Design and Fabrication of Automated Glass Cleaning Robot

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Abstract

The typical procedure of cleaning office windows cannot be applied to high-rise windows with huge portions of glass. Cleaning windows from the outside takes specific climbing tools and is highly dangerous. The suggested window cleaner would be a self-contained unit that would be operated by a remote control. In the case of tall glass skyscrapers, where the risk of human life is increased while using traditional cleaning methods, this technology would be safer than those typical window cleaning methods.

Introduction

In today's world, window cleaning in high-rise buildings is in high demand. As a result, window cleaners are forced to risk their lives by cleaning the windows by scaling the wall with a rope and gondola. The majority of them are still cleaned by hand at the moment. Window cleaning is the most risky maintenance activity in most workplaces. According to figures from the United States alone, an average of 70 window washers die each year, with another 130 being injured. The development of a mobile robot that can cleans windows will aid in the reduction of statistics. This project aims to introduce new ideas and innovation in the field of window cleaning robots.

Problem Statement

Many automatic window washing solutions are currently in demand on the market. The robot window cleaning needs are mentioned below as part of the investigation:

1. For mobility and portability, the robot should be small and light in size.
2. The robot should be able to clean the window's corner because dirt is frequently left there.

Objective

The goal of this project is to create a robotic device that can be used to clean high-rise window glass panels. The course focuses solely on mechanical engineering design, which entails starting from the scratch until a workable conceptual design is achieved.

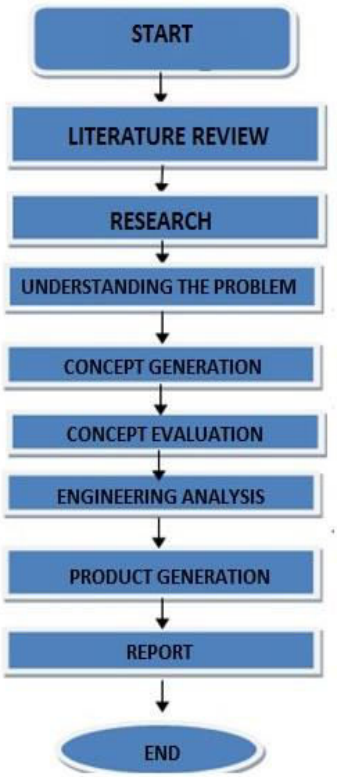
Scope

The goal of this project is to design a commercial window washing robot. The gripping mechanism, propulsion mechanism, cleaning mechanism, and turning mechanism must all be included in the robot. An analysis is done to calculate the suction force required for gripping of robot to the glass, static frictional force involve in the robot system, the cable force calculation and the motor torque calculation and selection of suitable motor.

Methodology

Figure 1: Methodology

Literature Review



Due to the extreme rising number of high-rise buildings and huge glass facades, as well as the resulting difficulty of safe and effective cleaning, a lot of effort has gone into developing automated cleaning systems

in the last several years. Japan and Europe have designed and created the bulk of systems to date. In the middle of the 1980s, Japan was the first country to employ automated cleaning systems for high-rise buildings. These systems were primarily created to be used on certain structures. They frequently required additional construction, such as guidance rails to the facade, for safety reasons or to guide the robot's movement on the facade. The prior solutions were usually unsuccessful in practise due to a lacklustre safety concept, poor cleaning quality, the need for additional facade building, or simply high initial and ongoing expenditures. Cleaning robots were among the first members of the service robot family to arrive on the market with useful and cost-effective solutions. High-rise windows cannot be cleaned in the same manner that regular office windows are. The reason for this is that windows are incredibly difficult to reach. Cleaning the windows from the outside requires the use of specific gear and is quite dangerous. Only experts, with all of their expertise and unique body movements, can do this astounding feat. Cleaning services will employ certain instruments that are appropriate for the height, size, and materials of the windows. Window cleaners, for example, can utilise long tools to clean and reach high windows without the need for scaffolding. An excellent sensing capability is a critical component of the climbing robot application's success. The cleaning robot must know when to start and finish the cleaning task, how to control the direction, and how to traverse the window frame in order to clean the glass surface. Due to which, the robot's orientation, distance from the window frame, and distance from the unclean place to be cleaned all need to be measured. Engineering analysis was required to ensure that all mechanisms in the conceptual design functioned properly. The first step in this section is to guarantee that the robot can stick to the window and hold it firmly in place. The second portion involves calculating forces such as frictional force that occur during robot movement. The third step is to determine the required motor torque in order for the robot to be lifted upward. The final step is to look into possible failure modes within the robot's system. The severity and likelihood of failures are used to classify the failures.

Proposed Model

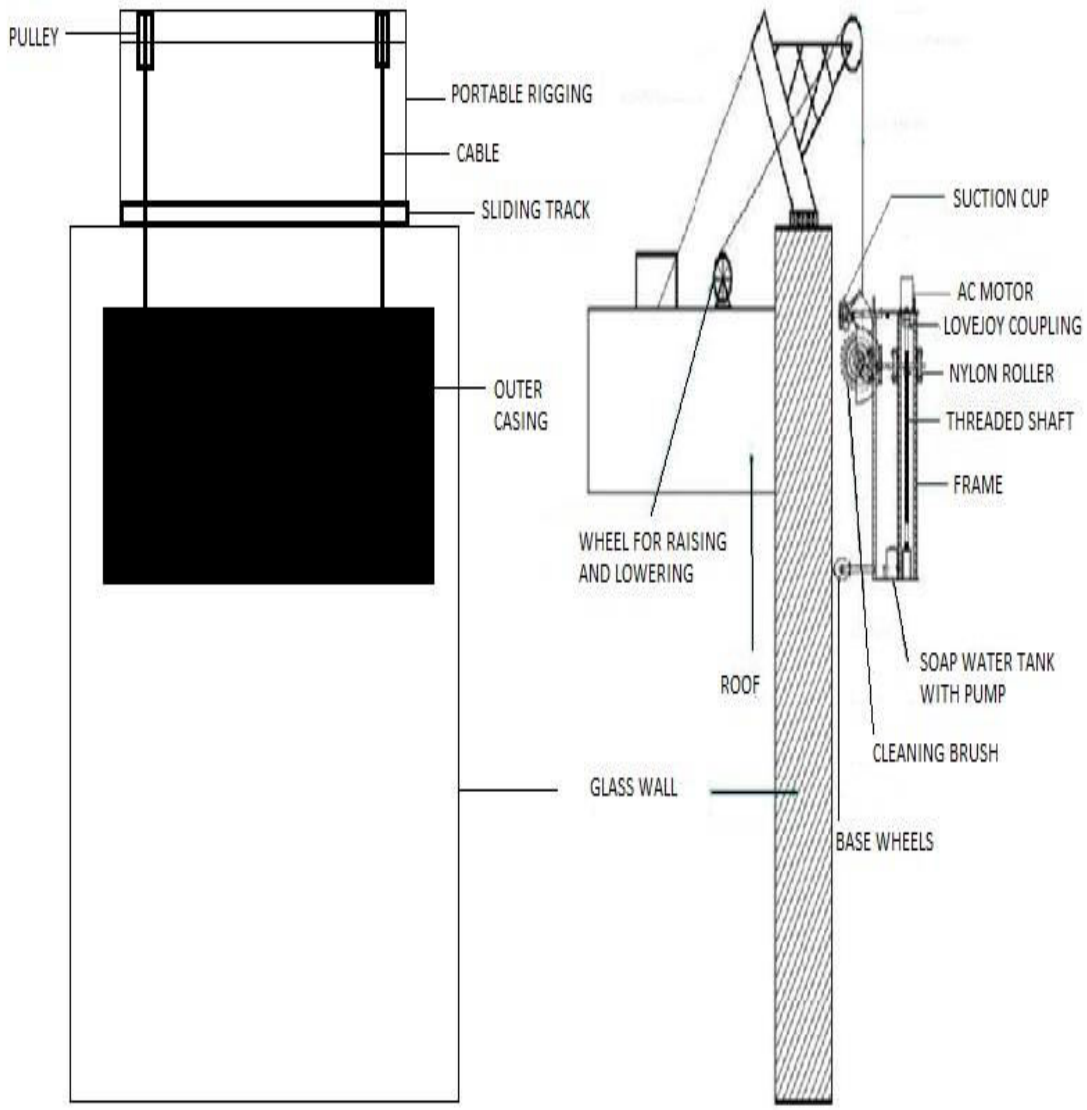


Figure 2: Window Cleaning Machine

Preferred dimensions

Table1: Preferred dimensions

Component	Dimensions
Power Supply	24 V
Portable Cleaning Machine Frame	500mm × 500mm × 200mm
Cleaning tank	50 ml

Execution Steps

1. Identify the customers
2. Determine the customer's requirements
3. Generate Engineering Specification
4. Relate Customer's requirements to Engineering Specification

Advantages

[1] This machine is suitable for buildings with entirely glass exteriors.

[2] The machine's architecture is capable of performing its intended function: effective glass surface cleaning.

[3] The suction cup attachment system is easy and reliable, and it ensures solid contact with the support surface.

Disadvantages

[1] Robotic vacuum cleaners are unsuitable for cleaning staircases.

Conclusion

The project uses a mobile rig to move a simple window cleaning machine, which reduces the cost of the climbing mechanism. This design takes traditional goods and systems and changes them into a dependable, innovative, and functional final product. Based on the results of the investigation, the robot concept is found to be suitable for the intended functionality. The project successfully meets its project scope and objectives, which include developing a working window cleaning robot for high-rise buildings.

Reference

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