International Conference on Recent Trends in Science & Technology-2021 (ICRTST - 2021)
Organised by: ATME College of Engineering, Mysuru, INDIA

Development of Glass Cleaning Robot

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Abstract— *A new glass cleaning robot design that can ascend vertically is introduced. A series chain on two tracked wheels with one suction position is used to create a continuous locomotive motion with a fast-climbing speed of 20m/min. The cleaning pads that connect to the vertical plane are triggered in sequence as each tracked wheel rotates. The tracked wheel's engineering study and detailed mechanism design are completed. It is a self-contained robot with a 220v vacuum fan and power supply that comes from the mains and is powered by a mobile app. On a vertical steel plate, the climbing output using the proposed mechanism is evaluated. This is a Taguchi-based optimization experiment to optimize vacuum pressure, which is a crucial factor in suction force. In this paper, we have developed a low-cost glass cleaning robot for high-rise buildings or glass structures, which was previously performed manually, which was extremely dangerous for the person.*

Keywords-component: DC motor, cleaning pad, vacuum fan, tracked wheel.

I. INTRODUCTION

The use of versatile robots in high places managing job like cleaning external dividers of tall structures, development work, painting enormous vessels and investigating stockpiling tanks in thermal energy stations is required in light of the fact that they are as of now performed transcendently by human administrators and are incredibly hazardous. Thus, as a particular exploration field of versatile mechanical technology, various climbing robots fit for climbing vertical surfaces have been investigated and built up everywhere on the world. The majority of current climbing robots can be divided into two categories: locomotion and adhesion. Climbing robots may use suction force, magnetic force, micro-spines for interlocking, and Vander Waals force to bind to the wall using an adhesive mechanism. Wall cleaning and maintenance robots have recently been created.

Some of the current kinematics for motion on smooth vertical surfaces are multiple legs, sliding frame, wheeled, and chain track vehicles. Climbing robots also use four common adhesion principles: vacuum suckers, negative friction, propellers, and gripping grippers. Due to the large number of degrees of freedom, robots with multiple legs kinematics are too complicated. Robots that rely on vacuum suckers and grasping grippers to bind to structures do not meet the criteria for miniaturization and low complexity. Climbing robots that can move on complex wall surfaces have been created. ROMA, the well-known robot, is a multifunctional self-supporting climbing robot. It can fly into a complex metallic world and use its locomotion mechanism to move in three dimensions. In general, the design and control of this type of robot is very complex, and it does not provide the high efficiency and easy operation that a wall cleaning robot requires. Typically, robots with wheeled and chain- track vehicles are portable. Negative pressure or propellers are used by this type of robot for adhesion, allowing the robots to travel continuously. In its negative pressure chamber, one type of robot has a pair of wheels actuated by electrical motors, allowing it to travel flexibly on the wall. It can only deal with plane walls, however.

II. PROPOSED METHODOLOGY

A. Investigate the operation's target

Since operating on glass walls is a completely new activity goal for a climbing robot, it is critical to investigate the consequences of doing so. Glass-curtain walls are a form of exterior decoration framework made up of glass planks built into metal components. Exposed framing glass-curtain wall, semi-exposed framing glass-curtain wall, concealed framing glass-curtain wall, and complete glass-curtain wall are the four types of glass-curtain walls found on high-rise buildings. Except in the case of glass walls with a particular curve, each piece of glass is a regular-shaped plank. A single plank's normal form makes it easy to scrub. These plank boundaries disrupt the working areas' continuity, and the robot will have to deal with them all. Glass walls with a unique curve shape are simply the product of each glass being attached to the surrounding glasses at a slight angle.

B. Basic functions for the glass wall cleaning robot

The basic functions of glass wall cleaning robots are divided into eight categories.

1) Safe and reliable association with the glass surface: The climbing robot should be safely connected to the glass divider and withstand gravity. The primary qualification between a glass divider cleaning robot and a ground-based strolling robot is this.

2) Movement in every single working region: The robots ought to have the option to drive in both up-down and right-left bearings to arrive at any point on the glass.

3) The capacity to cross window snags: In request to finish the cleaning task, the robots should confront all hindrances and securely and effectively cross them.

4) Enough information to recognize an assortment of hindrance circumstances: To manage the intricacies in the powerful world, various detecting and control frameworks are incorporated. Programming ought to have the option to perceive the different calculations of the divider and adequately keen to recreate the climate all alone.

5) Working self-sufficiently with the proper treatment: After the client has entered the worldwide assignment orders, the robot ought to stay joined to and step on the glass when playing out the cleaning errands.

6) Motion control work: Precise movement control is needed to meet the necessities of a wide range of development capacities, particularly when crossing window snags. When impediments are recognized on a superficial level, exact area control of the development will start promptly and naturally.

7) User-Friendly Graphical User Interface (GUI): The GUI is utilized to control and screen the robot, taking into consideration a more effective and easy to understand activity. During the criticism stage, all data assembled while working will be sent back and shown on the GUI simultaneously. The regulator on board will get some basic subtleties, for example, worldwide ecological boundaries and applicable sensor references.

8) Efficient cleaning: The main objective of cleaning robots is to provide efficient cleaning. This main point should be served by all the basic functions mentioned above.

C. Overview of the Work Carried

The essential sources are placed on the top of the structure. This is accomplished to relieve the principle robot's burden while additionally improving its cleaning execution and portability. Water, cleaning specialist, AC power source, vacuum siphon, and pneumatic siphon are totally situated on the structure's first floor. For it to work, lines should run from these parts to the fundamental robots. There are vacuum pipes for the vacuum siphon, pneumatic lines for the pneumatic siphon, and a water pipe for the water and cleaning specialists. A suspension link is associated with this, just as an AC power line. If the vacuum cups glitch, the suspension string fills in as a security outfit for the robot. The water lines and cleaning specialist will be connected to the shower spouts on the robot. To produce a vacuum in the pull cups, the vacuum lines will be utilized. The chambers will be moved utilizing compressed air provided through pneumatic lines. The solenoid valves, which are worked by the miniature regulator, will screen the activation of the attractions cups and chambers. A wiper, a turning brush, and a microfiber fabric will be utilized to clean the windows. The chambers, attractions cups, solenoid valves, cleaning framework, and shower spouts are completely remembered for this bundle. Figure 1 portrays the proposed framework's square chart.

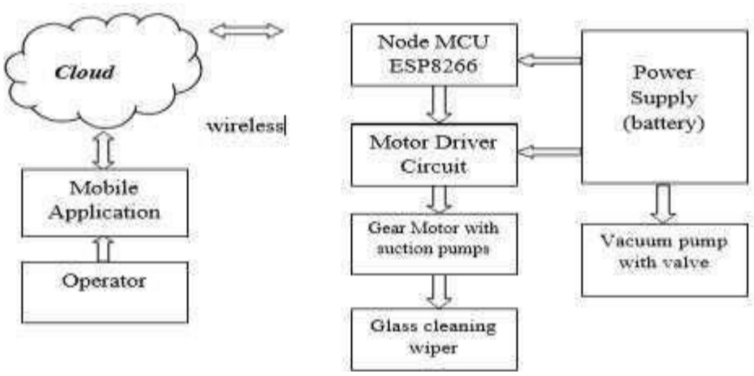

Figure.1: Block diagram of the proposed system

III. CALCULATIONS AND RESULTS

A. *Equations*

The following calculations were done in order to decide upon the selection of the motor and other parameters as described below.

- Load Calculation

$$D = 1.12 * \sqrt{\frac{m * S}{P_u n \, \mu}}$$

m - Mass of the robot

D- Diameter of suction cup, Pu = Pressure

If, mass, m = 2 kg, D = 8cm, n = 1, μ = 0.5 for glass and S = 4 for vertical and 2 for horizontal, then, by substituting these values in above equation.

We get Pu = 0.16587 bar,

Pu = 0.16587 x 1.019716 = 0.169048069 kg /cm^2.

This is pressure created by suction cup.

Now, if A is the area of the surface covered by the cup and if we have suction cup of Dia. 8cm, then the mass carried by single suction = A x P_u = 50.26 x 0.040788 = 2.05kg

- Force Required

F = force required

m = mass of the robot

$F = m \times a$

a = acceleration due to gravitation in m/s^2 for vertical surface= -9.81 m/s^2 Substituting the value of 'm' from load calculation and 'a' we get the force as,

$F = 2.05 \times -9.81$

$\boldsymbol{F = -20.11\ N}$

B. Results

The building glass cleaning robot has been developed and built. The components are basic and are inexpensive. The software programming is straightforward, and it can be quickly modified and implemented.

Figure.2a): Tracked wheel and working of the cleaning Robot

- With the experiment, It is found that the cleaning process takes about 2.5 minutes to finish a 1 Sq.m Glass
- window with a climbing speed of 20 mmps.
- Model tested to climb for an altitude of 25 feet over a glass surface for cleaning.
- Noise generated is found to be 65 dB.
- Navigates and turns exactly for 90 degree to left and right movement by tracking wheel mechanism

IV. CONCLUSION

The Glass cleaning robot for buildings and windows has been designed and fabricated. The components used are simple and cost effective. The software programming is simple. The robot moved on the window smoothly with adhering by a suction cup. And this robot has a function to change a traveling direction at right angle at the corner of the window. The Glass cleaning robot has Faster cleaning speed, stronger suction power, higher cleaning Efficiency.

V. REFERENCES

[1] J. Zhu nd D. Sun, S. Tso, 2002, Development of a tacked cimbingbot, Journal of Intelligent and Robotic Systems, 35 (4)427-443.

[2] S. Hirose, A. Nagakubo and R. Toyama, Machine that can walk and climb on floors, walls and ceilings, Proceedings of 5th International Conference on Advanced Robotics,1 (1991) 753-758.

[3] H. Choi, J. Park, and T. Kang, A self-contained wall climbing robot with closed link mechanism, Journal of Mechanical Science and Technology, 18 (4) (2004) 573-581

[4] Y. Wang, S. Liu, D. Xu, Y. Zhao, H. Shao and X. Gao, Development & application of wall-climbing robots, Proceedings of

IEEE International Conference on Robotics and Automation, 1207-1212 (1999).

[5] S. W. Ryu, et al.; Self-contained Wall-climbing Robot with Closed Link Mechanism.Proc. of the 2001 IEEE/RSJ Int'l Conf. on Intelligent Robots and Systems, pp. 839-844, 2001.

[6] H.Y. Fung, et al. Development of a Window-cleaning Robot, Workshop on Service Automation and Robotics, CIDAM2000, pp. 148- 153. 2000.

[7] D Longo and G Muscato; Design of a climbing robot for wall exploration – a neural network approach for pressure control onboard the Alicia II prototype, 5th Int'l conf. On Climbing and Walking Robots, pp. 1021-1026 ,2002.

[8] Y WANG, et al., The study and application of wall-climbing robot for cleaning, Third Int'l conf. On Climbing and Walking Robots, pp. 789-794, 2000.

[9] F Cepolina, R C Michelini et. al., Gecko-Collie-homecleaning automation of floors, walls and cupboards, Third Int'l conf. On Climbing and Walking Ro-bots, pp. 803-811, 2000.

[10] K. Yoneda, et al.: Development of a Light-Weight Wall Climbing Quadruped with Reduced Degrees of Freedom, Proc. of 4th Int'l Conf. on Climbing and Walking Robots (CLAWAR), pp.907-912, 2001.