Design and Development of Automatic Vacuum Cleaning Robot

[1]Pritam M. Deshmukh, [2]K.V.Bhadane, [3]Pravin P. Pawar, [4]Rohan R.Sonawane
[1,3,4]UG Student, [2]Associate Professor
Department of Electrical Engineering
Sandip Institute of Engineering and Management, Nashik
Savitribai Phule Pune University, Pune

Abstract: Automatic Vacuum cleaner is a compact robotics system which provides floor cleaning service in room and big offices reducing human labor. Basically as a robot it eliminates human error and provides cleaning activity with much more efficiency. If we clean the floor manually then there is a possibility that the operator will leave some portion of the floor. Also due to manual labor involved this is time consuming and irritating to clean the floor. Also in big offices floor area is very huge and the people involved there for cleaning purpose cannot clean it much more efficiently. This is where the robot comes as an advantage. Also the robot is small and compact in size. So we can carry it and place it wherever we can on the house. Also in industries the robot is very cost effective as compared to manual labor involved. The flexibility, time saving and efficiency make the robot a clean choice for cleaning the floor.

I. INTRODUCTION

An electromechanical device automates the work in many areas like industrial power plants, military applications, Domestic works, agricultural applications etc. Robots are reliable means to bring objects, do settings, clean area etc at places where human interventions are rather impossible or can cause hazardous effect on human health i.e., at nuclear power plants, chemical factories.

This paper focuses on developing a handy remote-controlled vacuum cleaner robot (automatic mode included) based on the principle of robotics. Basically, a robot is built and the vacuum cleaner is attached to it through robotic arm so that it can clean floor, wall and ceiling.

Looking at the present scenario, we have proposed the idea of building robot that include;

a) *Should be an autonomous robot with an option of manual control*
b) *A Robotic Arm that must be able to rotate in 2 axes*
c) *In θ–axis: clockwise and anti-clockwise rotation.*
d) *In Φ - axis: along upward and downward direction motion*

This paper basically focuses on the system which consists of three major parts: a robot chassis with robotic arm, remote controller and vacuum cleaner. The microcontroller is programmed to control the various operation of the robot. In remote controlled mode it works with two major units, one is transmitter and other one is receiver. These two units communicate with each other via radio waves. Here we will design the system to work at a frequency of 433 MHz In automatic mode it has sensors which can detect objects up to a certain range and when it is within that range, it turns in a different direction to avoid collision. Two vacuum cleaners are used one in the bottom of the chassis and another attached to the robotic arm for proper cleaning of the given area.

II. PROPOSED SCHEME

In this work, robot movements are controlled by pressing press to on switches. In the course, when any button is pressed, binary value corresponding to the button pressed will be encoded to serial data using IC74147 and HT12E encoders and is sent using RF transmitter operating at 433.92 Mhz.

Transmitter uses ASK modulation to transmit data. This serial data is received at the receiver part. This received serial data is processed by microcontroller AtMega16 with the help of decoder HT12D. The decoder decodes the serial data into its equivalent binary number and this binary number is sent to the microcontroller. The microcontroller is programmed to take a decision for any given input and outputs its decision to the motor driver in order to drive the motors to control the movement of robot and the robotic.

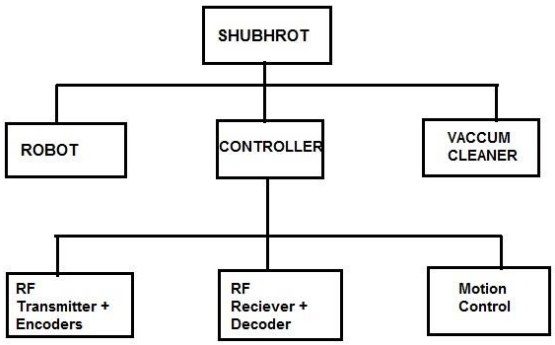

Fig.1. Block diagram representation of decomposition of project problem

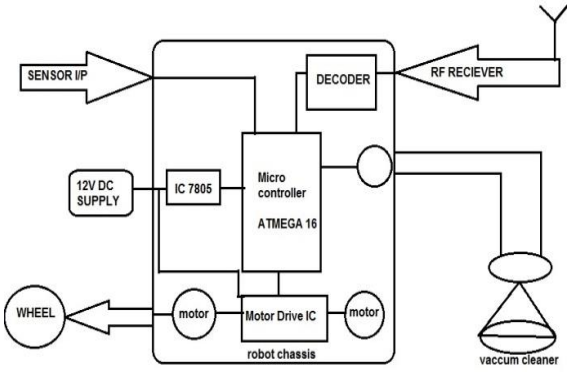

Fig.2. Block diagram representation of robot

The system consists of three basic blocks, each performing important functions.

A. Robot: It consists chassis with mechanical components similar to normal car on which a Robotic arm is placed on top of the chassis and two vacuum cleaners are placed one in the bottom of the chassis and another one attached to the arm.

B. Remote Controller: In the remote depending on the key pressed, the encoders generate control signals which are ASK modulated by the RF transmitter at a frequency of 433.92 MHz and transmitted using an antenna

C. Vacuum cleaner: Two vacuum cleaners are used one in the bottom of the chassis and another attached to the robotic arm for proper cleaning of the given area. In the making of vacuum cleaner for our robot, we have used a Dc motor and fan wing in its shaft to provide sucking power. It is designed in such a way that it creates low pressure inside the cleaner and high pressure outside so that air moves inside the vacuum cleaner taking dust with it. we have provided a sack to collect the dust inside the cleaner that requires a 3v supply. This was provided by using 2, 1.5 v battery cells.

III. HARDWARE COMPONENTS DESCRIPTION

1. ATmega16: The ATmega16 is a low-power CMOS 8-bit 40-pin DIP microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega16 achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption

2. L293D: The L293D is designed to provide bidirectional drive currents of up to 600- mA at voltages from 4.5 V to 36 V.

3. RF Module (Transmitter &Receiver): This RF module comprises of an RF Transmitter and an RF Receiver. The transmitter/receiver (Tx/Rx) pair operates at a frequency of 434 MHz An RF transmitter receives serial data and transmits it wirelessly through RF through its antenna connected at pin4. The transmission occurs at the rate of 1Kbps - 10Kbps.The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter.

4. HT12E Encoder IC and HT12D Decoder IC: HT12E is an encoder integrated circuit of 2^{12}series of encoders. They are paired with 2^{12} series of decoders for use in remote control system applications. It is mainly used in interfacing RF circuits. The chosen pair of encoder/decoder should have same number of addresses and data format. Simply put, HT12E converts the parallel inputs into serial output. It encodes the 12-bit parallel data into serial for transmission through an RF transmitter. These 12 bits are divided into 8 address bits and 4 data bits. It operates from 2.4 to 12v taking input from 2.5v as threshold.

5. DC Geared motors: We have used two 150 rpm motors for providing the motion of the robot and other two motors one 10rpm and other 100rpm for providing movement of robotic arm.

TABLE I: FEATURES OF DC GEARED MOTORS

Sr.No.	Parameter	Range
1	Power	0.5-3W
2	Voltage	3 - 36VDC
3	Output speed	1-150rpm
4	Reduction ratio	1: 6, 1: 10, 1: 20, 1: 30, 1: 60, 1: 90, 1: 180, 1: 270, 1: 540, 1:1620, 1: 2430

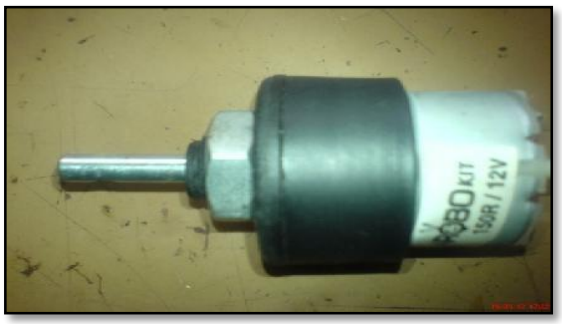

Fig 3. DC Geared motor

6. Wheels: We have used two rubber wheels and two caster wheels for providing motion of the robot. We selected wheels which would fit our work requirement so as to move easily without frictional loss on the floor. Caster wheels were provided for giving balance to the bot.

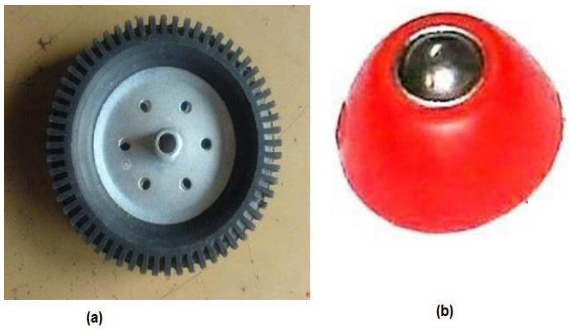

Fig.4.Types of Rubber Wheel

IV. ALGORITHM FOR EMBEDDED C CODE (ATMEGA16) FOR REMOTE CONTROLLED VACUUM CLEANER ROBOT

Step 1: Initialize ADC

Step 2: Set PORTD as output port

Step 3: Read control bits of the remote from the RF RX through ADC

Step 4: Decode the 4bit control information as

- *Manual mode (go to step 7),*
- *Robot control (go to step 5),*
- *Arm position control (go to step 6),*
- *default (go to step 3)*

Step 5: Decode the 4bit bot control information as left, right, forward, backward and set the PORTD correspondingly for controlling the motor. Go to step 3.

Step 6: Decode the 4bit arm position (2 degrees of freedom) control information as clockwise, anticlockwise, elevate, decline and set the PORTD correspondingly for controlling the arm position.

Go to step3.

Manual Mode

Step 7: Read outputs of the sensors through ADC

Step 8: No edge check for obstacles and move or rotate toward no obstacle direction (PORTD is set correspondingly).

Go to step7.

Step 10: Else (edge), Move backward a little.

V. APPLICATIONS

a) It can be used in industrial cleaning where in it reduces human contact to harmful chemicals and industrial waste
b) The robotic arm which has a vacuum cleaner integrated on it may be replaced by a hook connected to a motor to lift things from one place to another.
c) It reduces the necessity for having a maid to clean our houses
d) Used in agricultural operations for instance, in the recovery of grain dust from silos.
e) The same concept can be extended to cars as well where robots move automatically according to dimension of car and clean it.
f) This technology integrated with high power drier could be used to dry up cricket field if there is a shower in the middle of play reducing the delay in drying the field

VI. CONCLUSION

Robotics in turn takes the scale of development by employing various branches, tools, mechanism and performs a wide variety of functions for the benefit of mankind. From this whole ocean of robotics, the work presented in this paper had been successfully tested for design and application as a Vacuum cleaner robot. This work can be extended for a specific application as well as increase its functionalities by proper deployment of sensors and developing new architectures and designs even more accurately.

VII. FUTURE SCOPE

The vacuum cleaner on the robotic arm could be replaced by hand like structure that can lift things from one place to another. Scheduler allows the user to program the Robot to clean at certain times automatically. Homebase robot automatically returns to and docks here for recharging. Virtual Wall can be used for keeping the Robot out of designated areas. Voice controlled locomotion of robot instead of button control.

VIII. REFERENCES

[1] Razvan Solea, Adrian Filipescu and Grigore Stamatescu" Sliding-mode real-time mobile platform control in the presence of uncertainties", Decision and Control(2009) 3216-18

[2] T.Palleja,M.Tresanchez,M.Teixido,J.Palacin , Modeling floor-cleaning coverage performances of some domestic mobile robots in a reduced scenario", Robotics and Autonomous Systems(2010) 58 37- 45.

[3] M.R.B. Bahara, A.R. Ghiasib, H.B. Bahara, "Grid roadmap-based ANN corridor search for collision free, path planning", ScientiaIranica (2012) 191850-1855.

[4] Ayoub Bahmanikashkoolia , Majid Zareb, Bahman Safarpourc, Mostafa Safarpourd" Application of Particle Swarm Optimization Algorithm for Computing Critical Depth of Horseshoe Cross Section Tunnel "APCBEE Procedia(2014)9207–211

Go to step7.

[5] Spyros G. Tzafestas"9 – Mobile Robot Control V: Vision-Based Methods",Introduction to Mobile Robot Control(2014)319–384

[6] Masoud Nosrati, Ronak Karimi,Hojat Allah Hasanvand"Investigation of the * (Star) Search Algorithms: Characteristics, Methods and Approaches" Applied Programming (2012) 2251-256

[7] Ashraf A. Kassim, , B.V.K. Vijaya Kumar"Path planners based on the wave expansion neural network",Robotics and Autonomous Systems(1999) 261–22

[8] Kishor V.Bhadane , "Control and Protection Model for the Distributed Generation and Energy Storage System in Micro Grid". Journal of Power Electronics, Vol. 16, No. 2, pp. 748-759, March 2016

[9] Kishor V.Bhadane , "Smart Embedded Electrical Power Generation for Housing Society", Vol. no.08, Issue No.08,April 2017, pp.75-85.