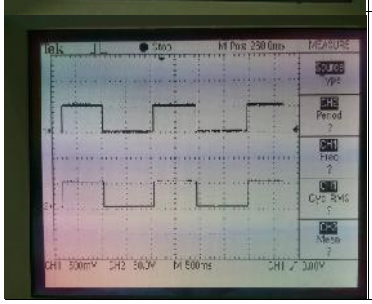
Figure 7 : Top and bottom view of the prototype model.

VI. RESULT

The results of the PWM signals for two RC servo motor were simulated through MPLAB IDE V8.33 software and observed with the aid of an oscilloscope. The oscilloscope is used to observe the PWM signals. Table 3 shows the PWM signals produced by each RC servo motors. The PWM will control the speed of each RC servo motors.

Essentially, the PWM is a square function with a DC offset that repeats each cycle. 'The 'ON' time determines how much of the voltage is being applied to both RC servo motors as shown on Table 3[7]. The higher the voltage the faster the RC servo motor moves. The frequency is 50Hz and duty cycle of 20ms for every pulse. These PWM signals are powered with a regulated voltage of 5V from the SK40C controller board.

Table 3 : PWM signal on Oscilloscope.

PWM Signals	Degree of Rotation	Explanation
	0°	RC servo motor OFF.
	90°	Both RC servo motor will rotate 90° in each period of 20ms.
	180°	Both RC servo motor will rotate 180° in each period of 20ms.

VII. DISCUSSION

The remote controlled lawn mower consist of two RC servo motor that uses PWM signals to control motors direction and position by sending a pulse of variable width. Each position on the servo corresponds to wheel speed. By controlling servos position, the remote controlled lawn mower can navigate according to the PS2 controller joystick to mow the lawn using a DC motor with cutter blade.

Referring to Table 3, when no pulse are given, the servo motor did not rotates thus the RC servo motor is in static or stop position. When the RC servo motor rotates for 180°, the PWM signals show that the signal will toggle "1" or 5 Volt are supplied for 10ms and toggle "0" or 0 Volt are supplied for 10ms which sum of 20ms for each period. The range for wireless PS2 controller is only limited to 7 meters.

VIII. CONCLUSION AND RECOMMENDATIONS

Throughout the hardware design, great care was taken to select the simplest, most cost effective method for solving each design challenge. The result is a solution that is capable of completing the task of mowing a simple lawn. Remote control of the mower is significantly simpler for the user than executing the task manually.

For the remote operation, it has been initially assumed that no humans would be present in the immediate vicinity of the robot in wide areas. With regards to this work, the design and implementation of the remote controlled lawn mower robot to navigate according to the buttons pressed on the PS2 controller that were generated by PIC16F877A microcontroller which interfaces with a SK40C controller board and PS2 Controller Starter Kit. Thus, the objective of this work was accomplished.

For the future development, the remote controlled lawn mower could be upgraded into an autonomous lawn mower. Autonomous lawn mower must be capable of governing the movement of a robotic platform and keep the platform within predefined bounds or along a path and to avoid obstacles during mowing process[8].

ACKNOWLEDGMENT

The author would like to would like express his gratitude to his supervisor, Dr. Rosidah Sam for the guidance throughout the entire project. The author's appreciation also goes to his family who give support until the project has been completed. Thanks for their encouragement they have given to him. Last but not least, the author appreciation dedicated to all his friends and those whom involve directly or indirectly to complete his final year project.

REFERENCES

[1] Richard Van Hook, Nicholas Baine, Dr. Kuldip Rattan, Dr. John Gallagher "Moogie the Robotic Lawnmower," Wright State University, Dayton, OH 45435

[2] Kevin LaMott, Sabri Tosunoglu," Development of a Robotic Lawnmower as an Adaptable Platform for Swappable Remote and Autonomous Control Packages', Florida International University

[3] Hudspeth, Matthew, "Remote Operated Mower", WESTERN WASHINGTON UNIVERSITY

[4] RC servo user manual, www.cytron.com.my

[5] "SKPSTutorial",http://tutorial.cytron.com.my/2012/08/15/project-16-driving-two-dc-geared-motors-with-md10c-by-using-skps/

[6] "SK40CTutorial", http://tutorial.cytron.com.my/2011/08/05/getting-started-sk40c-pic16f887/

[7] Jessie Lucero, Darwin Ramos, "Solar Powered Automatic Lawn Mower", SAN JOSE STATE UNIVERSITY

[8] MAKE Magazine, The Lawnbot 400 R/C Lawn Mower,Volume 22, Sebastopol, CA, 2010.