Proceedings of the
International Conference on Mechanical Engineering and Renewable Energy 2015
(ICMERE2015) 26 – 29 November, 2015, Chittagong, Bangladesh

ICMERE2015-PI-276

DESIGN AND IMPLEMENTATION OF A ROBOTIC LAWN MOWER

N. K. Das[1], Rajib Ghose[2] and Md. Monowarul Islam[3]

[1- 3]Department of Electrical & Electronic Engineering, Chittagong University of Engineering & technology (CUET), Chittagong-4349, Bangladesh
[1,*]nipu16@gmail.com, [2]rajib.ghose.eee@gmail.com, [3]monowar.ponney@gmail.com

Abstract- *A major goal of robotics is to develop machines that perform useful task independently with minimal supervision. It relieves people from many tiring and boring tasks. Lawn Mowing is also a time consuming task that makes life uncomfortable. With the development of science and technology, different automated lawn mowing systems have been introduced, among which robotic lawn mowers playing a significant role. But, even now all of the existing lawn mowing systems of Bangladesh is manually operated and they do not ensure proper safety and cost effectiveness. As a consequence, an automatic, safe, user-friendly, green and cost effective Robotic Lawn Mower (RLM) has been designed and fabricated in CUET electrical machine lab. This RLM comprises hardware and a software section. Here hardware section is design to execute the assign task and software section is used to drive it independently. It is designed to cut grasses in a given dimension 1 inch to 2.5 inch height either spiral or rectangular pattern chosen by the user. The fabricated RLM is tested and successfully cut grasses in playground autonomously according to the given instruction.*

Keywords: Lawn mower, counting sensor, spiral, rectangular, Arduino.

1. INTRODUCTION

In the time where technology has advanced, consumers are looking for things to do easily. Automated machines have taken over the duties of dangerous and mundane jobs from humans, allowing greater productivity. Because robots never tire, extra shifts have been added to factories. Farmers have taken advantage of new technology with automated harvesters; the waste disposal industry has implemented robots in some of its dirtier jobs. Grass cutting in gardens, lawns and play grounds is a boring and time consuming task. By the conventional system, grass can be removed but this takes too much time and many other harmful effects are faced. These are firing of grass is always harmful to nature.co2 gas increase by this way. With hand blades, grass can be removed but it is a lengthy process and it needs hard labor. Electric mower also required very long cables and also it depends on electricity. As consequences we design and fabricated a robotic lawn mower. This RLM is powered by solar energy with storage batteries system. It has no harmful effects on environment in comparison to the other lawn mower which are operated by fossil fuel or natural gas. Lawn Mower (LM) was invented by engineer Edwin Budding of England about a century ago right from the day. Since the initiation of LM much advancement has been made in its design through experimental studies and research. In this section some of the published works on LM and its components are presented. According to R. Jarvis, 2001, [1] describes the development of a robotic heavy duty lawn mower which is consists of many sensors and which initially provided Tele operation mode capabilities. Taj Mohammad Balochand and Timothy Thien Ching Kae, 2008, [2] describe in their paper that their designed lawn mower cut grass with a specified area and able to move according to the path defined by user while avoiding any obstacle blocking its path. Darwin Ramos and Jessie Lucero, 2009, [3] described in their project it cut grass randomly and spirally. It's not work with specific area. S. N. Fatehah Binti Zaini, 2011, [4] designed an Automatic Grass cutter which cut grass with path planning and in specific perimeter (2.5M (L) x1.5M (W)) it also detects obstacle and it is control by using PIC microcontroller. Dipin. A and T. K Chandrasekhar, 2014, [5] described about solar power vision robotic lawn mower. There are some preset patterns installed in the robot. This robot not only stays on the lawn it will detect and avoid objects and humans. And also it detects the land boundaries and start mowing upon the predefined pattern with the help of installed camera and MATLAB programming.

2. SYSTEM DISCRIPTION

The operating system of RLM is described by the following block diagram shown in Fig.1. This system consists of battery, IR sensor, driving motor, ultrasonic sensor, Arduino Mega, Blades, input circuit, LCD

display etc. Arduino controls the whole system. IR sensor is for counting the wheel rotation. Ultrasonic sensor detect obstacle to avoid collision. The length and width is to be entered to the input circuit. LCD display shows the whole statement.

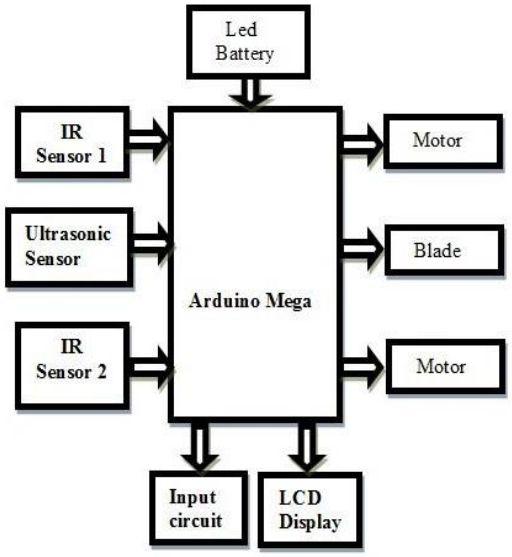

Fig.1: System Block Diagram of RLM

2.1 Hardware Section

Firstly, the body frame of this RLM is modeled by using Solidworks software. It is designed 3D view of the mower. Then structure is made by aluminium. Its length is 34cm, width (distance between two wheels) 30cm and height is 13cm. Diameter of the front wheels is 12cm. The design model is shown in Fig. 2 to Fig. 4 below:

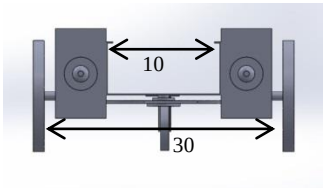

Fig.2: Front view

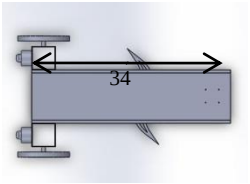

Fig.3: Top view

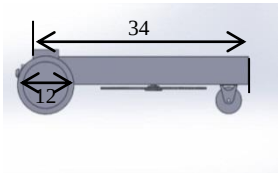

Fig.4: Side view

2.1.1 Counting Mechanism

For counting the wheel rotation, an IR sensor and encoded wheel are used. This sensor measured only infrared radiation shown in Fig. 5. The emitter is an IR LED (Light Emitting Diode) and the detector is an IR photodiode which is sensitive to IR light that's emitted from IR LED and its wavelength is 38 KHz. When photodiode received IR light, the resistances and these output voltages, change in proportion to the intensity of the received IR light.

Fig.5: IR transmitter and receiver

On the other hand Encoded Wheel is used to count wheel rotation. It is encoded by the eight pair of black and white band as shown in Fig.6

Fig.6: Encoded wheel

When wheel rotates, different intensity's IR received by the IR receiver due to black and white band. Output value of the IR circuit is changed with the wheel rotation. Processing unit read these values and counts the rotation number.

2.1.2 Obstacle Detector

Ultrasonic sensor (HC-SR04) is used to detect obstacle. It provides non-contact measurement function. Ultrasonic transmitter, receiver and control circuit are included in the module. Transmitter transmitted high level signal and receiver detect that the reflected high level signal within a time interval.

Test distance = (time interval× velocity of sound (340M/S) / 2.

2.2 Circuit Diagram

The schematic diagram of whole circuit is presented in Fig. 7.

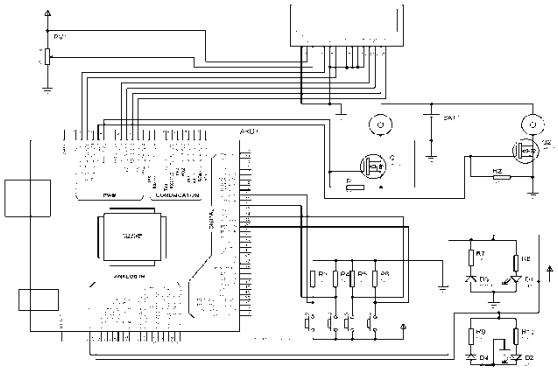

Fig.7: Circuit diagram

2.3 Software Section

To enable the hardware section, control unit (Ardunio) needs to be programmed first. Processing of the whole

system depends on the program. For programming Ardunio Mega and its IDE (Integrated Development Environment) is used. The flow chart shows the basic programming of the system in Fig. 8.

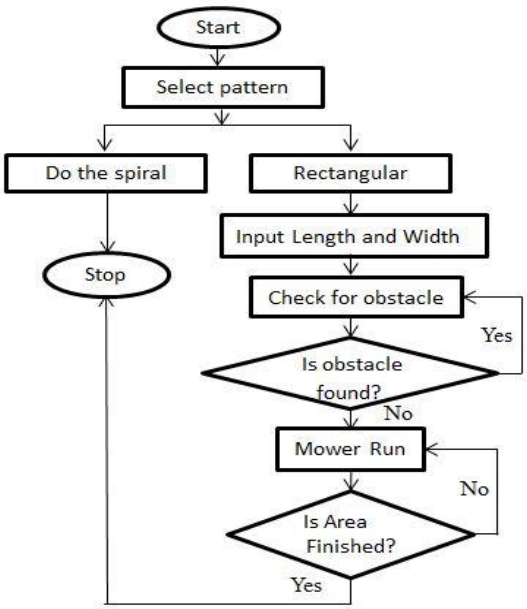

Fig.8: Basic flow chart

3. OPERATION

The Lawn Mower designed with two different cutting patterns. One is spiral and another is rectangular. User can choose any pattern according to his desire.

3.1 Spiral Pattern

Different wheel speed required to execute this cutting pattern. And the outmost wheel speed should be greater than inner one. This can be done by applying two different PWM signals. The spiral pattern shown in Fig. 9. Here two PWM channels are used. The PWM control the speed of each motor according to how much voltage is applied to the motors that are determined by the 'ON' time duration.

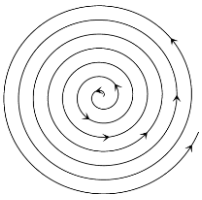

Fig.9: Spiral Pattern

The higher the voltage the faster the motor speeds. In Fig. 10 shows two different PWM signals. The PWM signal1 are used to drive the motors slower than the lower PWM signal 2.

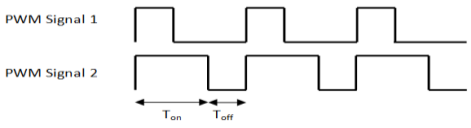

Fig.10: Two PWM signals

3.2 Rectangular Pattern

For rectangular pattern length and width of the field should be inputted which grass has to be cutting. Then the length is converted into number of forward wheel rotation and the width is converted into number of turn (left or right). How the RLM is cut grasses in rectangular mode is shown below in fig 11.

Area = Length * Width
If perimeter of wheel is = x
and distance between two wheels is = y
And,
If length is = a
and, width is = b
then, the number of forward rotation = a/x
and, number of turn = b/y
Cutting pattern of rectangular types shown below:

Fig.11: Rectangular pattern and turning method

3.2.1 Turning Method

When one wheel is completely stopped and the other being running, the mower starts rotating staying at a same place. To turn the face of the mower in opposite direction as shown in Fig.11 the running wheel has to traverse a distance equal to half of the perimeter of a circle. And it's radius is equal to the distance between two wheels. If distance between two wheels = radius of the circle = y
Now, perimeter of the circle = 2πy
and, perimeter of wheel = x
So, number of rotation to turn opposite direction = πy/x

4. IMPLEMANTATION

The Lawn Mower successfully implemented which consists of a12V power supply battery, display and input circuit, obstacle detector circuit, counting circuit and control board (Arduino Mega) shown in Fig.12. Two 12V gear motor are used to drive and a gear less motor used to rotate the cutting blade.

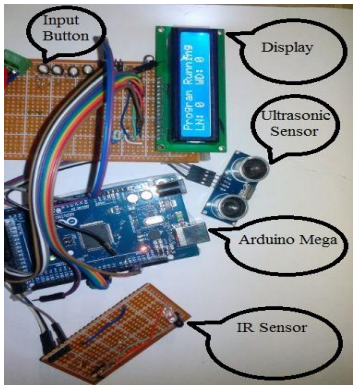

Fig.12: Overall circuit

In display unit, used a LCD display for displaying and four buttons for input and selection. Two button for selection and two for increasing and decreasing. MOSFET (IRF 3205) are used to drive motors. The speed of the motors can be changed by varying the gate pulse of MOSFET. This MOSFET are controlled by Arduino mega with pulse width modulation signal (PWM).In IR sensor unit two IR receivers and transmitter are used. An ultrasonic sensor used to detect the obstacle. The implemented Lawn Mower is shown in Fig.13.

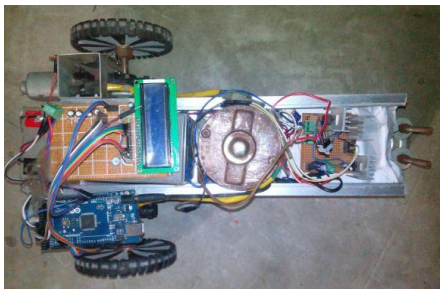

Fig.13: Implemented Lawn Mower

5. RESULT AND ANALYSIS

The RLM is tested in playground for cutting grasses of plain field. It can cut grasses in different height within 1 to 2.5 inch and also can detect obstacle within 2cm to 4m in-front of it. The RLM has successfully cut grasses in play ground by rectangular and spiral pattern. Time required to cut grasses by both pattern is presented in Table 1 and spiral cutting area is shown in Fig. 14.

Table 1: Experimental data

Pattern	Cutting Area(m^2)	Time in Sec
Rectangular	1	24
Spiral	4.6	114

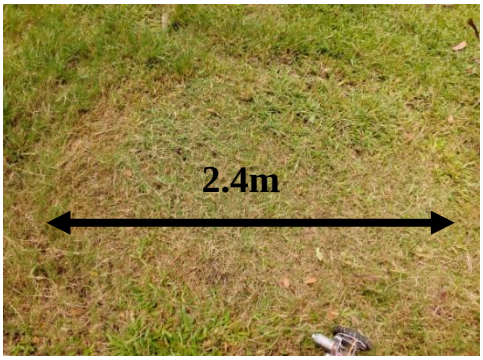

Fig.14: Spiral cutting area.

6. CONCLUCTION

Robotics is large research field. It can be beneficial in many ways. Automatic Lawn Mower is one of the examples which is presented in this paper even though it has some limitations. However further research and works are needed to improve the performance of the robotic lawn mower such as: i) more precise sensor can be used to get better performance ,ii) solar panel can be used for charging the power supply battery.

7. ACKOWLEDGEMENT

Our heartiest gratitude goes to Nipu Kumar Das, Assistant professor, Department of Electrical &Electronic Engineering Chittagong University of Engineering & technology (CUET), Chittagong-4349, Bangladesh for his generous suggestions and guideline on this project.

8. REFERENCES

[1] R. Jarvis ,"A Tele autonomous heavy duty Robotic lawn mower", in Proc. *2001 Australia Conference on Robotics and Automation*, Sydney, 14-15 November, 2001.

[2] Taj Mohammad Balochand Timothy ThienChing Kae, "Design and Modeling a Prototype of a Robotic Lawn Mower", *International Symposium on Information Technology, 2008*. 26-28 Aug. 2008.

[3] Darwin Ramos and Jessie Lucero, "Solar Powered Automatic Lawn Mower" San Jose State University, December9,2009 (On line available: http://www.engr.sjsu.edu/rkwok/projects/Lawn_Buddy.pdf).

[4] S. N. Fatehah Binti Zaini ,"Design and Analysis of Automatic Grass Cutter" University Technical Malaysia Melaka (UTeM), 14 April 2011.

[5] Dipin.A and Dr. Chandrasekhar.T.K,"Solar Powered Vision Based Robotic Lawn Mower", in *International Journal of Engineering Research and Reviews*, Vol. 2, Issue 2, pp: (53-56), Month: April 2014 - June 2014.