

Design and Fabrication of Arduino Operated Floor Cleaning Machine

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Abstract: Why machines required? The popular solution is to reduce human effort, and we are manufacturing cleaning machine which is self operated by using sensors and in special cases we can operate machine by android phone system, means we are using three modes in which manual handling (android phone system) and operation by sensors. Machine is not limited to clean dry waste rather machine can clean wet dust also. Machine is useful for small as due to manual work involved this is time consuming and irritating to clean the floor. Also in big offices floor area well as large area.

Robotic system is compact which gives efficient cleaning. Floor cleaning service in room and big offices reducing human labour. Basically as a robot it eliminates human error. We know that when human is doing cleaning then sometime it is dangerous to clean hazardous waste material and also if we clean the floor manually then there is a possibility that the operator will leave some portion of the floor. This is where the robot comes as an advantage. Also the robot is petite and compact in size. So we can carry it and place it wherever we can on the house. Also in industries the robot is very cost effective as compared to manual labour involved. The flexibility, time saving and efficiency make the robot a clean choice for cleaning the floor.

I. INTRODUCTION

As we know that robots and automation is being fundamental part to help peoples in their work. And we are introducing one type of robot which can reduce human work and also help them to increase efficacy of work. In the pace of robotics we are presenting cleaning robot. Since 2015 lot of work has been done on cleaning system and they did their work efficiently, as we know the popular cleaning machine bandicoot already invented in Kerala, which is most effective to help workers for drainage cleaning. This robot is semiautomatic, means robot require human intervention for cleaning. We have advantage over this robot because we are presenting robot which can operate automatically by using sensors, and can clean small as well as large area.

Here we doesn't require any human intervention at the time of cleaning, only drawback of our system is it can't clean rough surface. This system operated by three modes in which by using Arduino and sensor it avoid obstacle by using smart programming, then by using mobile app we can handle movement of machine and last but not least by using manual handling thorough handle.

Multiple modes can make machine mobile and gives flexibility to operator.

I.1 Problem statement: In day to day life we are looking for the machines which are easy our work. So in day to day life the surface cleaning is the most difficult and exhaust work for that we are design and optimized the automatic surface cleaning machine which are easily do work of surface cleaning and other work.

Cleaning is the essential need of the current generation. Basically in household floors the floor has to be cleaned regularly. Different techniques are used to clean the different types of surfaces. The reasons for floor cleaning are:

- Injuries due to slips on the floors are cause of accidental injuries or death. Bad practice in floor cleaning is a major cause of accidents.
- To beautify the floor.
- Debris and obstructions are to be removed.
- Allergens and dusts are to be removed.
- To make the environment sanitary (kitchens).

I.2 Objectives: To overcome problem arising due to untidy work and dirty floors, we build a model to reduce human efforts by autonomous movement of vehicle guided by the sensor as well as by mobile control system.

- 1) Design the chassis of cleaning machine for better surface cleaning.
- 2) Optimized the model for high efficiency and accuracy.
- 3) Dry and wet cleaning.
- 4) To save the time.
- 5) To achieve multi operational system.
- 6) To make environment sanitary.

II. LITERATURE REVIEW

1) Title : Multi-use floor cleaning machine [IJMET]

Author : Shubham khade

In these research paper, we found idea about manually operated cleaning by using handle when Arduino Uno is not in work and also get reference for motor calculation. In his machine, handle is fixed in ergonomics position.

2) Title: Design and Analysis of manually operated floor cleaning machine [IJERT]

Author: M. Ranjit Kumar

In these research paper, he had mention the idea about dry and wet cleaning in a single room along with that they had suggested eco-friendly concept by using Bi-cycle instead of using automation in cleaning process.

3) Title: Speech recognition system for voice controlled robot with real time obstacle detection and avoidance [IJEEDC]. Author: Yasir Ali Memon, Imaaduddin Motun.

This paper gives idea about voice controlled robot by using Arduino MEGA. And also get controlling methods such as WIFI and GSM connectivity to automate the. Floor cleaning machine .These machine is operated by internet connectivity through Wi-Fi and its range up to 30 meter.

4) Title: Automatic Floor Cleaner [IRJET]

Author: Manya Jain, Pankaj Singh Rawat

This paper provide idea about selection of ATmega328/ Arduino, which is cost effective. And it also provide SC-H04 Ultrasonic sensor, which has range to detect obstacle up to 2 cm to 4 cm. Up to these range ,they set their obstacle detection to collision between obstacle and floor cleaning machine. The modules include ultrasonic transmitters, receiver and control circuit.

5) Title: Arduino based voice controlled robot [IRJET]

Author: K. Kannan, Dr.J.Selvakumar

The purpose of this research paper is to build a robotic car, which could be controlled using voice command. Generally, these kinds of system are known as speech controlled automation system. Our system will be prototype of the same.

6) Title: Bluetooth based automated floor cleaning system [IJCTR]

Author: C.R. Balamurugan, P.Kirubha.

In this research paper ,they had compared Bluetooth along Wi-Fi .And they had concluded that, Bluetooth is 90% efficient than WIFI connectivity but it has disadvantage that ,it has less range as compared to Wi-Fi connectivity.

7) Title: Design and Development of floor cleaning machine [IJAERD]

Author: Muhammad Kashif Shaikh Ghaffar

In these research paper, we found criteria to select DC geared motor (12V, 3A, 200rpm) which is more preferable than any other AC motor .In his work, they also mention ideas regarding vacuum as well as mop cleaning simultaneously, which gives effective cleaning work .But, it has one disadvantage that, they had used vacuum cleaner which are more costly than conventional cleaning mechanism. Therefore, it is not convenient to use it for small floor cleaning.

8) Title: Design and fabrication of automatic floor cleaner [Thesis]

Author: Swarup Raj Jena

The purpose of these research paper is to build an automated floor cleaning machine by using Arduino Uno .In the automation part of this project, they get 90% efficiency in their model. And also, their model is capable of detecting dust particle by using sensor.

9) Title: Design and development of floor cleaner robot [IJCA]

Author: Manreet Kaur, Preeti Abrol

In this research paper, vacuum cleaner is use instead of dry cleaning .But also this lead to an overall bulkiness of whole machine ,which causes overall battery capacity and motor parameter to increase, which in fact lead to overall cost of machine.

10) Title: Modified floor cleaning machine [IJETER]

Author: Nikhil Murlidhar Chopade

Wide variety of floor cleaning technique are used in this research paper, such as floor buffers, automatic floor scrubber and sweepers, carpet extractors that can be deep clean.

The equations are an exception to the prescribed specifications of this template. You will need to determine whether or not your equation should be typed using either the Times New Roman or the Symbol font (please no other font). To create multileveled equations, it may be necessary to treat the equation as a graphic and insert it into the text after your paper is styled. A colon is inserted before an equation is presented, but there is no punctuation following the equation. All equations are numbered and referred to in the text solely by a number enclosed in a round bracket (i.e., (3) reads as "equation 3"). Ensure that any miscellaneous numbering system you use in your paper cannot be confused with a reference [4] or an equation (3) designation

III. DESIGN & CALCULATION

1) Design of wet roller:

Purpose of the roller is to wet the surface of floor and rub it. So in our proposed system, we select the sponge roller having diameter of 120mm.

Therefore $D=120\text{mm}$

Total weight of the roller is around 250gm

Therefore $F=.250*9.81= 2.4525$

2) Selection of motor:

For motor selection we required rated torque

$T=F*r$

$= 2.4525*.060$

$= 0.14715\text{N-m}$

Above is the required torque to rotate wet sponge roller but in market min 1N-m torque motor is available so we select that motor.

Selected Motor Torque = 1N-m

There is two variable speed available in this torque range motor one is 100 rpm and other is 200 rpm.

We have select 200 rpm motor, because having optimum speed gives us better surface cleaning.

3) Battery selection:

Initially we select 12V battery.

There are different voltage rating battery available in market but we select 12 V DC battery .Because in our project all electronics component are worked on 12V or 5V DC supply.

Therefore. We have select 12V DC supply.

If the current drawn is x amps, the time is T hours then the capacity C in amp-hours is

$$C = x * T$$

Major load in project is motor which have maximum current so total current drawn through motor is 480mA Remaining electronics components run on very small current rating so considering all components current rating is 10mA

Therefore capacity of the battery considering system run for 4 hrs.

$$C = 0.490 * 4$$

$$= 1.96 \text{ amp hour}$$

Rate of discharge considerations

For reference only

$$C = 1.96 / 0.8$$

$$= 2.45 \text{ AH}$$

Because Discharge factor = 0.8 for lead acid battery

Taking high rate into account

$$C = 2.45 / 0.5$$

$$= 4.9 \text{ AH}$$

Thus, we would need a 4.9 amp hour sealed lead acid battery to run the system for 4 hour at 0.490 amps average draw.

Battery specification is 12 V 4.9 AH.

4) Selection of wheel:

Selection of wheels is fully depends upon floor material, if floor material is smooth then we required wheel having rubber material peripheral for more friction. Size of wheel is independent we could select any wheel size as our choice.

But in our project, we used 100 mm diameter and 15 mm width wheel. Material of wheel is poly fiber having rubber material peripheral around it.

5) Selection of Ultrasonic Sensor;

There are different types of sensor available in the market like Hall Effect sensor, IR sensor, LDR, Piezoelectric Sensor, Humidity sensor etc.

But in our proposed work, we have to detect obstacle so we need a sensor which can detect object like proximity sensor.

There are multiple sensor such as

IR sensor – IR sensor worked on infrared rays it emits the rays and receive it and calculate the distance between the object and other system

Hall Effect sensor- Hall Effect sensor working on Hall Effect so we need magnet in this sensor

Ultrasonic sensor- ultrasonic sensor is worked on principle of echo

Above listed sensor IR and hall effect have very small range of detecting object whereas ultrasonic has very high range of detecting object. At the lowest range ultrasonic sensor can detect up to 3 cm distance.

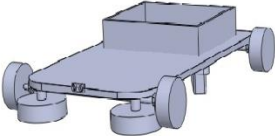

Hence we select ultrasonic sensor for their wider range of detection capability i.e. HC-SR04 Ultrasonic sensor with a range 1 meter.

6) Selection of material for chassis design:

Chassis should have more strength and having more load carrying capacity. There are wide range of material available in market such as aluminum, polymeric. , but these material is having less strength and durability as compare to Mild steel.

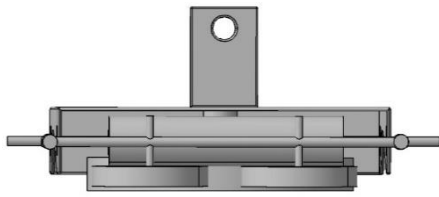
Therefore, we use MS sheet having thickness is 3mm for chassis design.

III.1 Detailing of Component

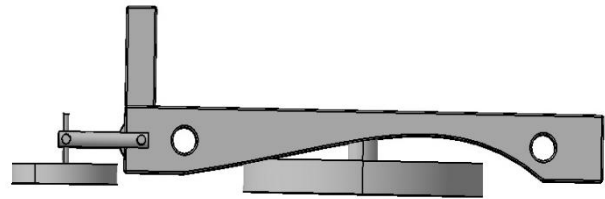
Component	Specification	Image	Quantity
Chassis	Material-Mild steel, Composition Carbon (0.16-0.18%), Silicon(0.40%)max Manganese (0.70-0.90%) Sulphur (0.040%) Chassis is use for enclosing all machine components along with it, this gives support to a DC motor, Arduino Uno, Ultrasonic Sensor, wheels, etc.		-
ATmega 328p/ Arduino Uno	ATmega 328p microcontroller has 28 pins. In that ,it contain 14 digital i/o pins along with that it contain 6 analog pins,2 ground pin,1supply pin It also include reset button, USB Plug for USB attachment		1
DC Geared Motor	12V,3A High torque geared DC motor 200RPM 125gm weight Same size motor available in various rpm 30 kg.cm torque		9
Battery	Lead acid battery has six single cells in series producing a fully charged output voltage of 12 volts. A battery cell consists of two lead plates a positive a positive plate covered with a paste of lead dioxide and a negative made of sponge lead, with an insulating material in between them.		1
Ultrasonic sensor	Ultrasonic sensor is a proximity sensor. There are many proximity sensor available in market, but ultrasonic sensor has wide range .It emits 40 KHz ultrasound which travel through air and if there is an object or obstacle on its path it will bounce back to the module. We use HC-SR04 Ultrasonic module which has a ground, VCC, Trig and Echo.		3

Model 1

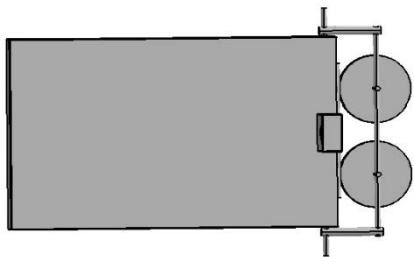
Chassis is design on CAD model such as CATIA to achieve better surface finish .It lead to a lustrous property of sheet metal. Following are some views made in CATIA model:



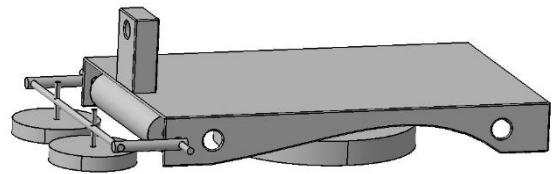
FRONT VIEW



SIDE VIEW



TOP VIEW



ISOMETRIC VIEW

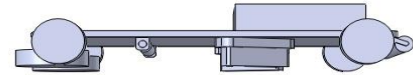
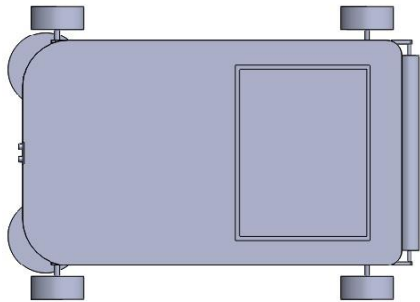
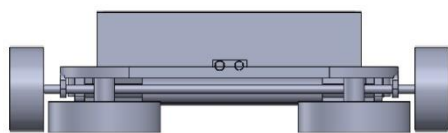
The concept of floor cleaning machine consist of chassis, which is made up of MS sheet metal with 3 mm thickness. Chassis is design on 3D software such as ANSYS tool.

Assumption made for FEA model on ANSYS software:

- 1) Material is assumed to be homogeneous isotropic and obeys Hooke's law.
- 2) It is assumed that Von-Misses Theory is use to evaluate stresses act on chassis.
- 3) We are considering 25% more dead weight to consider actual failure of chassis.
- 4) Considering structure of chassis is fixed on lower side to analyse the model.

Working procedure made to build ANSYS software:

- 1) Choosing the disciplines such as structural.
- 2) Choosing the suitable element from library as per National Agency for Finite Element Methods and Standards (NAFEMS).
- 3) Assigning material and geometric properties.
- 4) Construction of geometric model and importing.
- 5) Discretisation or meshing and mesh refinement.
- 6) Application of boundary condition and loading.

Assembly:**Top view:****Side view:****Front View:****Advantage**

- Human efforts are reduced.
- Machine save the time.
- Optimum battery capacity.
- Easy to operate.

Limitations

- Difficulties on rough surface.
- Less capacity of container.
- Less capacity of water tank.
- Less starting torque.

Future scope

- 1) Chassis will be built by PVC polymer. This will reduce overall weight of the chassis.
- 2) Foldable chair will also be operate on chassis by made up of polymer pipe.
This is for multitasking.
- 3) Reuse of water concept will be use in future by giving angle to the metal sheet to collect the water in tank.
- 4) Voice operated system.

IV. CONCLUSION

This project gives efficient cleaning machine to society. In this project the cleaning machine is assemblage different components of mechanical and electrical branch such as DC motor, ultrasonic sensors, Arduino ATmega328, arm, chassis etc., so it will be easy to handle.

Acknowledgement

We are thankful to our college and guide Prof. Chetan Kolambe for giving us opportunity to present our ideas and support us for the completing project. We take this opportunity with great pleasure to express our deep deep sense of gratitude towards them.

References

- [1] Subham Khade, Multiuse Floor Cleaning Machine, IJMET, May 2017.
- [2] M. Ranjit Kumar and N.Kapilan, Design and Analysis of manually operated floor cleaning machine [IJERT], April 2015.
- [3] Yasir Ali Memon, Imaaduddin Motun, et.al, Speech recognition system for voice controlled robot with real time obstacle Detection and avoidance [IJEEDC], Sept 2016
- [4] Manya Jain, Pankaj Singh Rawat ,et.al, Automatic Floor Cleaner [IRJET] ,April 2017.
- [5] K. Kannan and Dr.J.Selvakumar, Arduino based voice controlled robot [IRJET], March 2015.
- [6] C.R. Balamurugan, P.Kirubha.et .al, Bluetooth based automated floor cleaning system [IJCTR], 2018.
- [7] Muhammad Kashif Shaikh Ghaffar, Design and Development of floor cleaning machine [IJAERD], April 2018.
- [8] Swarup Raj Jena, Design and fabrication of automatic floor cleaner [Thesis], 2014-15.

