Simple Autonomous cleaner Robot

Karthick.T, Ravikumar.A, Selvakumar.L, Viknesh.T, Parthiban.B and Gopinath.A

Departmentof Electrical and Electronics Engineering
Sri ManakulaVinayagar Engineering College, affiliated to Pondicherry university,
Madgadipet,puducherry 605107.

[#]Departmentof Electronics and communication Engineering
Sri Aravindar Engineering College, affiliated to Anna university,
Vanur,Villupuram.

***Abstract*—The aim of this project is to develop an autonomous robot that can move itself without continuous human guidance. The autonomous cleaner robot consists of low power consuming electronic components and it can operate at very low power. Electronic parts are the controller board Atmega 2560, Ultrasonic sensors, voltage regulator IC and motor driver circuit. Mechanical part is motor with gearbox arrangement. Ultrasonic sensors will detect obstacles according to the program being implemented. A 12V,4.5Ah lead acid battery is the power source for this proposed cleaning robot.**

Vacuum cleaning system used in this robot is Cyclonic type filtration system which works under the principle of forced vortex flow same as in case of centrifugal pump. Centrifugal force will be created and all types of debris will be sucked in through pipe. The advantage of using this robot will saves time, it will be very much useful for people with mobility issues to clean the house without any difficulties. It is a simple and low cost robot.

***Index Terms*—Arduino, Atmega 2560**, **Autonomous cleaner robot, Cyclonic filtration,**

I. INTRODUCTION

Recently many robots in the form of mini RC cars and various equipment's are available in the market. Robots are utilized for many applications to assist Human Beings. The conventional vacuum cleaner system consists of large mechanical and electrical parts which are more costly and incur more losses. It works only on AC which consumes more power around 1000W and we cannot use it during power outage period. The autonomous cleaner robot consist of low power consuming electronic and mechanical parts and it can operate during power outage period and does not need any human guidance. By using this proposed autonomous cleaner robot operating cost and initial cost of the machine will be reduced and the human effort and time will be saved. Robots have electrical components which power and control the machinery. That power comes in the form of electricity, which will originate from a battery, a basic electrical circuit plays a vital role here. The electrical aspect of robots is used for movement through motors.Sensing is where electrical signals are used to measure things like heat, sound, position, and energy status.

Karthick.T, Department of Electrcial and Electronics Engineering,Sri Manakula vinayagar Engineering college, Puducherry 605107, India

Ravikumar.A Department of Electrcial and Electronics Engineering,Sri Manakula Vinayagar Engineering college, Puducherry 605107, India

Selvakumar.L Department of Electrcial and Electronics Engineering,Sri Manakula Vinayagar Engineering college, Puducherry 605107, India

Viknesh.T Department of Electrcial and Electronics Engineering,Sri Manakula Vinayagar Engineering college, Puducherry 605107, India

Parthiban.B, Assistant professor Department of Electrcial and Electronics Engineering,Sri Manakula Vinayagar Engineering college, Puducherry 605107, India

Gopinath.A, Assistant professor Department of Electronics and communication Engineering, Sri Aravindar Engineering college, Villupuram, India

Thus robots need some level of electrical energy supplied to their motors and sensors in order to activate and perform basic operations. Robots all have some kind of mechanicalconstruction, a frame or shape designed to achieve a particular task. The mechanical aspect is mostly the creator's solution to completing the assigned task and dealing with the physics of the environment around it.

ISSN: 2278 – 7798

II. BLOCKDIAGRAM

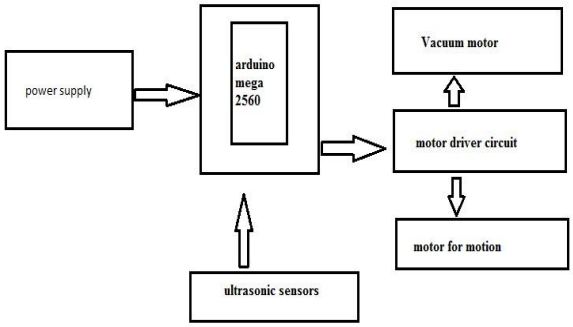

Figure.1 Overall block diagram

A. *Power supply*

Power supply to the robot is given through a lead acid battery, which acts as a heart of the proposed system. Entire power supply to the robot including motor, ultrasonic sensors and controller board is given through the 12V 4.5 AH battery. Power source can also be varied based on the usage time[1].

B. *Controller board*

A controller is a chip or a standalone device that that interfaces with a peripheral device. Controller board acts as the brain of the robot. In this system Atmega 2560 controller board is used.

C. *Ultrasonic sensor*

Ultrasonic sensors are used for the obstacle avoidance since it is the efficient sensor for detecting the obstacles. The human ear can hear sound frequency around 20HZ ~ 20KHZ, and ultrasonic is the sound wavebeyond the human ability of 20KHZ. Its working principle is simple which can be identified with the simple equation

Distance = Speed ×Time -in meter

D. *Motor Driver*

Motor driver is an intermediate circuit that interface Arduino controller with the motor. Arduino cannot run the motor directly since motor requires higher current rating, which can be maintained by the motor driver. Here L293D IC is used as driver circuit There are 4 input pins for this l293d, pin 2,7 on the left and pin 15 ,10 on the right. Left input pins will regulate the rotation of motor connected across left side and right input for motor on the right hand side. The motors are rotated on the basis of the inputs provided across the input pins as LOGIC LOW or LOGIC HIGH [1].

E. *Motor for movement*

Motors are the essential part in locomotion of the robot. Rotation of the motor will assists the wheel to rotate. DC-motors are very easy to use. Their usefulness for robotics is very dependent on the gearing available. DC-motors are made much more effective if they have an efficient gear ratio for a particular task. Here 5 Kg, 300 Rpm motor is used for movement Its current rating load condition is 0.25A

F. *Motor for vacuum system*

Since main purpose of this robot is used to clean the dirt's it should possess the maximum speed motor to get high speed so that the dirt's will be sucked in, Hence a high Speed DC motor of nearly 20000Rpm is being used, this motor is widely used for high speed applications like cooling fans, suction, RC planes etc. Since it has a high speed at no load this motor has been chosen for the vacuum motor. This motor is very light in weight and has a balanced torque to weight ratio at high speed [2]

Its speed varies with the range of voltage levels for 3V its speed will be 6500Rpm, similarly for its speed is nearly 13000Rpm which is essential for sucking the debris. Hence 6V supply is given for the motor to vacuum purpose

III. PROPOSED FILTRATION SYSTEM

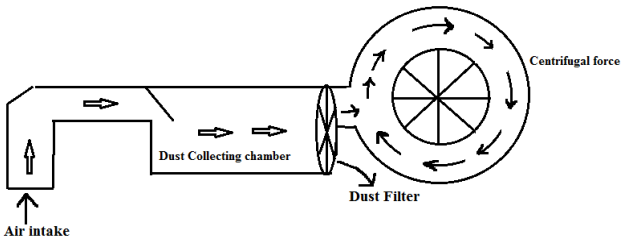

Figure.2 Cyclonic filtration system working

A high speed dc motor is used to make centrifugal force. Whenever the force created the dust will be sucked in and get stored in the dust collecting chamber. Dust filter is used to prevent the dust from damaging the vacuum system fan blade [3].

ISSN: 2278 – 7798

Figure.3 Proposed vacuum system

Figure 3 represents the vacuum system being implemented in the proposed cleaner robot. It has a tube arrangement for dust travelling to the container. The container used is detachable with mesh arrangement for filtering the dust particles[4].

IV. Cleaning methodology

This chapter deals with the methodology being used in this proposed autonomous cleaner robot to achieve the objective of cleaning the floor with less power consumption. Random cleaning is being used in this robot for efficient cleaning process

A. *Random cleaning*

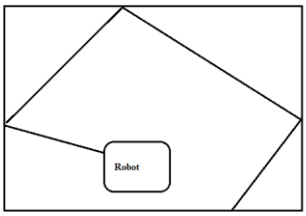

Figure.4 Random cleaning technique

Figure 4 represents the random cleaning technique. This cleaning method does not require any particular value for the cleaning plan.The robot moves in forward direction until an obstacle is sensed and then it turns if there is any obstacle in front of it. Next, it moves according the program being implemented[3].

B. *Flow chart for random cleaning*

The random algorithm is exhibited in Figure 5 In this method both the motion motor will run at fixed speed which is slightly slower than the normal speed and Vacuum motor speed will be higherRandom cleaning can be expressed with the help of single sensors or multiple sensors[6]. Let us know consider the random movement with the help of 2 ultrasonic sensors at the front[5]

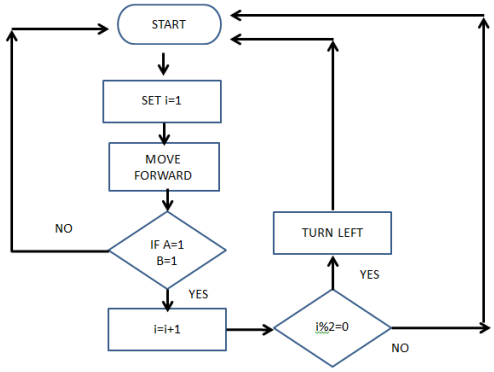

Figure.5 Random Algorithm

Let A and B be the left and right sensors respectively.

V. BATTERY POWER CALCULATION FOR PROPOSED ROBOT

A 12V, 7AH lead acid battery is used to power up the driver and the motor The robot can be operated up to 3 hours by using this battery

DC Geared motor for movement 2 motors

High speed motor for vacuum 1 motor

Battery rating = 12V,4.5 AH

$$\text{Peak power} = \frac{4.3 \times 300}{338.4} \quad (1)$$

Peak power (approximately) = 4 Watt

For 2 motors total wattage for motion = 8 Watt

HIGH SPEED DC MOTOR FOR VACUUM

Peak power = 4 Watt

Total wattage =8+4 = 12Watt

Battery Input energy = 12×4.5=54 Watt hour (2)

$$\text{Working hours} = \frac{54}{12} = 4.5 \text{ hours}$$

Battery should be discharged up to 80% of its capacity

80% of 54 W hour = 43.2 Watt hour

$$\text{Battery working hours} = \frac{43.2}{12} \quad (3)$$

Battery working hours =3.6 Hours

ISSN: 2278 – 7798

Battery working hours = 3Hours 36 minutes

Thus from above equation It is represented that the robot works for 3 hours approximately for the given 12V battery. In similar manner power rating for other batteries can also be calculated.

VI. DESIGN CALCULATION OF ULTRASONIC SENSOR

Ultrasonic sensor consists of transmitter and receiver circuit. Its design calculation is given below[1]

$$\text{Frequency } f = \frac{1}{2\pi RC} \text{ Hz} \quad (4)$$

Where R – Input resistance in Ω

C – Capacitance in Farad

$$\text{Frequency of oscillator 40 kHz} = \frac{1}{2\pi R(\ 0.01\mu F)} \quad (5)$$

R = 398 Ω

$$\text{Input current } I = \frac{V_0 - V_i}{R_f} \text{ in mA} \quad (6)$$

Where V_0 - Output voltage in Volt

V_i - Input voltage in Volt

R_f – ¿ Feedback resistance in Ω

$$15 \text{ mA} = \frac{5-4.5}{RF}$$

$$R_f = 39.8 \text{ k}\Omega$$

$$A_v = \frac{V_0}{V_i} \text{ in dB} \quad (7)$$

Where A_v - gain in dB

$$A_v = \frac{5}{4.5} = 0.9 \text{ dB}$$

$$R_{Comp} = \frac{R \times R_f}{R + R_f} \text{ in } \Omega \quad (8)$$

R_{Comp} = 500 Ω

VII. CLEANING SPEED OF THE PROPOSED ROBOT

$$\text{Area} = \text{length} \times \text{breadth in } m^2 \quad (9)$$

Room dimension = 4.5m× 2.5 m

Room dimension = 11.25 m^2

$$\text{Time} = \frac{Distance}{speed} \text{ in seconds} \quad (10)$$

Let speed of the robot is 0.25 m/s

Robot dimension = 0.2 m × 0.7 m

Robot dimension = 0.14 m^2

$$\text{Time} = \frac{11.25}{0.14 \times 0.25} \quad (11)$$

Time = 341.42 seconds

Time = 5.35 minutes

Hence time consumed by the proposed robot is 5.35 minutes to clean a room of dimension 4.5m× 2.5 m. From this we can calculate the cleaning time for other room dimensions [2].

VIII. HARDWARE RESULTS

A. *Obstacle avoidance*

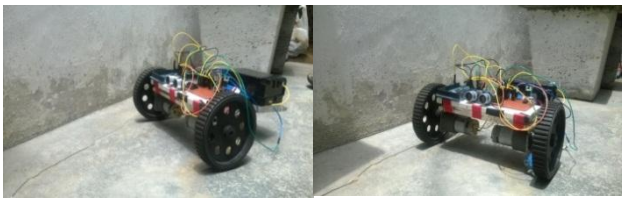

figure 6 (a) and (b) Avoiding obstacles

Figure 6 (a) and (b) represents the avoidance of obstacle when the robot encounters any object or wall at the front

B. *Factors guiding obstacle sensing*

ISSN: 2278 – 7798

There are certain factors which will assist the ultrasonic sensor to sense the objects perfectly, which can be described by the following figure 7.

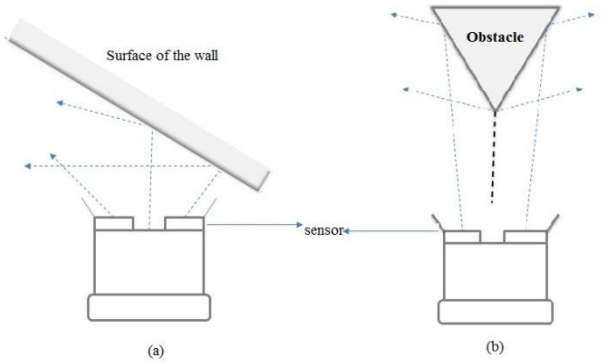

Figure 7Obstacle sensing

From the Fig 7(a) sensor generate an inaccurate measurement however, given that it is the left side of the ultrasonic sensor that is taking the measurement. Hence obstacle should be within its range of measurement say 15º.

From the Fig 7 (b)sensor generate a precise measurement, but it will give a view of the obstacle located directly opposite to the ultrasonic sensor.

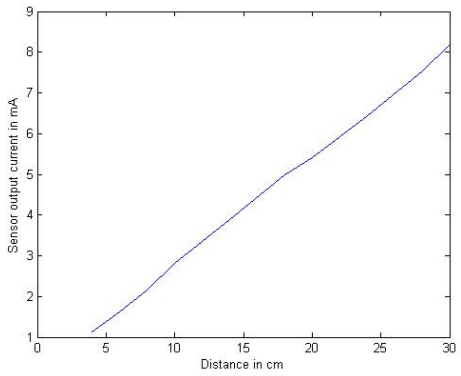

Figure.8 Distance vs Output current of sensor

C. *Comparison of actual and measured distance*

Actual distance and measured distance of the ultrasonic sensor varies from each reading which can be analyzed by the following table

Table 1

DISTANCE MEASURED in cm	ACTUAL DISTANCE in cm	ERROR in cm
100	93	7
70	66	4
50	47	3
40	35	5
30	27	3
20	18	2
10	9	1

It is evident that the measured distance will slightly vary then the actual distance of the object being placed. Hence Ultrasonic sensor is used for obstacle avoidance in the proposed autonomous cleaner robot.

Error = Distance measured – Actual distance (12)

Error = 100 – 93

Error = 7 cm

D. *Result of proposed filtration system*

Figure.9 creation of centrifugal force

Figure 9 represents the creation of centrifugal force and suction of debris through suction chamber.

IX. CONCLUSION AND FUTURE SCOPE

Thus the proposed Autonomous cleaner robot consists of DC battery which can be charged with in a hour and can be used during power outage period. It has a vacuum cleaning system which consumes very less power on comparing with existing system. The existing system consumes very high power of around 500W for suction whereas autonomous cleaning system only requires 10W for suction. So power consumption will reduced greatly and hence the operating cost is also very low.

A. *Future* scope

The additional features that may be added in autonomous cleaner robot are GPS control system using mobile phones for cleaning process. The control is also enhanced by controlling the robot by Bluetooth or zigbee. And by implementing solar panel in the robot we can charge the battery using light energy which can enhance the robot to operate in power failure condition. By implementing the fuzzy logic in the autonomous cleaner robot we can enable artificial intelligence in cleaning.

ISSN: 2278 – 7798

Acknowledgement

We would like to thank Mr.B.Parthiban, for guiding us in the design of autonomous cleaner robot and also we would like to thank our Head of the department(EEE) and college for making this student project.

References

[1]. Design and Development PIC- Based Autonomous robot- Gow Moh Kee and Zainah Md. Zain, Rahmatul Hidayah Salimin

[2]. .Design and Construction of an Autonomous Cleaner Robot, for an aquatic Environment- A. Rincón-Suárez, M. Rubín-Falfán, E. Sánchez-Sánchez and G.Trinidad-García.

[3]. Path Planning Algorithm Development for Autonomous Vacuum Cleaner Robots- Kazi Mahmud Hasan, Abdullah -Al-Nahid and Khondker Jahid Reza.

[4]. A Study on Development of Home Mess-Cleanup Robot McBot- YoungkakMa, Seungwoo Kim, Dongik Oh and YoungwanCho.

[5]. Cleaning robot control- Fumio Yasutomi, Daizo Takaoka, Makoto Yamada, and Kazuyoshi Tsukamoto

[6]. *A Neural Network Approach to Complete Coverage Path Planning- Simon X. Yang and Chaomin Luo.*

First Author: Karthick.T, Student Department of Electrcial and Electronics Engineering, Sri Manakula vinayagar Engineering college, Puducherry 605107.

Second Author: Ravikumar.A, Student Department of Electrcial and Electronics Engineering, Sri Manakula vinayagar Engineering college, Puducherry 605107.

Third Author: Selvakumar.LStudent Department of Electrcial and Electronics Engineering, Sri Manakula vinayagar Engineering college, Puducherry 605107.

Fourth Author: Viknesh.TStudent Department of Electrcial and Electronics Engineering, Sri Manakula vinayagar Engineering college, Puducherry 605107.

Fifth Author: Parthiban.B,Assistant professor Department of Electrcial and Electronics Engineering, Sri Manakula Vinayagar Engineering college, Puducherry 605107

Sixth Author: *Gopinath.A, Assistant professor Department of Electronics and communication Engineering, Sri Aravindar Engineering college, Villupuram, India.*

ISSN: 2278 – 7798