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Design and Fabrication of Semi-Automatic Cleaning and Painting Machine

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Abstract: ***In today's world one of the most exhaustive and hazardous job is painting the exterior walls and cleaning of windows Hence there is a need for development of mechanisms that may help in painting and at the same time, simultaneously it may be used for cleaning of windows(glass) at a greater heights. This design comprises of a mechanism that is incorporated in the wall climbing robots (inflator and deflator mechanism) for greater accuracy in its work. For the vertical motion of the wooden base consisting of brush, battery, motors etc. a railing and a pulley system has been adopted and for the horizontal motion of the system a perfect lock bolt mechanism is being used. The main objective of this design is to save the human life from the hazardous condition and satisfying the other criteria like simplicity in design, low cost, easily manage, and covering all the needs of various safety standards.***

Keywords: Window cleaning and painting, OSHA safety standards

1. Introduction

According to OSHA (Occupational Safety and health administration) falls are the leading cause of death in construction. In 2016, there were 370 fatal falls to a lower level out of 991 construction fatalities. One way to avoid the falls is by providing training to the workers in hazardous environments and to provide the right safety equipment. To protect the workers, they must need fall protection and the right equipment for the job, including the right kinds of ladders, scaffolds, and safety gear .

1.1Manual methods

Manual window cleaning is tiresome and tedious jobs, as they have to work at a greater heights there is a concern on safety of the workers. So the workers need to be equipped with proper personal protective equipment (P.P.E) like rope grabbing tool, a descent mechanism and of course a helmet. The workers generally seated on boatswain's chair which is anchored to roof structure which is mounted on the roof as shown in the Figure1 and some of the operations are carried from the ground as shown in Figure2 .

Figure 1: Boatswain's chair

Figure 2: Operations from ground

There are many issue related to safety such as, the worker experiences dizziness at a great height and further there are environmental factors like wind which become a problem for the worker.so one can say that manual window cleaning or painting is one of the toughest and hazardous job.

1.2 Proposed design

Proposed design ensures to eliminate the mentioned problems in the manual cleaning. We implemented the use of machine which is guided by the man at the roof top and he will operate the machine from the roof without the risk of falls, it also eliminates all the necessary personal protective equipment, this machine provides better quality and higher productivity.

2. Theory

2.1 Design parameters

Major parameter which are taken into the consideration are the movement of the slider along horizontal axis for one revolution and movement of wooden board along vertical direction , specification of side motor, specification of centrifugal pump , and battery .

2.2 Pulley system

The Pulley System makes use of a disk-shaped block that a rope wraps around to create a simple machine. The pulleys are used to move the board along the vertical direction.

The rope is wound and one end is glued to the pulley whereas the other end is attached to board. A handle is provided which is fixed rigidly to the pulleys, by the rotation of the handle the board moves in vertical direction.

2.3 Design of rectangular structure frame

The rectangular frame supports the entire machine and holds the parts together. bending stress are more prominent so we prefer rectangular cross section which is next best to I

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section, to assemble the metallic parts we use metal arc wielding as it provides more strength and use glue for non-metallic parts.

2.4 Thread rod drive system

Thread rod is used to achieve horizontal linear motion of the wooden board.

3. System design and components

Some of the major components involved in this system are:

- Chassis/frame
- Thread rod (100 mm)
- Ball bearings
- Pulley (700mm diameter, No-2)
- Railings or sliders
- Brush and pipe
- Johnson motor (5.5KG N/m)
- Battery (12 V,1.2 ah)
- Submersible pump (12 V, 5ft height)

3.1 Construction of chassis along with other components

A mild steel 4kg pipe (hollow) has been arc welded into a rectangular frame of dimensions (1000mm*300mm) as shown in the figure3.

Figure 3: Chassis along with other components.

A **threaded rod** made of stainless steel having a 16mm diameter has been attached to the rectangular frame with the help of a U-clamp having roller ball bearing attached to it.
A perfect lock bolt mechanism is adopted at the bottom of the wooden base for the horizontal motion of the system and L-clamps are provided for the support of the whole system.
With the help of the handle a rotary input is being given by the man and it's converted into translation motion.

3.1.1 Construction of the wooden board with other components

This wooden board (1) is involved in horizontal motion with the help of lock nut and bolt mechanism (castor balls have been attached at the bottom of the chassis for support). Wooden board consists of two pulleys and two railings which help in the vertical motion of the cleaning system; the input is given with help of a handle as shown in the figure4. The dimensions of the wooden board are 300mm*300mm.

Wooden chassis (2) consists of a battery, 2 DC Johnson motors and a brush. The ropes from the pulley are attached to the chassis with the help of U-clamps and its being supported with rail system for smooth operation in its work. The dimensions of the wooden chassis (2) are 300mm*300mm as shown in figure 5.

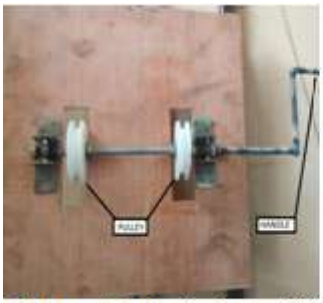

Figure 4: Wooden board (1)

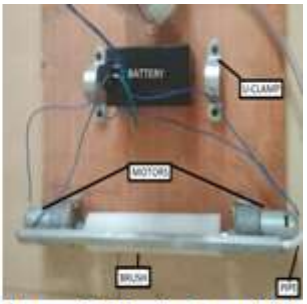

Figure 5: Wooden board (2)

4. Working

The working of this simple semi-automatic cleaning and painting machine can be easily conveyed through the below block diagram (fig. 6)

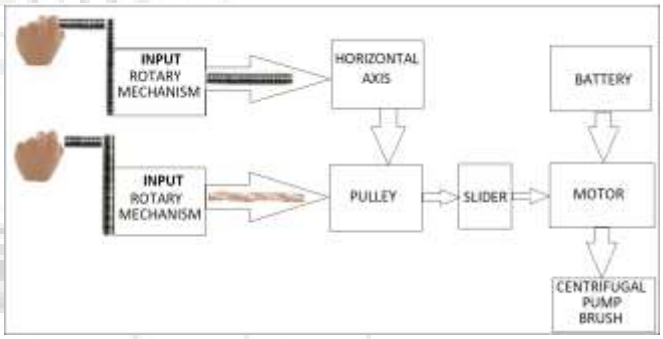

Figure 6: Block diagram of the model

Input to the machine: power supply from the battery, movement of the handles which, one is linked to thread rod and another to the pulley system.

Output of the machine: movement of the board along the rails, and along the threaded rod and rotation of brushes.

STEP 1- The entire machine is rigidly held to the roof or the wall.
STEP 2- The power supply to the submersible pump & motor is given from the battery by switching on the switch.
-Once the supply is given, the brush is set in rotation and water is sucked from the container which will flow along the pipe and finally falls in the form of droplets all over the brush, and hence the cleaning process is run entirely with the battery.
STEP 3- The movement of the board which contains the brush is to be driven manually with the hand.
STEP 4- Once the machine is set or power supply is on, vertical motion is given to the board and after retrieving back again in same direction a small horizontal displacement is given to the board and the process is repeated i.e. the machine moves entire length over the vertical direction returns and then a horizontal displacement is given.
STEP 5- The handle attached to pulley is given a rotary input with certain torque, then the pulleys starts rotating. One end

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of the rope is attached to the pulley and other one is fixed to the board.

As the pulley rotates the wire rope either gets wounded or unwounded over the pulley, which causes the vertical motion of the board.

STEP 6-After completing one round vertically the second handle attached to the threaded rod is rotated, there is a sliding block attached to the thread rod and as the rod is rotated the sliding block slides along the thread rod.

The above two steps are repeated until the work is done.

NOTE - Inflator and deflator is used for providing the suction force or squeezing effect so that that the brush is held with some pressure against the wall to provide better cleaning action and to seize the motion in unwanted direction e.g. when there is a gust of wind both the rails and suction help in providing balance for the machine

The figure 7 shows the circuit arrangement of the battery and motors. They are connected in a parallel connection.

The specifications of the battery are 12v and 1.2ah.

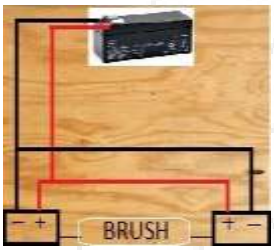

Figure 7: Circuit arrangement

5. Conclusions

The Semi-Automatic Cleaning and Painting Machine has been successfully designed and fabricated. The project work accomplishes simple glass cleaning and wall painting that uses a pulley and railing mechanisms for the motion thereby reducing the cost of climbing mechanism.

The machine construction is able to perform its predetermined function: the efficient cleaning of glass surfaces and painting of exterior surfaces. The inflator and deflator attachment system ensures good contact with the support surface, is simple and conscientious. This machine can work well for buildings having completely glass exterior.

6. Future Scope

Man always tries to develop more and more modified techniques to full fill his everyday needs. Hence there is always more and more scope for future developments:

1) We can adopt gear or chain mechanisms over pulley mechanism for improving the efficiency of the system.
2) A dirt detecting technique can be developed which detects dirt by measuring amount of dirt on the glass.
3) Controlled spray of water by using microcontroller to reduce wastage of water.
4) Ultrasonic sensors can be adopted for detecting minor cracks.
5) Intensity and amount of paint can be controlled by sensors.

7. Table

Bellow table1 shows us the working of man for sliding the wooden board (1).

Table 1: Practical calculation of the design

S.no	*Time(seconds)*	*No. of threads*	*Distance*	*No. of rotations*
1	3	3	0.5mm	2
2	10	11	200mm	10
3	14	20	500mm	16

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