

Semi-Automatic Glass Cleaning Machine for Dirty Windows

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ABSTRACT

Window panel cleaning makes the building's architectural glass free from dust and dirt. The traditional way of cleaning office windows cannot be applied to high-rise windows with huge sections of glass. Cleaning the windows from outside requires special tools in going up and it's unsafe. The Window cleaner proposed is a device that would be controlled by using a microcontroller. This device would be safer compared to traditional methods of window cleaning in case of high glass structures that increase the risk of loss of human life.

The structure of the proposed device consists of a triangular frame and uses a suction cup-based adhesion technique to adhere to the glass surface. The movement of the frame over the glass is done by using special rigging. The frame consists of an automated cleaner which is run by motors and pre-programmed microcontrollers. The automated cleaner moves in the vertical direction within the frame.

KEYWORDS: Motor, glass, window, frame, brush

INTRODUCTION

Cleaning machines are useful devices that can be adopted in a variety of applications like maintenance, building, inspection, and safety in the process and construction industries. These systems are mainly adopted in places where direct access by a human operator is very expensive, because of the need for scaffolding, or very dangerous, due to the presence of a hostile environment. As the results of surveying the requirements for the wall-climbing machine, the following points are necessary for providing the machine for practical use:

- It should be small in size and lightweight for portability.
- Automatic operation during moving.

A wall-climbing machine should be light and allow a large payload, reducing excessive adhesion forces and carrying instrumentations during navigation. Up to now, considerable research was devoted to these machines and various types of experimental models were proposed. The two major issues in the design of wall-climbing machines are their locomotion and the adhesion methods. Concerning the locomotion type, three types are often considered: the crawler, the wheeled, and the legged types. According to the adhesion method, these machines are generally classified into three groups: vacuum or suction cups, magnetic, and gripping to the surface. Recently, new methods for assuring the adhesion, based on biological findings, have also been proposed.

This procedure may be repeated until the entire building has been washed. Cleaning windows using scaffolding is extremely time-consuming. To reduce time and cost,

therefore being more competitive in the industry, Window washers tie a climbing rope to the roof anchors provided for the scaffolding and throw the rope over the side of the building. Then they attach a boson's chair to the rope and a climber's harness to themselves with repelling hardware. The mangoes over the side of the building with his tools and Water/soap bucket and cleans 6-8 horizontal glass Width per story. Then repels down to the next level and repeats until that drop is complete. Manual Washing of buildings has proven to be quite dangerous, especially concerning tall skyscrapers. Typical Wind and air drafts surrounding. Arun Kumar et al., (2017) described to automatic Skyscraper Window Cleaning System (ASWCS) aims at providing a risk-free and more automated solution for the problem of cleaning glass-windowed high-rise buildings. It consists of a rollers-based moving platform suspended by a motorized pulley from the top of the building. The cleaning is done with the help of a motor-driven cleaning roller brush and water spraying system provided on the platform.

A. Description of the cleaning module

The device generally comprises a metal, plastic, polymer, or composite frame and a rotating brush. In this example, the frame is formed of a steel alloy. The metal frame comprises a plurality of tubular sections that are bolted, welded, or fastened together via typical means to form the shape. Referring to the device more specifically, the automated window washing apparatus generally comprises a frame assembly, the main brush, an optional side brush, and a

How to cite this paper: A. Arun Negemiya | P. Aswathraj | S. Balaji | M. Hariharan | M. Hariharan "Semi-Automatic Glass Cleaning Machine for Dirty Windows" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-5 | Issue-4, June 2021, pp.1625-1628, URL: www.ijtsrd.com/papers/ijtsrd43683.pdf



IJTSRD43683

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shroud enclosing approximately half of the diameter of the main brush from end to end.

B. Problem description

It is observed that working with a glass panel cleaning job for a worker it may unguaranteed life and time took to clean a panel when manual work is done. In this project, the machine is designed to overcome the above problem and to reduce the labor cost. At first, the glass cleaning machine and the machine semi-automatically cleaning a window panel to control by remote control.

C. Objectives

The main objective of this project is to design a semi-automatic mechanical device used in cleaning the window glass panels in a building.

MATERIALS AND METHODS

This paper aims to design and fabricate a semi-automatic glass cleaning machine for using remote-controlled. This chapter deals with the design and analysis of the product and also the methodology of making the product. The materials and properties of the selected components are discussed in this chapter. Semi-automatic glass cleaning machine consists of frame, chain drive, rotary rubber, rollers, camshaft, and tank.

A. Conceptual design

Initially, the rough drawing and dimensions were drawn. After the drawing, the three-dimensional model of the semi-automatic glass cleaning machine was drawn in Solid Works. Each part has been drawn separately and assembled. While designing a glass cleaning machine, some assumptions are considered which is standard for their parts. Safe design for this machine by calculating the dimensions of each part and considering formulations. Material selection based on availability, durability, cost, and ease of fabrication were also considered. The conceptual design is shown in Fig 1.

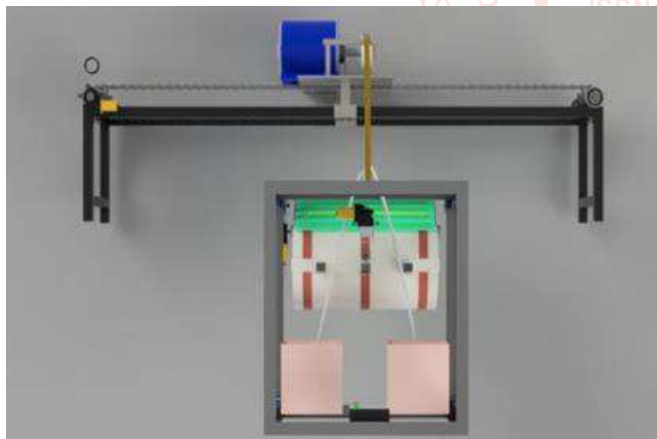


FIGURE 1 Conceptual design

B. Methodology

The methodology of the project is explaining the materials and methods which are used for designing the components of a semi-automatic glass cleaning machine. Semi-automatic glass cleaning machine consists of frame, chain drive, rotary rubber, rollers, camshaft, ball bearing, castor wheel, polyurethane tube, and water tank.

The frame is made up of mild steel materials and all the other components are mounted on it. The tool is made from the mild steel block and the cleaning process is done with the help of a roller brush, DC motor, and chain drive. The roller brush is operated by a DC motor and the polyurethane tubes are the help of water passes through a water tank to

the sprayer. The frame is connected with ropes and the ropes are mounted in pulleys. The pulley is movable and it's a working chain drive mechanism. The chain drive is used to move the linear motion and the chain drive system is working on the ball bearing and spur gear. During the process, the microcontroller is used to the controlled machine by remote-controlled and the microcontroller is connected with a 12v battery. The chain drive system is fitted to the top of the glass panel and with the help of a rope, the frame is movable to upward, downward and linear motion.

C. Working principle

The project consists of a frame, gears, chain drive, rollers, water tank, cleaning bushes, etc., The frame is made up of mild steel material and components are mounted on it. There are two frames present in the process, one consists of a chain drive set up along with the dc motor & the spur gear and the other one consists of a tank of water and the brushes for the cleaning process. The rope is used for the adjustable height.

D. Sequence of operation

The flow of the semi-automatic glass cleaning machine is shown in Fig. 2

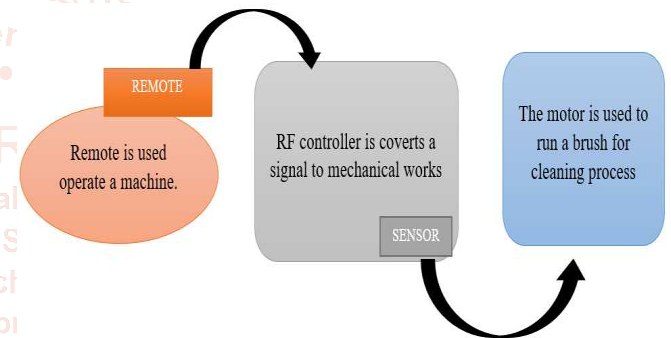


FIGURE 2 Sequence of operation

E. Design calculation

The machine is cleaning to glass on covered with plastics, rubbers, metal, aluminum frames.

Horizontal lifting force

Apply Newton Law to calculate the force on an 8 kg machine mass with a change in acceleration of 2 m/s² and a safety factor (SH) of 2.

$$FH(N) = \text{mass}(\text{kg}) \times (ag+ a) \times SH$$

$$FH(N) = 5\text{kg} \times (9.81\text{m}/\text{sec}^2 + 2\text{m}/\text{sec}^2) \times 2$$

$$FH = 118.1 \text{ N}$$

Vertical lifting force

Apply Newton Law to calculate the force on a 5 kg machine mass with a change in acceleration of 2 m/s² and a safety factor (Sv) of 4.

$$Fv(N) = \text{mass}(\text{kg}) \times (ag+ a) \times Sv$$

$$Fv(N) = 5 \text{ kg} \times (9.81 \text{ m}/\text{sec}^2 + 2\text{m}/\text{sec}^2) \times 4$$

$$Fv = 236.2 \text{ N}$$

Calculate the force on a 5kg mass with a dry surface, a change in acceleration of 2m/sec², and a change in travel acceleration of 2m/sec².

$$FM(N) = (FV^2 + FH^2)$$

$$FM(N) = [(5\text{kg} \times 2\text{m}/\text{sec}^2) \times 4]^2 + [5\text{kg} \times (9.81\text{m}/\text{sec}^2 + 2\text{m}/\text{sec}^2) \times 2]^2$$

$$FM(N) = (40kgm/sec^2)^2 + [118.1kgm/sec^2]^2$$

$$FM(N) = 1600kgm/sec^2 + 13947.6kgm/sec^2$$

$$FM = 124.69 N$$

$$FM/n = (124.69 N)/2$$

$$= 62.345 N.$$

RESULTS AND DISCUSSION

A. Methods of study

This project is involved cleaning the glasses with the help of a roller brush and microcontroller. The Semi-automatic glass cleaning machine is explained in the last chapter. The time study and cost estimation involved in the project are explained in this chapter.



FIGURE 3 Final prototype

B. Final fabricated prototype of semi-automatic glass cleaning machine

The following Fig 3 is shown us the final fabricated prototype of a semi-automatic glass cleaning machine.

C. Fabrication process

The material selected must possess the necessary properties for the proposed application. The various requirements to be satisfied can be weight, surface finish, rigidity, ability to withstand environmental attack from chemicals, service life, reliability, etc. The following three types of principle properties of material decisively affect their selection.

D. Test report

The test report of the semi-automatic glass cleaning machine has been generated with the duration of one hour shown in Table 1. The theoretical area capacity (FCt), Effective area capacity (FCe), and Field efficiency (η) were computed with equations.

Effective area capacity (FCe)= Actual area covered / Total time taken

$$FCe = A/t$$

TABLE 1 Result of area capacity and area efficiency

S. No	Time (min)	Area (m ²)	FC _e (m ² /hr)	Efficiency (%)
1	15	55	220	55
2	30	102	204	51
3	45	148	197	49
4	60	198	198	49
5	75	234	187	47

E. Important Findings

These types of wall climber and cleaning machine have a wide range of applications in the areas like,

- It can be a replacement for the GONDOLA system for high-rise building cleaning.
- Has the potential to serve as a base on which to mount data acquisition devices, surveillance equipment, or object-manipulation tools.
- Wireless/wired video surveillance possible.
- Public safety & military applications (surveillance, search & rescue).
- Consumer applications (window cleaning and painting)
- Inspections (building, aircraft & bridges, Pipes), etc.

Wall/glass cleaning and water sprinklers can be mounted.

CONCLUSIONS

A strong multidiscipline team with a good engineering base is necessary for the Development and refinement of advanced computer programming, editing techniques, diagnostic Software, algorithms for the dynamic exchange of informational different levels of hierarchy. This project work has provided us an excellent opportunity and experience, to use our limited knowledge. I learned a lot of practical knowledge regarding, planning, purchasing, assembling, and machining while doing this project work.

It has proud that completed the work with the limited time successfully. The “semi-automatic glass cleaning machine” is working with satisfactory conditions. these can understand the difficulties in maintaining the tolerances and also quality. It has done to our ability and skill making maximum use of available facilities. In concluding remarks of our project work. Thus, it has developed a “semi-automatic glass cleaning machine”. By using more techniques, it can be modified and developed according to the applications.

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