Conceptual Working Of Glass Cleaning Robot
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Abstract
The aim of research and implementation in services fields of washing-cleaning or periodical inspection of operational robots systems, used at exterior frontage of buildings that are designed for modular glass panels. The climbing-pneumatic constructive variant of robot is designated at service fields of robots, which are more used in cleaning-washing services of frontage buildings with glass walls. The system is composed from mechanical system with light structure, power system formed by pneumatic-vacuum system. Wall climbing robots is basically based upon optimized fabrication techniques and working linkage motion phenomena that can solve typical industrial problems, relating to inspection methods, live observations and security system. Different jobs and operations can also upgrade the purpose of GWCR.

Keywords— Climbing pneumatic robot system, Cleaning-washing services, Inspection of external glass frontage of buildings, linkage phenomena.

I. INTRODUCTION
There are a mixed bag of potential utilizations of apply autonomy to divider climbing operations that can expand proficiency and wellbeing. These incorporate examination of cement dividers, to access of underside of extensions, reactor weight vessel assessment and cleaning tall structures which are typically performed by people. Glass Wall climbing robots can possibly give a progressive venture in doing risky undertakings that are typically performed by people. Consequently expanding the rate of human life. As of late, there have been numerous requests for programmed cleaning framework on outside surface of structures, for example, window glass by expanding of present day architectures. Some redid window cleaning machines have as of now been introduced into the handy use in the field of building support. Notwithstanding, practically of them are mounted on the building from the earliest starting point and they needs extremely extravagant expenses. Subsequently, prerequisites for little, lightweight and versatile window cleaning robot are likewise becoming in the field of building upkeep. As the consequences of looking over the necessities for the window cleaning robot, the accompanying focuses are essential for giving the window cleaning robot to common sense utilization:

- It ought to be little size and lightweight for transportability.
- Automatic operation amid moving. [1]-[3]

The cutting edge structures are blessed with outer dividers from glass and an assorted qualities plan as per the undertaking them and particular structural perplexing of that structures zone.

- The cleaning robot structure diagram must to comprehend an OK adherence at vertical glass of divider surface on which it will be action [4].
- The vacuum framework that guaranteed the adherence must to apply a low weight on glass divider surface on which is moving to keep away from the windows breakages.
- The vacuum climbing framework to understand a uniform vacuum and un-vacuum of the altering suckers in concordance with a settled working system to do the move cleaning-washing cycle.
- The size of robot framework will be plan in such an approach to permit the right to gain entrance on totally cleaning surface of structures windows. The cleaning robot framework is enriched with a feature cam to guarantee supplementary assignments, which it placed in frontal method for robot moving. [5]-[10]

II. PROCESS PLANNING
A. Definition Of Problem
There are vast number of tall structures with glass dividers in urban communities. Outside dividers of structures gives an alluring outside surface appearance, as well as builds their solidness. These dividers oblige consistent cleaning which constantly risky, costly and arduous work noticeable is all around. Cleaning is standard in our life. It includes numerous exercises in our everyday life. It is a diligent work occupation and a considerable measure of time is expended. Glass cleaning is additionally one part of support action. The clean glass will certainly give an agreeable domain to the workplace occupants. The two primary focuses that are focused in this undertaking are to conquer the risk of human inclusion in cleaning outer glass action and diminish high cost by the customary technique for cleaning outside glass. It gets to be
important to conquer the confinement. The task plans to supplant or minimize human association in cleaning the glass window by supplanting it with a little cleaning robot for frameworks with a few abilities. The capacities are; compact, little size, lightweight, programmed operation and can clean all the corner of the outer glass windows.

B. Purpose, Scope And Objectives Of Glass Cleaning Robot

1) Purpose and Scope
The reason for the undertaking is to build up a robot that can climb divider. Keeping this in view, our motivation was to manufacture a machine that can stick on dividers and climb upwards. In the wake of considering the writing composed by the past searchers, suction containers procedure was utilized to stick the robot to the divider as all the obliged materials were accessible in the neighborhood market. In suction robot that are utilized for divider climbing robot, they utilized installed pump that made a weight drop inside the vacuum measures that are pressed against the divider or roof. As the vacuum mug are pressed against the divider, the on board pump will begin to pump the air in the vacuum measure out to the encompassing. After sooner or later, the weight inside the vacuum container is lower than that outside the vacuum measure therefore it has the capacity stick onto the divider.

2) Objectives
The main objectives of the cleaning robotic system are summarized below.

- High unwavering quality, because of the streamlined framework and the dependability of the suspending sub-framework.
- Because of the novel adsorbing gadget, the automated can append to glass, as well as to a divider with tile, aluminum-sheets.
- High cleaning proficiency and great quality, which are acknowledged by utilizing brushes, elastic scrubber and glass cleanser.
- As it recovers, refines and reuses the sewage, the robot is water sparing cleaning gadget.
- Remote control mode, simple to utilize and minimal cost.

C. Operation cycle

Fig.1 Basic Operation Cycle

D. Different Techniques To Stick Robot On The Glass Wall
A standout amongst the most difficult assignments in climbing robot outline is to build up a legitimate grip instrument to guarantee that the robot sticks to divider surfaces dependably without giving up portability.

After survey of the aforementioned writing and there created models we reasoned that So far, four sorts of bond systems have been explored.

- Magnetic gadgets for climbing ferrous surfaces
- Attraction power generators taking into account flight optimized standards
- Bio-mimetic methodologies propelled by climbing creatures
- Vacuum suction systems for smooth and nonporous surfaces.

Deciding to make fascination power taking into account aeromechanic standards including the utilization of propeller is a complex task.

E. List Of Components And Materials

<table>
<thead>
<tr>
<th>SR. NO.</th>
<th>COMPONENT</th>
<th>MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Main Column</td>
<td>Aluminum And Silicon Alloy</td>
</tr>
<tr>
<td>2.</td>
<td>Legs</td>
<td>Aluminum Alloy</td>
</tr>
<tr>
<td>3.</td>
<td>Slider</td>
<td>Brass</td>
</tr>
<tr>
<td>4.</td>
<td>Slider Housing</td>
<td>Mild Steel</td>
</tr>
<tr>
<td>5.</td>
<td>Suction Cups</td>
<td>Rubber Or Plastic</td>
</tr>
<tr>
<td>6.</td>
<td>Tee</td>
<td>Mild Steel</td>
</tr>
<tr>
<td>7.</td>
<td>Washer</td>
<td>Brass.</td>
</tr>
<tr>
<td>8.</td>
<td>Syringe</td>
<td>Plastic</td>
</tr>
</tbody>
</table>

III. PLANNING AND CLEANING PATH

Point-to-point (PTP) control robot: is fit for moving starting with one point then onto the next point as demonstrated in fig. 2 (a) the territories are recorded in the control memory [11]. PTP robots don't control the way to get starting with one point then onto the next point.

Normal applications incorporate segment investigation, spot welding, gap penetrating, machine stacking, and unrefined gathering operation.

Continuous-path (CP) control robot: with CP control, the robot can stop at any tagged point along the controlled way as demonstrated in fig. 2 (b). All the point along the way must be put away expressly in the robot's control memory. Commonplace applications incorporates spread painting, completing the process of, sticking, and curve welding operations.
Controlled-path (CP) robot: the control supplies can create ways of distinctive geometry, for example, straight lines, circles and introduced bends with a high level of precision. All controlled-way robots have a servo ability to amend their way.

Fig. 2 point to point motion path (a) and continuous motion path (b)

A. Robot Geometry And Kinematics

1) Robot geometry:

The stride of this divider climbing robot is comparative on both flat and vertical surfaces. Accept that the suction cushion is a vacuum sucker. A vacuum sucker obliges a tiny bit of time so as to pump out the air by a vacuum pump with a constrained limit (notwithstanding in light of the fact that the come back to climatic weight is carried out much quicker, the time for this stage is dismissed in the essential contemplations). At the point when the vacuum pump is close to its end position i.e. it is close to it’s most extreme vacuum it eases off. Rate of the vacuum pump is a capacity of sine.

The robot is constantly held to the divider by two mugs at once. While the other to push ahead or regressive. As demonstrated from figure the containers in slanting design are joined with the one vacuum pump. So the askew measures then again hold the robot on the divider. The vacuum created by the both the pumps stays same all through the robot operation i.e. the measure of vacuum created by both the pumps stays same.

Fig. 3 Robot Taking Left and Right Turn

2) Kinematics of robot

The arm of a robot comprises of connections joined by joints. Each one connection is impelled by an actuator and its movement can be precise pivot or rectilinear interpretation. Positive connections can be created between the joint actuators' dislodging and the last position and introduction of the end effector’s.

B. Defining the cleaning locations and robot setups

C. Robot Motion Simulation

The robot is backed on the divider with a vacuum glass. There is a weight contrast between within the container and outside. This weight contrast delivers the power which holds the container and thus robot on the divider.

The power is given as

\[ \text{Pat} - \text{Pin} = \frac{F}{A} \]

Where

- \( \text{Pat} \rightarrow \) Atmospheric Pressure
- \( \text{Pin} \rightarrow \) Pressure inside Vacuum Cup
- \( A \rightarrow \) Area of Vacuum Cup

\[ F = (\text{Pat} - \text{Pin})A \]

The force which does not let the cup slide on wall is frictional force.

\[ R = \mu F \]

Where

- \( F \rightarrow \) Reaction Force
- \( R \rightarrow \) Frictional Force
- \( \mu \rightarrow \) Coefficient of Friction between Pad and Wall

The forces acting on the robot are shown in a free body diagram below

\[ R = W \cos(90 - \theta) \]

\[ R = W \sin\theta \]

\[ W \sin\theta = \mu(\text{Pat} - \text{Pin})A \]
\[ W = \frac{\mu(P_{at} - P_{in})A}{\sin \theta} \]

Where
- \( W \) → Weight of Robot
- \( \theta \) → Angle of Inclination

The change in volume to make obliged weight can be figured from the accompanying computations

\[
\text{Pin} V1 = \text{Pat} V2
\]

\[
\text{Pin} = \frac{\text{Pat} V2}{V1}
\]

Where
- \( \text{Pat} \) → Atmospheric Pressure
- \( \text{Pin} \) → Pressure inside Vacuum Cup
- \( V1 \) → Volume at \( t=\text{max} \)
- \( V2 \) → Volume at \( t=0 \)

Presently the separation of focus of gravity from the glasses differs .The containers beneath the focal point of gravity obliges less compel than the mugs over the middle of gravity to keep the robot joined to the divider.

\[
W \times h + F_4d_1 + F_2d_2 + F_3d_3 + F_4d_4 = 0
\]

\[
W \times h = -(F_1d_1 + F_2d_2 + F_3d_3 + F_4d_4)
\]

Where \( d_1, d_2, d_3, d_4 \) Are the distance from center of gravity to the center of the respective vacuum cups.

![Fig. 6 Force Diagram of Robot](image)

Suppose that the distance of cups from center of gravity is same then the above equation becomes the following equation.

\[
= -(F_1 + F_2 + F_3 + F_4) d
\]

The containers over the inside of gravity are at same stature from focal point of gravity so the powers following up on these glasses can be included. Essentially powers following up on the containers underneath the focal point of gravity can be included. Hence

\[
F_1 = F_2
\]
\[
F_3 = F_4
\]

\[
W \times h = -(2F_1 + 2F_3) d
\]

As it can be seen from chart that strengths \( F_1 \) and \( F_2 \) act inverse to the power made by the vacuum in the vacuum glass while \( F_3 \) and \( F_4 \) act along the power made by the vacuum in the vacuum glasses. For the choice of the glasses of equivalent breadth the power following up on the containers over the inside of gravity must be considered.

D. Collision Detection

Impact evasion sensors give simple closeness estimations to different crash happening dangers. Crash evasion sensors are utilized to anticipate impact of programmed guided vehicle sand mechanized cleaning robot. A closeness sensor is mounted either in the front or at the again of programmed robots. Crash shirking sensors begin functioning when the robot is begun and the robot begins moving. An against crash sensor deals with ultrasound innovation. An ultrasound against crash sensor mounted on the robot persistently sends and gets sound wave signals from and to the moving item. The sound waves are sent to locate any impacting article showing up on the method for the moving item. When an impacting article is caught in the scope of 1 feet, the robot is cautioned with a caution sound and the robot can make the fitting move. There are various sorts of impact shirking sensors. Illustrations incorporate a stopping sensor and a radar closeness sensor. A stopping sensor is utilized as a part of vehicles for securely stopping the vehicles in the littlest conceivable space. A stopping sensor can likewise effortlessly distinguish objects that are out of vision reach. A radar vicinity sensor is a rate sensor that is utilized to quantify the pace of the robot. Other crash evasion sensors are usually accessible robot motion parameters

The outside size of climbing vacuum robot composed was chosen in capacity of windows' sizes of facade glass dividers, with additionally utilizing of 500 mm x 1200 mm x 500 mm.

The grip by moving of robot on the vertical surface of glass divider's building to guarantee the cleaning from washing is acknowledged dynamic activity of 4 suckers that meddle by adaptable funnels of vacuum robot framework.

The suction attachment robots are typically utilized on valley spans and the temperature could associate with 0 to 50 degree Celsius. With respect to the weight, this kind of robot ought not to be more than 5 kg. The inside of gravity of the robot must be kept as close as to the vertical surface as could be allowed, as the power needed to hold the entire weight of the robot will be diminished.

In spite of the fact that this sort of robot is regularly used to do the cleaning for high structures and under high way connects, this will thusly supplant people accordingly lessening the mishap rate. This will further build the individual rate of living.

IV. FUTURE ENHANCEMENT

- Material social event, examination and model for Glass Cleaning Robot.
- The suction glass has points of interest of no clamor, little volume and weight.
- The general weight of the machine is around 5-20kg.
- The cleaning methodology may take around 5 minutes to complete a glass window sheet.
• Uniform cleaning by utilizing elastic brush and ideal as a part of line water pump convey cleanser water for uprooting resolved stains and controlled splash of water by utilizing microcontroller to decrease wastage of water.

• Place the power supply on the robot.

• Add sensors onto the robot to search for obstructions.

• Create rationale for the robot to have the capacity to meander and not fall of or collide with things.

• Pressure sensors on the suction mugs to figure out whether a container is joined or not.

• Adding application gadgets, (for example, window washing device).

• Modify the robot to move quicker.

• Acquire better control over the definite position of the legs.

• Find approaches to organize supplies to permit a more prominent scope of movement.

V. CONCLUSION

The development and upkeep of savvy structures with structural engineering of frontages from glass dividers draw in the administrations of washing-cleaning and occasionally review of them. Taking care of cleaning of these frontages' structures assumed high expenses as cleaning taking care of conditions which are troublesome and dangers.

This smaller and lightweight mechanical stage gives a protected and viable intends to manage unsafe obligation operations. Inside the mechanical zone our vigorous stage measuring more or less 3-5 Kgs is created to get on generally smooth surfaces.

The productive variation of climbing vacuum robot from administrations fields as cleaning mechanical operations of frontages of outer glass dividers, displayed in this paper, has the mean to substitute the human administrator from hard, threat and hazard's workings. This vacuum robot introduced makes conceivable the robotized operations of washing-cleaning, checking, the scope of administrations which can be made by it can be expanded when required.

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