IC 201P – Design Practicum

Wall/Slope Climbing Bot

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Final Group photo of our team

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Certificate

This is to certify that the work contained in the project report entitled "Wall/Slope Climbing Bot", submitted by Group 33 to the Indian Institute of Technology Mandi, for the course IC 201P—Design Practicum, is a record of bonafide research work carried out by him under our direct supervision and guidance.

Dr. Manas Thakur	Signature and Date
Dr. Kaustav Mukherjee	Signature and Date

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Abstract

In this era of automation each and every task is being automated, but still a dangerous job like working at heights hasn't been automated which is sad. So, our project revolves around the idea of a wall-climbing robot which can be used to automate and simplify the task, reducing the overall cost of such jobs. There are many wall-climbing robots that use the concept of navigating on the wall via suction using a vacuum and compressor and they are extremely slow. Our basic idea is to build a car that can easily move on the wall and do the task of painting the wall by the use of EDF (Electric Ducted Fan) to apply force on the wall and use the principle of exhaust to create a vacuum field and hence creating suction. Furthermore, it would be equipped with a spray paint machine for painting the wall, a camera for image processing, and sonar or ultrasonic sensor for basic autonomous navigation on the wall. Teleop will also be an option. Other modifications may include using the camera or an IR sensor for crack detection etc. In this project we focus on building a wall climbing car that can navigate autonomously and also paint the wall, which can be further scaled up for jobs like inspection, maintenance and rescue operations.

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Abbreviations

IARC	International Agency For Research On Cancer
EDF	Electric Ducted Fan
AC	Alternating Current
PMS	Power Management System
ESC	Electric Speed Control
Rpi	Raspberry Pi
USB	Universal Serial Bus
DC	Direct Current
V	Voltage
A	Ampere
mAH	Milli Ampere Hour
LiPo	Lithium Polymer
PLA	Poly Lactic Acid
FDM	Fused Deposition Modelling
IEEE	Institute Of Electrical and Electronics Engineers

Chapter 1

Introduction

This is an era of robots, automation, and artificial intelligence. Even though everyone is moving towards automation and everything is being automated, there are still many tasks that require human labor even though they can be automated completely. Even our day-to-day tasks like cleaning, cooking, washing, etc. have been automated. We can find many automatic vacuum cleaners, dishwashers, and now even machines that can cook automatically. If all those tasks could be automated, why not tasks that involve working at heights like painting the walls and inspecting and maintaining them? Even today, to paint huge buildings and skyscrapers, the use of suspended scaffolds is very prevalent.

Working at heights is very dangerous, especially with such temporary arrangements, as it could lead to workplace accidents. Wall paints involve multiple chemicals, which are very dangerous and can lead to multiple diseases and health issues, with lung issues being one of the major issues [1,2]. Occupational exposure as a painter was classified as a Group-1 carcinogenic in the IARC Monograph Volume 47, based on an increased risk for lung cancer, and was reaffirmed in Monograph Volume 98, based also on increased risks for mesothelioma and bladder cancer [1,2]. So, there is a need of the hour to develop an innovative solution for it. We can define work at heights as a **4D [Dangerous, Dirty, Difficult, Dull]** environment and the work **as 4A [Automation, Augmentation, Autonomous, Assistance]** task. We developed a bot which can help us tackle the issue to an extent, so in this section we discuss the problem statement, design philosophy, and beneficiaries of the developed product.

I. Problem Statement & Design Philosophy

Working at heights for various reasons like painting, inspection, and maintenance can lead to workplace accidents and paint can lead to various health issues like lung cancer and other health issues, which calls for the need for state-of-the-art technology to overcome this problem in an autonomous and sustainable manner.

Design Philosophy:

- **Definition:** Our bot is an autonomous car using impeller technology(edfs) and high grip tires to move on the wall and paint it with the desired color, also giving live visual feed from the camera mounted. The painting module can be replaced with other modules for other purposes, but currently it only supports painting and visual inspection

- **Users:** It is intended for companies with huge buildings, architects and builders, painting, and maintenance services/companies.
- **Purpose:** The main reason to create such a bot is to tackle the above-mentioned pain points like working at high heights, cost issues for consuming such services each time, health issues, human labor, etc.
- **Differentiation:** The current prototype is cheap compared to other products in the market, so any company can buy it and by the time it reaches the production line we intend to reduce the cost even more. It shall reduce the amount of human labor required for these tasks, it will reduce the time required to complete these tasks and cost as well. As this product will be released in the market it will be a one-time investment for the companies. The best part is that it is autonomous.
- **Value:** It makes our users' lives better by reducing the labor required, cutting down the time, eliminating health issues, and also being easily usable by anyone. The final product which would be released in the market shall be very easy to use and even a person without any technical background shall be able to use it.
- **Goal:** Our end goal is to make all the tasks at height autonomous and our success shall be measured if we are able to achieve at least 50% of our target within the 5 years of our startup or the release of the product.

II. Beneficiaries:

- Large companies with a huge lot of buildings
- Architects and builders
- Painting and maintenance companies

****This product can be used anywhere where working at heights is required.**

Chapter 2

Market Research

Any product that is developed and released in the market or industry usually lies in the Red Ocean or the Blue Ocean. A "Red Ocean" is basically a zone where your product has multiple competitors and a well-developed market, whereas any product in a "Blue Ocean" doesn't have many competitors and a market. It usually has a high-risk high-return factor. Our product basically lies in the blue ocean. In this chapter, we will basically discuss the existing products, their features, their shortcomings, and how our product stands apart from them.

A. Existing Products – Features and Shortcomings:

(a) **Remote-controlled wall climbing car:** These cars are basically Chinese toy cars and are very lightweight and fun to play with. They are very cheap, and pretty much everyone can buy those cars. [3]

The major drawbacks of these products are that they are not indented for industrial purposes, they are very light and don't have a payload capacity, and they can also break easily. So, they can't be used in industry to carry out tasks like painting, inspection, etc. [3]

(b) **Hausbots:** It is a company that provides various services based on the wall climbing bot they have developed. The bot has various features like 42kg of suction force, can climb on any surface texture, can also climb on columns, tanks, flat walls, etc., and has a 6kg payload capacity. [4]

They provide multiple services like painting, visual inspection, and concrete inspection solutions like half-cell potential and ground-penetrating radar. It is a company that has been working on its product for a couple of years and has created a state-of-the-art product that minimizes the work at heights. [4]

Fig. 2.1. HausBot [4]

The company has its patent pending, which can help us launch our product first to market if we are able to get the patent first. The company also only provides services, not bots, so every time someone needs to get something done, they must call the company. That's another major drawback. Plus, their services are costly, as at that cost, the company can easily buy our bot. [4]

(c) **Geco Wall Climbing Bot:** It is a research project on a wall climbing bot by Ghent University made using impeller technology. It looks like an automatic vacuum cleaner. It is a DIY bot that anyone can make easily and is cost-effective. It is a good hobby project and a good college club project, and students can easily work on it and make it. [5]

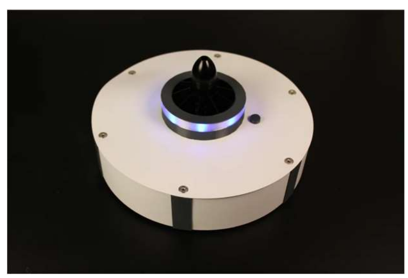

Fig. 2.2. Geco [5]

(d) **Crawlerbot**: This bot is a remote-controlled bot made by Astec engineers with 3D-printed components. It is a bot specifically designed for silos as it uses brushless AC motors for propulsion and magnetized wheels to adhere to the walls of the silo. [6]

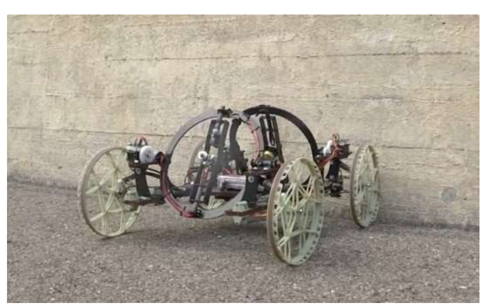

Fig. 2.3. Crawlerbot [6]

It can be used to measure the density of asphalt silo walls, which would eliminate the need for inspection scaffolding and send workers up into the silo to take measurements manually. This can also be treated as a drawback as it can only be used for a single purpose and only on a single type of surface. [6]

B. Individuality of our bot:

(a) Features: The bot is quite versatile. It can easily move on walls, autonomously navigate, and overcome any obstacle in its path. It can paint the wall with any color mounted on it and send back a live camera feed. As it applies 4.5kg of normal thrust, the bot has a payload capacity of 0.8-1kg depending on the surface. It can also easily move on the slope of high inclination due to the normal thrust and high grip wheels mounted on high torque motors.

It costs less compared to other bots on the market for industrial purposes, so companies can easily buy it and use it for any purpose. It would serve as a one-time investment for them. It is also light and has a reasonable size.

(b) Future Scope and R&D: There are many further improvements that can be made to the bot. Some of them are as follows:

1. A feature to change and mount any module for different purposes like painting, inspection, cleaning, etc. can be mounted. It can also be used for inspecting water pipelines, electric lines, and other cables that are within the wall.
2. The sound could be reduced using dampers
3. An aesthetic, lightweight, durable top covering can be designed to protect the internal components.
4. A user-friendly interface can be designed so that anyone with or without a technical background can use the bot and install and change modules on it according to the purpose.
5. It can also be equipped with airbags for various safety reasons.
6. The design can be modified so that the bot can easily move from ground to wall and vice versa.
7. A user-friendly application can be developed for the bot which makes is easy for anyone to operate the bot. Using the application, the bot would be able to do tasks with just a press of 1 button. For example, we can feed the map of the building in the bot and then the user can just select a wall or a room to paint or inspection and then just press start. The bot will then autonomously navigate to the location complete its task and return.

Chapter 3

Conceptual Design

The course of the design practicum can be described as a beautiful journey. It gave us the opportunity to get to know our batchmates and to learn a lot. During this period, we discussed many ideas, agreed upon some, rejected some, and also had conflicting views on some. We also had many brainstorming sessions to shortlist the ideas and decide the best one to work upon. Brainstorming sessions didn't come to an end after idea selection; we continued with those whenever there was any problem, an issue, or we had to buy something. In this chapter, we describe our journey through idea generation, proposition, and selection.

I. Ideation

- Our ideation process started with identifying 100 problems that are around us or the ones we usually face or the ones that are faced by a majority of the peoples.
- Each one of us contributed around 20 problems and they were all listed down in the diary.
- Then we started by elimination, we first eliminated the problems that were difficult to solve at our level or would require more funding, then we also eliminated those problems which don't require an immediate solution or solving them won't make much of a difference or a social impact.
- Then we boiled down to 8 major problems after multiple meetings, brainstorming and eliminating.
- We analyzed those problems in depth, we looked for the existing solutions, stakeholders, beneficiaries, ease to solve the problem, pros and cons, motivation to solve the problem, other issues connected with them and also looked for a chance to innovate.
- We made a detailed presentation and had a discussion with our mentors. Our mentors analyzed all the aspects and helped us boil them down to one issue.
- After finally having our final problem at had we went on with defining our problem statement. We pinpointed the pain points and pain relivers.
- We looked for the current existing solutions and what other solutions are the best possible solutions for the problem statement at stake.
- Then we analyzed all the problem statements and again held multiple brainstorming sessions. We discussed the number of other issues that could be solved with the product, how scalable & adaptable it is, ease of use, cost and time

effectiveness, ease of manufacturing, availability of components, varied applications, R&D opportunity, future scope, and user base. After considering all this, we finally decided on our solution to the proposed problem statement.

This was our voyage of ideation. In the next sections, we will present the decision matrix for the problems and ideas as well. We will all present the final solution in the upcoming sections.

II. Decision Matrix

- Problem Statement

DECISION MATRIX

	Agriculture	Light Powered Mobile Charger	Automatic Wallpainting Machine	AI-Powered Glasses	Black Box with IoT	Automatic Vehicle Starter	Quadbot	Fudity	Preferences
Existing Sc	5	4	3	2	1	4	4	2	Less
Stake Hold	4	4	4	3	4	3	2	4	Very High
Benificiari	4	4	3	2	4	4	2	4	Very High
Ease	3	3	3	2	3	4	3	2	Moderate
Pros and C	3	2	4	3	3	2	3	4	High
Motivatio	2	2	5	4	2	2	3	2	Very High
Cost	3	2	2	5	3	3	3	4	Less
Time	3	2	3	4	3	3	3	4	Moderate
Innovatio	2	2	5	4	4	3	4	4	High
Other con	2	1	4	2	3	1	4	3	High
Final									
Scale	Rating	Description							
	1	Very Less							
	2	Less							
	3	Moderate							
	4	High							
	5	Very High							

Fig.3.1. Decision Matrix - Problem Statement

- Solution

DECISION MATRIX

	Wall Climbing Car	Unmmaned Ground Vehicle(UGV) with Robotic Arm	Wall painting machine with rectangular skeleton which is installed on the wall	Preferences
Ease of Use	5	3	2	Very High
Pros	4	3	2	High
Cost	3	4	4	Less
Time	3	3	3	Moderate
Ease of Manufacturing	3	2	3	Moderate
Effectiveness	4	4	3	High
Availability of Components	4	4	4	High
Scalability	5	3	2	Very High
Varied Application	5	3	2	High
R&D Oppurtunity	4	5	2	High
Future Scope	4	4	1	High
User Base	5	4	2	High
Innovation	5	5	2	High
Final				
Scale	Rating	Description		
	1	Very Less		
	2	Less		
	3	Moderate		
	4	High		
	5	Very High		

Fig.3.2. Decision Matrix - Solution

III. Final Proposed Solution

After multiple meetings, discussions, and brainstorming sessions, we arrived at a final solution for the problem statement. Our solution was as follows:

To design a lightweight car that can freely move on walls using edfs (impellor technology), high torque motors and high grip wheels which could easily perform tasks without human intervention and was easy to use. It would also have a module mount which could be used for mounting different modules for various purposes like painting, inspection, maintenance, and rescue operations.

We decided to make a car and not go with the vacuum idea because that would be very slow compared to a car, it would be a very tedious task, and also it would lose its freedom as a car can go anywhere freely on the wall.

We also decided to use high grip/traction wheels to increase friction and also to maximize the payload capacity of the car. There is also an image of our product below.

Chapter 4
Embodiment and Detailed Design

1. Product architecture

The working of the bot is based on the appropriate power supply, leading to the correct suction created to get stuck to the bot. Electric Duct Fans (EDFs) are used to create the suction between the bot and the wall. EDFs are used at their maximum rpm speed to get stuck to the wall in one place, and then their speed is lowered so that suction becomes less, allowing the bot to move more freely on the wall.

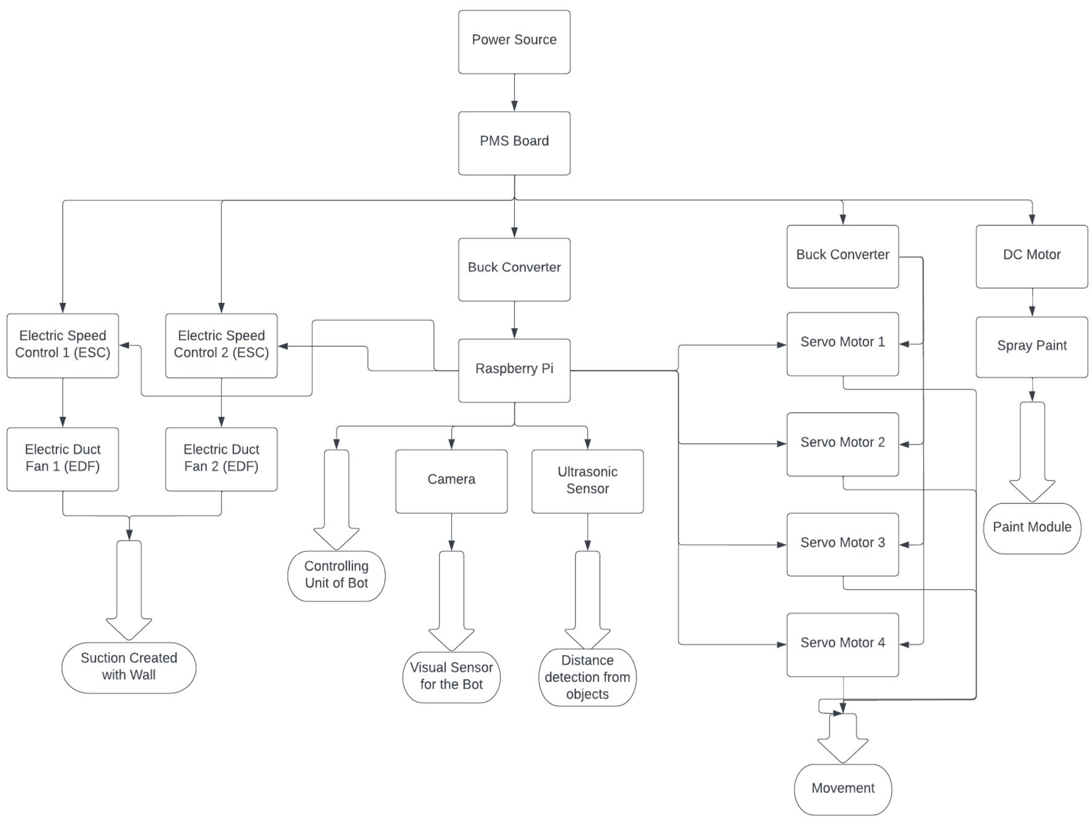

Fig. 4.1. Flow Chart of Product architecture

The paint module here is used to spray paint on the wall. Also, for the visual data of the environment, we are using a camera, and to protect the bot from various obstacles, we are using an ultrasonic sensor.

2. System-level

Here, the power is supplied to the Power Management System (PMS) board, after which power goes to all components. As the power supplier gives a voltage of 24V, which is beyond the usable voltage of much equipment, we used a buck converter for the functionality of the respective equipment. A 24V was stepped down to 12V for each servo motor, and a 24V was stepped down to 5V for the Raspberry Pi. For the functionality of electric duct fans (EDF), we directly connected the power supply to the electric speed control (ESC). The dimensions of the battery are 20*10*10cm. It weighs 14 kg.

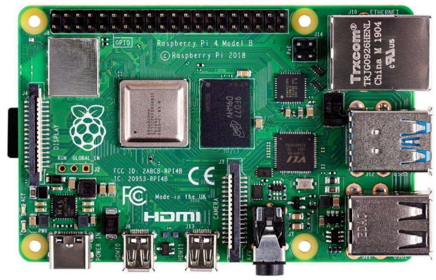

Fig.4.2. Raspberry Pi

The Raspberry Pi, the controlling unit of the bot, was given commands via a desktop to operate. First EDFs are started so that the bot gets attached to the wall, then servo motors give appropriate commands to navigate around the wall. The dimensions of the Raspberry Pi are 85 mm x 56 mm x 19 mm.

Fig.4.3. EDF motor

The EDFs are given power directly from the power source, and signals are provided by the Raspberry Pi to control the speed of the EDFs. The diameter of the EDFs used was 70mm and had 12 blades. It supports 6S voltage and 65A of maximum voltage and current, respectively.

Fig.4.4. USB Camera

We are using here a USB camera connected to the Raspberry Pi USB port. Here, it is used to collect the visual data of the wall and perform an appropriate function related to it.

Fig.4.5. Ultrasonic sensor

We are using ultrasonic sensors to calculate the distance of the bot from the obstacle and protect the bot from objects and obstacles on the wall. The dimension of the ultrasonic sensor is 45 mm x 20 mm.

Fig.4.6. Paint module of bot.

For paint is being sprayed from the painting module of our bot. The DC motor rotates at its location, which in turn presses the spray button of our spray paint, due to which the paint gets released on the wall.

3. Design configuration

To help the bot create suction we used a 70 mm diameter EDF. To provide enough space for Raspberry Pi, the distance between the two EDF's was kept at 60 mm. Considering these the length of the bot was kept 295 mm and width was kept 195mm and minimum width being 135mm. The gap between the 2 edfs was decided based on RPi dimensions (85 mm x 56 mm x 19 mm). The height of the bot was decided based on the wheels dimension (65mm diameter) and dimensions of the servo motor (50.4 x 37.2 x 20 mm).

The size of ultrasonic sensor 45 mm x 20 mm was chosen by keeping in mind that, when the signal transmitter transmits the signal, it gets received by the receiver.

Weight Calculations:

Thrust of each edf = 2.24kg (22.2V)

Net Thrust = 4.48kg

Coefficient of friction = 0.5

Maximum weight of the bot = 0.5 x 4.48 = 2.24kg

Current Weight of the bot = 1.6kg

Maximum Permissible payload = 2.24 – 1.6 = 0.64kg (The payload is subjected to change depending on the type of wall as the coefficient of friction shall also change)

4. Detailed design

- **Electronics:**

  In the electronics part, much of the focus was given to the power supply being provided to the entire bot. For EDFs to run at their maximum speed, we required a 24 V and a 150 A power source (one EDF required about 65 A of current). Considering the high demand for discharging current batteries we initially used two Lithium Polymer batteries of specifications as: -

  i. 4s Lithium Polymer battery of 4500mAh capacity, 35C.
  ii. 2s Lithium Polymer battery of 5200mAh capacity, 35C.

But as the capacity of these batteries was quite low from the perspective of experimenting with our bots for a longer duration of time, we used an alternate Lithium-Ion battery of 24V and 20Ah capacity. This satisfied our constraint of providing appropriate power to the EDF.

EDFs of 2100K rpm were used to provide the appropriate suction to the wall. At 2100K rpm, the EDFs were able to provide a normal thrust of 4.4N.

- **Software Aspect:**

  The code for the project could be accessed from the GitHub link: - https://github.com/Prashun123/Slope-Wall-Painting-Bot

  The structure of the code is: -

  a) Code for operating EDF's: -
     Functions for EDF's: -
     i) Calibrate – This function runs as a first-time setup for EDF's. Here the speed of EDF is set to the minimum speed at which it could run, then this speed is set as '0' and again the speed is set to the minimum speed of the bot. After this, the code goes for the control function.
     ii) Manual – This code is for controlling the speed of the bot entirely manually.
     iii) Control – As the name suggests this function could increase or decrease the speed of the bot by some rate from our commands.

  b) Code for movement of the bot - By controlling the duty cycle of the servo motor, we could control the direction of rotation of servo motors.

  c) Distance from obstacles – By using the ultrasonic sensors we are finding the relative distance of the bot from the object.

- **Mechanical Aspects**
  - **3D View:**

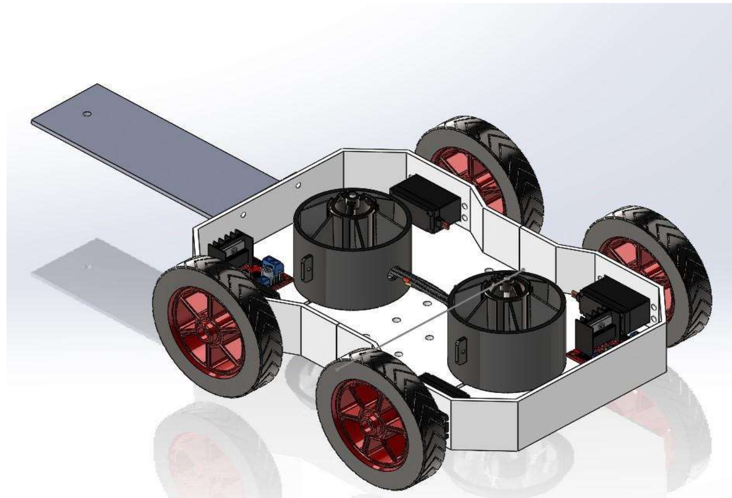

Fig.4.7. 3D view of bot

- **Orthographic Projection:**

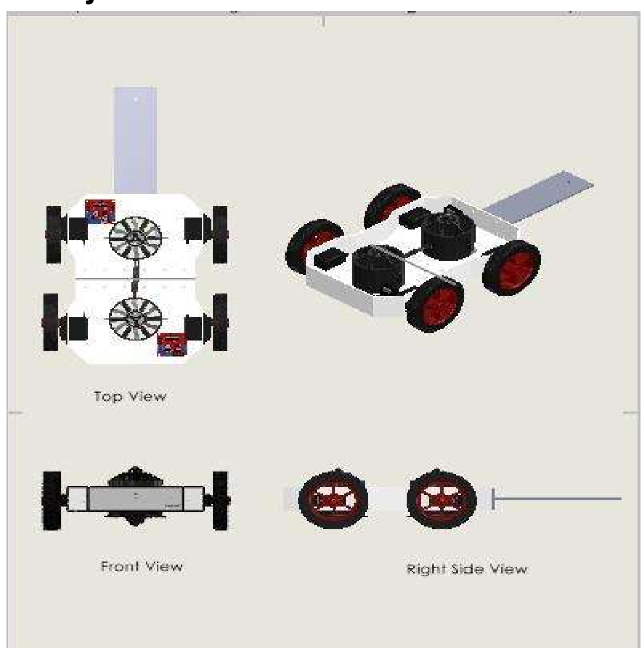

Fig.4.8. Orthographic projection of bot.

5. Results and Discussion

1) The overall weight of the bot is 1.85kg.
2) The design of the bot is kept compact as much as possible without compromising the features.
3) The spray bottle was chosen considering the weight of paint the bot could handle while sticking to the wall.
4) Wheels insured appropriate grip on the wall while maintaining the smooth movement.
5) Light Weight and powerful EDF's are chosen to meet both the requirements i.e., minimum weight and higher thrust.
6) The bot is successfully designed and fabricated under the budget.

Chapter 5

Fabrication and Assembly

After making a well-versed plan, we moved towards the final part of your journey. Fabrication and Assembly. It was the most fun part. We enjoyed it a lot. Debugging during this period was indeed tedious and stressful, and pushed us to our edge. We learned a lot during this phase of our project. We have got to know how something in the software looks completely different in hardware or when we deal with it in real life. This chapter describes the final phase of our project and the report. We present the bill of materials, drawings, material description, manufacturing process, assembly and integration, limitations and challenges, and plan, and finally end with our contributions as individuals followed by a conclusion.

1. Bill of Materials (BOM)

S.No.	Item	Quantity	Price(in Rs.)
1	EDFs – 70mm	2	9168
2	ESCs – 80Amps	2	4700
3	RPi 4B*	1	-
4	360 Servo Motors*	4	-
5	High Grip Wheels	4	310
6	Power Distribution Board	1	230
7	Buck Converter	1	104
8	4s LiPo Battery*	1	-
9	2s LiPo Battery	1	2799
10	Spray	1	50
11	Spray Paint	1	500
12	PLA for Chassis	1 rim	989
13	Camera	1	465

14	DC Motor	1	180
15	Wires	1 pack of each type jumper wires	199
16	Ultrasonic Sensor	1	247
	Total		19,476

*Personal items

Table1: Bill of Materials

2. Mechanical Drawings:

- **Chassis:**
  - **Material:** PLA
  - **Manufacturing Process:** 3D Printing (FDM)
  - **Drawing:**

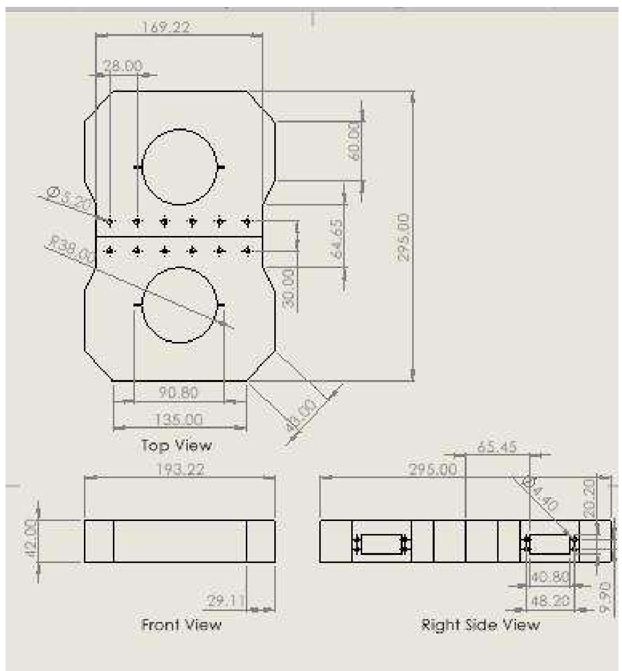

Fig.5.1. Mechanical Drawings of Chassis

- **L-Brackets:**
  - **Material:** PLA
  - **Manufacturing Process:** 3D printing (FDM)
  - **Drawing:**

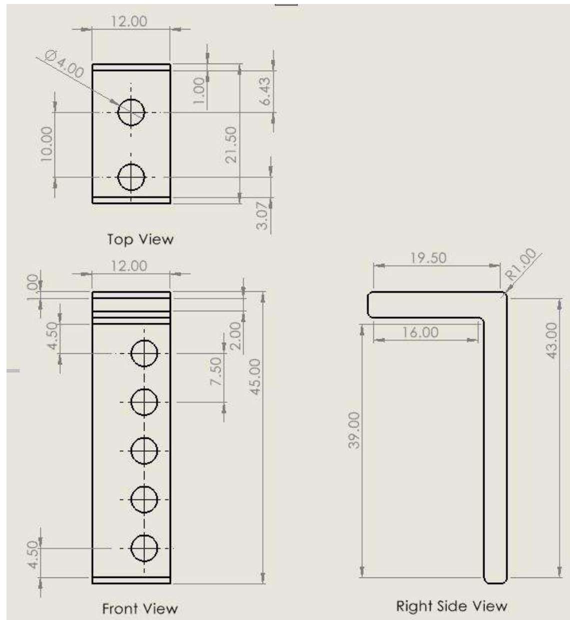

Fig.5.2. Mechanical Drawing of L-Brackets

- **Paint Module:**
  - **Material:** Acrylic
  - **Manufacturing Process:** Laser Cutting
  - **Drawing:**

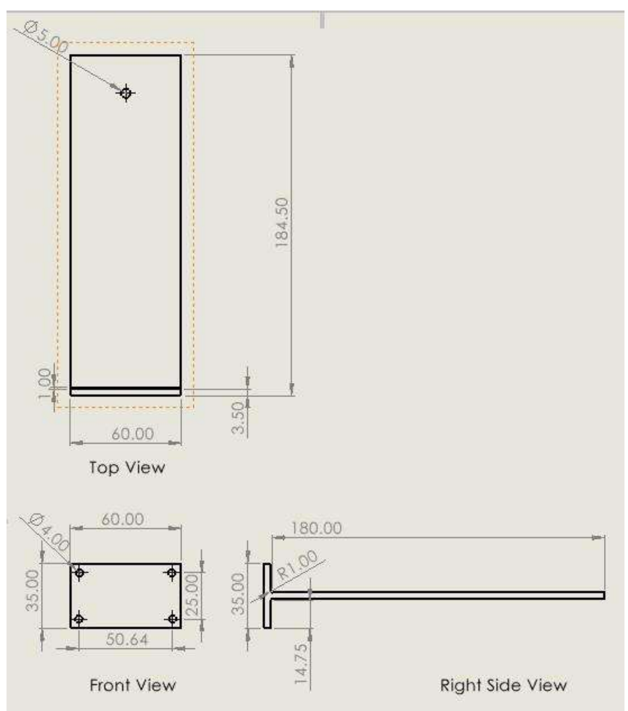

Fig.5.3. Mechanical Drawings of Paint module

3. Manufacturing Process description:

Since our car moves on walls, it has to be lightweight, so we can't use any metals, ceramics, or materials that would be heavy. This ruled out all the major manufacturing processes. We decided to use PLA as it would be light weight, just perfect for the chassis and acrylic sheet for the paint holder.

We used the following manufacturing process:

- **3D Printing (FDM)**: It is a type of additive manufacturing process. We used FDM type of 3D printing for manufacturing our chassis. We provided with a very high infill to increase its strength so that it wouldn't break by the force applied by the edfs. We used this method mainly due to 2 reasons, the 1st one being that it is an easy method and secondly it was a good option to manufacture for light weight chassis as our material was PLA. The Chassis was fabricated in 2 halves
  We also 3D printed our L-brackets because, again, using the metal ones would make it heavy. We had to 3D print them several times as they would just break. We had to try 3D printing them with different thicknesses to get the perfect one. It took a couple of trials, but we succeeded in making one that was stable, strong, and could hold efds in their position.
- **Laser Cutting**: It is a technology that uses laser to vaporize material, resulting in cut edges. This method was used to manufacture the spray paint holder as the one we tried to make by 3D printing was not stable enough.

4. Assembly

After the fabrication and testing of each individual electronic and mechanical part, we begin with the integration and assembly of our product. We went on to assemble the product in the following steps:

- First, we started by joining the 2 parts of the chassis using an adhesive and reinforcing it by using a butt joint.
- After that we installed the edfs in the chassis and held them in place by using L-brackets.
- Then we installed the servos in the chassis.
- After this we completed the power distribution circuit by soldering the ESCs and buck converters in the power distribution board.
- Then we mounted the RPi, power distribution circuit and buck converters on chassis and connected the ESCs with the EDFs.
- We then mounted the camera on chassis.
- As the EDFs were rated 22.2V and we required maximum thrust, we connected a 2S and 1 4S battery in series to obtain 6S and which was in turn connected to the power distribution circuit to power the bot. The battery circuit was kept on the ground.

- Then we made all the connections and tested the circuit and our code.

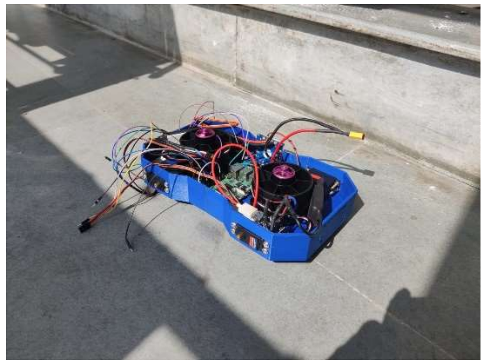

Fig.5.4. Prefinal – Assemble bot

- After this we started assembling the painting module.
- We installed the motor and spray paint on the holder made by laser cutting.
- This module was then mounted on the main chassis.
- Next, we connected the module to main circuit and once again tested the circuit and the code.
- We then finally mounted the wheels on the motors and tested it on the wall.
- It didn't work, it was not staying on the wall. Then we did some debugging, had some brainstorming sessions and looked for the problem. We made a rubber padding at the ends of the edfs to reduce the clearance between them and the wall and then also changed the tires.
- After a lot of debugging and above changes it finally worked the night before the presentation. Our project was a success, though it was a bit unstable it was able to achieve its objective.

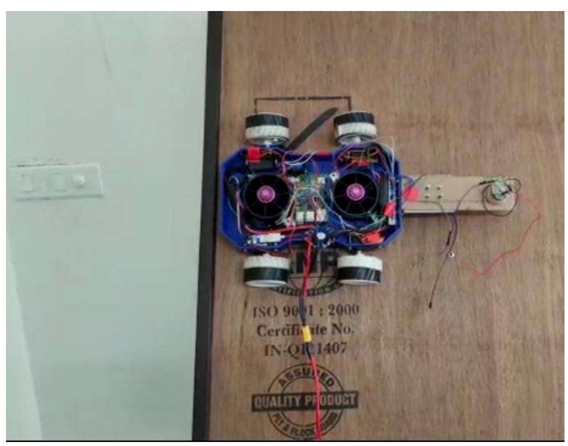

Fig.5.5. Final Bot (On wooden plank kept perpendicular to floor(along the wall))

5. **Limitations and Challenges**

- **Limitations:**
  - 3D printed chassis is not strong enough

- The circuit is exposed to environment and prone to damage
- The exposed circuit doesn't make it aesthetic
- Make a lot of noise
- Improper airflow
- Bit unstable
- 3D printers not working properly

- **Challenges:**
  - Figuring the best EDF for adequate thrust
  - Power supply
  - Designing and fabricating the chassis for minimizing the weight
  - Precise power distribution circuit
  - Wheel mounts
  - Designing a lightweight paint module

6. Scheduling plan:

In this section, we present the actual timeline that was decided for the project. The project, according to the actual deadline and plan, could have been completed within 45-60 days.

Fig.5.6. Scheduling Plan

7. Contribution

Here we present the contribution of each member towards the project:

- Harish – Dairy and ideas
- Prashant – Soldering
- Abhay – Spray Module Design, Report
- Goutham – Poster and assembly
- Prashun – Electrical Connection, Power & Report
- Shashwat Gupta (Leader) – Ideas, Components, Mechanical Design and Manufacturing, Proposal Report & Final Report

Conclusions

In this work, we present a project that can easily navigate on walls and perform tasks like painting, inspection, and maintenance autonomously. It uses impeller technology, a high torque motor, high traction wheels to move on the walls, and a camera and ultrasonic sensors to navigate and provide live feed while moving on the wall. Furthermore, we propose that with further research work it can be made highly scalable and the cost can be reduced. We also propose to use dampers for noise and vibration reduction to make the bot more stable. During the coursework, we learned a lot of things, and it was an excellent experience. We got to learn about various innovative ideas and products already existing in the market and got an opportunity to work on a project that can further become a startup. Our tests on the final day demonstrated that we were able to achieve the objective to a very high extent.

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