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Design and Development of Vacuum Operated Wall Climbing System: A Review

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Abstract: ***"The device is predominantly a vacuum motor that powers two suction paddles, and cling onto any building surface, be it glass, stucco, or brick, hinge on the altitude. Removal of air from suction cup is brought into play to stick the wall. It is similar to the suction cup where vacuum pressure of a particular amount of area moderately gets exhausted by an air pump. This suit is very useful in military applications as well as in fire brigade. Our aim is to make this suit perfect as per the aesthetics, ergonomic and safety consideration.***
Keywords: vacuum motor, suction paddle, glass, fire brigade, stucco

I. INTRODUCTION

THIS is Industrial applications, where a vacuum pressure is used include materials handling, lamping, sealing and vacuum forming. In terms of materials-handling applications, a pneumatic vacuum can be used to lift smoothly objects that have a flat surface and are not more than several hundred pounds in weight. Materials handling application where a vacuum cup called a suction cup is used to establish the force capability to lift a flat sheet. The cup is typically made of a flexible material such as rubber so that a seal can be made where its lip contacts the surface of the flat sheet. The last few years have witnessed a strong, renewed interest in climbing and walking robotic technologies. At the end of the decade, several different prototype robots were developed for different types of applications. The design of a climbing robot is based on the pneumatic principle. Lizards, which move vertically on about any surface, on closer examination one can find that they possess suction cups along their limbs. Suction cups produce a kind of vacuum between the surface on which it moves and its skin which allows it to stick on the surface. In terms of materials-handling applications, a pneumatic vacuum can be used to lift smoothly objects that have a flat surface and are not more than several hundred pounds in weight. Materials handling application where a vacuum cup called a suction cup is used to establish the force capability to lift a flat sheet. The cup is typically made of a flexible material such as rubber so that a seal can be made where its lip contacts the surface of the flat sheet. A vacuum pump is turned on to remove air from the cavity between the inside of the cup and top surface of the flat sheet. As the pressure in the cavity falls below atmospheric pressure, the atmospheric pressure acting on the bottom of the flat sheet pushes the flat sheet up against the lip of the cup.

This action results in vacuum pressure in the cavity between the cup and the flat sheet that causes an upward force to be exerted on the flat sheet. The magnitude of this force can be determined by algebraically summing the pressure forces on the top and bottom surfaces of the flat sheet. The atmospheric pressure on the top and bottom surfaces of the flat sheet cancels out away from the outer circle area of the cup lip. If all the air were removed from the cup cavity, we would have a perfect vacuum and thus the suction pressure would be equal to zero in absolute pressure units. A vacuum pump is turned on to remove air from the cavity between the inside of the cup and top surface of the flat sheet. As the pressure in the cavity falls below atmospheric pressure, the atmospheric pressure acting on the bottom of the flat sheet pushes the flat sheet up against the lip of the cup. This action results in vacuum pressure in the cavity between the cup and the flat sheet that causes an upward force to be exerted on the flat sheet. The magnitude of this force can be determined by algebraically summing the pressure forces on the top and bottom surfaces of the flat sheet. The atmospheric pressure on the top and bottom surfaces of the flat sheet cancels out away from the outer circle area of the cup lip. If all the air were removed from the cup cavity, we would have a perfect vacuum and thus the suction pressure would be equal to zero in absolute pressure units. "Vacuum wall climbing system". The device is basically a vacuum motor that powers two suction paddles, and sticks onto any building surface, be it glass, stucco, or brick, depending on the altitude The outer walls of high-rise buildings are made of various materials such as steel, red block, marble, glass, and so forth, and their surfaces can contain many grooves of irregular shapes and sizes materials used in the outer walls of buildings, as repo.

The outer walls of high-rise buildings require regular maintenance including cleaning and painting. Gondola systems are used to carry on platforms the workers who conduct maintenance work on the outer walls of high-rise buildings. However, for super-high-

rise buildings, i.e., higher than 30 stories, it is Very difficult to perform such work on their outer walls using a gondola due to external disturbances including squalls. To perform this kind of work on outer walls using gondolas, considerable attachment force (to the wall) is required, taking into consideration the external loads and work load. However, robots travelling on vertical walls have limitations in terms of the shape of the walls and their adhesive force. Therefore, the vacuum suction ability with the various wall shapes should be evaluated and Previous experiences of the authors in the field of flexible subjection methods showed that many flexible clamping devices can lead to marks or remains in the surface of the parts that have to be machined; for example, leading to infiltration of wax in the parts to be machined. Therefore, the objective of this study is to explore the possibilities of vacuum clamping devices in the search for flexible clamping systems without side-effects in the parts. Certainly, the effective force reached by a vacuum clamping device that only holds the part by its lower plain surface will depend on the combination of the Normal force (F_n) gained by the vacuum generation and on the Tangential force (F_t) resulting from the friction parameters. Assuming that the different materials in the study have a non-negligible anisotropic and heterogeneous behaviour, in order to analyse its level of potential response it has been necessary to assess the actual F*n* and F*t* in a test bench. As the finality of the study is to bring light to the development of clamping devices for climbing in which the materials tested in the study would perform as the clamping ends, the level of response will have to be compared to the machining cutting requirements of metallic parts; in the present study, steel and aluminium. In order to calculate the theoretical thresholds for both metals, which allows evaluating the cutting forces both in the normal and tangential direction. This theoretical implementation becomes very useful to provide theoretical requirements prior to enter into experimentation in an actual Machine tool. Also, the figures obtained reveal information that could be used in a further exploration for the subjection of non-planar surfaces.

Industrial applications, where a vacuum pressure is used include materials handling, lamping, sealing and vacuum forming. In terms of materials-handling applications, a pneumatic vacuum can be used to lift smoothly objects that have a flat surface and are not more than several hundred pounds in weight. Materials-handling application where a vacuum cup called a suction cup is used to establish the force capability to lift a flat sheet.

II. PROBLEM STATEMENT

In Today's world buildings are high land glasses the most preferred material for external side. Considering this reason, climbing of other method is not possible to use. Very fine surfaces like a glass wall, which is very high using rope it is difficult to climb because one cannot hold it for long time which is the need of the job to be done or is expected by the person. If person has some weight then this becomes even harder. For the work of maintenance the person is supposed to carry the tools with him which increases the weight. In Military at critical situation solders are required fast climbing for the operations. Solders have large bags with them. This weight makes the soldier slow and increases the overall time of operation or task. In the current urban area the space between buildings is less some time fire brigade vehicles cannot reach the building. Ideally in this situation it is expected that the fire man should go to the required floor for saving the peoples life in minimum time.

III. LITERATURE REVIEW

1) *Hwanj Kim, Dongmokkim, Hoojoong Yang.Development of wall climbing robot using tracked wheel mechanism, (2008).* In this paper, a wall-climbing robot using a tracked wheel mechanism was presented. Continuous locomotive motion with high climbing speed is achieved by employing tracked wheels on which suction pads are installed. The engineering analysis and detailed mechanism design of the tracked wheel, including mechanical valves, was described. The climbing performance on a vertical steel plate using the proposed mechanism was evaluated.
2) *B. Vishant, S. Khathiravan, S. Giri Prasad "Design and Development of a Climbing Robot for Several Application". (2014)* the robot is facing difficulty in climbing the normal surfaces where air leakage is a problem. The robot is facing difficulty in climbing more than 900 slant angle on walls. Robot is capable of carrying loads of weight around 4 kg. Compared to normal walls, it is working fine on glass walls and wooden walls. Wireless camera placed on the robot body is transmitting good quality video output up to 10 m. Direction control headset is working fine .And properly transmitting the navigation (Up, Down) signals and also receiving the sensor data effectively. Similarly the robot is receiving the direction control signals and changing the directions as expected up to a distance of 100 ft. he suction mechanism is working satisfactorily. The temperature sensor placed on the robot body is also functioning properly.
3) *Gosavi Sagar, Patil Sharad, Pawar Chetan, Pawar Rahul, Prof. Honrao V.P, Prof. Bhane A.B "Vacuum Wall Climbing Machine".(2016)*Vacuum wall climbing suit is not only efficient but best option for the wall climbing. This suit gives chance to

carry heavy work to the climb. System with less weight and aesthetics and ergonomic consideration this suit reduce the human effort

4) *Shunsuke Nansai, Rajesh Elara Mohan "a Survey of Wall Climbing Robots: Recent Advances and Challenges". (2016)* a detailed survey of adhesion principles adopted in wall climbing robots. Categorized the adhesion Principles founding the literature in to six broad categories namely: suction cup adhesion, suction cup crawler, vacuum pump adhesion, magnetic adhesion and bio-inspired adhesion. Summarized the impact of each of these adhesion mechanisms on various robot design considerations, including locomotion, stability, infrastructure needs and perception by deriving septic cases from the literature. Going beyond the adhesion issues in wall climbing robots, also put forward a set of desirable design attributes for glass façade cleaning robots for the rest time derived from rigorous analyses that has the potential to facilitate targeted future research with clear technical goals and well-defined design trade-off boundaries. Such a set of design attributes also offers significant potential for use as performance metrics in evaluating facade cleaning robots, as well as comparing competing design.
5) *Anubhav Gatap "Skyscraper Glass Cleaning Automated Robot" International Journal Of Scientific And Engineering Research (2013)* This project is based on a climbing robotic system aimed to climb of wall used to fire rescue, and inspection of high pipes and walls of high-rise buildings, using suction cups for adhering to the glass. Based on the results of interdisciplinary fields like mechanics, electronics and informatics are gaining more and more attention. The field of professional and domestic services, especially the wall cleaning of high buildings, is one of the areas that are expected to obtain a strong benefit from the use of these systems able to displace on vertical surfaces.
6) *Ritesh. G. Mahajan, prof. S. M. Patil, "Development of Wall Climbing robot for Cleaning Application". (2013)* Climbing suit are useful devices that can be adopted in a variety of applications like maintenance, building, inspection and safety in the process and construction industries. The study and production of that device for domestic application is a relatively recent research field. This kind of device is actually in continuous development. Our target is to build a wall-climbing device for various applications. The Wall Climbing device having capability that it can stick on a vertical as well as inclined surface and can easily move over the surface. The targeted capability to stick with surface can be achieved by suction pads. Suction pads create a vacuum pressure used to stick with vertical or inclined surface. For movement (climbing) on wall it is necessary that some of suction cup should release & that arrangement is obtained by developing the structure such that in which one frame is used to hold the device to wall & other for climbing
7) *Joan Ramon Gomaayats, Joaquim Minguella Cancela, Salome Mandret Panaranda "characteristic of the effective clamping force obtained by the apllication of vacuum techniques to different material probes".(2008)* A good clamping system is basic to guarantee the correct machining of parts. In particular, for the vacuum clamping systems, it is fundamental to ensure that the clamping forces generated are sufficient to support the parts while being machined. In the present paper are presented the results of a set of experiments performed on a work bench in order to characterize the effective clamping forces obtained by the application of vacuum clamping techniques to 7 different materials. The rationality of this study lies on the need to study the response given by the materials to Normal and Tangential stresses, in order to define the suitability of each of them for the usage as flexible clamping ends. The study finishes with the comparison of the results obtained with the theoretical thresholds needed during the machining of two metallic parts: one made of steel and another made of aluminium.

IV. COSTRUCTION AND WORKING

Vacuum Wall climb system is powered by two 1200 Watt motors. That are mounted on Frame with the assistance of nut and bolts. Vacuum at suction pad is made by motors and with the assistance of two separate versatile hose pipes. This hose pipes goes from motor to suction pad and are sealed with the assistance of clamps. Suction pad is created with grey forged iron material. It's an oblong frame and at joints it's sealed with rubbers (Bidding rubber). At the higher right side of rectangular suction pad there's a hole that supports the hose for suction and is fastened with clamps for no discharge.

High ropes are strength accustomed support the legs. Ropes are suspended or are tied with a correct knot at suction pad. These ropes suspended from pads with a correct length which can be most possible for climb. Foot Rest is offer at finish of rope to support legs.

The cup is often a product of a flexible material like rubber so a seal are often created wherever its lip contacts the surface of the flat sheet. An air pump is turned on to get rid of air from the cavity between the within of the cup and high surface of the flat sheet. Because the pressure within the cavity falls below air pressure, the air pressure functioning on bottom of the flat sheet pushes the sheet up flat against the lip of the cup.

This action leads to vacuum pressure within the cavity between the cup and also the flat sheet that causes associate in nursing upward force to be exerted on the flat sheet. The air pressure on the highest and bottom surfaces of the flat sheet cancels

out far away from the outer circle space of the cup lip. If all the air were off from the cup cavity, we might have an ideal and therefore the vacuum suction pressure would be up to zero in absolute pressure units.

Vacuum often are accustomed elevate swimmingly objects that have a flat surface and don't seem to be quite many hundred pounds in weight. Vacuum cup referred to as a suction cup is employed to determine the force capability to elevate a flat sheet. The cup is often product of a versatile material like rubber so a seal are often created wherever its lip contacts the surface of the flat sheet.

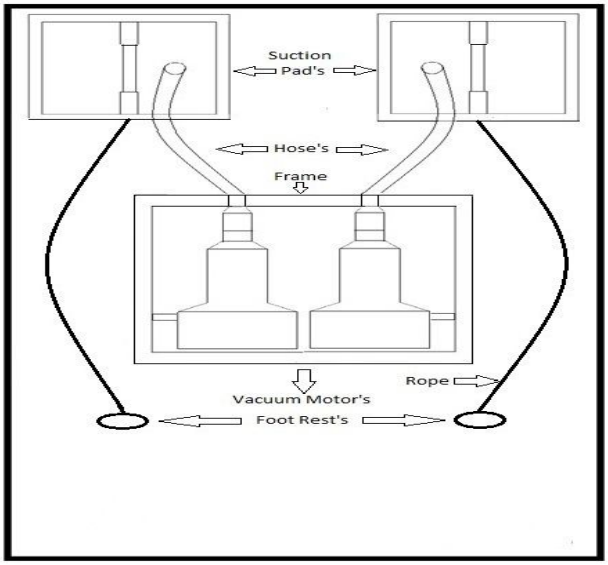

Fig.1 construction of vacuum suit

V. CONCLUSION

After reviewing above all research papers, we conclude in this paper, proposed system which will able to climb walls surfaces like rough surface, glass, concrete, stucco in different working conditions. This efficiently reduces the size of the system because of the use of two vacuum motor. Due to the combing of systems, maintenance cost of the system also reduces. The main advantages of this system will be that it is easy to rectify the fault and use for any type wall climb. No trial is carrying out for conclusion.

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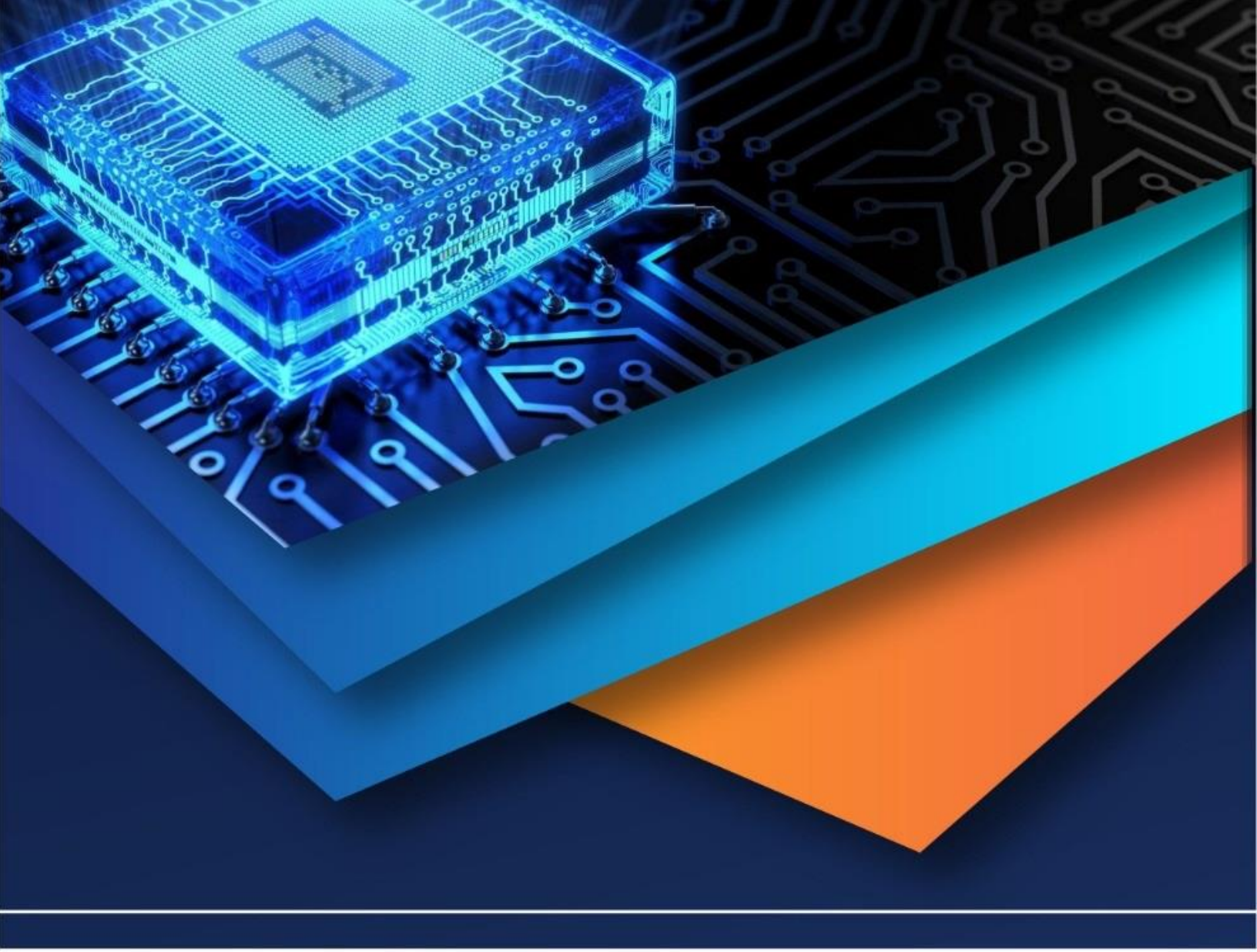

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