

# Semi-Automated Glass Wall Cleaning Robot

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**Abstract:** Cleaning the outer walls of high-rise buildings is always dangerous and laborious work in mid-air. In that case wall cleaning and maintenance is very difficult and also that cleaning of curved surface is more complex. Only minimum number of skilled labors does do it in those high-rise buildings with much cost. This project gives an alternative solution to use robots which overcome the above-mentioned problems in the appropriate fields. A robot has a small size and lightweight then it gives more advantage. This project aims work with human help. In this the cleaning robot can be operated by both automatic and remote control. With the help of several suction cups, by traveling both horizontal direction and vertical in the glass surfaces. This robot will have more advantage and better scope for future purposes

**Keywords:** suction Cups, vacuum, compressor, cylinder and etc.

## 1. INTRODUCTION

Recently, there have been many demands for leaning system on outside surface of buildings such as window glass cleaning by increasing of modern architectures. In recent times, increasing pollution and dusty environment lead to the deposition of precipitate on the surface of glass and walls. So, there has been increasing demands of cleaning system on the surface of buildings such as window glass of modern architectures such as skyscraper. In places like Dubai, there is a vast demand for such mechanism and systems. Some of the customized windows cleaning robots have already been installed in practical use for the same purpose. However, most of them are mounted on the wall of the buildings and are expensive in cost and in maintenance. So, the demand of small, lightweight, portable and cheap window cleaning robot

are increasing in the market. Some customized window cleaning machines have already been installed into the practical use in the field of building maintenance. But that is not much more effective. So an alternative is robot. Because the Robots have been created to assist and replace humans in various dangerous and difficult tasks. Robots have been used in construction, manufacturing, security and etc. This is because they are able to adapt to different environments and situations. They have conquered nearly all environments that humans have put them through. So, the following must be noted before designing a cleaning device

- It should be small size and lightweight for portability.
- Automatic operation during moving
- Large range for remote control.

So move to use robot for overcome the problem. In this project a suction cup with a vacuum pressure is created for wall climbing and cleaning glass surface.

## 2.LITERATURE SURVEY

SuryakantRathod et al. Provide Skyscrapers Wall Climbing and Glass Cleaning Automated Robot. In this project have cleaning robot then we get that knowledge for glass cleaning robot. In that project they were used a suction cup and controller for wall climbing and glass cleaning. Then we get used project for part of this project [1, 3]

Mr.Atul Sharma, Mr.A.M.Borkar, Mr.Y.M.Gaidhan at Pneumatic Controlled Glass Climbing Robot. In that project we have observed following requirements [2, 5, 8]

1. Lightness of weight: This is followed by low energy suction pump, to increase the autonomy and payload of equipment.

2. High mobility: This enables the climbing robots to move over various environments with different geometries and materials such as glass.

3. A reliable grasping mechanism for climbing on various surfaces

Hwang Kim et al [2017] they have provided idea for movement. In suction pads are widely used for industrial purposes and the most currently applicable and robust compared to other adhesive mechanisms. In the case of

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locomotive mechanisms, they can generally be divided into legged mechanisms, sliding mechanisms and tracked wheel mechanisms. The advantage of the climbing robots employing a legged mechanism is that they can overcome uneven surfaces climbing [3]

Wall Climbing Robot for Dust Cleaning in a High Risk Buildings at R. Geethanjali et al [2016]. In that project we get knowledge for Self balancing of that robot and stick on that wall that information. That was good and very important for a glass climbing device should be light in weight so that it can stick on the glass surface. Moreover, it must also have large payload so that it can carry equipment. The design of this robot is based on three basic principles: - 1. Adhesion principle 2. Locomotion principle 3. Pneumatic principle [3]

#### 1. PROBLEM IDENTIFICATION:

Window's outer wall cleaning is very complex and also difficult to do. These very dangers and washing skyscraper windows remains a perilous profession, requiring workers to have the reflexes of a trapeze performer high above city streets. Data from the International window cleaning Association showed that between 2010 and 2014, one high-rise window cleaner was dead each year.

This project cleaning will handle by the robots. It was very helpful for that field people. Because the Robots have been created to assist or replace humans in various dangerous and difficult tasks.



Fig 1 Manual Method of wall cleaning

#### OBJECTIVE

In this project scrubber is very use for the glass outer wall clear in high risk buildings. This project has more safety and more help full for the humans. This will stick on the outer wall and cleaning the glass. It's was overcoming other previses project. And it will more advantage because, that robots or machines was working with the help of ropes and other thinks.

But in this project we develop a machine without any rope and other think. It may be used in various application.

#### COMPONENT DESCRIPTION

**Suction Cup:** When the Centre of the suction cup is pressed against a flat, non-porous surface, the volume of the space between the suction cup and the flat surface is reduced. In this methodology used 8 suction cup. For vertical direction have four and horizontal direction have four for the better climb. The working face of the suction cup is made of elastic, flexible material and has a curved surface. [3] The force required to detach an ideal suction cup by pulling it directly away from the surface is calculated.

**Vacuum Pump:** Vacuum pumps are combined with chambers and operational procedures into a large form of vacuum systems. When discussing a leak in the system or back streaming through the pump, throughput refers to the volume leak rate multiplied by the pressure at the vacuum side of the leak, so the leak throughput can be compared to the pump throughput.

**Double Acting Cylinder:** Actuators used in this project have a Bore diameter of cylinder 32mm. Length of the Piston rod 200mm

**Valves:** Valves are used to regulates, directs or controls the flow of a fluid (gases, liquids) by opening, closing. These valves are used to control the cleaning and machine movement from one place to next place to be cleaned.

#### METHODOLOGY

Using Vacuum pump with suction cap to creating grip on glass and there will be motors which will handle the robot motion. By applying both we are making a robot which will take a grip on glass and also move in any direction. In future this robot can be made wireless so that it can be used in so many tasks like security, details of an object, etc

#### DESIGN CALCULATION

Radius =  $r=25$  cm

Sweeping Angle =  $\Theta = 115^\circ$

Total Area cleaned by two wipers,

= 2 \* Area cleaned by one wiper

= 2 \* Area of Sector with angle 115

=  $2 * \frac{115}{360} * \pi r^2$

=  $2 * (115/360) * (22/7) * (25)^2$

=  $(158125/126) \text{ cm}^2$

Hence,

Area cleaned by both wiper =  $(158125/126) \text{ cm}^2$

Suction calculation:

Display style  $F=AP$

Where,

F is the force,

A is the area of the surface covered by the cup,

P is the pressure outside the cup (typically atmospheric pressure)

This is derived from the definition of pressure, which is:

Display style  $P=F/A$

### 7. BASIC FUNCTIONS

- 1) Safe and reliable attachment to the glass surface: The scrubber robot should be sucked to the glass wall safely and overcome its gravity. That is the first difference between a scrubber robot and an ordinary walking robot.
- 2) Movement spreading over all the working areas: The robots should have a function to move in both the up-down direction as well as the right-left direction to get to every point on the glass.
- 3)Efficient cleaning: Efficient cleaning is the ultimate objective of cleaning robots.
- 4) Motion control function: To meet the requirements of all kinds of movement functions.
- 5)The ability of crossing obstacles
- 6)Effective cleaning/surveillance/sensing/glass cutting/ Painting etc.
- 7)Enough displacement on complex structure

### 8. WORKING

This project is used to clean the glass in buildings. This project is work with help of pneumatic air. Components have used in this project are two double acting cylinder, suction cup, compressor, valves, wiper motor, wiper blades and arrangement, battery, nozzles, aluminum block, S.S rod. Construct the components as per the diagram. First generate the compressed air using compressor. Attach the arrangement in the glass. Send the compressed air to the cylinder 1. Due to cylinder 1 action, cylinder 2 get moved due to the action of Piston. The air is given to the cylinder through the tube. Which hold the pressure up to 10 bar. The special valve is in the cylinder to send the air into the cylinder and hold the tube. Due to high pressure normal valve get release the tube, but this will not allow to release the tube.

Then send the compressed air to the cylinder 2. Then due to the cylinder 2 Piston action the cylinder will move. This the supply of air into the cylinder is done by the switching of the valve named as 3/3 valve. Then fixing of wiper arrangement in shown in figure. This we used two nozzles, 1 is for blowing the air to clean the dust. This make some scratches while cleaning the glasses. This air blowing is done by the help of switch. Then 2<sup>nd</sup> nozzle is for sprinkle the soap solution to clean the glass.

This the wiper motor is get connect the linkages as per the diagram. This linkage helps to wipe the glass. The blade size is 13 inches. Then this diameter for cleaning is 25 cm.

The sweeping angle of the wiper is 115°.So by the calculations this may covers up to 158125/126 cm square.

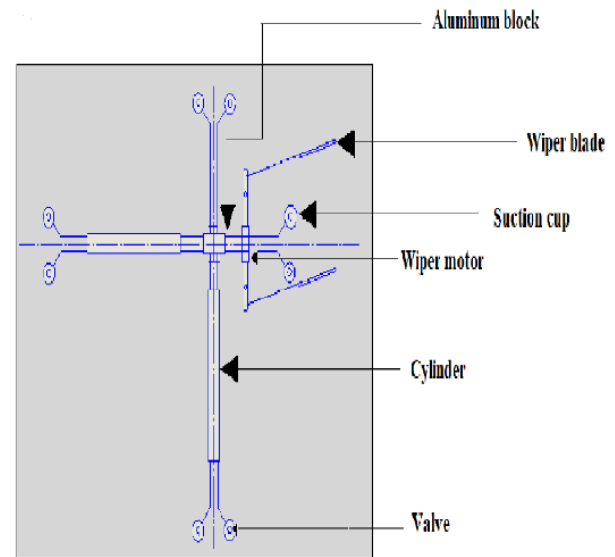


Fig 2D diagram

Wiper motor get operate by the help of battery arrangement. Initially the machine is fixed in the vertical wall using the suction .Check the pressure in the entire suction cup. And then apply the pressure in the suction cup to drive the motor in forward direction. In case there is any obstacle is detected. When move robot in horizontal direction in the vertical to the surface. Otherwise the process is continuous until the coverage of the vertical wall .This arrangement was show in the figure.

### 9. CONCLUTION

This machine can work well for buildings having completely glass exterior. The components required are simple enough and the programming required is basic. However, the material used to hold the suction cup is made out of light aluminum thus making it hard to weld the fitting together. This robot should be further developed so that it can be assigned to do tasks that would be difficult for humans to do.

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