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DESIGN AND DEVELOPMENT OF FLOOR-SWEEPER ROBOT

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Abstract

The purpose of this work is to clean the floors in hospitals, auditoriums, malls and workshops. The aim of this work is to design and develop process for cleaning the floor having wet and dry surfaces. It is very useful for cleaning the wet as well as dry floors. In modern days interior decorations are becoming an important in our life cleaning of floor is very important for our health and this floor cleaning machine reduces the effort required for cleaning. Hence this project is very useful in our day to day life. Floor-sweeper is a smartphone-controlled floor cleaning robot which cleans a dirty floor automatically using a set of commands given to your device by a smartphone. Floor-sweeper has two modes of cleaning – Mopping and Wiping. These two variations can be dedicatedly used in various applications in the cleaning industry and can break the manual labor in terms of cleaning is concerned. The device communicates through Bluetooth technology via a HC06 Bluetooth module that will be used to exchange commands to the microcontroller -Arduino Atmega 2560. The robot is given power by a 12V lead-acid battery, the apt voltage requirement used for all motors here. The driver motors use 100 rpm type while the run with mops 60rpm plastic geared motors attached to them. Essentially Floor-sweeper has a very discrete design in terms of compactness and usability as it is very handy and easy to operate. The mops and wipers are used out of waste and hence the objective of innovation is also inculcated in this project.

The overall cost of this machine is also cheap. Such type of machines is widely used for this purpose but they are working under different principles and the cost is very high. In recent years, floor cleaning machines are getting more popular for cleaning large floor area in minimum time. However, in India which is a developing country requires large type of such machines to satisfy the cleaning needs.

Keywords: Robot, floor cleaning, floor sweeper, automatic cleaner, mobbing, wiping.

1. Introduction

Household cleaning is a repetitive task carried out by number of people every day. Hence there is a need of bringing revolution in the area of science and technologies, which could help easily in repetitive tasks which we perform daily. Floor cleaning is mainly of two types- Dry cleaning, which mainly involves removal of dust and particulate matter and wet cleaning, which involves cleaning of the surface with the use of water and other floor disinfectants to clean the floor of liquid waste. Here we had designed a cleaning machine is operated using smartphone. But recent statistics have shown an increasing number of slip and fall incidents due to the unclean floor and have an alarming impact on the safety of the people walking on floors at public places. Slip and fall constitute about 15% of all accidental deaths per year. 1 in 6 workplace accidents is caused due to ineffective floor and surface cleaning. The reason behind ineffective floor cleaning is majorly it being considered as menial and being a very laborious task to do. If we talk about dry cleaning processes, it has taken a greater advancement leap with the introduction of vacuum cleaners. This enables people to easily remove dust and particulate matter not just in industries but in households. But in case of the wet cleaning process or mopping, there hasn't been any major technological advancement and thus makes it much more unappealing to do.

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A Smartphone is use to build on a mobile computing platform, which has more advanced connectivity and computing ability than what a feature phone. An implication on cleaning machine was done by using various techniques such as using Rasp-berry Pi, Arduino, PIC controller and so on. Every implication has its advantages and limitations too. On the basis and study of those limitations new inventions are carried out. Here in this project we are using Arduino Atmega2560 Microcontroller. The innovation in this project is obstacle avoidance and control using android app via Bluetooth. Here we are using sensor to detect obstacles. The cleaning machine uses a microcontroller to detect obstacles and manipulates its direction as per the input from ultrasonic sensor mounted in front and the machine would stop automatically. In India, robots are used for street cleaning, railway station and airport cleaning which are controlled manually. In this project, we are designing a semi- automatic floor cleaner. Which is capable of wet cleaning as well as dry cleaning. For mapping of room, we use different technology. But here we use ultra-sonic sensor for edge detection and obstacle detection. In this project we also use Arduino Atmega 2560 microcontroller. By this project, we tried to reduce the cost of mopping robot as compare with other mopping robots. The Floor sweeper is very simple construction and is very easy to operate; anyone can operate it without any prior training of any sorts with safety.

2. Elements of Sweeper Robot

Robot is an intelligent device having its own brain fed with computer logic so that it can do the work based on the algorithm designed. Autonomous motion of vehicle is guided by the logic controller designed. Robots plays an important role in every field of life. It is used in industries, in households and in institutes. The robots are just becoming as intelligent as human now a days. Mostly an average human uses 2-3 robots per day in his day to day life.

Various robotics parts are: -

1, Pneumatic devices
2, Actuators
3, Sensors
4, Mechanical control devices like valve
5, Microcontroller – Controlling unit

Mechanical control devices are used to control the flow or movement of materials or any other parts present in the device. Actuators are used for controlling a mechanism which ultimately controls a part of the device. Sensors are the sensing devices which transmit a signal and receives the signal and accordingly used to accumulate the various environment information which is ultimately fed to microcontroller for deciding the working of machines. Microcontroller is the brain of robot where program is written and sensors are connected as input and actuators as output. The controlling of the robot is governed by various algorithm like fuzzy controller, machine learning based practices and artificial neural network-based algorithms.

2.1 Body:

The body of the robot has many small components. Like all robots it has sensors, microcontrollers and actuators and other components. It has vacuum pumps connected at the centre as well as front side of the robot. A 100 rpm DC motor is to drive the body and 60 rpm DC geared motor is connected to the robot with the scrubber. One microcontroller over on one motor shield is attached and also one ultrasonic sensor is attached to it. The scrubber rotates at very high speed which performs very good mopping action.

2.2 Navigation System

Navigation system of the robot is basically dependent on the sensors, bluetooth module and microcontroller and algorithm fed to it. Basically, the data acquisition system (here sensor) first collects the data from the controller through smart phone and feeds to microcontroller. The

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microcontroller uses the following algorithms are: -

1, Mop motion algorithm.
2, Random Straight path following.

2.3 Mop Motion

Basically, after sensing the obstacle distance from outside environment, if the robot has sufficient space on its four sides, it will move in mop path at first half of its running. The mop path can be rotate either direction of anti-clockwise and clockwise.

Basically, random straight path searches from one node to another by the help of natural heuristic search. After the mop motion the robot if detects a collision then it follows the edge of the wall until it gets enough free space for mop motion again. After some moment if it doesn't get any specific clear area for mop motion then it will move in random path for some time and the obstacle detection and avoidance system will be carried out by the help of ultrasonic sensors. After that robots stop rotating if the timer is over. In this process we can divide a particular area in the floor as grids and move accordingly so that it will have very confine control over the robot. So, it will have grid-based search over the floor for movement. Finally, we implemented computer vision by the help of ultrasonic imaging and analysing the image for the dust particles by the help of supervised learning and clustering the data.

2.4 Arduino Atmega2560:

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560 (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 an AC-to-DC adapter or battery to get started. The Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila. The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than fiveVolts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts. The ATmega2560 also supports TWI and SPI communication. The Arduino software includes a Wire library to simplify use of the TWI bus.

Fig. 2.4. Arduino Atmega 2560

2.5 Arduino motor shield l293d:

The L293D is a dedicated module to fit in Arduino UNO R3 Board, and Arduino MEGA. It is actually a motor driver shield that has full featured Arduino Shield can be used to drive 2 to 6 DC motor and 4 wire Stepper motor and it has 2 set of pins to drive a SERVO L203D is a monolithic integrated that has a feature to adopt high voltage, high current at four channel motor drivers designed to accept load such as relays solenoids, DC Motors and Stepper Motors and switching power transistor. To simplify to use as two bridges on each pair of channels and equipped with an enable input. A separate supply input is provided for the logic, allowing operation at a lower voltage and

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internal clamp diodes are included. The device is suitable for use in switching applications at frequencies up to 5 kHz. The L293D is assembled in a 16-lead plastic package which has 4 centre pins connected together and used for heat sinking. The L293D is assembled in a 20-lead surface mount which has 8 centre pins connected together and used for heat shrinking.

Connect type:

i. Control up to 4 DC motors.
ii. Control 2 Servos.
iii. Logic Control Voltage VSS: 4.5 ~ 5.5 V
iv. Motor Supply Voltage VSS: 15v
v. Drive operating current IO: 1.2A
vi. 8 Stage Serial Shift Registers

Motor requires more energy especially cheap motors since chip motors less efficient. The important thing you need is find out what voltage require you're going to use. Some small motors are only intended to run at 1.5 volts but it is just a common to have 6 ~ 12v motors. The motor controller on L294D shield is design to run at 4.5v to 25v. Most 1.5 ~ 3 volts motor will not work on this shield. Another thing you need is to figure it out how much current the motor will support? The L293D chip support up to 600 mA per motor, with 1.2A peak current.

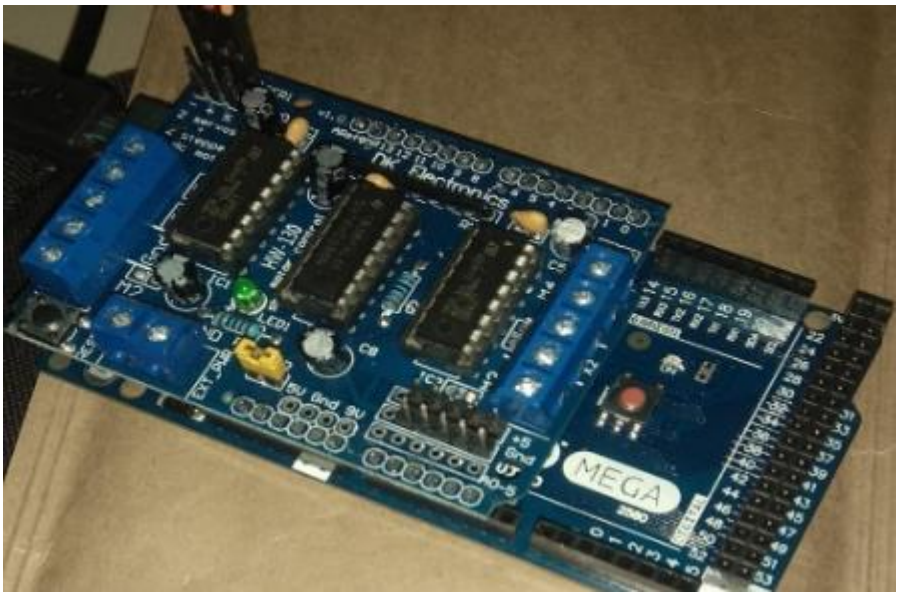

Fig. 2.5 Arduino L293D motor shield

2.6 Blue Tooth Module

HC-06 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. The HC-06 Bluetooth Module can be used in a Master or Slave configuration, making it a great solution for wireless communication. This serial port bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Bluecore 04-External single chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature).

The Bluetooth module HC-05 is a MASTER/SLAVE module. By default, the factory setting is SLAVE. The Role of the module (Master or Slave) can be configured only by AT COMMANDS. The slave modules cannot initiate a connection to another Bluetooth device, but can accept connections. Master module can initiate a connection to other devices. The user can use it simply for a serial port replacement to establish connection between MCU and GPS, PC to your embedded project, etc. Just go through the datasheet for more details.

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Fig.4.3 Bluetooth module

3. Working Principle of model:

In this project, for controlling the robot we are using Bluetooth and it is at the transmitter side and receiver side. By passing the commands, from mobile phone and maintain minimum prescribed distance by the Bluetooth committee for transfer of information. Based on the instruction's robot will starts the working.

When the instruction transmitted to the parent device the command pass to the microcontroller (Arduino Atmega 2560). Then per-coded command is compiler with slave command. After compiling microcontroller process according to the command. For example, from the phone we send a "F" command to slave device microcontroller it compiles the command and process according "on" the motor for moving "forward" like this all command are process according to our need.

4. Conclusion:

The product thus developed is fully operational and gives desired motion. It is being tested in a room which results in successful outcome. The scrubber design should be modified in future because the current design has few problems. Few of those are the motor is not detachable and the high rpm leads to vibration of the whole system. If these features will be modified, this will work well. In our case 2 vacuum pumps are used which leads to loss of power. This can be reduced by substituting these 2 pumps with one pump having 2 path ways. This will be the next development stages. This not only decreases cost but also increases reliability of the instrument. Overall, the concept is very much helpful and there is scope of a lot of development in mechanical parts. The optimization will continue till achieving the best one. Overall, the project is successful to its intent and will definitely change the era robotics and floor cleaning. In the automation part the algorithm are designed to give 90% efficiency which is too high in current scenario. The development can be made in the field of sensing. But this product has the capability to detect as well as move in the direction of dust and thus resulting in better cleaning of floors. As a whole this is a successful product developed that can be used in current Indian house-hold.

5.Future Scope:

The scrubber design should be modified in future because the current design has few problems. Few of those are the motor is not detachable and the high rpm leads to vibration of the whole system. If these features will be modified, this will work well. The development can be made in the field of sensing and to detect as well as move in the direction of dust and thus resulting in better cleaning of floors. Monitoring, self-charging, lighter body weight, to set alarm on/off time manually, Voice controlled locomotion of robot instead of remote control, Automatic charging, Virtual wall-used for keeping the robot out of designated areas are the future scope of this project.

References:

[1]. M. Ranjit Kumar and N. Kapilan, "Outline and Examination of physically worked floor cleaning machine," IJERT ISSN: 2278-0181 Vol. 4 Issue 04, April-2015.

[2]. Andrew Ziegler, Duane Gilbert, Christopher John Morse, Scott Pratt, Paul Sandin, Nancy Dussault, Andrew Jones, "Autonomous surface cleaning robot for wet and dry cleaning," U.S.

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Patent 7389156 B2, June 17, 2008.

[3]. Harvey Koselka, Bret A. Wallach, David Gollaher, "Autonomous floor mopping apparatus," U.S. Patent 6741054 B2, May 25, 2004.

[4]. IEEE Standard for User Interface Elements in Power Control of Electronic Devices employed in Office/Consumer Environments, IEEE Standard 1621,2004(R2009).

[5]. Jagdeesh Chandra A.P, Venugopal C.R, Novel Design solutions for remote access acquire and control of Laboratory experiments on DC machines, IEEE transaction on instrumentation and measurement, 6. 2. 2012.

[6]. Jens-Steffen Gutmann, Kristen Culp, Mario E. Munich and Paolo Pirjanian. The Social Impact of a Systematic Floor Cleaner. In IEEE international workshop on advance robotics and its social impacts, Technische University munchen, Germany May 21-23, 2012.

[7] G Tuangzhi Dai and Tiequn Chen.Design on measurement and control system of cleaning robot based on sensor array detetion.In IEEE International conference on control automation Guangzhou, CHINA-MAY 30 to June 1, 2007.

[8]http://www.tutti.ch/thurgau/spielzeuge basteln/modellbau/angebote/experimentier-board-arduino-uno r3_19193472.htm(arduino).

[9]. 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)9 207–211.

[10]. IT-Head solutions, Make innovations easier- ―HC-05 bluetooth to Serial Port Module‖.

[11]. IT-Head solutions, Make innovations easier- ―Ultrasonic Ranging module –HC-SR05‖.

[12]. H.J. Kim, H.J. Lee, S. Chung, and C.-S. Kim, "User-centered approach to path planning of cleaning robots: analysing user's cleaning behavior," in Proc. ACM/IEEE International Conference on Human robot interaction, Washington D.C., USA, pp. 373-380, Mar2007.