DESIGN AND IMPLEMENTATION OF WALL CLIMBING ROBOT

A Project Report

Submitted by

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to

APJ Abdul Kalam Technological University

in partial fulfillment of the requirements for the award of the Degree of

Bachelor of Technology (B.Tech)

in

MECHATRONICS ENGINEERING

Under the guidance of

MS SHAMIN ELIZABETH VARKEY

CREATING TECHNOLOGY
LEADERS OF TOMORROW
ESTD 2002

DEPARTMENT OF MECHATRONICS ENGINEERING

Jyothi Engineering College

NAAC Accredited College with NBA Accredited Programmes*

Approved by AICTE & affiliated to APJ Abdul Kalam Technological University

A CENTRE OF EXCELLENCE IN SCIENCE & TECHNOLOGY BY THE CATHOLIC ARCHDIOCESE OF TRICHUR

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MAY 2023

DECLARATION

We the undersigned hereby declare that the project report "DESIGN AND IMPLEMENTATION OF WALL CLIMBING ROBOT ", submitted for partial fulfillment of the requirements for the award of degree of Bachelor of Technology of the APJ Abdul Kalam Technological University, Kerala is a bonafide work done by us under supervision of Ms Shamin Elizabeth Varkey. This submission represents our ideas in our own words and where ideas or words of others have been included, we have adequately and accurately cited and referenced the original sources. We also declare that we have adhered to ethics of academic honesty and integrity and have not misrepresented or fabricated any data or idea or fact or source in this submission. We understand that any violation of the above will be a cause for disciplinary action by the institute and/or the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been obtained. This report has not been previously used by anybody as a basis for the award of any degree, diploma or similar title of any other University.

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Place:

Date:

Jyothi Engineering College

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DEPARTMENT OF MECHATRONICS ENGINEERING

JYOTHI ENGINEERING COLLEGE
LEAD KINDLY LIGHT
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CREATING TECHNOLOGY
LEADERS OF TOMORROW
ESTD 2002

CERTIFICATE

This is to certify that the report entitled " **DESIGN AND IMPLEMENTATION OF WALL CLIMBING ROBOT** " submitted by ALBIN DAVID C(JEC19MC004), AWIN SAJU(JEC19MC014), JOEL VARGHESE(LJEC19MC045), SAJAN T JOHN(JEC19MC038) to the APJ Abdul Kalam Technological University in partial fulfillment of the requirements for the award of the Degree in Bachelor of Technology in **Mechatronics Engineering** is a bonafide record of the project work carried out by them under my/our guidance and supervision. This report in any form has not been submitted to any other University or Institute for any purpose.

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Internal Supervisor

Dr.Anoopa Jose Chittilapilly
Associate Professor
Head of the Department

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Finally, we take this opportunity to express our gratitude to the parents for their love, care and support and also to our friends who have been constant sources of support and inspiration for completing this project work.

VISION OF THE INSTITUTE

Creating eminent and ethical leaders through quality professional education with emphasis on holistic excellence.

MISSION OF THE INSTITUTE

- To emerge as an institution par excellence of global standards by imparting quality Engineering and other professional programmes with state-of-the-art facilities.
- To equip the students with appropriate skills for a meaningful career in the global scenario.
- To inculcate ethical values among students and ignite their passion for holistic excellence through social initiatives.
- To participate in the development of society through technology incubation, entrepreneurship and industry interaction.

VISION OF THE DEPARTMENT

Create eminent and ethical leaders committed to profession and society in the field of Mechatronics through quality professional education to excel in industrial automation and innovation.

MISSION OF THE DEPARTMENT

- To impart orientation to meet the challenges of the modern industry and provide motivation for research.
- To provide quality education to create graduates with professional and social commitment.

PROGRAMME EDUCATIONAL OBJECTIVES

PEO 1: Graduates shall possess fundamental and advanced knowledge in electronics, electrical and mechanical along with fundamental knowledge in mathematics, basic sciences and computer programming to analyze and solve the challenges related to automation.

PEO 2: Graduates shall have ability to design and create novel solutions with modern tool usage which lead to a lifelong learning or higher qualification, making them experts in their profession.

PEO 3: Graduates shall have the ability to work in a multidisciplinary environment with good professional and ethical commitment.

PROGRAMME SPECIFIC OUTCOMES

Graduate possess -

PSO 1: Professional skills: Associate the concepts related to electrical, electronics, Mechanical, Robotics, Control and Instrumentation to solve the challenges of modern industries.

PSO 2: Problem solving ability: Analyze and design systems with modern tools for the benefit of the society.

PROGRAMME OUTCOMES

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

COURSE OUTCOMES

COs	Description
CO1	Model and solve real world problems by applying knowledge across domains(Cognitive knowledge level: Apply).
CO2	Develop products, processes or technologies for sustainable and socially relevant applications (Cognitive knowledge level: Apply).
CO3	Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks (Cognitive knowledge level: Apply).
CO4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms (Cognitive knowledge level: Apply)
CO5	Identify technology/research gaps and propose innovative/creative solutions (Cognitive knowledge level: Analyze).
CO6	Organize and communicate technical and scientific findings effectively in written and oral forms (Cognitive knowledge level: Apply).

CO MAPPING TO POs

	POs											
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	2	2	2	1	1	1	1	2
CO2	2	2	2		1	3	3	1	1		1	1
CO3									3	2	2	1
CO4					2			3	2	2	3	2
CO5	2	3	3	1	2							1
CO6					2			2	2	3	1	1
Average	1	1.17	1.17	0.3	1.5	0.83	0.83	1.17	1.5	1.3	1.33	1.33

CO MAPPING TO PSOs

	PSOs	
COs	PSO1	PSO2
CO1	3	3
CO2	3	3
CO3	3	3
CO4	3	3
CO5	3	3
CO6	3	3
Average	3	3

ABSTRACT

The aim of the project is to develop a modular, re-configurable, wall-climbing robotic system and to investigate intelligent control methods and vision algorithms to control and coordinate a team of such robots to perform various function. A wall climbing robot is a robot with the capability of climbing vertical surfaces. The targeted capability to stick with surface can be achieved by duct fan.

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LIST OF FIGURES

CHAPTER 1

INTRODUCTION

It is a kind of electro mechanical machine which can perform various tasks automatically according to the installed programmable commands. Robots can perform different tasks in an unfriendly environment where it is tough for human to accomplish it. In the modern scientific era, robots are one of the most exclusive inventions by which our life became easier and comfortable. Climbing robots are mainly adopted in places where direct access by a human operator is very expensive, because of the need for scaffolding, or very dangerous, due to the presence of a hostile environment. In the last decades, different applications have been envisioned for wall climber robots, mainly in the field of technical inspection, maintenance, surveillance, space activities and failure or breakdown diagnosis in dangerous environments. These tasks are necessary in the outside of tall buildings, bridges, nuclear power plants or pipelines, for scanning external surfaces of gas or oil tanks and offshore platforms, for performing nondestructive tests in industrial structures, and also in planes and ships. Furthermore, they have been applied in civil construction repair and maintenance, in the prevention and fire-fighting actions, in anti-terrorist actions, in cleaning operations of sky-scrapers/buildings.

the walls and ceilings of restaurants, for transportation of loads inside buildings and for reconnaissance in urban environments. Finally, their application has also been proposed in the education and human care areas. Wall climbing robots have been developed for decades to increase working efficiency and to ensure worker's safety. The robots are popular in various prospective applications such as cleaning, inspecting, painting, and blasting for high-rise structures. In the field of the climbing robots, locomotion mechanism design to enlarge the applicable areas of the climbing robots is the major issue. Wall-climbing robots, are mainly employed for the tasks that are dangerous or costly when performed by a human operator in the harsh environment. Some tasks include wall cleaning of high buildings, remote maintenance of large storage tanks, inspection of large concrete structures such as bridge pylons, cooling towers or dams and in-pipe inspections. According to the adhesion method, these robots are generally classified into four groups: magnetic, vacuum or suction cups, gripping to the surface and propulsion type. According to locomotion mechanisms they are classified as legged mechanisms, translation mechanism, wheel driven mechanism and tracked wheel mechanism.

CHAPTER 2

LITERATURE SURVEY

2.1 A Novel Mechanism Design Technique To Develop A Vertical Climbing Robot With High Mobility For Flat And Spherical Surfaces,Shahriar Siraj Khan*, Alve Rahman Akash, Sheikh Maaj, M D. Rakibul Hassan, Md. Abdur Rahman

The following paper represents a new and improved wall climbing mechanism that can climb on flat and spherical surfaces. The design methodology of the robot was solely directed towards heavy lifting purposes; as the robot uses a redesigned mechanism to endure an enhanced workload. The robot was specially designed to climb any given vertical surface with the help of the Reverse Propulsion technology; which provides backward thrust as a convenient heavy-duty suction mechanism. The robot was built keeping overall body weight at a minimum and consisted an array of powerful brushless motors for the suction and navigation. The robot can be put to multiple use based on its operation such as surveillance, inspection, cleaning etc.

2.2 Design Implementation of Vertical Surface Climbing Cleaner Robot,Prof. Dr. M. A. Mannan, Director, Faculty of Engineering, American International University-Bangladesh (AIUB).

This paper presents a vertical surface climbing robot for cleaning of dust from high rise building. Usually, people clean their wall of outer surface of building by human. Often it becomes risky and costly also. A portable robot having the ability to climb on vertical surface has been expected for a long time. To protect human's life we designed a prototype of vertical surface climbing robot for cleaning and other multipurpose operation. Some combination of technology has been shown such as smart wireless control with all direction moving capability. Four Dc motors are used to move the robot and one Dc motor is used to rotate the cleaning brush. There is one Electric Ducted fan (EDF) which helps the robot to stick to the surface against gravitational force. An Arduino uno is used as a controller for different There is a Bluetooth modular which has been used to connect with smart phone and take command from user. Four motor helps it to move in up, down, right and left direction by the according commands given by smart phone. The full robot is power by using DC battery and AC to DC converted adapter combined. To observe the outcome of the project, we analyzed the performance of the robot .

2.3 A Small-sized Wall-climbing Robot for Anti-terror Scout,Shuyan Liu, Xueshan Gao, Kejie Li, Jun Li, and Xingguang Duan Intelligent Robotics Institute Beijing Institute of Technology

This paper presents a small-sized wall climbing robot for anti-terror and rescue scout tasks, which takes advantage of a method called critical suction. In this paper the critical suction mechanism is discussed in theory. Furthermore, the fluid model of the robot's suction system is set up using the fluid network theory. According to the dynamic response equation of the negative pressure inner the suction cup, the robot suction process on the wall is simulated. Finally, the results of the experiments for adsorbing on the sorts of walls proved this type of robot can be adsorbed on the surfaces.

CHAPTER 3

METHODOLOGY

The development plan is shown in Figure 3.1 by a simple block diagram. The block diagram is divided in two parts as its main duty is in two portions. Microcontrollers, ducted fan, dc motors, and motor drivers are operated for moving toward the vertical direction.For operating two pairs of dc motor, there are two motor drivers which is enough for all the dc motors.As a power supply a 12,volt DC SMPS is used which can supply a continuous electricity. This power supplied can be supplied by 220-volt line voltage by an AC to DC converter. Two L298 motor drivers are used for operating DC motors. Each motor driver operates two individual motors. As a controller Arduino Uno is used for multiple operation like an operating motor driver. When the motor drivers get command from the controller, those motor drivers start to operate the two DC motors individually. As the DC motors are started then the whole robot will move vertically.The robot is operated by a 4wheel drive design with high grip wheels to help it move over the wall with ease.The robot uses a high torque drone motor with propeller to produce the suction needed to cling on to the wall. Controller circuitry controls the 4 motors. The controller makes use of a Bluetooth module to receive movement commands from the user.The user uses an android app to connect to the robotic system using Bluetooth. Once connection is successful the user may press buttons on the app to start the suction as well as control movement of the robot on wall.

3.1 List of Components

- BLDC Motor
- Propeller Blade
- Gear Motors
- Bluetooth Module
- wheels
- Supporting Frame
- Screws and Fittings

3.1.1 BLDC Motor

It is this motor which takes the electrical power from the power source and converts it into mechanical power in the form of suction with air flow.

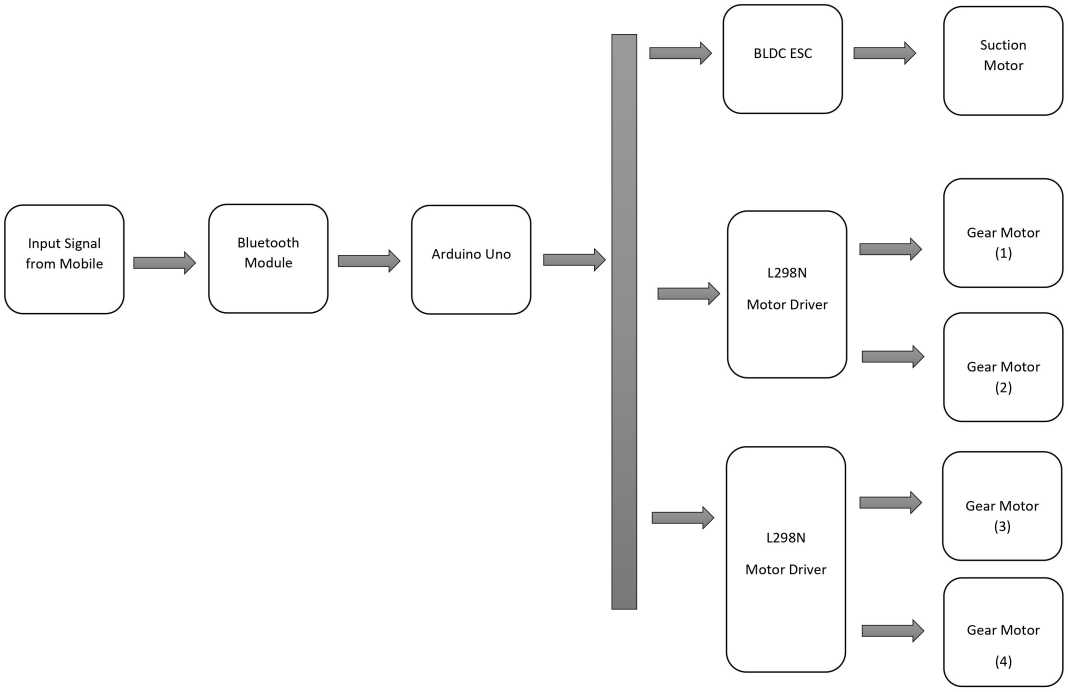

Figure 3.1: METHODOLOGY

3.1.2 Gear Motor

In this project, 4 dc gear motors are used to drive the wheels.Operating Voltage 3 to 12V.RPM: 200 rpm.

3.1.3 ESC

Standard 30A ESC Electronic Speed Controller can drive motors that consume up to 30A current. The onboard ESC provides regulated 5V (2A max draw) to power the flight controller and other onboard modules. This is useful to control our brushless motors.

3.1.4 L298N

This L298N Motor Driver Module is a high power motor driver module for driving DC and Stepper Motors. This module consists of an L298 motor driver IC and a 78M05 5V regulator. L298N Module can control up to 4 DC motors, or 2 DC motors with directional and speed control.

3.1.5 Wheels and Tyres

A wheel having a rim and a hub as the major parts revolve around the axle to enable it to move easily over the wall. It is used to move forward direction and backward direction also move left and right side. This is rotate with help of DC gear motor.

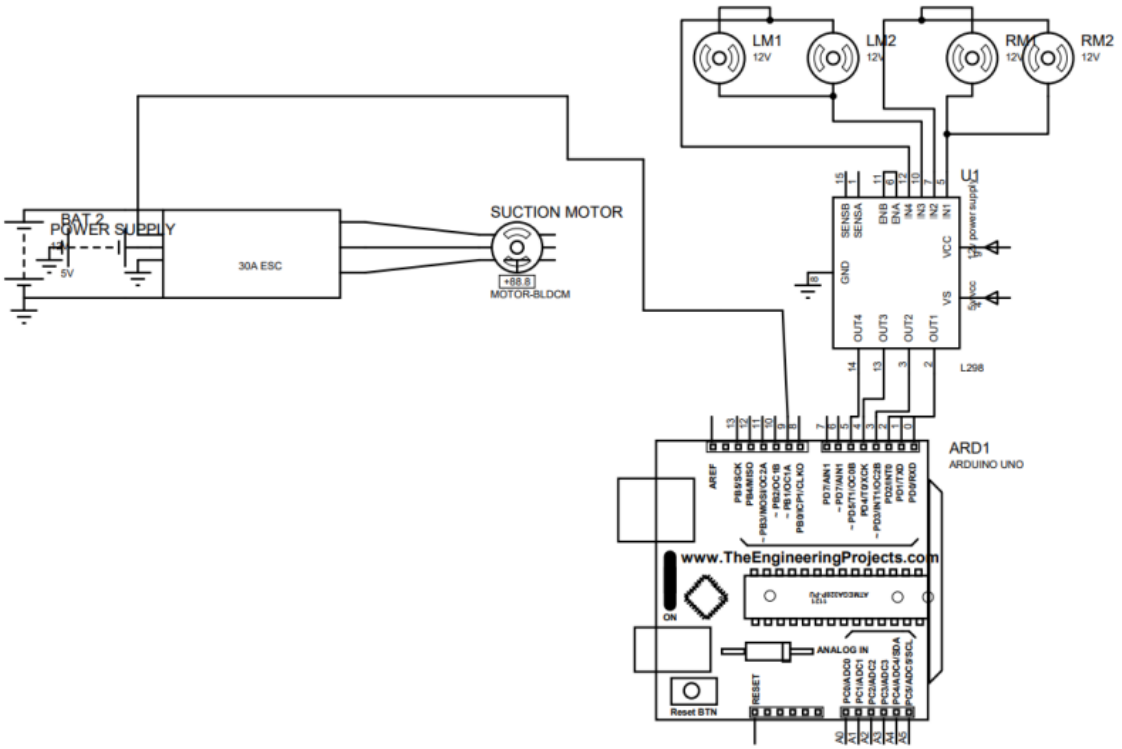

Figure 3.2: CICUIT DIAGRAM

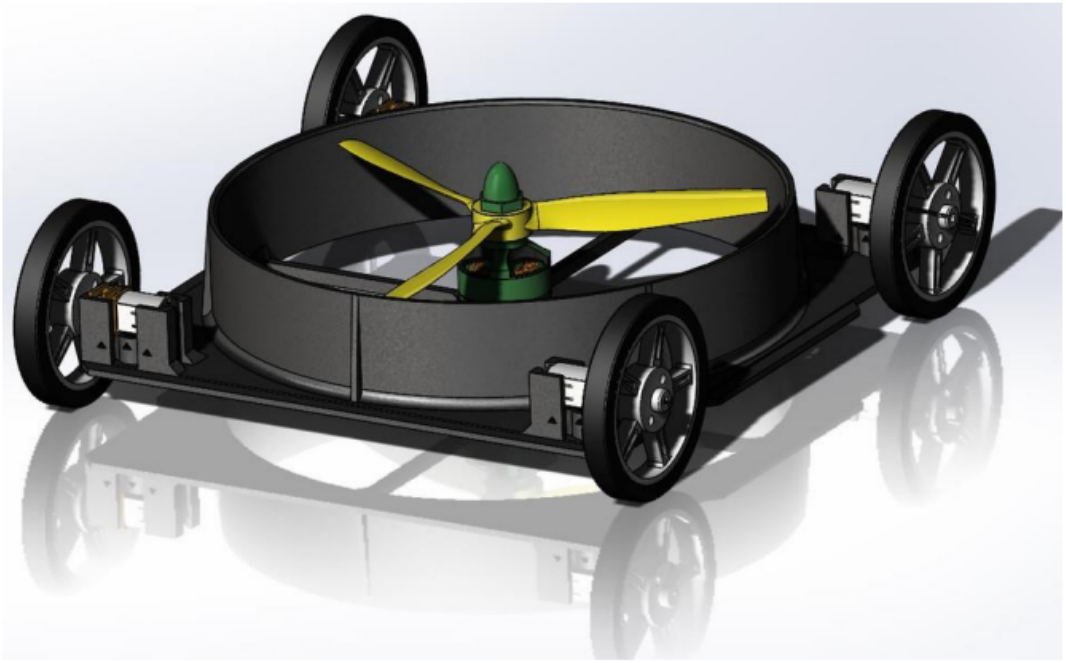

Figure 3.3: DESIGN

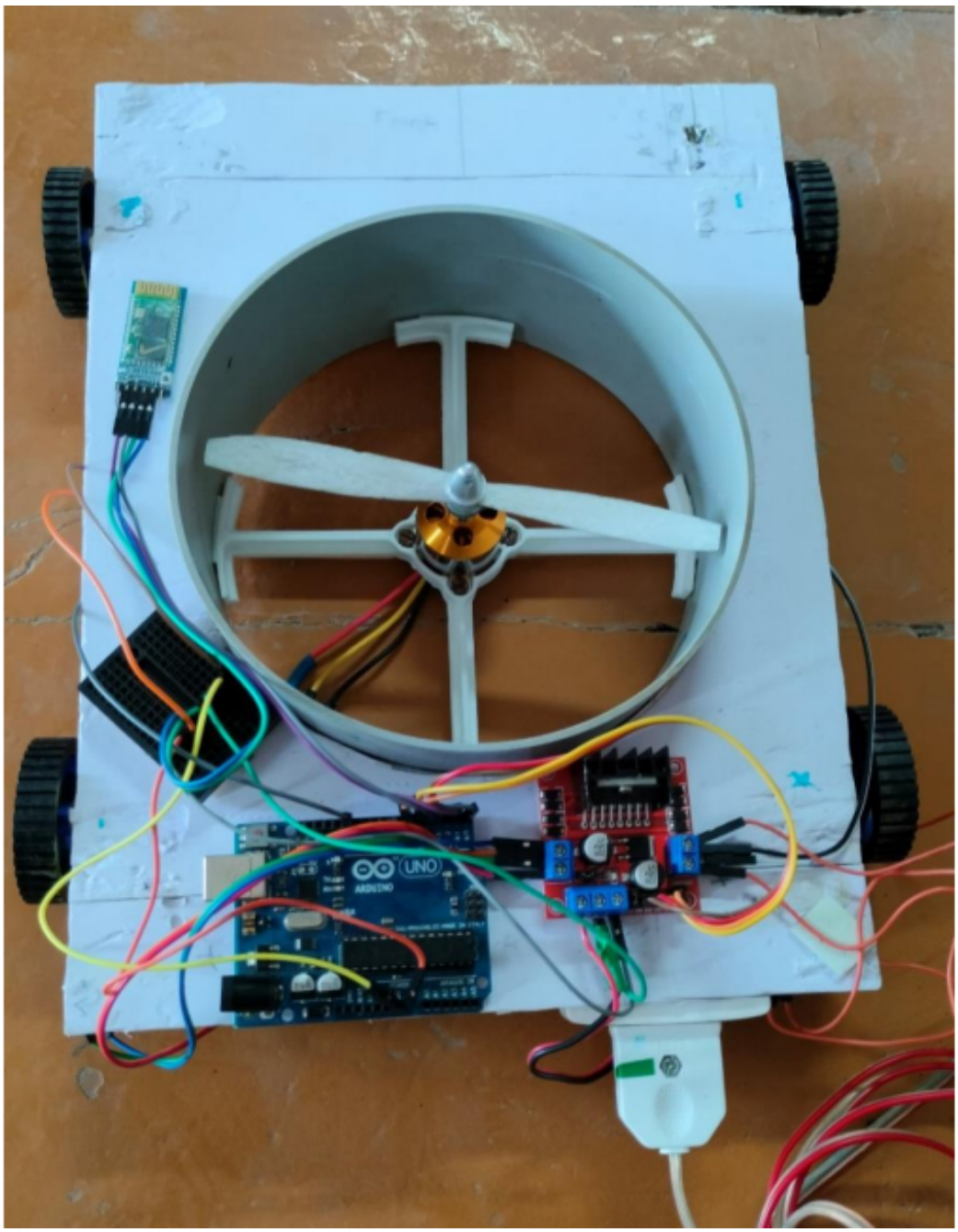

Figure 3.4: Testing

CHAPTER 4

CONCLUSION & FUTURE SCOPE

In modern society, there is an increasing need for climbing robots to clean, weld or inspect different kinds of surfaces of high buildings, large oil tanks and rough concrete facilities, replacing workers in these hazardous environments, so as to ease the difficulties in performing various tasks. During the two last decades, the interest in climbing robotic systems has grown steadily. A lot of improvement is expected in the future design of the wall climbing robots depending upon its utility. Consequently, robotic technologies have been developed and applied according to the needs in different fields. High rise buildings having glass facades face a constant problem of maintenance. Maintenance involves cleaning of glass surface. Robots have been created to assist or replace humans in various dangerous and difficult tasks. Robots have been used in construction, manufacturing, security etc. This is because they are able to adapt to different environments and situations. Nowadays, with the large increase in development of tall and smart buildings in urban areas, the development of a window cleaning robot has become a necessity. Currently window glass cleaning in high rise buildings has been carried out manually usually with a machine to lift worker to the desired location. Objectives of our work is to design and fabricate a glass cleaning robot for glass covered high rise buildings and to effectively increase safety and efficiently clean the glass panes. This will ensure a faster cleaning operation and will prevent accidents due to the human workforce used in high rise building. Designed our own unique wall-climbing robot with mechanisms for suction and I implemented techniques for its control as well.

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