Remote Controlled Autonomous Floor Cleaning Robot

R.Senthil Kumar, Vaisakh KP, Sayanth A Kumar, Gaurav Dasgupta

Abstract— Cleanbot 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. Cleanbot 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 HC05 Bluetooth module that will be used to exchange commands to the microcontroller -Arduino UNO. The robot is given power by a 12V lead-acid battery, the apt voltage requirement used for all motors here. The driver motors uses 100 rpm type while the run with mops 60rpm plastic geared motors attached to them. Essentially Cleanbot 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.

Keywords- mopping, Bluetooth module, motor, inculcated, Arduino , innovations

I. INTRODUCTION

Floor Cleaning has always been an integral part of the daily health and hygiene routine, be it a household or an industry. 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. 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. Thus, there is an emerging need of a paradigm shift in the field of mopping to more technologically sound machinery.

II. HISTORY AND EVOLUTION OF MOPPING

A. History of Mopping

The mop has been a very important invention in terms of addressing the history of society as well as being a part of the evolution of house wares#. Thomas W. Steward, an African-American inventor invented the mop. Steward's deck mop was made of yarn and became an instant hit in terms of usability in household and cleaning in industries and factories because of its ease. A squeezing mechanism made the process of mopping easier and could also be cleaned with greater ease.

In 1950, Peter Vosbikian created a mop essentially made of sponge type material which was basically used to function as a lever. This was also used as a flat metal strip to push against the wet mop so that it can be dried up. This automatic mop outdated the initial model of mops which required the need of bending over and wringing the mop.

B. Types and parts of mopping

The basic design of a mop consists of as simple as a cloth attached to a stick. But with time, there have been variations in the types of cloth being used and different attachment to the mop setup like integrating a bucket and drying mechanism (see fig 1). But there are various types of mops and their other components. Some of the most prominent ones are listed below.

i. Dry/Dust Mop:

These kind of mops are made to absorb dry and loose particles like dust, earth etc from the surface of the floor. It consists either a yarn or similar kind of fabric and it is considered as a initial step of cleaning a floor.

ii. Wet/Moist mop:

A wet mop is used as a secondary step in cleaning surface and is swept all over the surface to dissolve and absorb liquid form of waste. These usually consists a flat sheet of microfiber textile or a plain sheet with a surface of the looped yarn.

iii. Miscellaneous types:

Other types of mops involves a *hot mop* which essentially follows the concept of a steam iron and uses heated water to subsume the contaminated surface and then can be removed

Revised Version Manuscript Received on 10 September, 2019.

Mr.R.Senthil Kumar, SRM Institute of Science and Technology, Kaatankulathur, Chennai, Tamil Nadu, India.

Vaisakh KP, SRM Institute of Science and Technology, Kaatankulathur, Chennai, Tamil Nadu, India.

Sayanth A Kumar, SRM Institute of Science and Technology, Kaatankulathur, Chennai, Tamil Nadu, India.

Gaurav Dasgupta, SRM Institute of Science and Technology, Kaatankulathur, Chennai, Tamil Nadu, India.

with a solvent. Another common type of a mop is the *microfiber* type which a mix of split microfiber strands attached to a mop handle.

While many of these mops are used in almost every household of the world, this type of mopping is laborious which increases the chances of inefficiency. Although there has been some advancement in the mopping mechanism to be easy and non-tedious, it has yet not been introduced into the daily life of cleaning. In the next section, we shall discuss the advancement in the automatic mopping mechanisms used for large areas like airports, malls, offices etc and discuss the scope of using these kinds of devices on a much smaller scale, i.e. households.

III. AUTOMATIC MOPPING MACHINES

In large industries and public areas like malls, airports, railway stations etc, the surface of mopping increases and hence there is a requirement of devices that can clean a large area with less amount of work. Thus there are a number of integrated cleaning machines used and can be seen being used in public places. To give an example we here have shown one model of automatic cleaners to introduce the concept of automatic cleaning.

The Global Industrial Auto Floor Scrubber

The Global Industrial Floor Cleaner is an integrated floor cleaning device. It is one of the most durable devices and is very easy to use. It has three major components- Machine, Mop Assembly and Pad Driver.

Rotationally molded polyethylene tanks are corrosion and impact resistant. 20" cleaning pad provides a wide 20" cleaning path for greater coverage in less time. Pad Assist feature helps in pulling the machine forward by friction of the scrub deck pad against the floor, the operator simply needs to tilt the scrubber forward to enable the spinning pad to contact the floor. Let us look at the specifications of the machine.

Clean Width	20”
Squeegee Width	30”
Work Capacity	1800 sq.ft/hr
Pad Pressure	84lbs
Brush RPM	180
Brush Motor	120V/750W/6.25A/60Hz
Suction Motor	120V/1200W/10A/60Hz
Solution Tank	12 gallon
Recovery Tank	15 gallon
Machine Dimensions	46”x 22”x 38”
Cord	12 AWG Cord,82 ft
Machine weight	209lb

Table1. Technical Specifications of the Global Industrial Electric Auto Floor Scrubber

Global Industrial Automatic Electric Floor Scrubbers can clean up to 19,000 square feet per hour for Heavy Duty Industrial Cleaning

Fig 2. Global Industrial Auto Floor Scrubber

There are even more types of automatic floor scrubbing machines which are prevalent in the market nowadays. But there are several reasons why these machines can’t be scaled down for the usage of household

1. *Size*: The size of the automatic floor scrubbers are large because of the large solution tanks they use. They are also very bulky to use.
2. *Cost*: The cost of such machines can go as high as $5000. Even if these kinds of machines are to be scaled down for the housed hold, the cost is relatively high and thus becomes less favorable to replace the traditional mop.
3. *The requirement of manual presence*: Even though the floor scrubbing machines are non-traditional and do not use the mop and handle mechanism, they are either walk-behind types or ride-on types, both of which require a manual presence to operate. A greater requirement of maintenance also makes the investment on such a device unsuitable and unfavorable over the traditional mop.

Other machines also pose similar problems to scale it down to a smaller size which can be effectively used for a household. Thus, by analyzing the design, specifications and the flaws in larger machines, we have come up with a solution to scale down a floor cleaning machine to the size of a remote-controlled car. Presenting CleanBot

IV. CLEANBOT

CleanBot is an essentially a compact remote controlled autonomous floor cleaning device which cleans the floor by a set of commands given from a smartphone using Bluetooth signals given through a Bluetooth module.

Retrieval Number: B12950982S1119/2019©BEIESP
DOI: 10.35940/ijrte.B1295.0982S1119

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Essentially CleanBot has a very discrete design in terms of the compactness and usability as it is very handy and easy to operate. Let us discuss the design and the construction of CleanBot in detail.

A. Elements

CleanBot is a combination of various different elements and the complete integration of these elements make it a working prototype. Let us discuss these elements in detail.

i. Base and Mop mechanism:

A strong base needs to be prepared so the parts can be placed on it. For this we need a plywood cut roughly of 12x9 inches. The next step is to drill two holes at the back of the plywood, at both sides for the motor clamps.

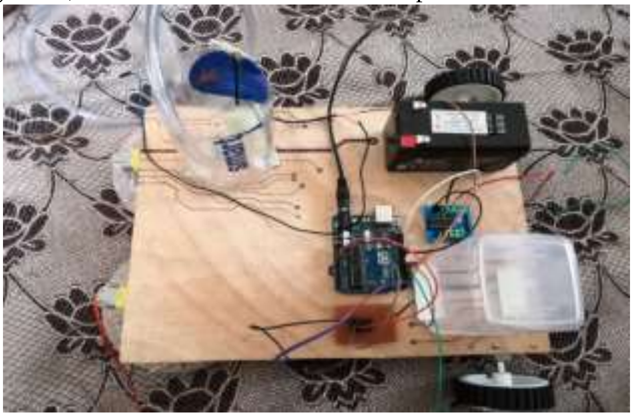

Fig.3: Base Mechanism

To make the mops, old compact disks is used by marking a circular shape cloth around the CD and sewing the cloth around it.

The mops need to be attached to the plastic geared motors and attached to the plywood such that the motors are equidistant from the corners of the base.

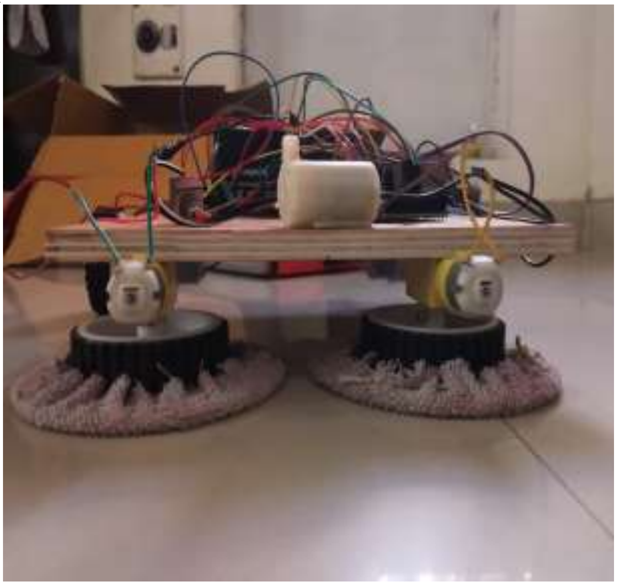

Fig.4: Mop Mechanism

ii. Water Supply Mechanism:

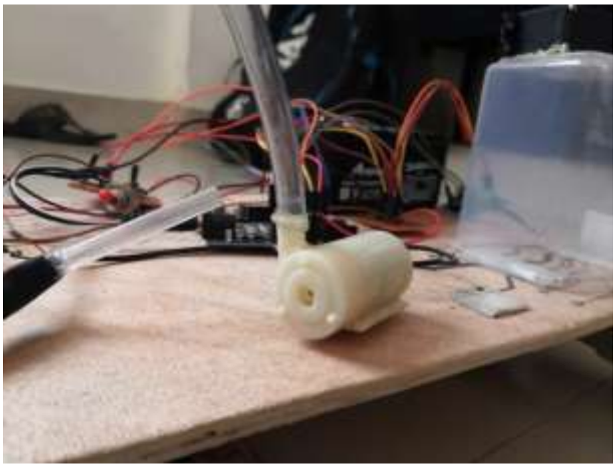

Fig.5: Water Pump

We use a 12V water pump for this purpose. The pump transfers the water from the water storage tank and spills it in front of the mops on the floor. The storage tank is hot glued to the base to give it stability

Next, we make the use of rubber pipes and connect it to the inlet of pump to take water from the water tank using the pump to drop it in front of the mops.

The pump can be operated via smart phone.

iii. Roller Mechanism:

The roller is essentially used to give an evenly clean surface after the mops have cleaned the surface. It is also used to clean the surface of any remnants of dirt missed by the mops. These are also used to clean corners as the circular mops are not able to reach the corners. It may not be used every time while the robot moves and therefore it just integrated and can be lifted it up or down via a servo motor to park when not in use. First a hole needs to be drilled on the servo attachment. Then another hole must be drilled on roller handle of almost the same size. The screws must be tightened to the attachment so that the roller so it stays steady. The motor should be placed at an optimum height so that the roller touches the floor and can be lifted easily.

iv. Sensor Mechanism:

Sensors have been used in the device to detect different combinations in the floor setting, like height of the floor and other types of sensor which can sense the nearby objects so that the device can maneuver without bumping into nearby objects. The different types of sensors have been described below

a. Sharp GP2Y0D810Z0F digital IR proximity sensor:

These sensors are basically used for observation of the stairs. Sharp sensors are used so that it can detect a drop in height and eventually helps the robot detect any change in the height drop of the surface such as stairs or high platforms. When sensor detects stairs, state on the output will be high. Once the drop in height is detected, the robot immediately goes back to a safer area so that it can operate like it does in normal conditions. The proximity sensor has four connections: ground (GND), logic power (VDD), digital detection indicator (OUT), and lastly IR emitter should be enabled (ENABLE).

b.IR Proximity Sensor :

A proximity sensor is used to detect the change in field or any kind of obstruction on the pathway of the robot. This is done by emitting out electromagnetic waves. The object being sensed is known as the proximity sensor's target. Palolo#2460 38kHz is a sensor designed to detect the obstacles additionally which may have been missed by Ultrasonic sonar so as to give a better sense of direction and control of the surface hence enhancing the efficiency of the cleaning process and preventing any kind of damage.

V. CIRCUIT CONNECTIONS

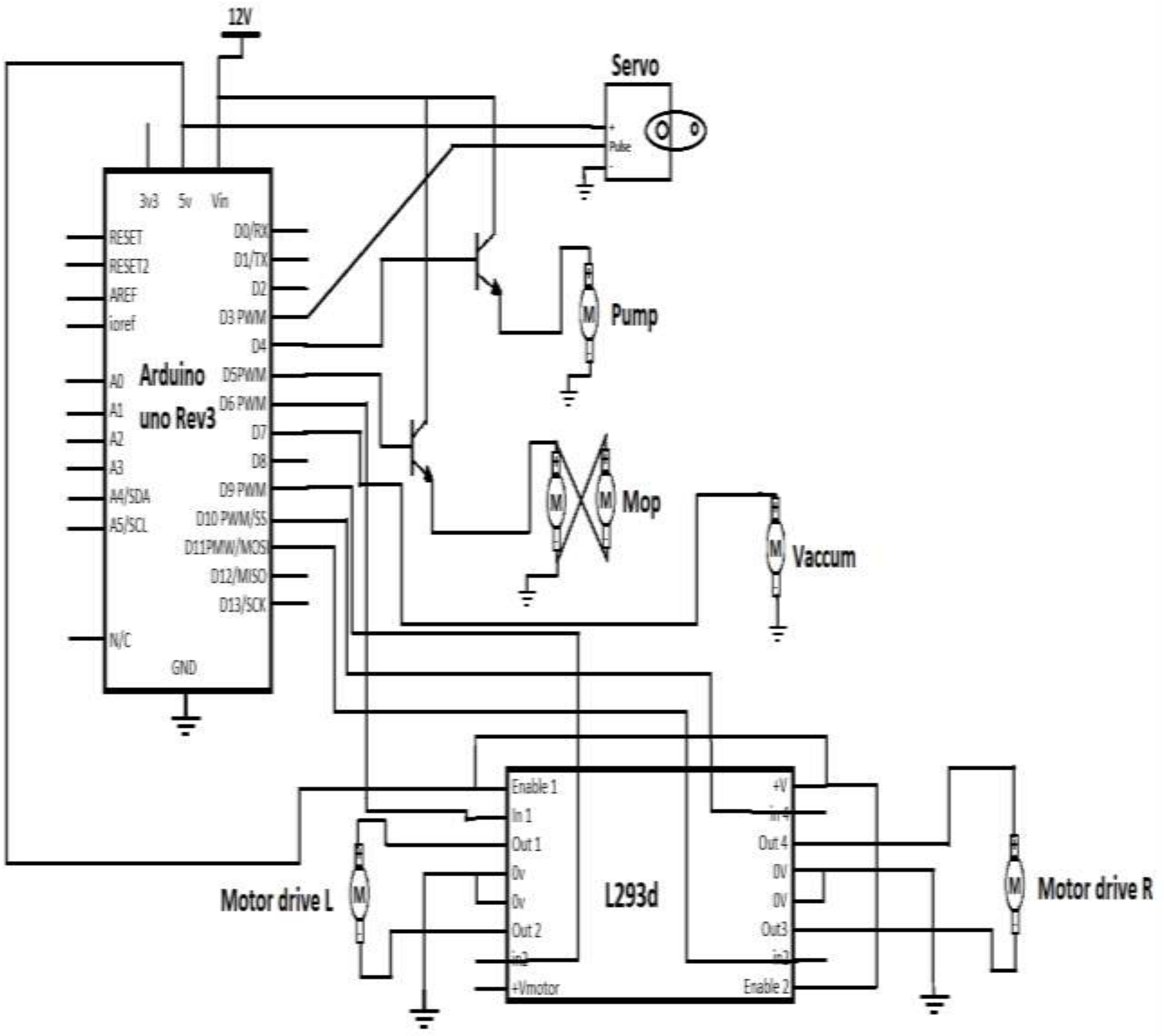

Fig.6: Schematic Circuit Diagram

The geared motors need to be connected to the driver board. All the motor terminals should be soldered and the screw terminals connected to the driver circuit. The rest of the pins should to be connected as per the given instructions underneath:

Signal 1 will be given to D6 of Arduino. Signal 2 will be given to D9 of Arduino. Signal 3 will be given to D10 of Arduino. Signal 4 will be given to D11 of Arduino. +5V is given to Arduino along with GND signal. +12V (Motors will move at this voltage) connected to 12V rechargeable battery. A voltage divider needs to be added to the signal pins so that the signal pins on Arduino will not get burnt. The two plastic motors that are used for mops have to be connected in parallel so that one runs clockwise while the other counterclockwise when seen from the front. Next, the motor wires must be connected to the transistor circuit as per the circuit given above and similarly the water pump connections should also be done.

The 12V voltage from the battery is given to the transistor circuit directly and then the same amount of voltage will pass to the VCC of Arduino and eventually to the motor driver circuit. The base of transistor 2 should be connected which is supposed to control the mops, to D5 on Arduino and transistor 1, controlling the pump to D4 on Arduino. The ground wires which are common from all the motors have to be connected to the GND on Arduino.

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VI. APPLICATION CONFIGURATIONS

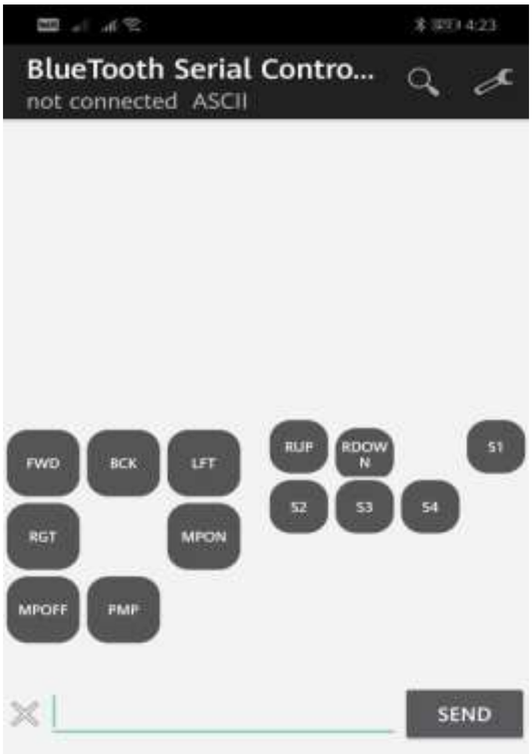


Fig.7: Bluetooth Mobile Application

'Bluetooth Serial Controller' is application which is used here and can be downloaded from Google Play Store which lets us set our own control buttons and commands. Under the 'stop commands' section in 'commands' we need to set the stop command only for the buttons mentioned .Then the paired up module must be connected with the mobile phone via the app with the given password.

VII. DESCRIPTION OF IMPORTANT COMPONENTS & RESULTS

Some of the most essential components used in the device are:

i. Arduino Uno:

Arduino UNO is an open-source microcontroller board that is based on the Microchip ATmega328P microcontroller and is developed by Arduino.cc. The Arduino board has different sets of digital and analog input/output pins that can be integrated to different expansion boards (shields) and other circuits.

Fig.8: Arduino Uno

ii. Bluetooth Module:

The HC05 is a class two slave Bluetooth device designed especially to transmit data through wireless serial communication.

Fig.9: Bluetooth Module

iii. Motor Drive:

L293D is a Motor Driver IC which helps the motor run clockwise and counterclockwise. L293D is a 16-pin IC which can control two DC motors simultaneously in any direction.

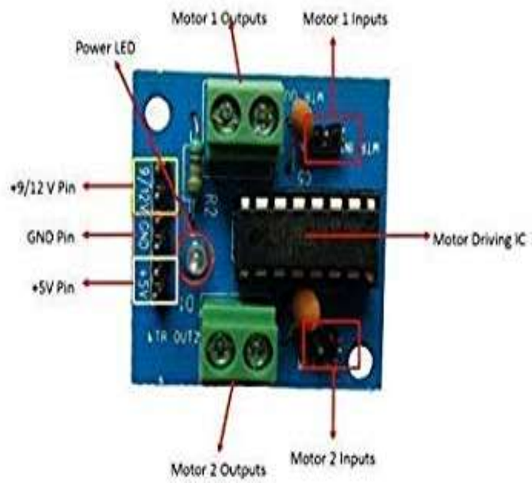


Fig.10: L293D Motor Drive

iv. Motors:

Here we use two types of motor- 60 RPM plastic geared DC motor and 100rpm Geared DC motor

Plastic geared motor:

These motors give a better amount of torque and rpm when they are operated at low voltages, which is one of the biggest advantages of these motors. Smaller shaft size with proper matching wheels gives it optimum design for our application. Mounting holes on the body & light weight makes it easy for in-circuit placement.

Fig.11.Plastic geared motor

v. DC geared motor:

DC geared motors have gear box pre-attached to them which is used in a variety of robotic applications. They have drill holes in middle of the shaft measuring approximately 3mm, making it very simple to connect it to wheels or any other assembly.

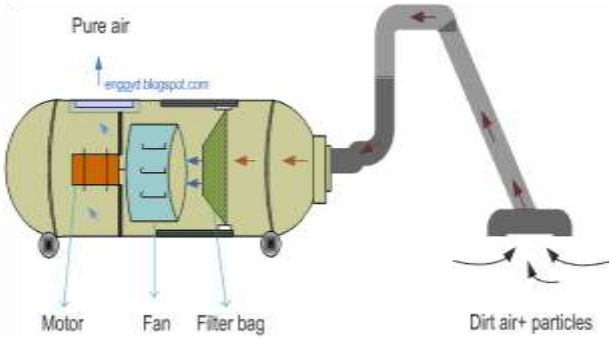
Fig.12.Dc geared motor

vi. Servo motor:

Servo motors have been utilized in many applications. Their size is small thus work efficiently and economically. This is one of the major reasons why servo motors are used in remote-controlled toy cars, robots etc. Servo motors are also utilized in industrial applications, robotics and in-line manufacturing etc.

vii. Vacuum cleaner:

The motor inside a vacuum cleaner creates a channel of suction caused by the differences in pressure of the air inside the vacuum cleaner and the air outside. This creates a circulatory motion of air, forcing the air outside to push inside the vacuum cleaner therefore taking the dust and dirt particles inside the vacuum cleaner



VIII. CONCLUSIONS

This paper has presented and described the Remote-Controlled Autonomous Floor Cleaning Robot. Additionally it is also an attempt to use and integrated sense of technology from different disciplines to scale technology down to the basic household requirements. We have mentioned and clarified the requirements of architecture and developed it to satisfy the requirements. This particular endeavor has allowed us to attach both the process of vacuuming and moping into a single device. Experimental results target task clearly showed that the developed strategy was useful for developing the autonomous service robots. In conclusion, robot operation can be and probably must be used in cooperation with human beings. The developed propositions were useful for both extending robot's ability and developing a new platform. We can make it avoid rugged surfaces and walls. As always, possibilities are endless.

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