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Robotic Automated Floor Cleaner

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Abstract - *Good sanitization and cleaning leads to proper health of human beings, which directly affects our homes and our surroundings. In recent years, cleanliness has become an important factor for the betterment of one's personal health, thus to support the cause we have conducted a study, prepared a design and working model of a Robotic Automated Floor Cleaner, in an attempt to deliver easy and time efficient cleaning of any indoor space, by reducing human efforts. The manually operated units are very laborious and time consuming and as every coin has two sides the fuel operated machines are very costly, affecting the environment. So, we have thought of an alternative which can be used to nullify the former limitations. Dust poses a major risk to the human health in any household, hospital, hotel rooms, dormitories, schools and colleges, etc. Automated machine cleaners are pivotal in the modern era for modern living due to its elective lowering of the labor cost of a human being, saving both time and money. Most of these cleaners are designed purposely to satisfy the special need of the consumers. The project is a collaboration of Mechanical, Electrical and Electronic streams and employs devices and systems of these fields. It is an assembly of various rigid components like chassis, some motors and various electromechanical devices. Our motive is to present a working model of a cleaning machine which will be used in a household with minimum utilization of the resources available with us.*

Key Words: **Motors, Arduino, Bluetooth, Ultrasonic sensors, Robotic, Floor cleaners, Automated Cleaners**

1. INTRODUCTION

Cleanliness plays a vital role in daily life. It is the process of keeping our surrounding dust-free, diseases free for social and intellectual health. Several cleaning solution are available in recent years to keep your house free of dust. MACHINE-CONTROLLED FLOOR cleaners were introduced for the sake of the betterment of mankind. The Vacuum cleaner is one of the best and valuable tools which in turn help homeowner to keep their floors clean. These available vacuum cleaners have their respective pros and cons. Dusting and sweeping is a household chore that has to be repeated everyday to maintain cleanliness of one's household. In recent years cleanliness has become an important factor for betterment of one's personal health and so to support we have proposed a robotic Automated floor cleaner. Basically as a robot it eliminates human errors and provides cleaning activity more efficiently. This Robotic machine is based on simple obstacle avoidance using Ultrasonic sensors. By utilizing local resources reducing power consumption we are making it cost effective. Here we are using image processing technique to achieve a desired motion and to avoid obstacle. To make it simpler we made this device as Wireless Bluetooth enabled device which operates at 2.4GHz ISM band for short range wireless communication. For a reliable mobility of this device we introduced a motor Driver IC which is used to control motors in Autonomous Robots. It acts as an interface between Arduino and motors for hardware projects. Arduino is great where you want the things to respond via manual input and various sensor readings. In case where the owner loses a remote to operate the machine, wireless Bluetooth Application is connected to the Android Application to operate it manually.

1.1 Problem Statement

To maintain Cleanliness daily household chores like Dusting and Sweeping has to be repeated every day. But this physical activity of cleaning can be harmful at times. To counter such problems there are several machines which are designed for ease to humans, breaking down the complex tedious task into simpler one. But these vacuum cleaners are complex, bulky and heavy making it tedious to move and clean. Vacuum cleaners available in market consume hundreds to thousand watts of electricity which in turn increases the electricity bill. The operating electric motor becomes too hot and burnout the vacuum cleaner

motor. While in physical activity of dusting certain particles which when inhaled cause problems in respiratory system of that person which in turn lead to more health issues. Several machines available in market employ specific mechanical and electrical systems to ensure a clean household. Some vacuum cleaners don't offer a reusable dustbin bags. These machines make life and cleaning task more difficult because one has to be physically present for mobility of machine. To reduce such efforts for cleaning our project aims to create a device that is low cost, utilizing local resources to design which serves the purpose of sweeping and dusting from a place which is far away from dusty environment, using DC motors, Android Application, Bluetooth, Ultrasonic sensors and remote controlled device instead of manual labor.

1.2 Literature Review

A.] Journal Automation and controlling of Automated floor cleaners [4]
Traditionally floor is cleaned with the help of dry mop or wet mop using the hand as a potential tool. They have to scrub hard on the surface. This includes cleaning of various surfaces basically cement floors, highly polished wooden or marble floors. Among these floors the rough surface floor such as cement floor, mostly present in semi urban areas are covered with so much dust. The body of the robot has many small components. Like all robots it has sensors, microcontrollers and actuators and other components.

B.] Author Mun-Cheon Kang, Kwang-Shik Kim, Dong-Ki Noh, Jong-Woo Han, and Sung-Jea Ko of A Robust Obstacle Detection Method for Robotic Vacuum Cleaners [1]
Conventional robotic vacuum cleaners (RVCs) with ultrasonic or infrared (IR) sensors present problems in detecting obstacles when they clean the floor in complex situations, for example, under tables or chairs with thin legs. A robust obstacle detection (OD) method based on the triangulation principle for RVCs operating in various home environments. The proposed method uses the IR emitter of the RVC to project a horizontal IR beam toward the floor, following which the RVC's wide-angle vision camera captures an image that includes the IR line reflected by the floor or an obstacle. Obstacles are detected by using the image coordinates of the pixels that belong to the IR line in the captured image.

C.] Author Muhammad Faisal Khan, Abdul Basit Zia and Tahseen Amin Khan of Smart Floor Cleaning Robot (CLEAR) [2]
With the advancement of technology, robots are getting more attention of researchers to make life of mankind comfortable. This presents the design, development and fabrication of prototype Smart Floor Cleaning Robot (CLEAR) 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 bag-less dirt container with auto-dirt disposal mechanism. This work can be very useful in improving life style of mankind.

D.] International journal of Design and Development of Floor Cleaner Robot (Automatic and Manual) by Manreet Kaur [7]
This is the technology that proposed the working of robot for Floor cleaning. This floor cleaner robot can work in any of two modes i.e. "Automatic and Manual". All hardware and software operations are controlled by AT89S52 microcontroller. This robot can perform sweeping and mopping task. RF modules have been used for wireless communication between remote (manual mode) and robot and having range 50m. This robot is incorporated with IR sensor for obstacle detection.

E.] Design and Fabrication of Automatic Floor cleaners by National Institute of Technology Rourkela[6]
Mobile robots are a major focus of current research and almost every major university has one or more labs that focus on mobile robot research. Mobile robots are also found in industrial, military and security settings. Domestic robots are consumer products, including entertainment robots and those that perform certain household tasks such as vacuuming or gardening. From then on more sophisticated robot is designed for household equipment for automating the tasks including washing machine, microwave oven. After that only the revolution of mobile robotics came to household usages.

2. CONTRIBUTION

Robotic floor cleaners have been on the market for some years now, but it's just recently that they have started to become more extensive. Revolutions and growth in technology have allowed manufacturers to

modify and add more convenient features, becoming the key factor for development of fully automated and highly efficient cleaners. They are basically used in residential areas and malls for floors. Robotic floor cleaners usually comprises of programming software, a mobile base, batteries, cleaning system and other accessories and qualities designed to offer propitiousness and effortless use to the end user.

Robotic floor cleaner is still a miniscule part of the global cleaner markets, but they are growing at a good pace. Today's busy manner of living has left little or no time at all for home cleaning chores, also as they provide fully automated functionalities, now are the prime motive for the demand for Robotic floor cleaners across the globe, especially in the developed countries.

3. SYSTEM DESCRIPTION

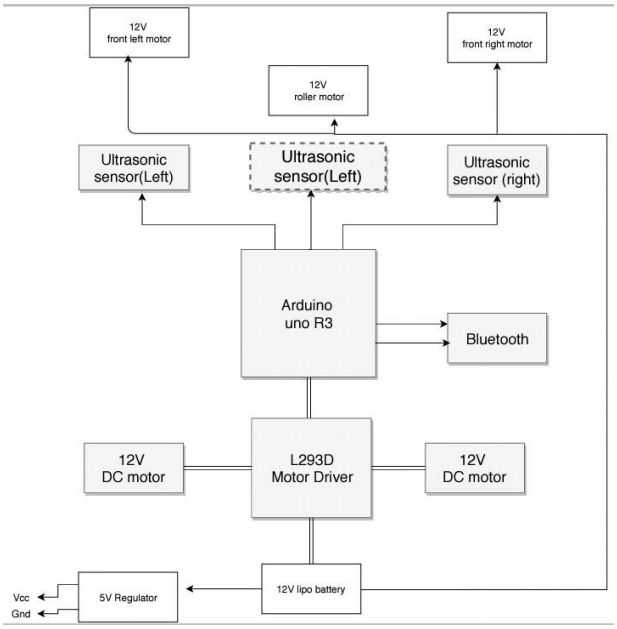

Fig -1: Block Diagram

This is the block diagram of Robotic Automated Floor Cleaner. Here we have used 5 motors. The first 3 motors, i.e. 12V Front-Left Motor, 12V Roller Motor and 12V Front-Right Motor are high speed motors, where the Front-Left and the Front -Right motors comprise of dummy wheels which does not make any motion but rather act as a support to the whole Model. They consist of one brush each for the cleaning, and the roller motor consists of roller brush for the front-back movement. The 2 motors at the bottom, i.e. 12V DC motors are high torque motors which are used to measure the angular velocity of the mechanical component. Here the movable wheels are placed for the movement of the model. The Arduino Uno R3 can't supply the required power to the DC motor, and so to prevent the Arduino from burning, L293D Motor Driver IC is connected to the Arduino. There are 3 Ultrasonic Sensors placed on the frontal, left and right side of the model for sensing the distance to the target. Ultrasonic sensors are used for the automatic mode of the model, as they work using sound waves and so lighter or darker environment wouldn't cause any hurdles for the model to work. For the Manual mode, we've used a Bluetooth which is used to establish a connection between the user's mobile phone and the model, so that the user can operate the model manually. We've used a 12V Lithium Polymer (Lipo) battery, a rechargeable battery connected to a 5V regulator which is used to maintain the output voltage at a constant value.

3.1 Flowchart

A] MANUAL MODE:

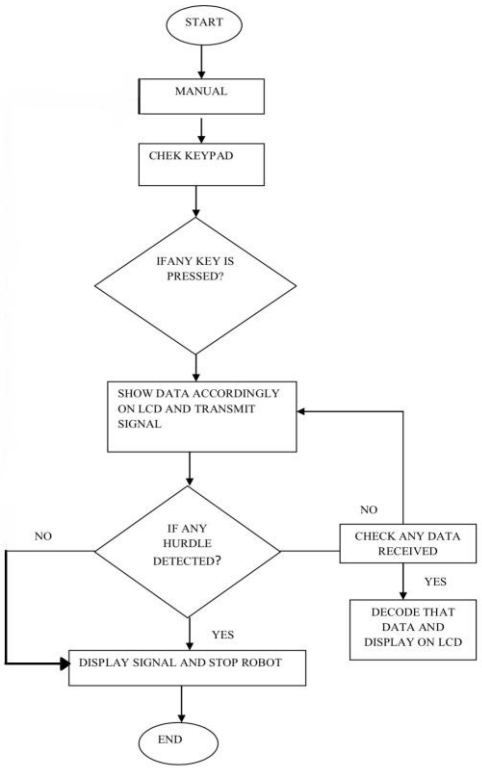

Fig -2: Manual Mode

First it checks if it's on manual mode. If yes, then it checks the keypad. On keypad it checks if any key is pushed, i.e. Left, Right or Center. If yes, then the data is displayed accordingly on the LCD screen, i.e. our

Mobile phone which we are using as a remote to control the robot manually. The data is transmitted to the bot. Then it checks if any hurdle is detected. If yes then the signal is displayed and the robot is informed to stop and it goes back to manual mode. If no hurdle is detected, the robot checks for the data signal received. If the data signal is received, then it starts decoding the data and is displayed on the LCD. If the data signal is not received then it goes back and checks for the data signal transmitted.

B] **AUTOMATIC MODE:**

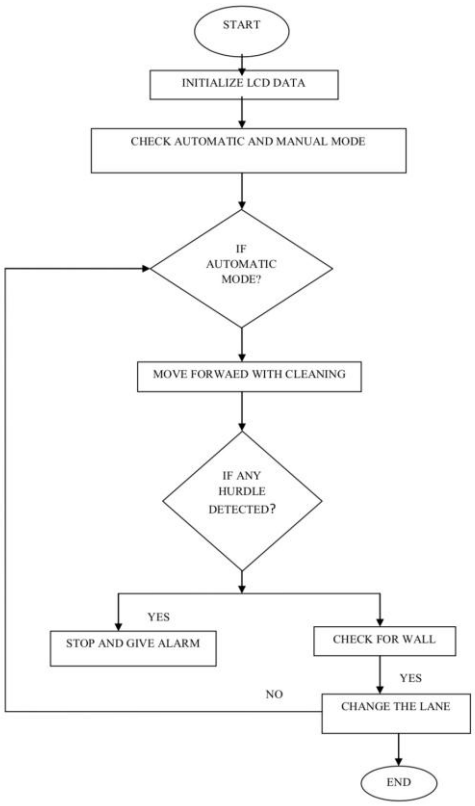

Fig -3: Automatic Mode

First it initializes LCD data. Then it checks if it's on Automatic mode or Manual mode. If it's on Automatic mode then it moves forward with cleaning. Then it checks for hurdle. If any hurdle is detected then it stops immediately and gives alarm. If not then it checks for wall. If yes then it changes the lane and terminates. If no then it continues with cleaning.

4. PARAMETERS

Table -1: ULTRASONIC SENSORS

Sr. No	Parameters	Value
1	Power Supply	+5V DC
2	Effectual Angle	¡ 15 degree
3	Ranging Distance	10cm
4	Measuring Angle	30 degrees
5	Trigger Input Pulse Width	10s

Table -2: MOTORS

Parameter	Front Motors	Rear Motors
RPM	1000	250
Stall Torque	1.2kgcm	10kgcm
No- Load Current	140mA	60mA
Load Current	1A	300mA
Weight	300gm	125gm
Operating Speed	0.23s	0.1s

5. BOT ALGORITHM

1. First we start the bot.
2. Then we select mode in which we want it to operate: Automatic Mode or Manual Mode.
3. If Automatic Mode is selected, then it goes to Auto Mode Subroutine.
4. If Manual Mode is selected then it goes to Manual Mode Subroutine.
5. This loop will go on until we've switched off our power supply

I.] Manual Mode Subroutine:

1. Scanning using Bluetooth data.
2. If data = 1, turn left.
3. If the previous Condition is false, check if data = 2.
4. If yes, turn right.
5. If the previous Condition is false, check if data = 3.
6. If yes, turn backward.
7. If the previous Condition is false, check if data = 4.
8. If yes, move forward.
9. Continue the loop till input is given and executed.

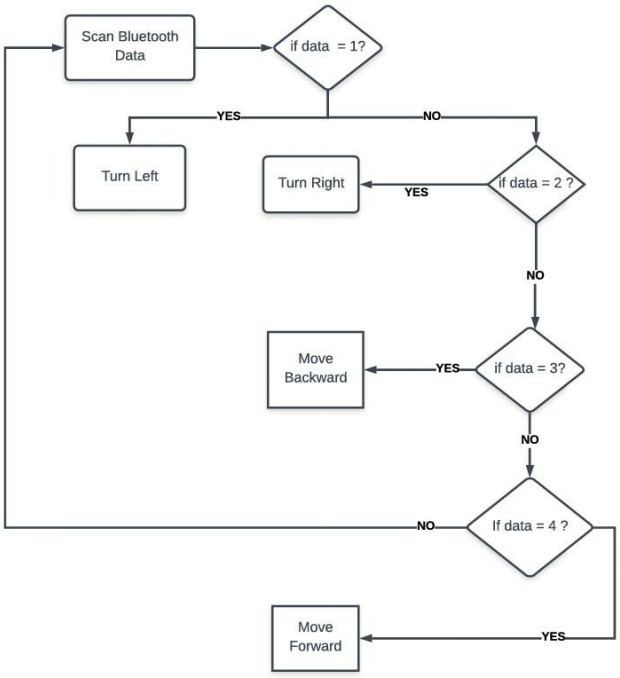

Fig -4: Manual Mode Subroutine

II.] Automatic Mode Subroutine:

1. Scanning using front, left and right ultrasonic sensors.
2. Conversion of obtained data/value into distance i.e. cm.
3. If the distance in the front is less than the maximum distance, turn left.
4. If the previous Condition is false, check the distance to the left side of the bot.
5. If the distance to the left is less than the maximum distance, turn right.
6. If the previous Condition is false, check the distance to the right side of the bot.
7. If the distance to the right is less than the maximum distance, turn left.
8. If the previous Condition is false, check if all the conditions have been satisfied.
9. If yes, start moving backwards.
10. Continue this loop till the Robot gets Power Supply and till the time the conditions are being satisfied.

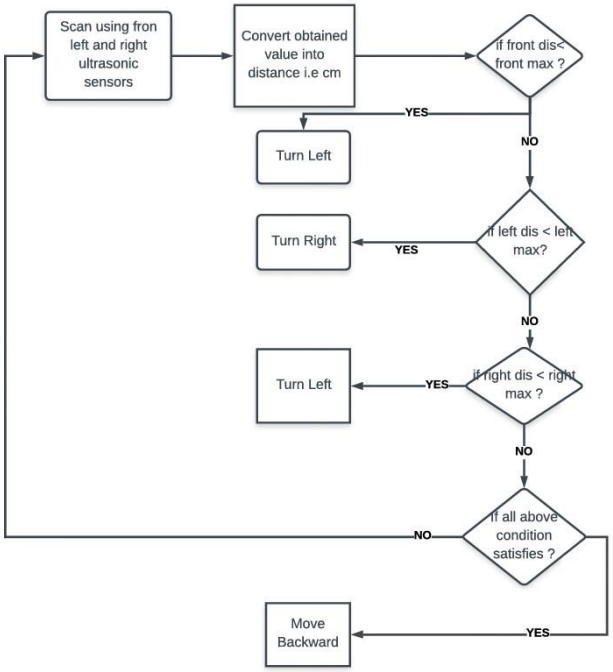

Fig -5: Automatic Mode Subroutine

III.] OUTPUT

After we have done the connections, we copy and paste the code into Arduino IDE and upload it. Once uploaded, we will get to see that both the motors have started rotating.

6. ANDROID APPLICATION

6.1 Introduction

An Android application has been made so that it becomes easy to operate the Robotic Automated Floor Cleaner manually by the user. It becomes easy for the users to operate it via their phone as we have our phones with us all the time, and thus reduces the cost of the remote for handling the Cleaner, and the worry of the remote of it getting lost.

6.2 Operation

Once installed in the Android phone, the user can operate it easily. Directions for use are shown below:

1. Before connecting, a 'DISCONNECTED' tag will be seen in RED. This instructs the user to connect the bot to their Android device via Bluetooth. Without connecting it, the bot will not make any manual function as required by the user.

2. After connecting it via Bluetooth, the 'DISCONNECTED' tag in RED will turn to 'CONNECTED' tag in GREEN.

3. Now the user can make the bot move with the instructions given.

4. If the user wants the bot to move forward, he has to tap on the 'FORWARD' key on the app and it will start moving forward

5. If the user wants the bot to move in the left direction, simply clicking on the 'LEFT' key will do the work.

6. Similarly if the user requires the bot to move in the right direction, the 'RIGHT' key has to be clicked.

7. And if the user wants the bot to come backwards or in reverse direction, clicking on the 'REVERSE' switch will do the work.

8. Once the job is done, the user can disconnect their Android device from the Bot by clicking on the 'STOP' switch. By doing so, the 'CONNECTED' tag in GREEN will turn to the 'DISCONNECTED' tag in RED.

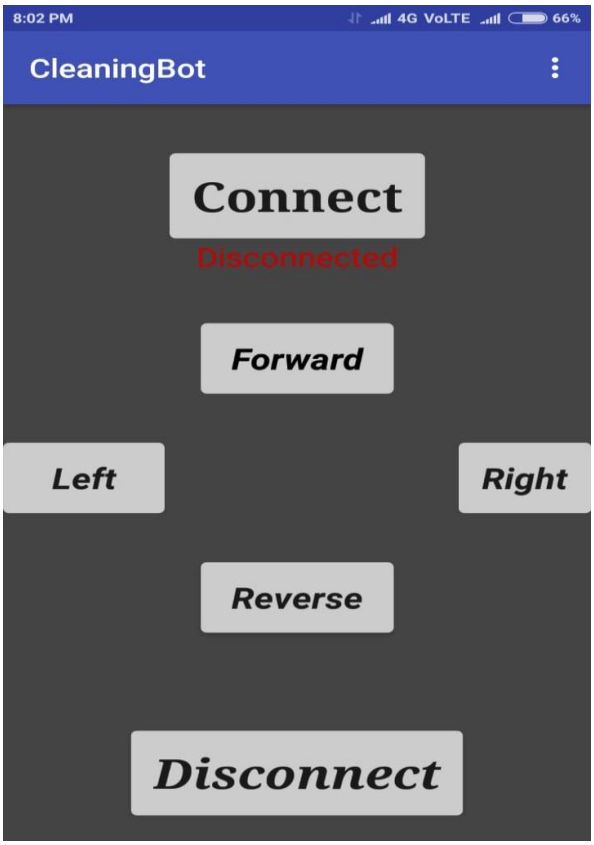

Fig -6: Android app

5. CONCLUSIONS

As the requirement of advanced less time consuming automated machines are in high rise the authors developed this hardware model of smart home cleaning appliance. Analytical study reveals that the simulated results satisfactorily match with the real time hardware operations of the machine. Moreover, the sophistication is of the finest state of art. The model is unique as the user does not need any technical expertise in handling the system. Thus the authors believe that the designed model is commercially viable.

7. Future Scope

Further alterations can be made to the existing system, like an amalgamation of wet and dry cleaning.
A lot of other systems can replace the Arduino, but in turn would increase the overall cost of the system.

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