Smart Indoor Floor Cleaning Robot

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Abstract- *Service robots are robots that are intended to perform tasks normally done by humans in an environment inwhich humans work as well. However, they are neither required to accomplish these tasks in the same way as humans nor need to look like a human being. A tele-operated robot is controlled from a distance (near or far) by a human operator. The human operator can control the robot either by joysticks or by instructions. This paper is about the design and development of automatic floor cleaner. This robot operates autonomously with vacuum suction mechanism. The proposedrobot is very useful in households by saving the time required for floor cleaning.*

Keywords- Floor Cleaning Robot,obstacle avoidance, Vacuum Cleaner.

I. INTRODUCTION

In this era, robotic floor cleaners have been a major area inrobotics research due to the increase in popularity and ease of use as a service robot from household to other public places like hospitals, restaurants, etc. [1] Generally floor cleaners differ,based on their cleaning mechanism like wet 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.

II.SURVEY

Vacuum cleaning robot can be classified under the category of service robot. Elderly persons who can't afford to clean in the indoors or in public places where there is a need to employ laborers for cleaning can use vacuum cleaning robots [2]. Navigation and obstacle avoidance are discussed by Rahul Kumar in [3].By this idea obstacle avoidance is implemented. The reason for using ultrasonic sensor instead of an IR sensor is that the former is not sensitive to light while the latter is sensitive to light [4]. Normally, for obstacle avoidance an array of ultrasonic sensors is used on all sides of the robot.This increases the cost, circuit complexity and power consumption. By mounting the ultrasonic sensor on a servo motor, it can be made to rotate about 180 degrees, thereby minimizing the cost, power consumption and circuit complexity that is required for an array of ultrasonic sensors [5].The types of cleaning process are explained in [6]. Vacuum suction mechanism is one of the commonly used cleaning techniques.The existing floor cleaning robots that are available in the markets like Bravaa jet mopping robot, hybrid robots, Mint floor cleaning robots and Dyson 360 Eye popular today. But these are highly expensive and high power consuming [7]. These can't be afforded by everyone for their needs. So, low power consuming and low cost robot is designed for performing cleaning process by vacuum suction mechanism. The vacuum cleaner is used for the sucking the dust particles such as small papers and dusts [8-9].The robot would be even more efficient it is made completely autonomous by keeping the elderly and physically handicapped people, people who could not find time to clean their house in the mind [8],[10] and moreover in order to make it autonomous an IMU unit must be included [8].

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 cheap. Cleaning robot consists of low power and it operates during power outage period and does not need manual interruption. Robots have electrical components which power and control machinery. The electrical power supply of robot is used for movement via motors. Thus robot need supply energy to the motors in order to activate and perform operation and task. Vacuum cleaning part is attached in order to collect dust and small waste particles inside the room. The cleaning machine uses a Raspberry Pi, sensors and actuators to control the device such as detect the obstacle and manipulate the direction as per the input. The software part on Raspberry Pi is done by Python programming.

III. PROPOSED WORK

A. Block Diagram

Overall block diagram of our model is shown in Fig. 1.Here ultrasonic sensor is used for obstacle avoidance. The ultrasonic sensor is mounted on a servo motor so that it can be rotated about 180 degrees. Waste collection is done by vacuuming mechanism and the power supply is given by 12V rechargeable battery. Motor driver (L298) is used to drive the DC motors.

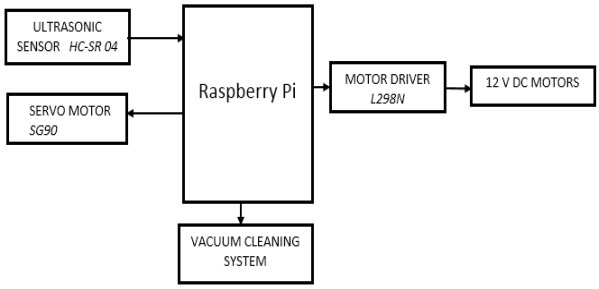

Figure 1.Block Diagram

B. Description

1.Raspberry pi:

There are five Raspberry pi models in the market. Here Raspberry Pi 3 model is used. This is single board computer speed of CPU is 1.2 GHZ and has memory of 1GB RAM. Storage device (SD card) is used for OS storage. It consists of 4 USB slots, a HDMI port and a composite video output. Here GPIO pins support common protocols like I2C. It has on board Bluetooth and Wi-Fi 802.11.

2. Motor driver (L298N):

Motor driver L298N is the module used to drive the DC motor. This may work on 5V and 12V power supply. 12V power supply is used in this work. It acts as a high current motor driver integrated circuit. This can control up to four motors at a time. Input pins of L298N is connected to processor (Raspberry Pi) and output pins are connected to the motors.

3. Ultrasonic sensor (HC-SR04):

Ultrasonic sensor is a device which is used to measure the distance of an object by using sound waves. The operation is to trigger the 8 sound pulses at the time interval of 10msec. The pulses travel to the object and then is reflected back to the receiver. With the use of time taken for transmission and reception, the distance of the obstacle from the sensor can be found

Distance= (speed * time)/2 [1]

For finding the distance in centimeter,

Distance=17150 * time. [2]

4.Micro Servo SG90:

Servo consists of 3 pins i.e. Vcc, ground and a PWM pin

It is made to rotate approximately 180 degrees. Servos are controlled by sending an electrical pulse of variable width, or pulse width modulation (PWM), through the control wire. There is a minimum pulse, a maximum pulse, and a repetition rate. A servo motor can usually only turn 90° in either direction for a total of 180° movement

5. Vacuum Cleaner:

In vacuum cleaner, fan is attached to the DC Motor. When the electric current flows, fan will rotate. So it forces the air to move towards the exhaust port. When the air particles are driven forward the density of waste increases in front of the fan and decreases behind the fan. This pressure drop creates suction inside the vacuum cleaner because the pressure inside the vacuum cleaner is lower than the pressure outside. Whenever the fan is rotating, a constant stream of air is moving out in the exhaust port.This willsuck the dustand small waste particles around the vacuum cleaner.There are 3 factors that determine the effective suction of the vacuum cleaner. They are,

1. Cutoff angle: The cutoff angle must be approximately 30 degrees.
2. Casing: The casing must be designed in such a way that the spacing between the impeller and the outer casing must be very minimum.
3. Clearance: The vacuum cleaner sucks air along with the dust particles. So there must be a proper outlet for the air to go out.

C. Working

The Cleaning robot consists of three main modules i.e. wheel drive mechanism, obstacle avoidance, vacuum cleaning. The Raspberry Pi 3 is a platform consisting of all hardware components assembled on it. Obstacle avoidance is done by using ultrasonic sensor which is mounted on a servo motor in the front portion of the robot so that it can scan for obstacles by rotating about 180 degrees. If any obstacle gets detected, then the robot stops. If the obstacle is detected within 90 degree rotation of servo, then the robot will move left i.e. in the direction where the servo motor would point to 90-180 degrees. If the obstacle is detected at a point greater than 90

degree rotation of servo, then the robot will move right i.e. in the direction where the servo motor would point to 0-90 degrees. This flow is clearly depicted in Fig. 2. The cleaning process is done by using vacuum cleaner. It can collect fine dust particles to bits of paper and can store in the collector.

D. Flow Diagram

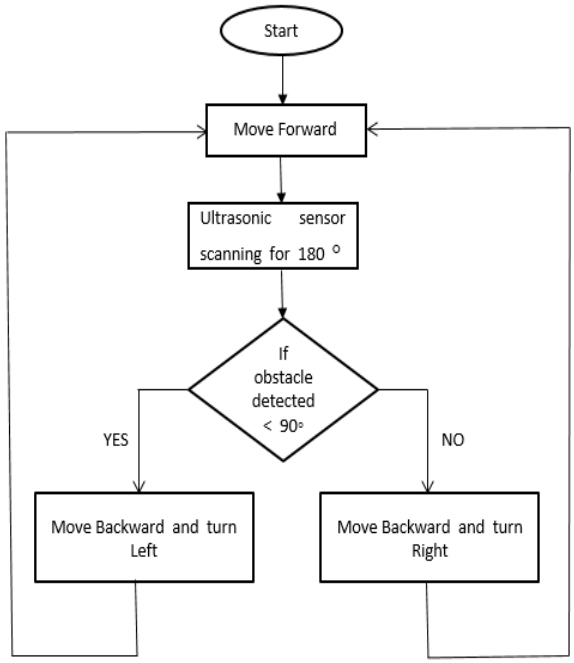

Figure 2. Flow Chart

The implementationof the proposed work is shown in Fig. 3. The vacuum cleaning part is done with the concept of centrifugal suction. The impeller is chosen such a way that the cutoff angle is 30 degrees. The impeller used is injection molded. So all the wings do not have a cutoff angle of 30 degrees. Such an impeller with 30 degree cutoff angle can be 3D printed to have perfection. The wheels are chosen in such a way that the robot moves faster, it turns quickly that is technically termed as "hard turn", it could bear the weight of the components. Lesser the wheel diameter, more the speed and also turning depends on the wheel size. The power supply that is used for the motor in the vacuum cleaner can be increased in order to have an even more efficient suction.

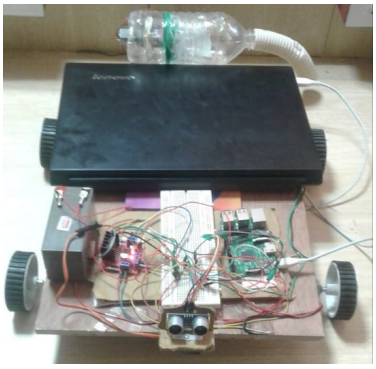

Figure 3. Implementation

IV. CONCLUSION

The robotic vacuum cleaners existing in the market are costly and it can't be afforded by people from all walks of life. The proposed work would be a low cost vacuum cleanerfor indoor cleaning. The implementation of the obstacle avoidance and the vacuum cleaning part are done with Raspberry Pi. Future work includes addition of wet cleaning part and autonomous implementation of the robot by using SLAM based navigation.

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