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Floor Cleaning Smart Robot

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ABSTRACT
This paper presents on smart cleaning robot to makes the tedious, tiresome household works to simpler and automatic. The main objective of this robot is to reduce the human interaction in the cleaning process. The proposed system has mopping section and vacuum section. Mopping section consists of a mop attached to the robot which is used for cleaning the floor. It is attached to a small water container from which water is dipped in order to make the mop wet. Vacuum section consists of vacuum pump for sucking the dust particles on the way. All hardware and software operations are controlled by Arduino mega microcontroller. GSM module has been used for wireless communication between Robot and user. An acknowledgment message is sent to the user when the robot starts working and when the mop needs to be replaced. According to the user convenience, mode of cleaning can be selected. i.e., dry cleaning mode or wet cleaning mode. Other than sending commands, the robot can be turned on and off by pressing external switches. This robot can perform sweeping and mopping task. The robot is able to avoid obstacles and must be capable of cleaning the room upon user command and is designed for a collision free navigation.

Keywords – Arduino, floor cleaning, smart robot, vacuum cleaner, GSM module

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I. INTRODUCTION

From the very beginning of human era, cleaning was one of the tedious tasks. There were many methods for cleaning the premises. But those methods were tedious and needed high effort. It has become difficult for the working population to find time for room cleaning. Because of the difficulties, the existed system was not considered as an efficient method. As the technology has advanced, with the help of automation, cleaning task was made much more efficient. The burden of cleaning can drastically be reduced by means of using an automatic floor cleaner capable of accepting user commands via mobile. Main objective of this project is to design and implement a robot by using Arduino Mega, Ultrasonic Sensor, LCD display, etc. and thereby controlling the robot through user commands by means of GSM. Among various vacuum cleaning robots present in the world only some robots can be used especially for doing the household chores of man. Among those robots, one special kind of robot that is very useful for everyone is cleaning and mopping robot.

A simple automatic robot that uses some prefixed algorithms and programs to clean the specified area is called a cleaning robot. The main use of this robot is to reduce the human interaction in the cleaning process which can be a time taking process. These robots can be used anywhere i.e., in offices, houses, industries etc. These robots can be activated with the press of a single button or can be pre-set to activate at a particular time.

There are many successful products in the market. The leading products are IRobot Roomba, Rrimin Smart Vacuum Cleaners Intelligent Automatic Sweeping Clean Robots, Exilient Ready Maid Robotic Vacuum Cleaner and many more. Every product has its own pros and cons. The main problem with these products is they are costly and not much compatible for Indian users. These products are much effective for wooden floor than the tiles. Some products do work for the tiles but this is available in high-end versions only.Before the early discussions on the project, a market survey has been done in which a target group of 100 families was consulted and enquired about the cleaning and mopping robots. The result of this survey is as shown in the Fig. 1. Fig. 1, depicts the result of the

market survey conducted on a target group of 100 families, from the figure it is understood that more than 60% of the families don't about the existence of such kind of robots and the 40% of them felt that the price of the robot is too high.

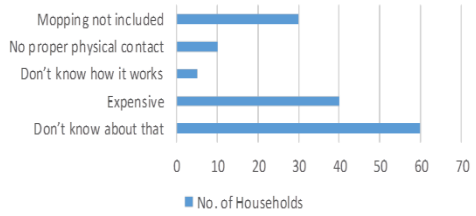

Fig.1 Market Survey on Automatic Cleaning Robot

The main motto of the project is to make a vacuum cleaning and mopping robot which navigates based on information received from ultrasonic sensors and limit switches using an Arduino microcontroller, affordable and suitable for the Indian users and factories. Also, test the working of the robot replacing the IR sensors with the Ultrasonic Sensor, and including the mopping mechanism to the robot. Finally, make the robot effective on the ceramic tiles. These robots can be used anywhere i.e., in offices, houses, industries etc. The next section, section II of this paper provides literature review, section III explains proposed system of smart floor cleaning, section IV provides results, section V and VI provides conclusions and future scope.

II. LITERATURE SURVEY

Earlier sawdust was used to remove water that spilled on the floor. Tea leaves were used to remove the dirt and odour on the carpets. As time passed on, broom sticks and mops were invented. Still it required manpower. The evolvement of vacuum cleaner helps the human to reduce the task of cleaning to an extent by sucking the dust particles. Even though requires the human attention. Later the emergence of room cleaning robot with random cleaning algorithm occurred but the system should be monitored by the user and they failed to produce complete cleaning [1]. After this smart vacuum cleaner in various platforms emerged, but it isn't much convenient for the user and doesn't provide a particular algorithm [2]. Then smart vacuum cleaner using wireless network developed but it is much complex on obstacle detection [3]. Since our requirement is to produce a robot which offers perfect cleaning by mopping and sucking simultaneously. Most of them must be turned ON manually. Table 1 provides survey of existing systems.

Table no.1 Literature Survey

Techniques	Advantages	Disadvantages
Sawdust	Was used to remove water or any liquid that spilled on the floor	Running electricity bill. Depending on the vacuum cleaner model uses hundreds to thousands watts of electricity
Broomsticks and mops	Removes all particles from a hard floor on the first pass makes cleaning more efficient	It requires manpower.
The emergence of room cleaning robot	Vacuum under furniture and beds	The emergence of room cleaning robot with random cleaning algorithm occurred but the system should monitored by the user and they failed to produce complete cleaning
Smart vacuum cleaner	They are more convenient to use because they can vacuum on their own.	Smart vacuum cleaner using wireless network developed but it is much complex on obstacle detection

The main objectives of this project is to design and implement a robot by using Arduino Mega, Ultrasonic Sensor, LCD display, etc. and thereby controlling the robot through user commands by means of GSM. The main motto of the project is to make a vacuum cleaning and mopping robot which navigates based on information received from ultrasonic sensors and limit switches using an Arduino microcontroller,

affordable and suitable for the Indian users and factories.

A simple automatic robot that uses some prefixed algorithms and programs to clean the specified area is called a cleaning robot. The main use of this robot is to reduce the human interaction in the cleaning process which can be a time taking process. This project is to design and implement a robot by using Arduino Mega, Ultrasonic Sensor, LCD display, etc. and thereby controlling the robot through user commands by means of GSM. There are so many cleaning and mopping robots present in the market but only some of them are affordable and economic. There are very fewer robots that include both cleaning and mopping. With this work, we tried to reduce the cost of the robot and make it more compatible with the Indian Users and the Industries.

III. PROPOSED SYSTEM

The proposed system is able to do the whole cleaning process automatically. The user has to keep the robot on the place where the cleaning has to be done. The robot consists of both mopping and vacuum section. It offers the complete cleaning of the room by following an 'S' path. We have incorporated some advancement in GSM technology, SIM 900D for transmission and reception. SIM900D is a Tri-band GSM/GPRS engine that works on frequencies EGSM 900 MHz, DCS 1800 MHz and PCS1900 MHz.SIM900D provides two unbalanced asynchronous serial ports. Autobauding supports baud rate from 1200 bps to 115200 bps. Commands into the robot can be passed as text messages from mobile phones. The robot will be able to receive messages through the GSM module attached to it. Starting and stopping of the robot can be insist by means of messages. Ultrasonic sensors which will record the elapsed time between the sound wave being generated and bounce back wave. The measured distance is compared with predefined threshold value so that it can make a decision for its further movement. It will clean the floor by sucking the dust particles as well as by supports wet cleaning along with it. Stop message from user via GSM helps robot to stop its current task. If the robot is in close vicinity with the user, rather than sending commands via text messages, the user can simply turn on and off the robot by pressing the external switches provided on it.

Figure 2, gives a brief idea of the how the design of Automatic Cleaning and Mopping Robot is done. It starts with deciding on the how the cleaning and mopping is done and ends with the testing and calibration.

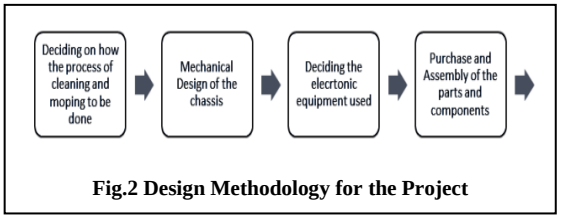

Fig.2 Design Methodology for the Project

Figure 3, shows the working of Automatic Cleaning and Mopping Robot which starts by switching on the device, the robots move forward my checking for obstacles and avoids them if any. As soon as the robot is switched on it starts cleaning and mopping simultaneously and if any obstacle is there in its path it deviates from that and cleans the entire space.

Fig.3 Working Methodology for the Robot

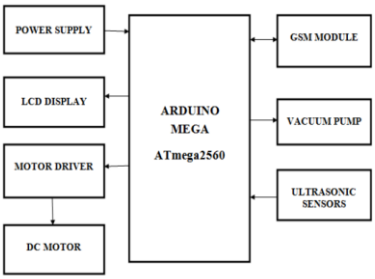

Fig.4 Block diagram of smart floor cleaning robot

The proposed system consists of Arduino Mega, 3 ultrasonic sensors one on front and the other two in left and right side respectively, two geared DC motors, A motor driver, LCD display, GSM module and a vacuum pump. The Arduino Mega controls all the process to be carried out in the system. Ultrasonic sensors are implemented to calculate the distance between the obstacle and the system. In order to detect the edges and to avoid obstacles,

ultrasonic sensors are mounted on front, right and left side. Geared DC motors are which are driven by motor driver (L293D) is used to drive the robot. GSM module is used to transmit the commands through cellular network. Our system can be started and stopped by sending message from mobile phones. Vacuum pump is used to suck out the impurities on the ground. LCD display is used to display the status of the system. It displays the current operation being carried out by the robot.

Here an Arduino mega (Atmega2560) is used as the microcontroller. Circuit consist of a GSM module, an ultrasonic sensor, two L293D driver ICs, two motors, a vacuum cleaner and an LCD Display. The ultrasonic sensor 1 trigger and echo pins are connected PWM pins 12 & 13 of Arduino respectively. The trigger and echo pins of Ultrasonic sensor 2 and 3 are connected to pins 22, 23 and 24, 25 of Arduino respectively. The virtual terminal represents the GSM Module. The RXD and TXD of GSM module is connected to TXD and RXD of Arduino. Motor driver IC (L293D) for driving the two motors are connected in such a way that the IN1 & IN2 for driving motor 1 and motor 2 are connected to pins 2,3 & pins 4,5 respectively.OUT1 & OUT2 of L293D is connected to motor 1 and OUT3 & OUT4 are connected to motor 2 . LCD is interfaced in such a way that RS,E, D4-D7 of LCD is connected to pins 40,38,36,34,32,30 of Arduino respectively and RW pin is grounded. Vacuum cleaner is connected to IN1 another driver IC, IN2 is grounded. ON switch and OFF switch is connected to pins 46 and 44 of Arduino respectively.

IV. IMPLEMENTATION AND RESULTS

Fig 5. shows hardware circuit of smart floor cleaning. The flow chart of the system implementation is shown in Fig. 6.

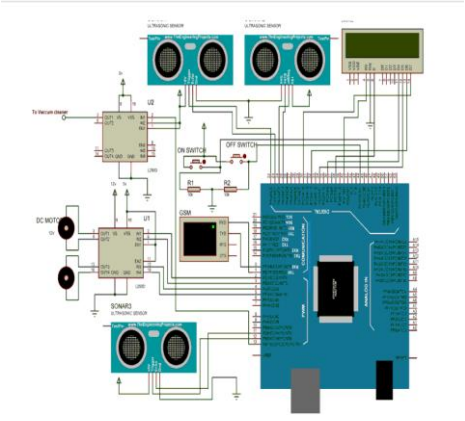

Fig.5 Schematic diagram of smart floor cleaning

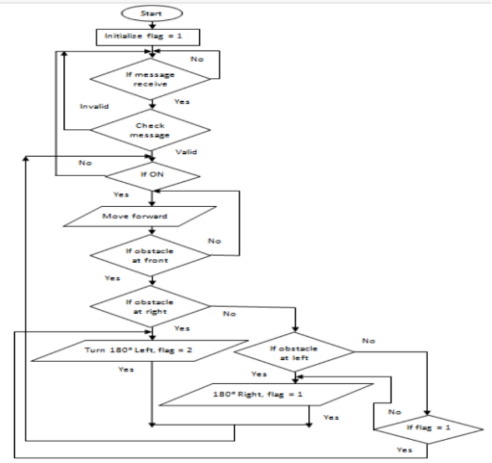

Fig.5 Flow Chart of proposed system Implementation

Initially the flag is set as one. The robot will be in idle condition and will be waiting for the message from the user. The commands are preset on the program. When a valid message is received, it turns on the robot and moves forward. When a single obstacle is being detected at the front ultrasonic sensor, the robot is rotated 180^{o} left and flag is incremented to 2. Then the cycle repeats and on detecting next obstacle the robot rotates 180^{o} right to maintain the 'S' path. On detecting more than one obstacles i.e., if an edge is being detected at left, the robot is turned 180^{o} right and similarly if the edge is detected at right, the robot is turned 180^{o} left and continues the 'S' path. The cycle is repeated until a valid stop message is received. Also an acknowledgement message is sent back to the user when the machine is started and when the mope needs to be replaced. The robot can be turned ON/OFF manually by pressing external switches mounted on it. An acknowledgment message is sent to user when the system starts, when the mop needs to be replaced and when the system is turned off. Algorithm is given below.

Algorithm

1. Start
2. Initialize flag = 1
3. If message is received, check the message. If the checked message is valid, check if it's ON.
4. If the message is not received, check again if the message is received or not.
5. If the checked message is invalid, again check if the message is received or not.

6. If ON, move forward.

7. If obstacle is at front, check if obstacle is at right.

8. If obstacle is not at front, again move forward.

9. If obstacle is at right, turn 180° left and make flag= 2.

10. If obstacle is not at right, check if obstacle is at left. If yes, move 180°right and make flag =1.

11. If obstacle is not at left, check if flag= 1.

12. If flag= 1, turn 180° left and make flag= 2.

13. If flag is not equal to 1, turn 180° right and make flag= 1.

14. If the turn is 180° left and flag =2 and if the turn is 180° right and flag = 1, again check if it's ON and repeat the steps from step 6.

15. End

V. CONCLUSION

In this paper, we introduced an automatic floor cleaning robot capable of performing both vacuum and mopping. It follows an 'S' path in order to assure complete and perfect cleaning. The use of passive IR sensors is replaced with ultrasonic sensor and is the major feature of this robot. GSM module helps to enhance its performance by proper communication between user and robot. Moreover in certain scenario, it is necessary for the robot to run more than once through the floor to ensure complete cleaning.Also, automatic charging process using wireless can be implemented as well as the advancement in speed change mechanism.

VI. FUTURE SCOPE

To further enhance the navigation performance of the robot, feedback sensors such as optical encoders can be integrated. Cleaner brushes can be added to vacuum cleaning mechanism to increase the efficiency of dust collecting. Lithium polymer batteries can be used to reduce the weight of the robot which can further lead to the reduction of power consumption.

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