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DESIGN AND DEVELOPMENT OF VERTICAL SURFACE INSPECTING MACHINE USING AERODYNAMIC PNEUMATIC SUCTION

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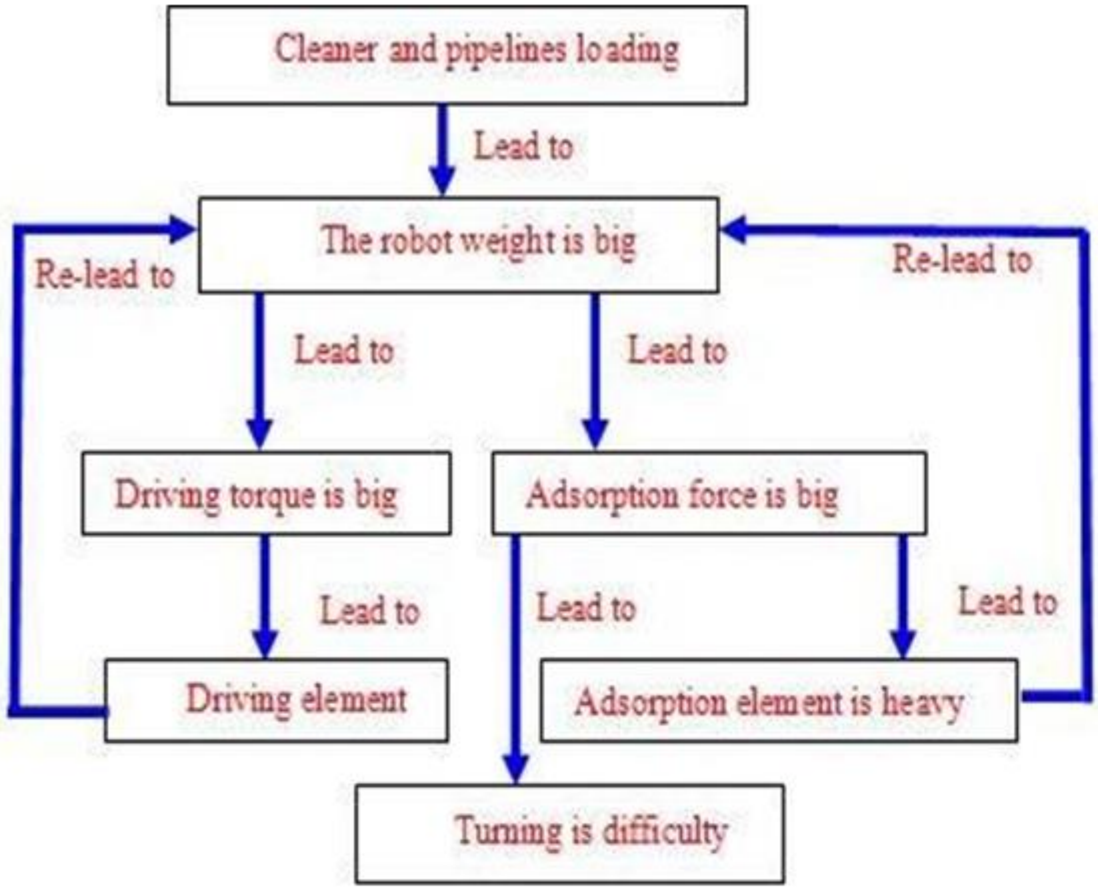
Abstract

This work deals with the of the vertical surface inspecting machine. A machine that can self-govern move vertically along an unpleasant surface for example, offers extensive military and citizen points of interest. Situated high on a building, cleans the walls and glasses, paint works, explosives and for inspection. It can also climb any surfaces like metals, concrete walls, wood surface etc., Simple Design & Portable in use, Light weight, Automatic operation while working. Our project satisfies the above requirement which is light in weight and can independently climb and clean up on walls using the concepts of the vacuum. A simple component such as the vacuum cups, DCV Valves, one stage vacuum pump, etc. and also the low cost of the system makes the project more versatile.

Keywords: vertical surface inspecting machine, Design, Vacuum, Suction, Valves.

INTRODUCTION

The flow control concepts I have explored are uniquely tailored to the ducted fan flow phenomenon. If the flow over the duct surface can be controlled. Flow turned, accelerated, separation eliminated or produced on demand. Then a ducted-fan vehicle could be optimized for combating gusting winds. Asymmetric lift resulting from one side of the duct having attached flow, while the opposite side is separated, could be used as a control moment or to alleviate undesirable moments due to wind gusts. Achieving attached flow on the entire duct during a typical stall condition could enhance vehicle performance and efficiency. The concepts use separation on the leading edge to affect thrust and pitching moment, and a Co and surface at the trailing edge to create a normal force, thereby reducing pitching moment. Discovered and documented by the Hungarian the tendency of a fluid jet or stream to attach itself to a nearby curved surface. In the first flow control concept, a steady or synthetic jet is applied against the existing flow over the duct lip, resulting in separation. When the jets are turned off the flow naturally reattaches. Figure 1-9 illustrates this concept. Inducing flow separation can decrease the pitching moment experienced during wind gusts and could reduce the amount of flight control actuator usage to maintain stable flight.



While the payoffs in capabilities make ducted fan vehicles desirable, special care must be taken to successfully develop a flight vehicle with adequate performance and control power. Kriebel [39] was one of the first to model ducted fan aerodynamics for forward flight and angle of attack using a potential flow method. He derived expressions for the forces and pitching moments, and investigated stability derivatives for longitudinal flight. 20 Mendenhall and Spangler [40] were some of the first to develop a computer code to predict ducted fan flow fields and pressure distributions. They compared their model to the Mort and Gamse data presented in [32], with fair agreement. Chang and Rajagopalan [41] developed an incompressible Navier-Stokes Computational Fluid Dynamics (CFD) solver for axisymmetric ducted fans. The modeled the fan through a 'momentum source.' concept. There code was compared to wind tunnel data for the Trek Aerospace ducted fan [34] and Micro-Craft.'s LADFUAV, showing good agreement. However, the code was limited to pure axial flight only (vertical climb). Quackenbush et al.[42] developed a free-wake potential flow method for propellers and coupled it with a fast surface method for fuselages and ducts to enable analysis of ducted fan aerodynamics. They showed good agreement for isolated annular wing without propellers presented by Fletcher [43] as well as the X-22A ducted rotor powered data from Mort and Gamse [32]. Their results matched for a range of angles of attack that were below the duct stall condition. Drela and Youngren [44] developed a design code for duct, fan, and stator geometry called DFDC (Ducted Fan Design Code). They included both actuator disk and blade element treatments of the fan and stator, and used a panel method for duct, fuselage, and blockage objects within the duct. The code is available under the GNU general public license, but is in an unfinished state. He described a potential flow method coupled with a blade element treatment of the propeller for aerodynamic modeling of ducted fans. The method is capable of modeling the ducted fan at an angle of attack. The results showed good agreement with test data forces, but pitching moment agreement was not as good. A potential flow approach as well, and explicitly modeled ground effect.

A lot of research has been done with wall climbing robots and various types of experimental models have been already proposed. Different types of wall climbing robots are made based on different mechanism like legged mechanisms, sliding mechanisms and tracked wheel mechanisms. Legged mechanism is used to build such robots that can overcome uneven surfaces. Due to their heavy weight and complicated control system, these results in low speed and discontinuous motion. Meanwhile, the sliding mechanism is relatively simple in comparison with legged mechanisms, but the problem remains with discontinuous motion. In searching to the solution of this problem, many research has been devoted on Tracked wheel mechanism for faster and continuous motion. In recent years, several different approaches have been taken to develop robots that have the ability to climb vertical surfaces against the gravitational force like, Wallbots, Stickybots etc. Wallbots used magnetic force to run on the vertical planes. The Stanford Research Institute (Also known as, SRI Technology) creates Shakey the first mobile robot to know and react to its own actions.

A research group of Dr. Li Hiu has recently successfully developed the bionic robot; which are also called gecko robots, named ”Speedy Freelander”. This gecko robot can instantly climb up and down in a variety of building walls, walking upside down on the ceiling or, groundand vertical wall fissure. In 2007, Researchers at the Robotics Institute at Carnegie Mellon University (CMU) have created a robot that can run up a wall as smooth as glass and onto the ceiling at a rate of six centimeters a second which uses fibers that are twiceas adhesive as those used by geckos. At the 2008 IEEE International Conference on Robotics and Automation (ICRA 2008), engineers presented their wall climbing bot which inspired from geckos. The robot could scale buildings or creep up windows, secretly spying for hours. They could also be used for search-and rescue operations. More benignly, they could inspect and repair the hard-to-reach parts of airplanes, spacecraft, and bridges. In collaboration between Disney Research Zurich and ETH, a wall climbing robot named VertiGo was built. The robot has two tiltable propellers that provide thrust onto the wall, and four wheels. One pair of wheels is steerable, and each propeller has two degrees of freedom for adjusting the direction of thrust. By transitioning from the ground to a wall and back again, VertiGo extends the ability of robots to travel through urban and indoor environments .method (VSM) which is a another kind of suction strategy for wall climbing robots. Stephen Paul Linder have designed a low cost robot to climb in inclined surface using computer vision .The paper by Jason Gu proposed a research on wall climbing robot with permanent magnetic tracks where mechanical system architecture is also described in the paper. ShangingWu proposed wirelessdistributed wall climbing robotic system for reconnaissance purpose Design and control of a lightweight magnetic climbing robot for vessel inspection by Markus Eich and Thomas Vogele is proposed for the solution for inspection of marine vessels Houxiang Zhangs paper presented three different kinds of robots for cleaning the curtain walls of high structural building

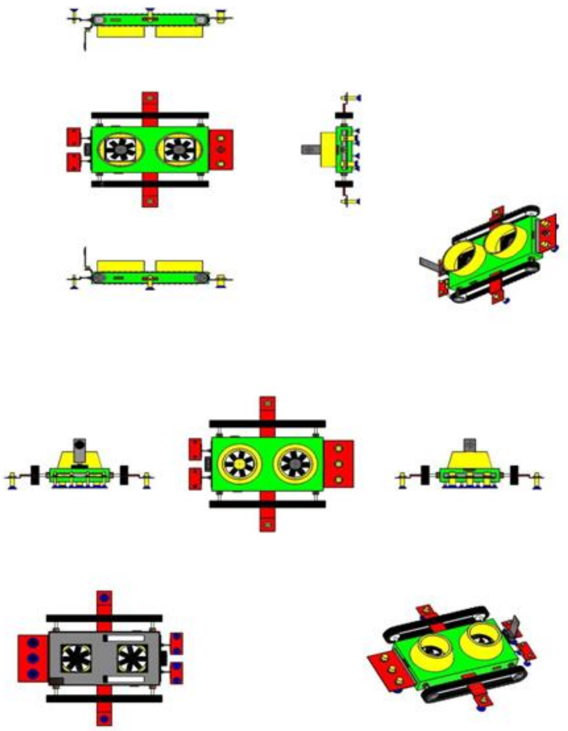
METHODS AND MATERIALS

2.1 Ducted Fan Vehicle Design

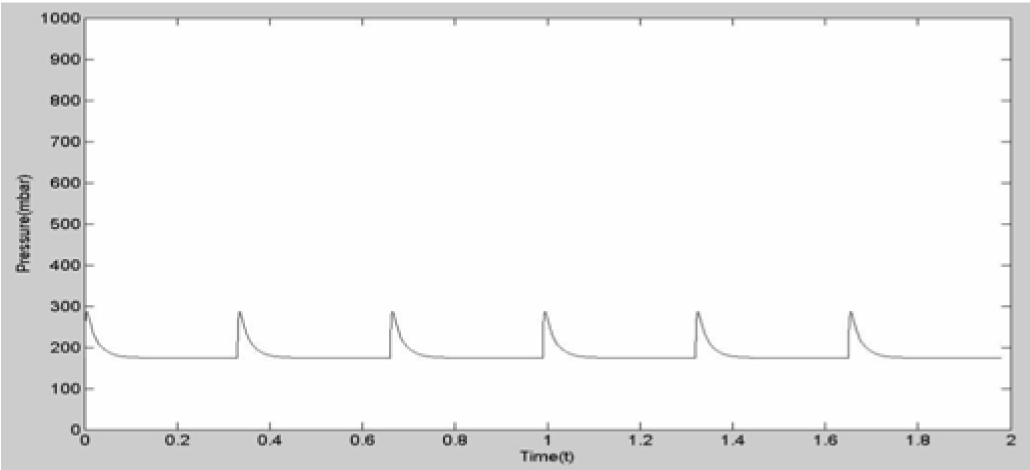
Our design showed good understanding of ducted fan vehicle design, and this reference was one of the first documented methodologies on the subject. He compared a toroidal duct shape to a traditional duct cross-section, and concluded that the toroidal duct produced more pitching moment. He describes methods for modeling the fan, flow straighteners control vanes, as well as the free-stream effect on system control authority. intent to evaluate vehicle dynamics. The present. ‘trim.’ analysis versus flight speed to show the vehicle’s forward flight performance. Linear stability analysis of the trimmed equilibrium conditions leads to a discussion of eigenvalues and eigen vectors, root presented a parametric aerodynamic buildup approach to modeling ducted fan systems explicitly modeling the effects of the duct, propeller, control vanes, stators, and pods. They implemented a multidisciplinary design optimization framework to enable conceptual design of ducted fan UAVs. Their results showed good agreement with wind tunnel test data of the Allied Aerospace 29.” iSTAR vehicle. described the multidisciplinary methodology employed in their design tool, with considerations for airframe geometry, aerodynamics, propulsion, stability, mass properties,

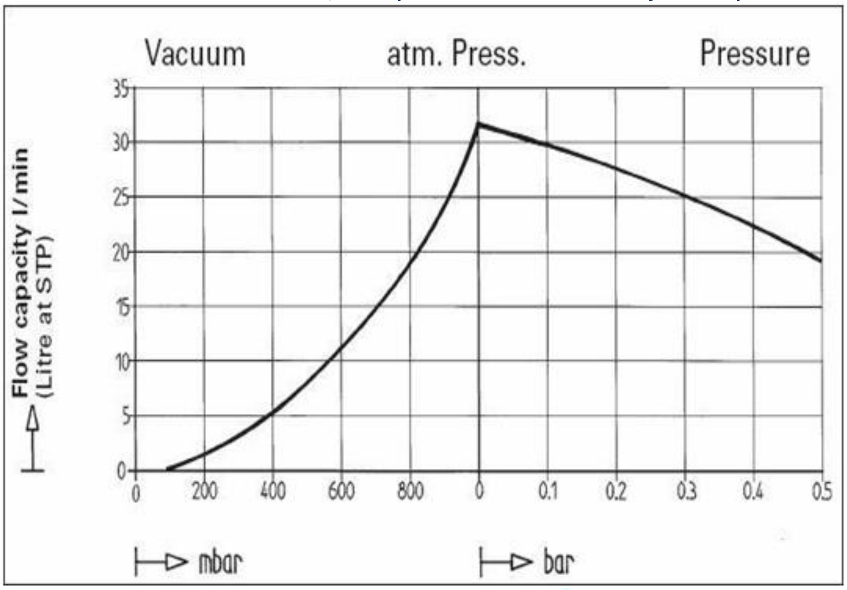
vehicle trim, and mission performance. The design tool’s purpose is to enable multidisciplinary design optimization (MDO) and trade studies in the conceptual and preliminary phases of design. Under the aerodynamic modeling section, they describe one way of modeling the ram drag and pitching moment characteristics of the vehicle, as seen in They model the center of pressure as remaining on the vehicle axis of symmetry, with vertical movement to account for pitching moment changes due to angle of attack and thrust variation.

SOLID WORKS DESIGN



The idea and primary knowledge of the robot was gathered from different research and journal papers. Primarily a list of different components had been made. A theoretical research was done on the electric and electronic components. Torque, speed, pressure and power of different components were calculated theoretically. A prototype body of the robot was designed using 3D Studio MAX and Auto CAD 3D. Then solid works simulation was used for calculating the required strain, stresses, friction and balance. Difference between simulation result and theoretical calculation was thoroughly observed and the correction was made. As a consequence, the main body of the robot was again designed which reduced the size and weight of the body compared to the prototype design. The project work had been divided into two major parts: mechanical and electrical.




Vacuum
atm. Press.
Pressure
Flow capacity l/min
(Litre at STP)
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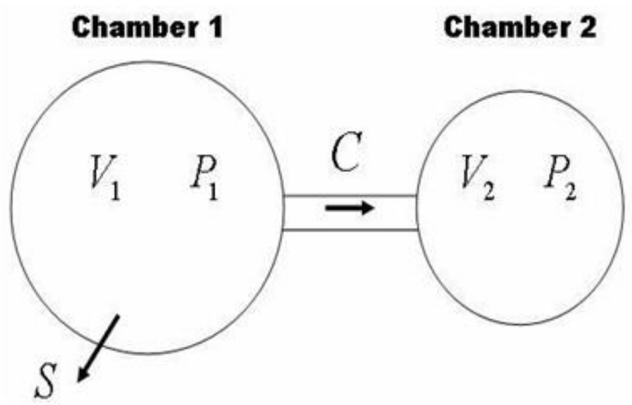
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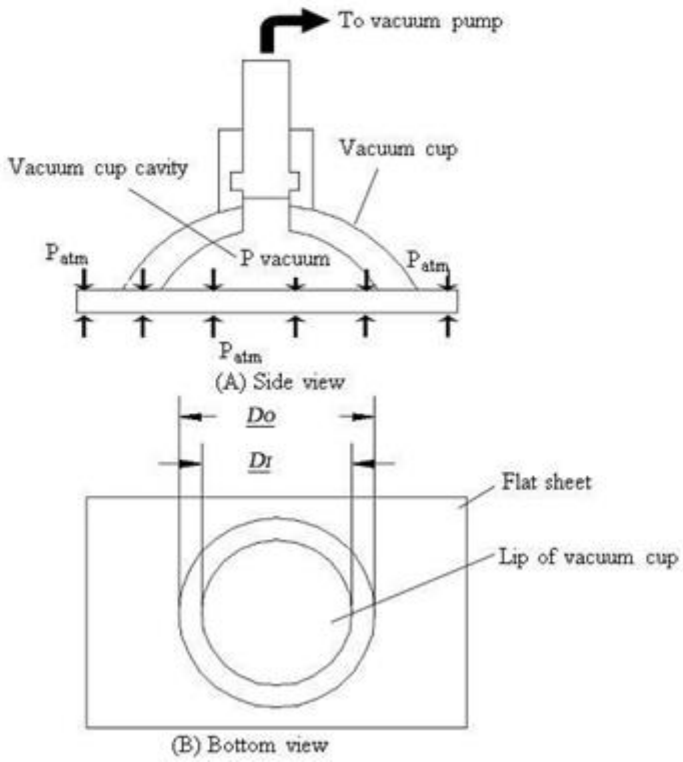
To vacuum pump
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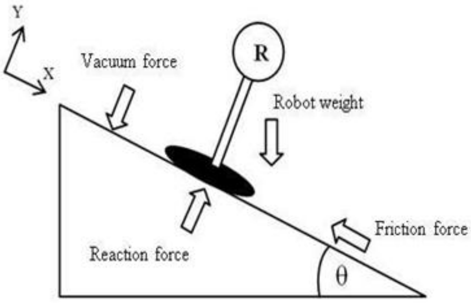
Lip of vacuum cup
(B) Bottom view



Forces acting on a slope

RESULTS AND DISCUSSION

1. MACHINE INSPECTING ON A SMOOTH TILE WALL.

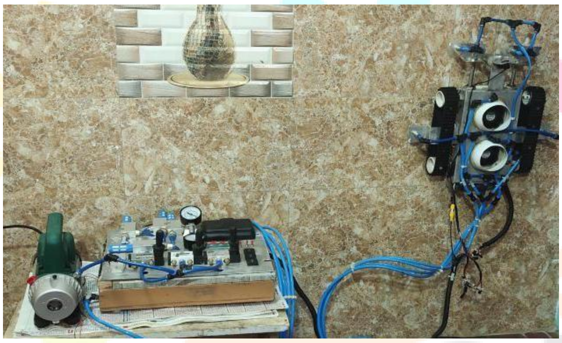


FIG.11.1 MACHINE ON TILES

2. MACHINE INSPECTING ON PAINTED CEILING 360 DEGREE.

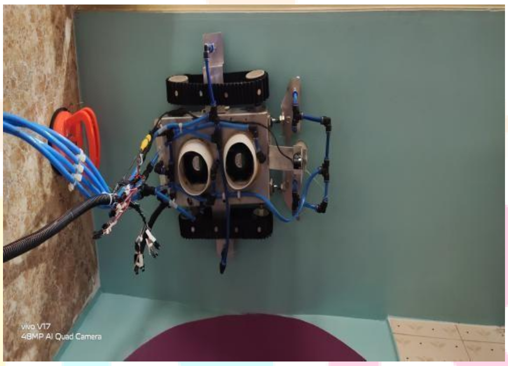


FIG.11.2-MACHINE ON A WALL

FIG.11.3 MACHINE ON CEILING

3. MACHINE INSPECTING ON VERTICAL GRANITE PILLAR.

FIG.11.4 MACHINE ON A GRANITE SURFACE

4.MACHINE INSPECTING ON ROUGH PAINTED WALL.

FIG.11.5 MACHINE ON A ROUGH WALL

5. MACHINE INSPECTING ON CAR MIRROR .

FIG.11.6 MACHINE ON A CAR MIRROR

Good structural design is important in most building designs, but particularly for skyscrapers since even a small chance of catastrophic failure is unacceptable given the high prices of construction. This presents a paradox to civil engineers: the only way to assure a lack of failure is to test for all modes of failure, in both the laboratory and the real world. But the only way to know of all modes of failure is to learn from previous failures. Thus, no engineer can be absolutely sure that a given structure will resist all loadings that could cause failure, but can only have large enough margins of safety such that a failure is acceptably unlikely. When buildings do fail, engineers question whether the failure was due to some lack of foresight or due to some unknowable factor. One of the many things that make skyscrapers special is their substructure. For example, the depth of the pit that holds the substructure has to reach all the way to bedrock. If bedrock lies close to the surface, the soil on top of the bedrock is removed, and enough of the bedrock surface is removed to form a smooth platform on which to construct the building's foundation.

The load a skyscraper experiences is largely from the force of the building material itself. In most building designs, the weight of the structure is much larger than the weight of the material that it will support beyond its own weight. In technical terms, the dead load, the load of the structure, is larger than the live load, the weight of things in the structure (people, furniture, vehicles, etc.). As such, the amount of structural material required within the lower levels of a skyscraper will be much larger than the material required within higher levels. This is not always visually apparent. The Empire State Building's setbacks are actually a result of the building code at the time, and were not structurally required. On the other hand, John Hancock Center's shape is uniquely the result of how it supports loads. Vertical supports can come in several types, among which the most common for skyscrapers can be categorized as steel frames, concrete cores, tube within tube design, and shear walls.

The wind loading on a skyscraper should also be considered. In fact, the lateral wind load imposed on super-tall structures is generally the governing factor in the structural design. Wind pressure increases with height, so for very tall buildings, the loads associated with wind are larger than dead or live loads. Other vertical and horizontal loading factors come from varied, unpredictable sources, such as earthquakes. A shear wall, in its simplest definition, is a wall where the entire material of the wall is employed in the resistance of both horizontal and vertical loads. A typical example is a brick or cinderblock wall. Since the wall material is used to hold the weight, as the wall expands in size, it must hold considerably more weight. Due to the features of a shear wall, it is acceptable for small constructions, such as suburban housing or an urban brownstone, to require low material costs and little maintenance. In this way, shear walls, typically in the form of plywood and framing, brick, or cinderblock, are used for these structures. For skyscrapers, though, as the size of the structure increases, so does the size of the supporting wall. Large structures such as castles and cathedrals inherently addressed these issues due to a large wall being advantageous (castles), or able to be designed around (cathedrals). Since skyscrapers seek to maximize the floor-space by consolidating structural support, shear walls tend to be used only in conjunction with other support systems.

The classic concept of a skyscraper is a large steel box with many small boxes inside it. By eliminating the inefficient part of a shear wall, the central portion, and consolidating support members in a much stronger material, steel, a skyscraper could be built with both horizontal and vertical supports throughout. This method, though simple, has drawbacks. Chief among these is that as more material must be supported (as height increases), the distance between supporting members must decrease, which actually, in turn, increases the amount of material that must be supported. This becomes inefficient and uneconomic for buildings above 40 stories tall as usable floor spaces are reduced for supporting column and due to more usage of steel. Building skyscrapers can be difficult for factors other than complexity and cost. For example, in European cities like Paris, the difference between the appearance of old architecture and modern skyscrapers can make it hard to get approval from local authorities to construct new skyscrapers. Building skyscrapers in an old and famous town can drastically alter the image of the city. In cities like London, Edinburgh, Portland, and San Francisco there is a legal requirement called protected view.

CONCLUSION

This project satisfies the needs of the workers who works in the high sky scraper buildings, Rust inspection in ships, painting the vertical surface, visual inspection for power plant boilers etc., the time consumption is reduced for completing the works. Reduces the human errors. Save human life in risky conditions. Future developments f this project leads to New method of inspection in this field.

1. It is used to climb the wall safely and overcome its gravity

2. To reduce the human effort, It can move in any terrain surface using belted wheels.

3. Time consumption for dusting, cleaning, painting, inspecting purpose in a high risk buildings, Ships, Chimneys, Steam power plant boilers etc.,

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