FLOOR CLEANING MACHINE FOR DIRT AND STAIN REMOVAL

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Abstract. This paper describes the design of floor cleaning machine for dirt and stain removal. The machine has Arduino Uno as the microcontroller. The movement of the machine is done with the help of L293D motor driver and the automated movement is done with help of Ultrasonic sensor HC-SR04 supported by a servomotor of 180 degree rotation. The sensor is fitted for obstacle detection and for obstacle avoidance the Ultrasonic sensor checks for obstacles on both right and left and takes a turn to the side where there is no obstacle. The dust removal is done for the entire floor by the vacuum fitted on the machine. For the stain removal, the Arduino is trained with the flooring colour with the help of colour sensor TCS3200. When the flooring colour deviates from the stored colour the floor is considered as stained. The Arduino is programmed to switch on the mopping kit to remove the stain. Coding the Arduino is done using Arduino IDE software.

Keywords: Obstacle Detection,Dust Removal, Arduino UNO, Colour Sensor TCS3200

1 Introduction

Cleaning is one of the important chores that has to be carried out daily. At times, people are assigned and paid to carry out the cleaning chore but sometimes cleaning is required in areas where presence of living is dangerous. Pandemic situations have led people to a worse condition. Getting out laborer for day-to-day activities had become tough in those situations. Even when we recruit people, we cannot afford them to undertake the work under health threatening situations. In some places, there may be restrictions to human manpower over areas like nuclear plants or chemical industries etc. Many conventional methods are there for cleaning the floor but manual help is needed. For these reasons, an Automated Floor Cleaning Machine is required. The machine is designed in such a way that it is cleans the area reducing the human effort just by energizing the machine. The objective is to build the machine in a way it cleans the whole area. Basically, the machine that cleans by itself must be ergonomic and smaller to move around the floor avoiding the obstacles and be easy enough to lift it in case of any problem to check the cause of the problem or move it to the charging socket to charge the machine [1]. When the types of locomotion were studied to know which is best suited for a floor cleaning machine, wheeled locomotion was found to be the best for easy movement. For free movement, sensing the surrounding area and signaling the microcontroller to perform the necessary action as programmed is essential. These listed features are found in ultrasonic sensor making it a suitable one to detect the obstacles [2]. Further, an ultrasonic sensor helps in detection of all kinds of obstacles ranging from a metal to any transparent object such that even any limitation such as poor lightning cannot affect it [3,4]. Wheels can be fitted at the back and for the balance at the front a small wheel is placed. The wheels and the motors which help in its operation are directly connected without any additional support helps in the avoidance of odometry errors which is caused by the twisting angles. Many methods are present to suck out the dust [5]. Among which vacuum motor can be used to collect the dust into a container. Some floor cleaning machines designed detect dust using many techniques like Gaussian mixture models, Image processing, Convolution Neural Networking. Since our motive is to develop a floor cleaning machine for large area floors and of low cost with all these features, we opted for a RGB colour sensor. The RGB color sensor can helps in the recognition of eight colors where the minimum working distance must be within five cm [6]. Thus, the machine designed is of low cost, low powered and portable.

The following sections of the paper elaborate the technical and the working aspects of the machine. Section II represents the technical specification of the machine. In Section III, the implementation of the design is described followed by the results and discussion in Section IV. Section V sums up the present and the future scope of the designed machine.

2 Technical Specification

2.1 Arduino Uno

Arduino Uno is the brain of the floor cleaning machine. It uses the ATmega328 microprocessor. Arduino has 14 digital pins which can operate either as input or output pins but in digital mode, 6 analog pins and an USB connector pin to supply the power. The required Arduino libraries must be imported for easy programming. Arduino UNO can be programmed using Arduino IDE software and the programming language is Embedded C. The programmed code is imported into the Arduino UNO by connecting it to PC or Laptop using USB cable as a connector. It communicates with the sensors connected and carries out the work as programmed.

Fig. 1. Arduino Uno

2.2 Ultrasonic Sensor

The ultrasonic sensor HC-SR04 emits ultrasonic sound waves to measure the distance between the machine and the obstacle. This is done by calculating the time it takes for the waves emitted by the sensor to strike the obstacles. It has trigger and echo pin which acts as the eyes to the robot. The measurement of the distance ranges between 2cm and 400 cm.

Fig. 2. Ultrasonic sensor HC-SR04

2.4 Colour Sensor

TCS3200 is a colour sensor which converts light to frequency and it is a programmable one. This sensor helps in the detection of variety of colors based on their wavelength with the help of any microcontroller. For sufficient lighting purpose during the colour detection, four white LEDs are provided and the main block contains the sensor chip. Basically, the input voltage given to the sensor is 5V.

Fig. 3. TCS3200 colour sensor

2.4 L293D Motor Driver

The L293D driver board is used for the purpose of driving the DC motors fixed to the wheels by receiving the signal from the Arduino Uno and transmitting the signal to the motors. Since it is a bidirectional motor driver it is fixed to the wheels to drive it in both forward and reverse direction. One L293D motor driver is sufficient to drive both the wheels since it has 16pins. Further, the two voltage pins are used for the purpose of L293IC working and to supply voltage to the DC motors connected to the wheels.

Fig. 4. L293D Motor Driver

3 Design Implementation

The floor cleaning machine block diagram is shown in Fig. 5. The Arduino Uno has the control over the sensors in the system. It gets input from the sensor performs the action as programmed and performs the output accordingly. One of the L293D motor driver is fixed for the movement of the machine. The automated movement is done with help of Ultrasonic sensor HC-SR04 supported by a servomotor of 180-degree rotation helps to check the obstacle and provide input to the Arduino Uno. The Ultrasonic sensor checks for obstacles on both right and left and takes a turn to the side where there is no obstacle. Thus, the machine moves in an automated manner where there is no need of manual help. Colour sensor TCS3200 is connected to Arduino Uno to provide the floor colour as input to Arduino Uno. The other L293D motor driver (mopping component) is powered by Arduino Uno to clean the stain.

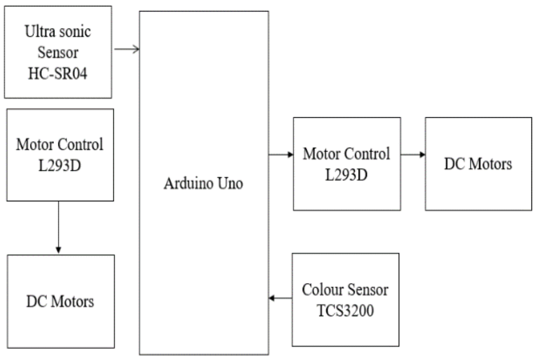

Fig. 5. Floor cleaning machine block diagram

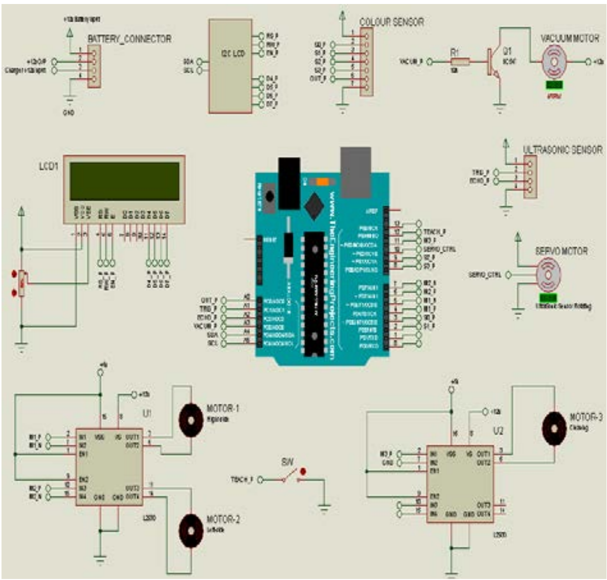

Fig. 6. Floor cleaning machine circuit diagram

The circuit diagram of the floor cleaning machine is shown in Fig. 6. The circuit is energized by 12-volt Lithium-ion battery. Ultrasonic sensor's trigger and echo pins, Vacuum motor input are connected to the analog pins of the Arduino Uno. L293D motor driver boards used for cleaning and movement purpose, Servomotor, TCS 3200 colour sensor are connected to Arduino Uno digital pins. The output of U1 motor driver is given to the 12V motors (wheels) through LM2596 DC-DC Buck Converter to adjust the speed of the wheels by adjusting the output voltage. The machine is designed with two layers to accommodate the components in a balanced way for free movement. Thus designed machine can operate in two modes: i) Dirt Removal ii) Stain Removal.

Dirt removal: The dirt removal is carried out using a vacuum motor. The automated machine goes throughout the floor and the vacuum motor sucks out the dirt present on the floor.

Stain removal: The stains are identified using TCS3200 when the machine moves throughout the floor. When a stain is identified, it is removed using the motor attached for mopping purpose. The motor attached for mopping purpose is connected to U2 motor driver.

4 Results and Discussion

Figure 7 portrays the designed floor cleaning machine. On the completion of the basic connection of the automated vehicle, we faced some shortcomings. It was able to run freely when there was no obstacle and was able to sense when the obstacle was a thicker one in breadth. When the obstacle was too closer when it takes a turn, it was not able to sense since the time is to less for the obstacle to be sensed and hence it hit the obstacle. So, we lengthened the body of the object at the front such that when it hits the obstacle, the ultrasonic sensor gets some time to sense the obstacle and take a turn. On further testing, we noted that when the obstacle is lengthier and does not have a wide open on either side, the machine turned after it sensed the obstacle but hit the obstacle again and couldn't turn much. For this cause, we increased the delay for the machine while taking a reverse. This means that, when the machine senses a lengthier obstacle, it takes a long reverse and then takes a free turn to avoid the obstacle. For stain detection, when the colour deviates from the stored colour in Arduino Uno, the motor driver U2 starts operating the mopping motors. To completely clean the stain, once the colour is identified it has been programmed that the machine goes forward and backward for four times and then checks for the stains in other places. This kind of machine as tested clearly works for large spaced and single floored type places.

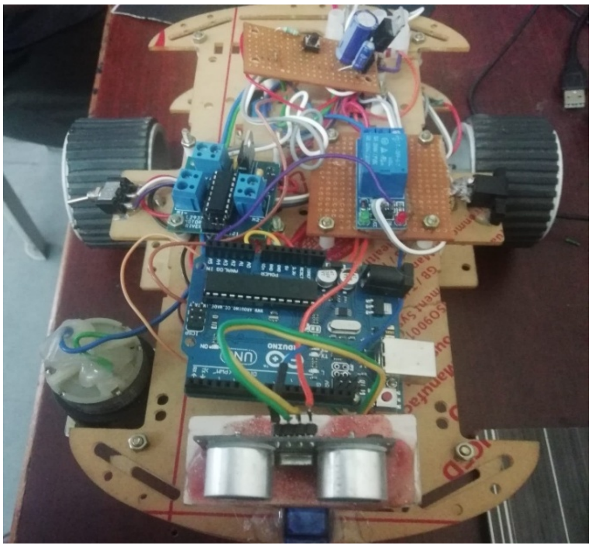

Fig.7. Designed floor cleaning machine

5 Conclusion

Amidst many products developed for floor cleaning, this machine has a special feature of automated movement and identifying the stains and mopping that place alone which in turn reduces the power consumption. Two modes of operation can be performed in a single machine which is an add-on. This machine is suitable for cleaning wide and single floored areas such as hospitals, malls, human hazardous zones etc. This in turn reduces the need for large number of labours to complete the cleaning work. This machine can further be enhanced by designing it with a camera and a microcontroller which has more memory which can be trained using to locate stains while staying in a place. This encourages the economical use of power. Further, the body of the machine and the mopping component can be designed in a way such that it covers a large area while cleaning. In an era where everything is becoming automated, enhancing these types of machines will be of much use reducing the workload of labours and educating them about the technology. This kind of cleaning machine which has no manual labour has proved itself as an essential one during these pandemic times.

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