Design and Fabrication of Automatic Window Cleaner

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Abstract- *Window cleaning is the cleaning of architectural glass used for structural, lighting, or decorative purposes. It can be done manually, using a variety of tools for cleaning and access. Cleaning the windows from outside requires special tools in going up and it's really unsafe. The window cleaner proposed is an unmanned device which would be controlled by using a microcontroller. Structure of the proposed device consists of a base with a screw rod and with a support for wiper which rides on a window track. The movement of the frame over the glass is done by using lead screw mechanism. This paper is based on an automated glass cleaner which is aimed to clean glasses of high-rise buildings or skyscraper, using lead screw mechanism. The base design allows the robot to cover the entire x-axis of the window, to move on the y-axis, the robot uses the lead screw arrangement which converts the rotatory motion into linear motion.*

Keywords- Automatic window cleaner, Microcontroller, Mobile Operated, Lead screw mechanism.

I. INTRODUCTION

The traditional way of cleaning office or general store windows cannot be applied to high rise windows with huge sections of glass. Automation plays an important role because it achieves high safety and reduces man power, work load. Currently there is no development of automated robot systems for cleaning the exterior walls of high rise buildings. The reason behind this work is it is inaccessible to reach the window at such heights. It is really unsafe to clean the windows from outside as it requires special tools in going up. Robots have been created to assist or 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. Cleanliness is one of the important aspects in human life. Because of this importance, many kind of cleaning mechanisms are invented to ease the human daily chores such as vacuum cleaners, window cleaners which are used to clean glass windows. Cleaning skyscraper windows is a dangerous job and not for the faint-hearted. It takes a certain type of person to be able work at heights way above the ground. Skyscraper window cleaners are skilled professionals, aware of the perils of their job. One slip or mistake and people could die, so safety is always foremost in window cleaner's mind. Safety drills are performed regularly and everyone knows exactly what to do while suspended high up in the air. Wind can play a big part too. Way up on the side of a skyscraper, winds generally blow at a much greater speed than down on the ground, which makes it absolutely vital for cleaners to be equipped with the relevant safety equipment. The kind of tools and equipment that protect workers from dangerous incidents and help them clean windows include rope protectors, a descent mechanism, a safety rope, rope-grabbing tools, a lanyard and suction cups. Workers washing windows on skyscrapers are attached to an anchor that's mounted on the roof, allowing them to clean the windows as they move jerkily down the building. Over the years, many different mechanical platforms and devices have been used to help professional widow cleaners get to where they need to be to clean the windows properly and safely. Cleaning is routine in our life. It involves many activities in our daily life. It is a hard work and a lot of time is consumed. Window cleaning is also one aspect of office maintenance activity. The clean windows will irrefutably provide a comfortable environment to the office inhabitants. The two main points that are stressed in this project are to overcome the hazard (HSE, 2008) of human involvement in cleaning office window activity and reduce high cost by the conventional method of cleaning window. It becomes necessary to overcome the limitation. The project intends to replace or minimize human involvement in cleaning the window by replacing it with a small cleaning robot for office window with several capabilities. The abilities are; portable, small size, lightweight, automatic operation and can clean all the corner of the office window. The goal of this project was to create a simple robot which could easily clean the high rise window completely autonomously, i.e. no human interface. The processes involved in this project included devising a method for the robot to search a window for cleaning, designing a way to physically move a robot to dirty window, and enabling a robot to clean it.

II. MATERIALS AND METHODS

The components and materials taken for preparation of prototype are:

i. DC Motors
ii. Lead Screw
iii. Relay switch
iv. Microcontroller
v. Driver Circuit
vi. Bluetooth
vii. Adapter
viii. Frame
ix. Acrylic (Polymethylmethacrylate)
x. Cleaning brush(Sponge)

A glass cleaning machine is designed to clean the surface of glass wall of high rise buildings. It consists of a rectangular metallic frame on which the slider is attached over guide vanes. A Cleaning drum along with brushes is fixed to the slider. It is fixed in such a way that half the diameter of the drum protrudes outside the frame. Such an arrangement of the drum does not allow the frame to touch the glass wall preventing from any damage occurring to the glass. A threaded shaft is provided to give vertical movement to the slider. The nylon rollers assist the vertical movement of the slider over the frame. The shaft is coupled to an AC motor which rotates the shaft at 60 revolutions per minute using a Lovejoy coupling. The cleaning drum is coupled to wiper motor which rotates the drum at 50 revolutions per minute. The cleaning drum is covered using a sheet metal casing which is fastened to the slider. The casing is fitted with 8 nozzles out of which 5 nozzles spray pure water and 3 nozzles spray soap water. The supply of pure water can be done by pumping it from an external source and the supply of soap water is done by using a pump which is attached to a separate tank fastened at the bottom of the frame. Pure water is sprayed through the 5 nozzles on the glass wall. Remaining 3 nozzles spray soap water on to the brushes to ensure efficient cleaning. A wiper is riveted to the casing which is actuated by a DC motor, controlled by the microcontroller. The reed switch is fixed to the frame and two magnets are placed at appropriate positions on the slider. As the slider approaches the upper/lower limit of the threaded shaft, the reed switch gets actuated by the presence of the magnetic field. This will send a signal to the microcontroller which reverses the direction of the slider. Cleaning of the surface is done in two passes. In the first pass the slider moves from bottom to the top of the threaded shaft. At this time the nozzles spray the soap water solution and cleaning brush rotates throughout the pass. This ensures in the even application of the soap solution on the glass surface. In the second pass the slider moves from top to the bottom of the threaded shaft. The nozzles spray pure water throughout the pass. Wiper is actuated on to the surface using a motor such that the water is wiped off in this pass. In the end of second pass wiper returns to its initial position. The machine is of hanging type which can be raised or lowered by using pulley mechanism. The machine is made to hang in such a way that only the brushes come in contact with glass which is possible by using the rigging as shown in the Figure 1-3. As the machine moves up there are chances for the brushes not to touch the surface glass wall due to wind or due to height of building, to make sure the brushes touch the glass wall two suction cups are provided on the top of the frame which creates contact between the brushes and the glass wall there by helping in proper cleaning. The suction cups are pushed forward towards the glass by a DC motor and the adhering is done by another motor with the help of wedges. The micro switch limits the movement of the suction cups such that when the suction cups touch the glass wall, the switch gets actuated and sends a signal to the toggle switch to stop the suction cup movement. Two rubber wheels are provided at the bottom of the frame to ease the vertical movement of the machine on the glass wall.

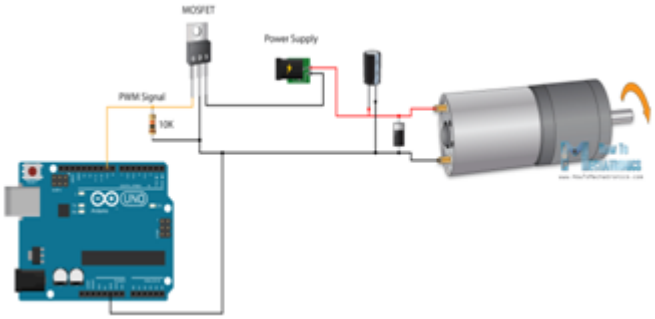

Fig. 1: Control of dc motor with the help of Arduino Uno board

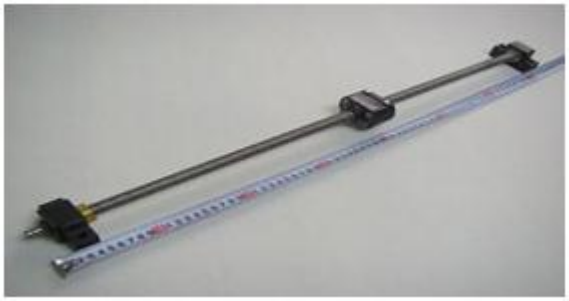

Fig. 2 Lead Screw

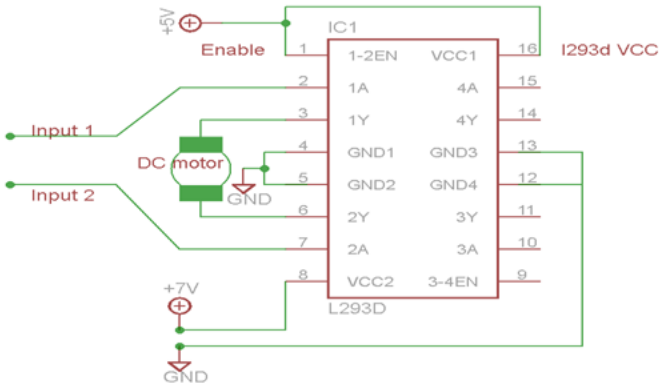

Fig. 3 Circuit Diagram

III. FABRICATION OF AUTOMATIC WINDOW CLEANER

Fabrication of window cleaner prototype mainly consists of following steps:

1. Bending Process
2. Stick Welding Process
3. Cutting Process
4. Metal Punching
5. Finishing Operations

3.1 Bending Process

Bending is a manufacturing process that produces a V-shape, U-shape, or channel shape along a straight axis in ductile materials, most commonly sheet metal. Commonly used equipment include box and pan brakes, brake presses, and other specialized machine presses. Bending is a cost effective process when used for low to medium quantities.

3.2 Stick Welding process

Stick welding, also known as shielded metal arc welding or MMAW, makes use of a consumable electrode covered with a flux. Different types of electrode can be used depending on the application, the color match required, and the amount of machining to be done after welding. Nickel alloy electrodes are the most popular for cast iron welding.

3.3 Cutting

It is the separation or opening of a physical object, into two or more portions, through the application of an acutely directed force. Cutting is compressive and shearing phenomenon, and occurs only when the total stress generated by the cutting implement exceeds the ultimate strength of the material of the object being cut. The stress generated by a cutting implement is directly proportional to the force with which it is applied, and inversely proportional to the area of contact. Hence, the smaller the area (i.e., the sharper the cutting implement), the less force is needed to cut something. Laser cutting sheet metal produces flat parts and etches and engraves parts from complex or simple designs. It is used over other cutting options for its quick process and customizable abilities.

3.4 Metal Punching Process

Punching is often the cheapest method for creating holes in sheet materials in medium to high production volumes. When a specially shaped punch is used to create multiple usable parts from a sheet of material the process is known as blanking. In metal forging applications the work is often punched while hot, and this is called hot punching. Slugging is the operation of punching in which punch is stopped as soon as the metal fracture is complete and metal is not removed but held in hole.

3.5 Finishing Process

Finishing processes is employed to improve appearance, adhesion or wettability, solderability, corrosion resistance, tarnish resistance, chemical resistance, wear resistance, hardness, modify electrical conductivity, remove burrs and other surface flaws, and control the surface friction.

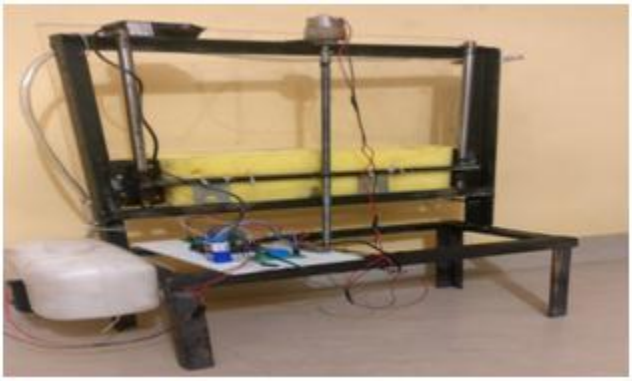

Fig. 4 Prototype of window cleaner

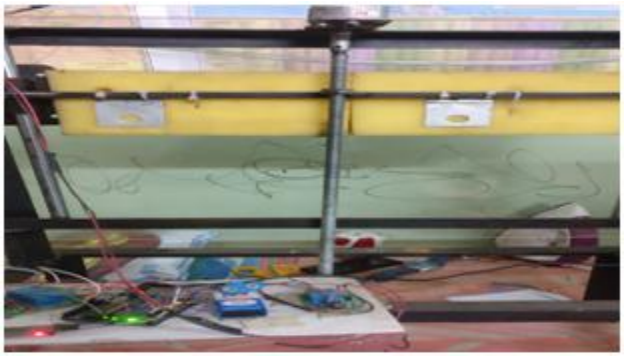

Fig. 5 Cleaning is done automatically

IV. CONCLUSIONS

The automated glass cleaning machine has been successfully designed and fabricated. The project work implements a simple glass cleaning machine that uses a portable rigging for the motion there by reducing the cost of climbing mechanism. The proposed design of Automated Glass Cleaning System is constructed as a proto type for covering a span of 1.5 ft x1.5 ft of the glass area, as the area increases the size of the lead screw get increased and also the base structure is being strengthened by providing suitable ribs for the support members. This machine can work well for buildings having completely glass exterior. The machine

construction is able to perform its intended function: the efficient cleaning of glass surfaces. The suction cup attachment system ensures good contact with the support surface, is simple and reliable. Comparing with the traditional suction cup robots, the suction cup in this project does not need any onboard vacuum pump and it has advantages of no noise, little volume and weight. The overall weight of the machine is around 20kg. The cleaning process takes about 5 minutes to finish a glass window panel. Uniform cleaning by using rubber brush and optimal in-line water pump deliver soap water for removing stubborn stains and controlled spray of water by using microcontroller to reduce wastage of water, cleans at faster rate when compared to others. With some modifications the machine can also be used for wall painting. Moreover, a dirt detecting technique is developed which detects dirt by measuring amount of dirt on the glass. Results of experiments using the dirt detecting technique show the validity of the discussions. By implementing these types of systems the requirement of working labour at such risky areas will be reduced and also work will be completed in short time. Thus the dangerous accidents occurring during these operations can be reduced.

V. ACKNOWLEDGMENT

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