

Design and Simulation of Advanced Floor Cleaning Machine

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Abstract - Keeping our floor clean and tidy at home, industries is really important. In this process we waste a lot of water and also reuse the same water again and again. By doing this we are not actually cleaning the floor. We also have to put in a lot of manual effort while cleaning. We can also slip and fall due to wet surface while cleaning the floor. We studied various floor cleaning machines available. We then designed a floor cleaning machine which is an advanced version of the existing floor cleaning machines. We have introduced motor driven brush to improve cleaning action, sprinkler system to sprinkle water to floor and to eliminate unnecessary wastage of water, a vacuum system to collect the dust particles from floor and a drying mechanism which helps in drying the floor after cleaning. We have included few mechanisms for the proper functioning of the machine as intended and to improve the efficiency of cleaning. The model designed is slightly big in size and is suitable for industries, big houses and halls but the size of various components can be reduced for its usage in our homes. We have also tried to enhance the functionality of the existing automatic floor cleaners.

Key Words: Automatic, Sprinkler, Vacuum, Drying, Mechanisms

1. INTRODUCTION

Floor cleaning machines are devices used to clean the floor. It can be of different types, such as mop, scrubber, vacuum cleaners etc. With the advancement in technologies we have many robots which will help us clean the floor. These robots include mobile controlled robots, automatic vacuum cleaners etc. In the following section we have described some of the existing floor cleaning tools.

1.1 Vacuum Pump

The vacuum cleaner is an electric machine which uses pneumatic technology to suck in dust particles and other residues left behind in the floor. The vacuum pumps are available in different sizes based on their area of usage. The industrial vacuum cleaners used in mechanical industries are used to recover oil from cutting machine and metal chips. Some of its characteristics include

- Battery powered vacuum cleaners
- Vacuum cleaners are provided with wheels.
- Very huge vacuum cleaners which can hold up to 100 kg of dust and residues before being emptied.
- We also have vacuum trucks which can remove contaminated soil.

1.2 Mop

The dry mop can in numerous cases supplant a brush and can hold a limited measure of residue or sand inside itself. The heads of dry mops are detachable and can be washed and supplanted when soaked with dust. Another alternative is utilizing a vacuum cleaner to suck surface residue away from mop; notwithstanding, this is significantly more restricted in its viability. Single-utilize dry mops are additionally accessible and generally sold.

A wet mop also known as moist mop is, capable of cleaning, used after removing the dust from the floor. The wet mop is cleared over the surface to deteriorate and hold fat, mud and dried-in liquid pollutions. Wet mops generally have a leveled sheet of microfiber material it can also be a sheet having surface of circumnavigated yarn, generally around 17 cm wide and it does come in various length of 31 – 101 cm.

1.3 Drawbacks In The Existing Cleaning Techniques

- Water is reused in the cleaning process which will reduce the efficiency of cleaning.
- The floor is wet after cleaning.
- Most of the techniques involve human effort.
- The automatic machines available are very expensive and are not affordable by everyone.
- There is a lot of time invested in cleaning the floor every day.

We have studied the different techniques used for cleaning and the drawbacks existing in floor cleaners. We have combined vacuum system, sprinkler system, scrubber and drying mechanism in one machine to enhance the cleaning action.

2. METHODOLOGY

To enhance cleaning we have introduced various systems in the floor cleaning machine, other parts which will allow the mechanisms to function as intended.

2.1 Vacuum System

The vacuum system is used to collect dust particles from floor. This will enhance the cleaning action. This vacuum system is placed in front portion of the cleaner. A vacuum chamber is included in this system which stores the collected dust particles. A pipe is provided between the inlet and the chamber which is used to carry the dust particles to the chamber from inlet. The chamber can be opened from top,

which is helpful during maintenance. A pipe is placed on the right face of the chamber, through which dust particles can be taken out easily.

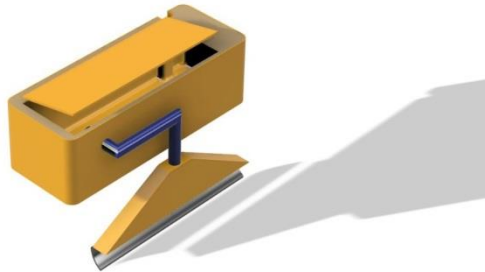


Fig-1: Vacuum System

2.2 Sprinkler System

The sprinkler system is used to sprinkle water on to the floor. By installing a sprinkler system we need not reuse the water which is been done in current cleaning techniques. The system consists of tank and pipes. Tank is used to store water for cleaning. Water can be filled into the tank through an opening provided at the top. A pipe is provided at the bottom with small holes, though which water is made to fall on the floor.

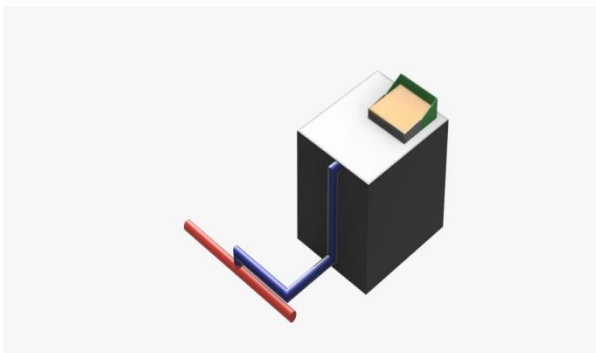


Fig-2: Sprinkler System

2.3 Drying Mechanism

A drying section is placed behind the brush. A cloth is placed between two rollers, this cloth continuously moves between the rollers. One portion of the cloth is always in contact with the floor and wipes the floor. As the cloth continuously move between the rollers, the cloth gets squeezed and the dirty water is collected in a small tank. By doing this the floor is cleaned and is kept dry. The rollers have gears on its one side. The gears are placed on one another; one of them is connected to a shaft. The shaft is linked with the motor with the help of a chain. Hence when shaft of motor rotates rollers rotates which intern moves the cloth between the rollers.



Fig-3: Drying mechanism

2.4 Motor and Brush

A motor with two shafts is used in this model has two functions. Firstly the motor is used to rotate the brush which is placed at the bottom of the cleaner, which is achieved with help of the first shaft. Secondly the second shaft of the motor is connected to two rollers with the help of a chain. Hence a single motor is used to two operations simultaneously. The motor is rotate at a speed of 60 rpm. The brush continuously rotates with the help of motor and is used to clean the floor.

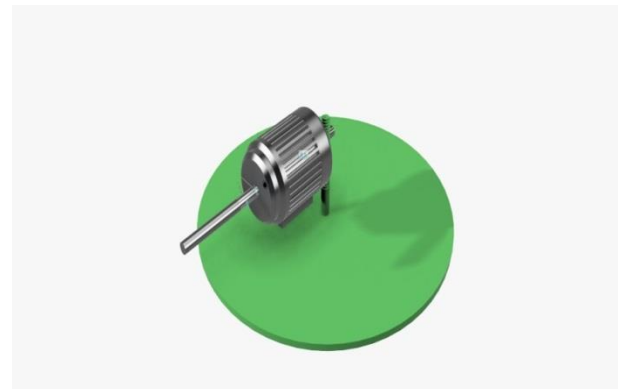


Fig-4: Motor

2.5 Battery

Battery is the power source used in this cleaner. The battery is placed on the cleaner. it used to run the motors used in this cleaner. The battery can also be used to supply power to the electronic components that can be added in the model.

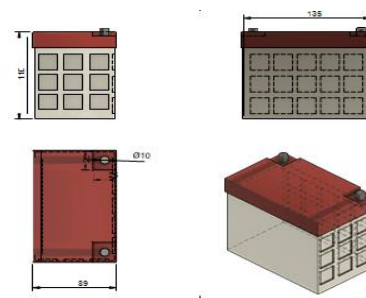


Fig-5: Battery

2.6 Wheels

There are four wheels in the floor cleaning machine. D.C motors are attached to these wheels. These motors are powered with the help of batteries.



Fig-6: Wheel

2.7 Chain

Chain used in our project has a connection with the shaft of the motor at one side, while the other end is connected to setup consisting of two cylindrical rods, which are responsible for squeezing of the wet cloth used for drying the water on the floor. The chain motion begins when the motor is started.



Fig-7: Chain

2.8 Gear

A gear is a device used for transmitting power. We have used two gears in this model to transmit power from the shaft of motor to the drying mechanism with the help of a chain.



Fig-8: Gear

2.9 Rollers

Two cylindrical long rollers are used in the drying mechanism. The cloth moves between the two rollers and later helps in drying the floor. The rollers have gears on one side which is further attached to a chain.

2.10 Working

Motors are connected to wheels which will help in the motion of the vehicle. Vacuum system in front of the cleaner will take in the dust particles which are left behind in floor. The particles are collected in the vacuum chamber. Dust particles in the chamber can be removed with the help of pipes provided on the chamber. Once the dust particles are removed water is sprinkled on the floor with the help of sprinkler system. The water needed for cleaning is stored in the tank. Water can be filled through the opening provided on top of the tank. Brush is provided at the bottom which helps in the cleaning action. A drying mechanism is used for enhanced cleaning. It consists of a cloth which moves between two rollers. This cloth wipes the floor continuously, gets squeezed between rollers. The dirty water is stored in a small tank which can be removed and cleaned. We can add a lot of electronic components in this model to make it completely automatic.

3. DESIGN AND SIMULATION

Parts are designed using Autodesk Fusion 360.

3.1 Model A - Vacuum System

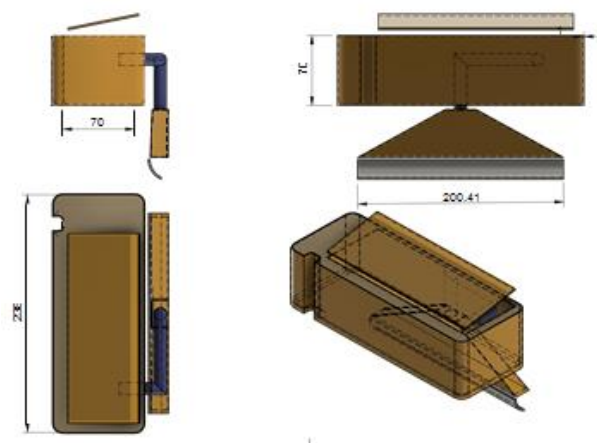


Fig-9: Different Views of Vacuum System with Dimensions

3.2 Model B – Sprinkler System

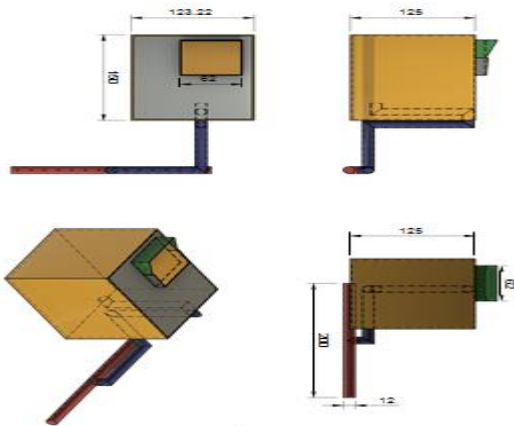


Fig-10: Different Views Of Sprinkler System With Dimensions

3.3 Model C – Drying System

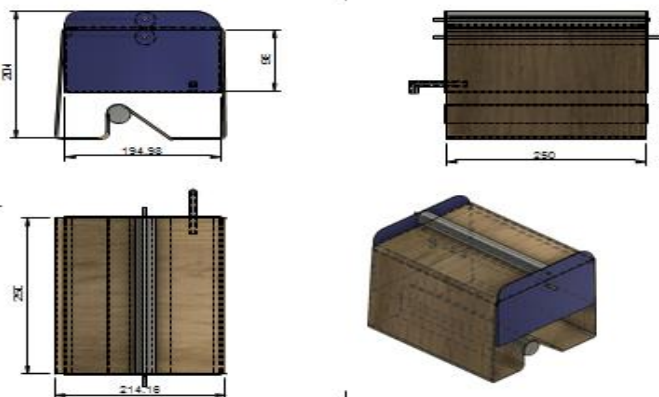


Fig-11: Different Views Of Drying System With Dimensions

3.4 Assembled Model

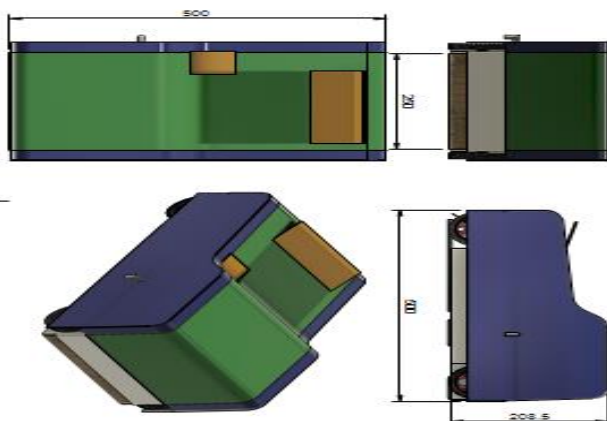


Fig-12: Different Views Of Assembled model With Dimensions



Fig-13: 3D View Of Assembled Parts

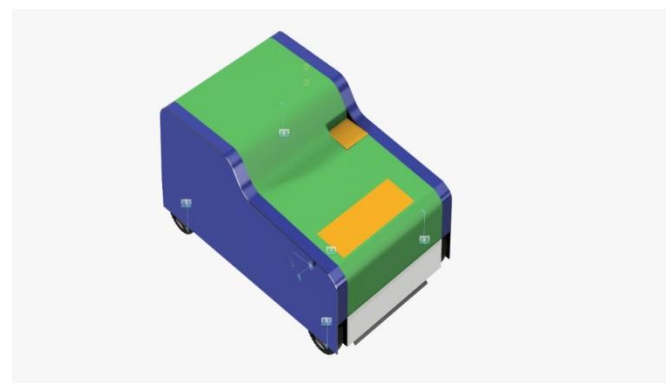


Fig-14: 3D View Of The Floor Cleaner

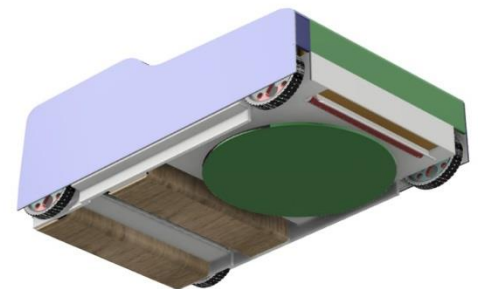


Fig-15: 3D Bottom View Of The Floor Cleaner

The cleaning system is mounted on a vehicle which has 4 wheels and driven by motor. Vacuum system is mounted on the front portion of the cleaner, hence the dust particles is first removed before sprinkling water. A sprinkler system is placed behind the vacuum system which consists of a tank and pipes. A double shaft motor is placed next to the sprinkler system. This motor is further connected to the brush and is also connected to the drying system with the help of a chain. The drying system is placed behind the sprinkler; it consists of rollers, gears and cloth. A battery is placed in the cleaner which is used to power the motors and other electronic components that can be added.

3.6 Material Selection

Table-1: Material Selection

Item	Part	Material
1	Brush	Walnut
2	Motor	Steel
3	Spur Gear(15 teeth)	Steel
4	Chain and Gear	Steel
5	Cloth	Fabric
6	Base	Stainless steel
7	Body	Steel
8	Vacuum Chamber	Polyamide (Kapton)
9	Water Tank	Polyamide (Kapton)

3.7 Specifications

Total mass, $M = 10$ kg

Water Tank Capacity = $123 \times 120 \times 140 = 2066.4 \text{ cm}^3$

Water mass, $W_w = 997 \times 2066.4 \times 10^6 = 2$ kg

Dust Container Capacity = $220 \times 70 \times 70 = 1078 \text{ cm}^3$

Dust mass, $W_d = 1.49 \times 1078 \times 10^6 = 0.002$ kg

Miscellaneous mass, $W_m = 2$ kg

Front Tire Diameter, $D = 90$ mm ; Radius, $r = 45$ mm

Rear Tire Diameter, $D = 90$ mm ; Radius, $r = 45$ mm

Coefficient of Rolling Resistance, $C = 0.01$

Total Reduction (From motor to wheel) = 1

The speed of the machine = 60 rpm.

Minimum Motor Torque = 3.8 Nm

The minimum motor output power = 23.87 watt

3.8 Simulation

Simulation of the mechanisms involved in the machine was done in Autodesk Fusion 360. Simulation was carried out after assembling all the parts in the floor cleaner. Firstly the

rotation of the brush was simulated. Secondly the chain and gear mechanism involved in the drying mechanism was simulated. Thirdly the movement of wheels was simulated. The results obtained after simulation was satisfactory, the machine is ready for fabrication.

4 RESULTS AND DISCUSSION

The model is designed and assembled in Autodesk Fusion 360. The assembled model was then simulated in Autodesk Fusion 360. In simulation various mechanisms included in the design was tested, its performance was satisfactory. The machine is designed to provide multiple levels of cleaning. The vacuum chambers and water tank provided are really big in size and its maintenance is easy. Electronic components like ARDUINO, sensors etc. need to be placed along with PCB during fabrication to control the machine with the help of remote or a mobile application.

4.1 Scope of Future Work

- To add the necessary electronic components, making it fully automatic.
- To reduce the size and weight of the final product for its usage in small houses.
- To fabricate the model and check its performance
- To operate the machine using a mobile application.
- To make the final product available in market.

5. CONCLUSION

Studying various literatures it was found that there were few drawbacks existing in various floor cleaners which can be improved. Few of them are debated earlier in this report. We have designed and simulated a machine which could overcome the drawbacks and help us keep the floor clean. We have introduced innovative and advanced technologies while designing. Use of latest technology can be really help us increase the efficiency of cleaning and we can reduce the human effort to a great extent. As we reduce the human effort in cleaning it can lead to frequent cleaning. Cleaning the floor everyday will lead to increase in hygiene. If we make such small steps in bring in innovative ideas we can make India a better place to live in.

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