SMART FLOOR CLEANING ROBOT

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ABSTRACT

The world today is governed by automation. When complex operations are made automated to simplify tasks, the benefits of automation can also be tapped to perform simple household tasks. One such task is cleaning. Cleaning, though undermined for its nature of work, is extremely vital. Cleanliness begets a healthy life. However, in the hustle and bustle in today's world cleanliness has been neglected. The smart floor cleaner is both an autonomous and manual controlled cleaning machine used to simplify and achieve the task of cleaning. By means of its dry and wet modes all round cleanliness and hence good health is achieved. With the advancement of technology, robots are getting more attention of researchers to make life of mankind comfortable. This paper presents the design, development and fabrication of prototype Smart Floor Cleaning Robot using IEEE Standard 1621 (IEEE Standard for User Interface Elements in Power Control of Electronic Devices employed in Office/Consumer Environments). Subject robot operates in autonomous mode as well as in manual mode along with additional features like scheduling for specific time and bagless dirt container without-dirt disposal mechanism. This work can be very useful in improving lifestyle of mankind. Index Terms—Autonomous roaming, manual control, power status indications, power controls, power efficient, cleaning robot.

Keyword- *robot,Arduino,lcd.*

INTRODUCTION

In recent years, robotic cleaners have taken major attention in robotics research due to their effectiveness in assisting humans in floor cleaning applications at homes, hotels, restaurants, offices, hospitals, workshops, warehouses and universities etc. Basically, robotic cleaners are distinguished on their cleaning expertise like floor mopping, dry vacuum cleaning etc. Some products are based on simple obstacle avoidance using infrared sensors while some utilize laser mapping technique. Each cleaning and operating mechanism of robotic floor cleaners has its own advantages and disadvantages. For example, robots utilizing laser mapping are relatively faster, less time consuming and energy efficient but costly, while obstacle avoidance-based robots are relatively time consuming and less energy efficient due to random cleaning but less costly. Some countries are way back in manufacturing robotic cleaners. Importing them from abroad increases their costs. The main objective of this work is to provide a substantial solution to the problem of manufacturing robotic cleaner utilizing local resources while keeping it low costs in this work, "smart floor cleaning robot" has been designed for consumer/office environments and its each component in accordance with IEEE Standard is discussed. Proposed design is being operated in dual modes. In one of the modes, the robot is fully autonomous and making decisions on the basis of the outputs of infrared proximity sensors, ultrasonic sensors and tactile sensors after being processed by Arduino (mega) controller and control the actuators (2 DC encoder motors) by the H-bridge driving circuitry. In manual mode, the robot can also be used to clean a specific area of a room by controlling it manually from laptop

with a Graphical User Interface (GUI) in Visual Studio (C# programming language) via Bluetooth connectivity.

DESIGN METHODOLOGY

A number of software and hardware implementation techniques were used to design and develop the system. Fig. 1 shows the block diagram of system. We used a 12VDC motor, L293D IC, Different Sensors, Real Time Clock, Vacuum mechanism and Arduino to develop our system.

The operation of the robotic vacuum is going to be based on retrieving data from an array of inputs that will tell the condition of the floor space around the vacuum. These inputs include sonar, touch sensors, and a digital compass. Each of these parts will be described in further detail further on later in the documentation. The data from these inputs will be fed into the chip(s) which through its software program will decide which direction the vacuum should move by sending the control signals out to the drive motors.

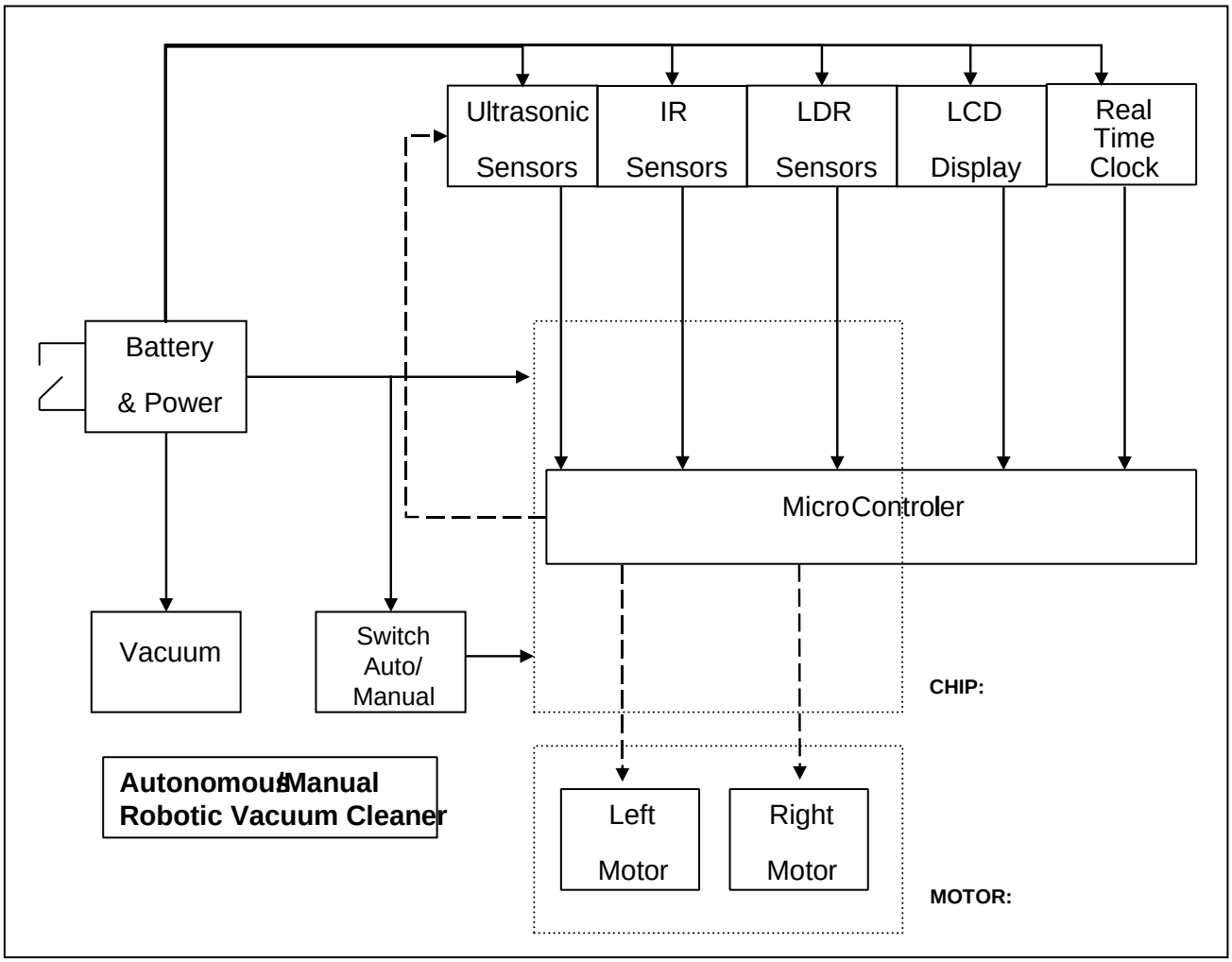


Figure 1.1 The initial block diagram for the Autonomous/Mannual Robotic Floor Cleaner

Components:

2.1 Microcontroller: Arduino Mega 2560

The Arduino Mega is a microcontroller board based on the ATmega1280 (datasheet). It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

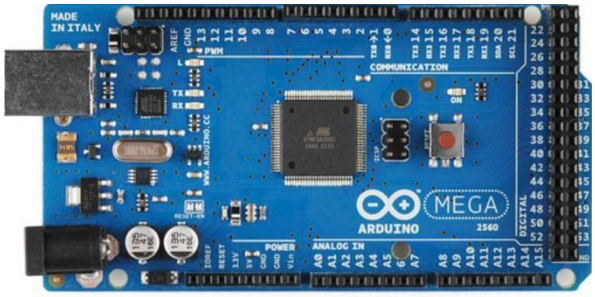
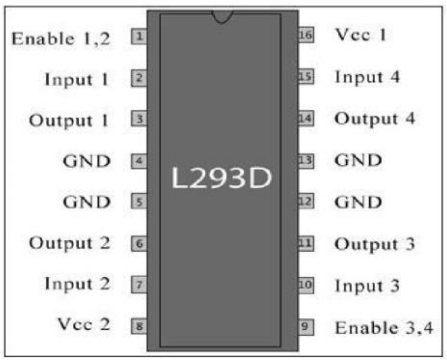


Figure 2.1: Arduino Mega Front

2.2 Motor Driving IC L239D

A very easy and safe is to use popular L293D chip. It is a 16- pin chip. The pin configuration of a L293D along with the behaviors of motor for different input conditions is given in fig. 4. The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. When an enable input is high, the associated drivers are enabled. Also their outputs are active and in phase with their inputs. When the enable input is low, those drivers are disabled, and their outputs are off and in the high-impedance state. With the proper data inputs, each pair of drivers forms a full-H (or bridge) reversible drive suitable for solenoid or motor applications.

Table 2.2: Behaviours of motor for different input conditions



Direction	Motor 1		Motor 2	
	Input 1	Input 2	Input 3	Input 4
Forward	High	Low	High	Low
Reverse	Low	High	Low	High
Left	High	Low	Low	High
Right	Low	High	High	Low

Figure 2.2.1: (A) Pin configuration of L293D

The dc motor and L293D IC has been connected according to the fig. 9. The circuit schematic as shown has been designed using Proteus 7.

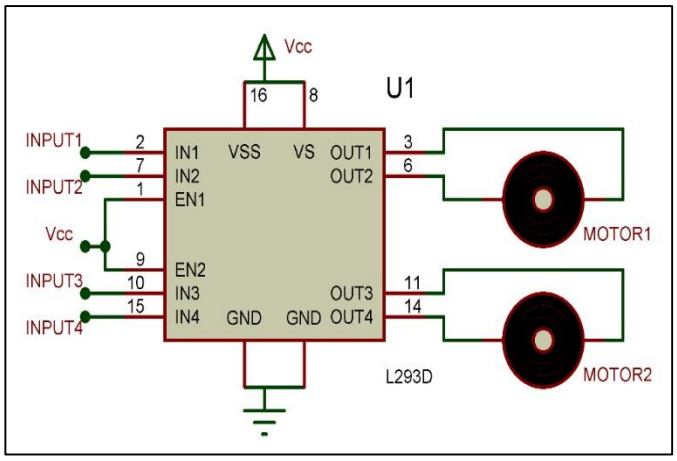


Figure 2.2.2: Screenshot of DC motor and L293D IC interfacing circuit

2.3 DC Motor

Almost every mechanical movement that we see around us is accomplished by an electric motor. Electric machines are means of converting conventional energy. Motors take electrical energy and produce mechanical energy. Electric motor is used to power hundreds of devices we use in everyday life. An example of motor used in day to day life is automobiles, food blenders and so is vacuum cleaner.

2.4 Bluetooth (HC - 06)

For the communication of the robot with the cell phone or a mobile we are using the Bluetooth device. The Bluetooth device (HC-06) is attached to the robot that receives the data from the mobile and also it can transmit the data. It is used for converting serial port to Bluetooth. It has two modes: Master and Slave. Bluetooth is a wireless communication protocol running at the speed of 2.4 GHz with the architecture of client-server and which is suitable for forming personal area networks. It is designed for devices such as mobile phones (low power). Bluetooth protocol uses the MAC address of the device. Bluetooth gives the connectivity between two devices using their MAC address.

Figure 2.4: Bluetooth Module

2.5 IR Sensor

The sensor consists of two eyes. One eye sends the infrared light and the other eye sees the reflection of that infrared light and measures the distance which is then sent to the Arduino through analog input to perform further operations based on the distance. There are three wires coming from the sensor .i.e. Red, Black and White or it can be Red, Brown and Yellow. Red is connected to 5V

of Arduino. Black or brown to Ground of Arduino. White or yellow to analog input pin of Arduino i.e. in this case to analog pin 0.

2.6 LDR Sensor

The light dependent resistor is an electronic component whose resistance decreases with increasing light intensity. It is also called as "Photo Resistor" or "Photo conductor". The light dependent resistor uses high resistance semiconductor material. When light falls on such a semiconductor the bound electrons [i.e., Valence electrons] get the light energy from the incident photos. Due to this additional energy, these electrons become free and jump in to the conduction band. The electron –hole pairs are generated. Due to these charge carriers, the conductivity of the device increases, decreasing its resistivity.

2.7 Ultrasonic Sensor

This sensor is a high-performance ultrasonic range finder. It is compact and measures an amazingly wide range from 2cm to 4m. This ranger is a perfect for any robotic application, or any other projects requiring accurate ranging information. This sensor can be connected directly to the digital I/O lines of your microcontroller and distance can be measured in time required for travelling of sound signal using simple formula as below. Distance = (Echo pulse width high time * Sound Velocity (340M/S)/2) or Distance in cm = (Echo pulse width high time (in us)*0.017) The module works on 5VDC input and also gives an output signal directly for detection of any obstacle up to 4M.Power up the sensor by 5VDC using pins "VCC" and "GND". First of all a 10us trigger input has to be given to the pin named "Trig" on the sensor. This starts one cycle of range conversion and sends 8 bursts of sound waves from the transmitter. As soon as the signals are transmitted the "Echo" pin goes to high level and remains in high level until the same sound waves are received by the receiver. If the received sound waves are same as what the same sensor transmitted then the Echo pin goes to low level. If no object is detected within 5M after 30ms the Echo signal will automatically go to low level.

Figure 2.7: Ultrasonic Module

2.8 Real Time Clock

A **real-time clock** (**RTC**) is a computer clock (most often in the form of an integrated circuit) that keeps track of the current time. Although the term often refers to the devices in personal computers, servers and embedded systems, RTCs are present in almost any electronic device which needs to keep accurate time.

Although keeping time can be done without an RTC, using one has benefits:

- Low power consumption (important when running from alternate power)
- Frees the main system for time-critical tasks
- Sometimes more accurate than other methods

2.9 LCD 20X4 Module

A liquid crystal display (LCD) is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals. Liquid crystals do not emit light directly. 20x4 means that 20 characters can be displayed in each of the 4 rows of the 20x4 LCD, thus a total of 80 characters can be displayed at any instance of time.

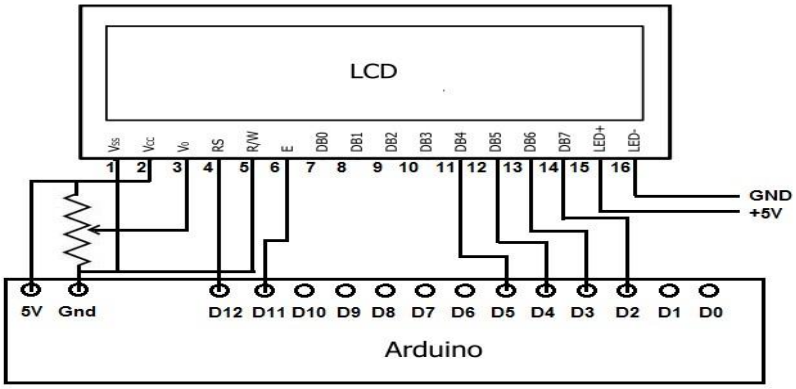


Figure 2.9: LCD Module

APPLICATION SOFTWARE

The Android app is generally developed using JAVA language. The app controlling this vacuum robot can be built without having the knowledge in java language. It is called as “VBot211” developed by MIT App Inventor. Shown below is a diagram which shows the interface of the app. The app shown below has 5 buttons and all the button gives 5 different bytes in the output that is to be fed to the microcontroller to further process. For e.g., if we press Up! Button, the Bluetooth module will give 1 byte at its output.

Figure 3.1: Application Display

The app invented by these searches for the Bluetooth devices along with their MAC addresses. The user just needs to select a particular MAC Address. When a particular MAC is selected, the status shown on the screen is "Connected".

RESULT AND ANALYSIS

The aim of this project is to design and develop an Autonomous and Android Application based Vacuum Cleaning Robot.

Table 4.1: Operation of components in different modes

Components↓ Modes→	Autonomous mode	Manual mode
LCD	□	□
RTC	□	□
LDR	□	□
LED	□	□
Switch	□	□
Motors	□	□
IR Sensors	□	NA
Ultrasonic	□	NA
Bluetooth	NA	□

CONCLUSION:

A cheaper and user-friendly Vacuum Cleaner robot can be developed with two different mode of controlling (Manual and Autonomous mode) using an Arduino Board with more electronics functionality. Battery monitoring, self-charging, lighter body weight and to set alarm on/off time manually are the future scope of this project.

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REFERENCES

1. L293D datasheet. Website (www.ti.com)
2. S.Muruganandhan, G.Jayabaskaran, P.Bharathi, "LabVIEW-NI ELVIS II based Speed Control of DC Motor," International Journal of Engineering Trends and Technology (IJETT) Volume 4 Issue 4, April 2013
3. A Technical Analysis of Autonomous Floor Cleaning Robots Based on US Granted Patents, European International Journal of Science and Technology Vol. 2 No. 7 September 2013. Liu, Kuotsan1, Wang, Chulun
4. http://web.stevens.edu/ses/me/fileadmin/me/senior_design/2007/group01/DesignFinal.pdf
5. http://eng.najah.edu/sites/eng.najah.edu/files/robotic_vacuum_pre_1.pptx
6. http://www.ecs.umass.edu/ece/sdp/sdp05/preston/sdp_data/Draft%20System%20Specification.doc
7. http://letsmakerobots.com/node/40288
8. http://www.intorobotics.com/build-diy-roomba-style-robot-vacuum-cleaner/
9. http://www.irobot.com/For-the-Home/Vacuum-Cleaning/Roomba.aspx
10. http://eprints2.utem.edu.my/4710/1/Design_And_Implementation_Of_Vacuum_Robot_-_24_pages.pdf
11. http://www.instructables.com/id/Floor-vacuum-cleaner-robot-controlled-by-Arduino-w/
12. http://www.scribd.com/doc/231094704/Automatic-vacuum-cleaner-project#scribd