SMART SOLAR AGV FOR AGRICULTURAL FIELD USING IOT

ME19811 PROJECT PHASE-II THESIS

Submitted by

BRIJESH M (2116191101026)

AVINASH B (2116191101020)

CHANDRASEKAR S (2116191101028)

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RAJALAKSHMI ENGINEERING COLLEGE

(an Autonomous Institution Affiliated to Anna University Chennai)

BONAFIDE CERTIFICATE

Certified that this Phase –II Thesis titled **"SMART SOLAR AGV FOR AGRICULTURAL FIELD USING IOT"** is the Bonafide work of **BRIJESH M (2116191101026), AVINASH B (2116191101020), CHANDRASEKAR S (2116191101028)** who carried out the work under my supervision. Certified further that to the best of my knowledge the work reported here in does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

Dr. S.P. Srinivasan	**Dr.S.Senthil Murugan**
Professor and Head	Assistant Professor (SG)
Department of Mechanical Engineering	Department of Mechanical Engineering
Rajalakshmi Engineering College	Rajalakshmi Engineering College
Chennai- 602 105	Chennai- 602 105

Certified that the candidate was examined in the "**VIVA-VOCE**" Examination held on ………………

INTERNAL EXAMINER **EXTERNAL EXAMINER**

ME19811 PROJECT PHASE-II THESIS

DEPARTMENT VISION

To provide a world class education in mechanical engineering through innovation, excellence in teaching and research

DEPARTMENT MISSION

M1. To impart high quality technical education and prepare Mechanical Engineers with all round knowledge of multi-disciplinary branches of Engineering and Technology.

M2. To foster skill sets required to be a global professional for industry, research and technology management.

M3. To provide consultancy to the neighbourhood industries. M4. To cultivate the spirit of entrepreneurship

PROGRAMME EDUCATIONAL OBJECTIVES

PEO I

To provide students with a sound foundation in the mathematical, scientific and engineering fundamentals necessary to formulate, analyze and solve engineering problems and to prepare them for graduate studies and for successful careers in industry.

PEO II

To impart students with skills for design, improvement and installation of Mechanical and allied integrated systems of men and material

PEO III

To educate the students on designing the modern mechanical systems and expose them to industrial practices for better employability and adaptability.

PEO IV

To install the values, skills, leadership and team spirit for comprehensive and wholesome personality, to promote entrepreneurial interest among students and to create a fervor for use of Engineering in addressing societal concerns.

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyse 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 modelling too complex engineering activities with and 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 environment

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.

PROGRAM SPECIFIC OUTCOMES (PSOs)

1. To innovate a Mechanical System which meets the desired specifications and requirements using CAE tools.
2. To explore alternate materials for automobile, manufacturing and process industries
3. To lead a professional career in industries or an entrepreneur by applying Engineering and Management principles and practices.

COURSE OBJECTIVES

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students in preparing project reports and to face reviews and viva voce examination.

COURSE OUTCOMES

- On completion the students can able to execute the proposed plan and identify and overcome the bottlenecks during each stage.
- On Completion of the project work students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.
- Students will obtain a hands-on experience in converting a small novel idea / technique into a working model / prototype involving multi-disciplinary skills and / or knowledge and working in at team.
- Students will be able to interpret the outcome of their project.
- Students will take on the challenges of teamwork, prepare a presentation in a professional manner, and document all aspects of design work.

ABSTRACT

In recent years, there has been a growing demand for sustainable and efficient agricultural practices. To address this need, we have developed an agriculture robot that takes measurements such as pH, moisture, and humidity from the fields and autonomously dispenses water and pesticides according to the measured values. In addition to this, the robot also inputs the measured values to the ThingSpeak website using ESP32, allowing farmers to remotely monitor and analyze the environmental conditions of their fields. The project is based on an Arduino Uno microcontroller and is powered completely by solar energy, making it an independent agricultural AGV project. The use of solar power makes this technology sustainable, cost-effective, and easily deployable in remote areas. Our project aims to address the challenges faced by farmers by developing an agriculture robot that can autonomously measure the pH, moisture, and humidity of the soil and spray water and pesticides accordingly. The robot is equipped with a solar charge controller and soil tilling mechanism that allows it to operate independently, making it ideal for use in remote areas with limited access to power sources. The soil tilling mechanism ensures that the soil is well-aerated and promotes healthy root growth, while the solar charge controller ensures that the robot's battery is always charged and ready for use. This project has the potential to revolutionize agriculture by reducing labor costs, increasing crop yield, and minimizing the use of harmful chemicals, resulting in a more sustainable and efficient farming industry.

Keywords: Agriculture, AGV, Ph sensors, smart agriculture, agribot

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BRIJESH M,

AVINASH B,

CHANDRASEKAR S.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUTION TO AGV:

Automated Guided Vehicle, AGV, is described as an unmanned vehicle used to transport objects. They are autonomous driverless vehicles that follow a planned route using various types of guiding technology such as:

- Magnetic strips
- Marked lines
- Tracks
- Lasers
- A camera (visual guiding)
- GPS

An AGV is powered by a battery and equipped with safety protection aswell as various auxiliary mechanisms Autonomous Guided Vehicles (AGV) for agricultural applications are being developed at a record pace. The labor-saving potential employing these vehicles is huge. These vehicles provide opportunity for automating many agricultural functions including seeding, fertilizing, weeding and harvesting operations. An important key to the successful use of this AGV technology is efficient and positive positioning control of the AGV vehicle and its robotic arm. A mobile robot called an automated guided vehicle (AGV) navigates by following cables or markings on the floor or by using vision, magnets, or lasers. Unmanned mobility's emergence may lead to the development of agricultural vehicles with novel form elements. In particular, a few huge, heavy, and speedy traditional agriculture vehicles may eventually be replaced by vast fleets of small, light, slow agribots. Because autonomous mobility reduces the wage bill overhead per vehicle, these new vehicle form factors are feasible. In this scenario, a small number of people will remotely oversee and manage the operation of a big fleet. In this case, individual units may be less productive than more conventionally powered vehicles like tractors, but the fleet's aggregate output may be higher.

1.2 AUTOMATION IN AGRICULTURE

The agricultural industry is labor-intensive and strongly dependent on human labor. Surprisingly, there is a growing trend towards highly automated agriculture in nations where there is a shortage of labor, hiring agricultural labors is expensive, and agricultural productivity is highest. Not only is automation necessary for the entire process of growing plants, but it is also necessary for the transportation and storage of agricultural products. Every application of technological automation contains elements of mechatronics. Mechatronics operations in agriculture include harvesting, maintaining the land and water systems, and monitoring crops, plants, and animals.
Automation in agriculture involves the use of various technologies and machinery to automate tasks traditionally performed by humans. It includes a wide range of technologies, from simple tools like automated irrigation systems to more advanced systems like self-driving tractors and drones. One of the primary goals of automation in agriculture is to increase efficiency and productivity while reducing costs.
Automated systems can perform tasks much faster and with greater precision than humans, leading to higher crop yields and reduced waste.

1.3 PESTICIDE FOR AGRICULTURE

A pesticide is any substance used to kill, repel, or control certain forms of plant or animal life that are considered to be pests. Pesticides include herbicides for destroying weeds and other unwanted vegetation, insecticides for controlling a wide variety of insects, fungicides used to prevent the growth of molds and mildew, disinfectants for preventing the spread of bacteria, and compounds used to control mice and rats. As per many researches and surveys conducted the nearly 45-50 percentages of the crops are damaged due to overuse of the pesticides by humans which may also make the agricultural soil more infertile. In the present study alpha-cypermethrin (46%) was the most commonly used pesticide followed by methyl parathion (25.6%), imidacloprid (16.4%), dichlorvos (7.8%) and phorate (4.2%). In this project the amount of pesticide sprayed will be monitored properly by Ph sensors and by timely management using automation hence by preventing the above said problem in agriculture.

1.4 NEED FOR IOT IN AGRICULTURE

In agriculture, technology use is at previously unheard-of levels. There are numerous innovative agricultural technologies that appear to hold great promise for the industry's future. The applications of the Internet of Things in agriculture target conventional farming operations to meet the increasing demands and decrease production losses. IoT in agriculture uses robots, drones, remote sensors, and computer imaging combined with continuously progressing machine learning and analytical tools for monitoring crops, surveying, and mapping the fields, and providing data to farmers for rational farm management plans to save both time and money. Agriculture through precision farming implements IoT through the use of robots, drones, sensors, and computer imaging integrated with analytical tools for getting insights and monitoring the farms. Placement of physical equipment on farms monitors and records data, which is then used to get valuable insights. The Internet of Things (IoT) is a network of interconnected physical devices that are embedded with sensors, software, and other technologies that enable them to collect and exchange data. IoT has the potential to revolutionize agriculture by improving efficiency, reducing costs, and increasing yields. In agriculture, IoT devices can be used to monitor soil moisture, temperature, and other environmental conditions, as well as the health and growth of crops and livestock. This data can then be used to optimize farming practices, such as irrigation scheduling, pest management, and fertilizer application.

1.5 DRAWBACKS OF TRADITIONAL METHODS OF AGRICULTURE

It is vital that the health of soil systems is maintained to optimize water usage and crop yield. Traditional farming tends to leech the land of its nutrition over time resulting in soil that is undernourished and eroded. Self-contained farming systems do not have negative impacts like this on the environment. The community of microorganisms living in the soil can be degraded and harmed by the extensive use of pesticides in agricultural production, especially when these chemicals are overused or misused as chemical compounds accumulate in the soil. Many studies have found detrimental effects of pesticides on soil microorganisms and biochemical processes, while others have found that the residue of some pesticides can be broken down and assimilated by microorganisms. The full impact of pesticides on soil microorganisms is still not fully understood. The effect of pesticides on soil microorganisms is impacted by the persistence, concentration, and toxicity of the applied pesticide, in addition to various environmental factors. This complex interaction of factors makes it difficult to draw definitive conclusions about the interaction of pesticides with the soil ecosystem.

1.6 TYPES OF AGV'S

- Automated Guided Carts
- Forklift AGV
- Towing AGV
- Unit Load Handlers
- Heavy burden Carriers
- Autonomous Mobile Robot AGV

1.6.1 Forklift AGV

Fork vehicles, or forklift automatic guided vehicles, are another commonly used type of AGV. They're designed to perform the same functions a human- operated forklift performs (transporting pallets), but without the need for a humanoperator. (As shown in Fig1.1)

Figure 1.1 Forklift AGV

1.6.2 Towing AGVs

Towing vehicles, or tugger automatic guided vehicles, pull one or more non-powered, load-carrying vehicles behind them in a train-like formation. Sometimes called driverless trains, powered towing vehicles travel on wheels. Tugger automatic guided vehicles are often used for transporting heavy loads over longer distances. They may have several drop-off and pick-up stops along adefined path through a warehouse or factory. (As shown in Fig 1.2)

Figure 1.2 Towing AGV

1.6.3 Unit Load AGVs

Unit Load AGVs, also known as Unit Load Decks, date back to the earliest iterations of AGVs. These robots are portable and autonomous cargo delivery systems that are able to travel around a warehouse or facilities performing different AGV navigation technologies. (As shown in Fig 1 . 3)Some AGV types tug goods while others pull or carry them

Figure 1.3 Unit Load AGV

1.6.4 Heavy Burden Carrier AGV

Heavy Burden Carriers AGV, also called as Heavy Burden Carrier Vehicles and Heavy Large-Platform Bidirectional Driving Knapsack AGV, (As shown in Fig 1.4) this automatic guided cart can be supplied with self-loading capabilities aswell as standard, pivot and omni-directional steering.

Figure 1.4 Heavy Burden Carrier AGV

1.6.5 Autonomous Mobile Robots AGV

Autonomous mobile robots (AMRs) are typically more technologically advanced than other types of AGVs. While many AGVs use fixed navigation systems, such as wires or magnetic tape, many AMRs are equipped with intelligent navigation capabilities such as sensors and camera systems that enable them to detect and navigate around obstacles. Thanks to more sophisticated technology, AMRs can dynamically navigate a warehouse or other facility and plan the most efficient paths.

Figure 1.5 Autonomous Mobile Robot AGV

1.7 THING SPEAK

ThingSpeak is an open-source Internet of Things (IoT) platform that allows users to collect, analyse, and act on data from sensors or other devices. It was created by MathWorks, a software company that specializes in mathematical computing. ThingSpeak provides a cloud-based infrastructure for IoT applications and supports various communication protocols such as HTTP, MQTT, and TCP/IP. Users can connect their devices to ThingSpeak using different hardware platforms such as Arduino, Raspberry Pi, and ESP8266.

Once the devices are connected, users can log and visualize data in real-time using customizable graphs and charts. They can also set up alerts to be notified when certain conditions are met. ThingSpeak supports integration with third-party services such as MATLAB, IFTTT, and Twilio, allowing for more advanced data analysis and automation. ThingSpeak is free to use for personal and non-commercial projects, with some limitations on the number of channels and data points. For commercial projects or larger-scale applications, paid plans with additional features and capacity are available.

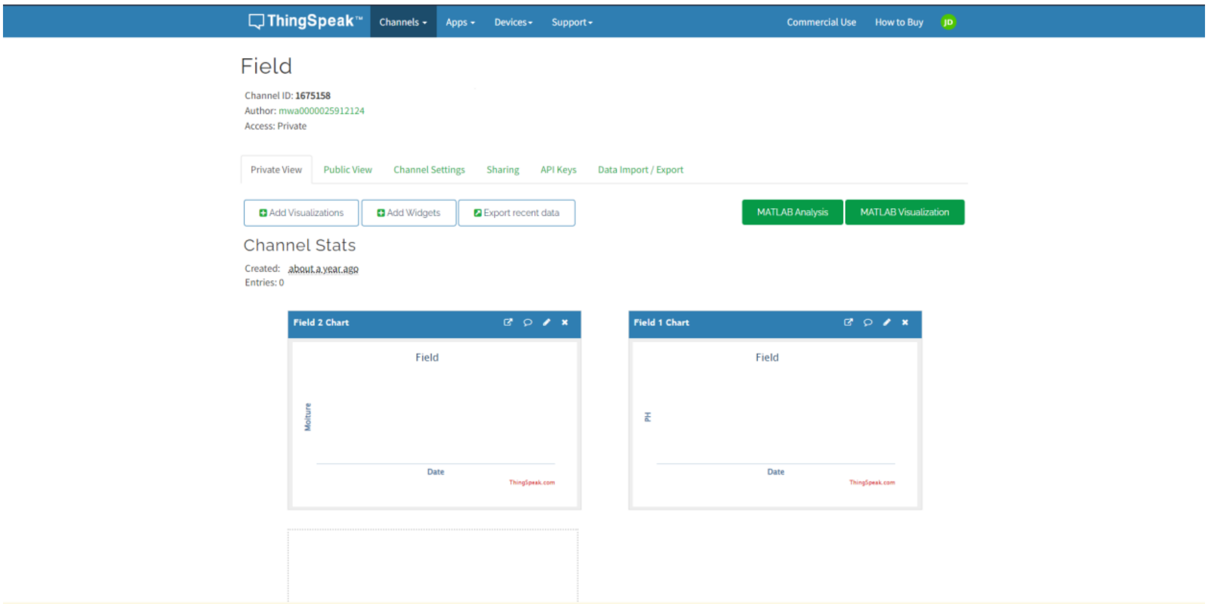


Figure 1.6 Thingspeak Website

CHAPTER 2

LITERATURE REVIEW

2.1 LITERATURE SURVEY

- **Philippe Martinet et al., (2020),** developed a guidance system for agricultural vehicles which helps the operator to use the machine for agricultural applications carefully. Machines like lawn mowing, cultivation, seeding, fertilization are used generally for agriculture. The aim of this study is to identify the areas which are not mowed, and which are mowed by the equipment with the help of video camera sensors, ultrasonic sensors, laser telemeter sensor. For the detection, an image segmentation is used in which two parameters of texture and two parameters for histograms are used. The lawn mower is guided to detect the cut and uncut crops with the help of vision sensors. The Guerin Courde lawn mower is used for application. The machine consists of two steerable wheels and two driven wheels. Certain assumptions are presumed like there are no flexible parts, the vehicle moves on plain surface and there are no translational slips between wheels and surface. Two VME microprocessor boards are used for vison system and image processing. The study has developed a guidance system that assists the operators in complicated and fatigue tasks in agricultural applications.

- **Fredrik Engström, Rasmus Andersson et al.,(2018) ,**they worked on the autonomous technology which is becoming more advanced, available and affordable than everbefore, new demands are created. The industry calls for innovative material handling automated guided vehicles to meet the requirements. These vehicles willincrease the owner's profit by being more efficient in terms of time, size and cost. A generic product development process is utilized. The concepts are compared with each other and the initial specification to assess the most suitable lifting mechanism. The single acting hydraulic system,including a Micro Power Pack and four small hydraulic cylinders, is considered the best suitable choice for an ultra-compact material handling automated guided vehicle.

- **Saira Latif et al.,(2021),**the focus of this thesis is to advance the existing autonomy level in agricultural vehicles for field operations. This is done by investigating current challenges and opportunities with agricultural vehicular automation and potential improvement for one of the field operations. Bales collection operation is one of the riskiest operations and taken as one case with potential for improvement with automation. Study of path planning approaches for bales collection operation in typical fields environment shows that optimized solution with concept autonomous articulated vehicle with neighborhood collection capabilities (ANV), can reduce working distance by 15-20% for this task. To further, a new approach of pure pursuit algorithm with increased reduction in tracking errors of an articulated vehicle is developed and evaluated.

- **Er.R. D. Dhete et al.,(2015),**in India about 73% of the population is directly or indirectly dependent upon farming. Hence it is said that India is an agriculturally based country. But till now our farmers are doing farming in the same traditional ways. Farmers are doing seed sowing, fertilizers and pesticides spraying, cultivating by conventional methods. There is need for development in this sector and most commonly on fertilizers pesticides spraying technique, because it requires more effort and time to spray by traditional way. One of the more common forms of pesticide application, especially in conventional agriculture, is the use of mechanical sprayer. Hand-operated hydraulic pump that forces liquid pesticide through a hose and one or more nozzles. Pump is usually activated by moving a lever. It consists of a tank, a pump, a lance (for single nozzles) or boom, and a nozzle (or multiple nozzles). Sprayer convert a pesticide formulation, often containing a mixture of water (or another liquid chemical carrier, such as fertilizer) and chemical, into droplets, which can be large rain-type drops or tiny almost-invisible particles.

- **Rahul Warghane et al., (2021),**this paper shows how researchers have focused on the implementation of Automated Guided Vehicle in farm applications. Automated guided vehicle used in farm applications, interfacing of devices and agricultural spraying. The AGV is planned to operate within the agricultural fields as per the input given by the operator. As with the leading population day-by-day, the demand for the agricultural products are increasing subsequently; but with the current technology it will be difficult to meet the requirements. In order to achieve the desired inputs, technological advancements must be made in the field.

- **Manali Pohare, Ashok Shinde and Prashant Borkar et al.,(Jan 2015),**AGV which follows a given path on a flat surface with the help of two dc motors and one freewheel. Camera is interfaced with PC for image acquisition and processing is done with the help of Matlab. Path can be determined by the user with the help of GUI application. RF module is used for communication between PC and microcontroller. Commands can be sent from PC based on location of vehicle. Microcontroller will then move the vehicle forward, left, right and stop.

- **Chandrajeet Charde, Manoj Sheoran, Gaurav Kolhe et al., (March 2015),**the methodology which can maximize the performance of an AGV and the algorithm to avoid obstacles in the way of an AGV and also to find the shortest path to the destination. This methodology not only reduces the cost but increase the efficiency from compared to previously proposed AGV. This increases the working speed of AGV as it will not need to stop its work due to some external obstacles. The usage of Kalman filter and PID to increase the accuracy of AGV. The algorithm is used to find the shortest path by avoiding obstacles to reach destination in minimum time. The directional sensors to get information about current position and destination of AGV. The highly accurate directional sensor will help AGV to easily calculate the position of it at any point**.**

- **Chirag S Matholiya et al., (2022),** vision-based and sensor-based technology has been implemented several decades ago. RTK-DGPS and Radar (lidar) have also been used widely for the automatic guidance system since many years ago. Mostly automated guided vehicles and agricultural robots have been developed in overseas countries that are very costly as per their methodology used and materials procurements and market segmentations.

- **Sørensen et al.,(2018) ,**this literature survey provides an overview of recent developments in agricultural robots, including their applications, design considerations, and challenges. The authors discuss various types of robots used in agriculture, such as drones, ground robots, and autonomous tractors. They also examine the role of sensors and software in enabling precision agriculture and discuss the challenges of developing robots that can operate in complex and variable environments.

- **Mulla et al.,(2017),**this literature survey focuses on the applications of unmanned aerial vehicles (UAVs) in precision agriculture. The authors review the use of UAVs for tasks such as crop mapping, yield estimation, and disease detection. They also examine the challenges of integrating UAVs into agricultural workflows, such as regulatory barriers and technical limitations.

- **Stoll et al., (2017), t**his literature survey focuses on the development of robotic systems for weeding in organic agriculture. The authors review various types of weeding robots, including mechanical and chemical methods, as well as more recent approaches such as vision-based weed detection and targeted spraying.

They also discuss the challenges of developing weeding robots that can effectively distinguish between weeds and crops.

- **Cai et al. (2018),t**his literature survey examines autonomous navigation systems for agricultural robots. The authors review various types of navigation systems, such as GPS and vision-based systems, and discuss their advantages and limitations. They also examine the challenges of developing navigation systems that can operate in complex and dynamic environments, such as uneven terrain and changing weather conditions.

- **Fountas et al. (2020),** this literature survey focuses on the use of robotics and autonomous systems for in-field crop phenotyping. The authors review various types of sensors and platforms used for crop phenotyping, such as LiDAR and hyperspectral imaging. They also discuss the challenges of developing systems that can accurately measure crop traits in the field, such as plant height and biomass. Additionally, the authors examine the potential of machine learning and AI for automated crop phenotyping.

2.2 SUMMARY OF LITERATURE REVIEW

- The summary of this literature reviews is to advance the existing autonomy level in AGV for agricultural for field operations.
- India is known for its agriculture and many farmers are not capable of affording modern machineries and tractors So they are finding many difficulties and requires more time to do that work.
- So we can use Automated guided vehicles for several agriculture purpose
- Overall, these surveys provide a comprehensive overview of the current state of agricultural robots and their applications in agriculture.

- They highlight the challenges and opportunities for agricultural robots and propose potential solutions to overcome these challenges. These surveys are useful for researchers, engineers, and practitioners working in the field of agricultural robotics.

CHAPTER 3

3.1 METHODOLOGY

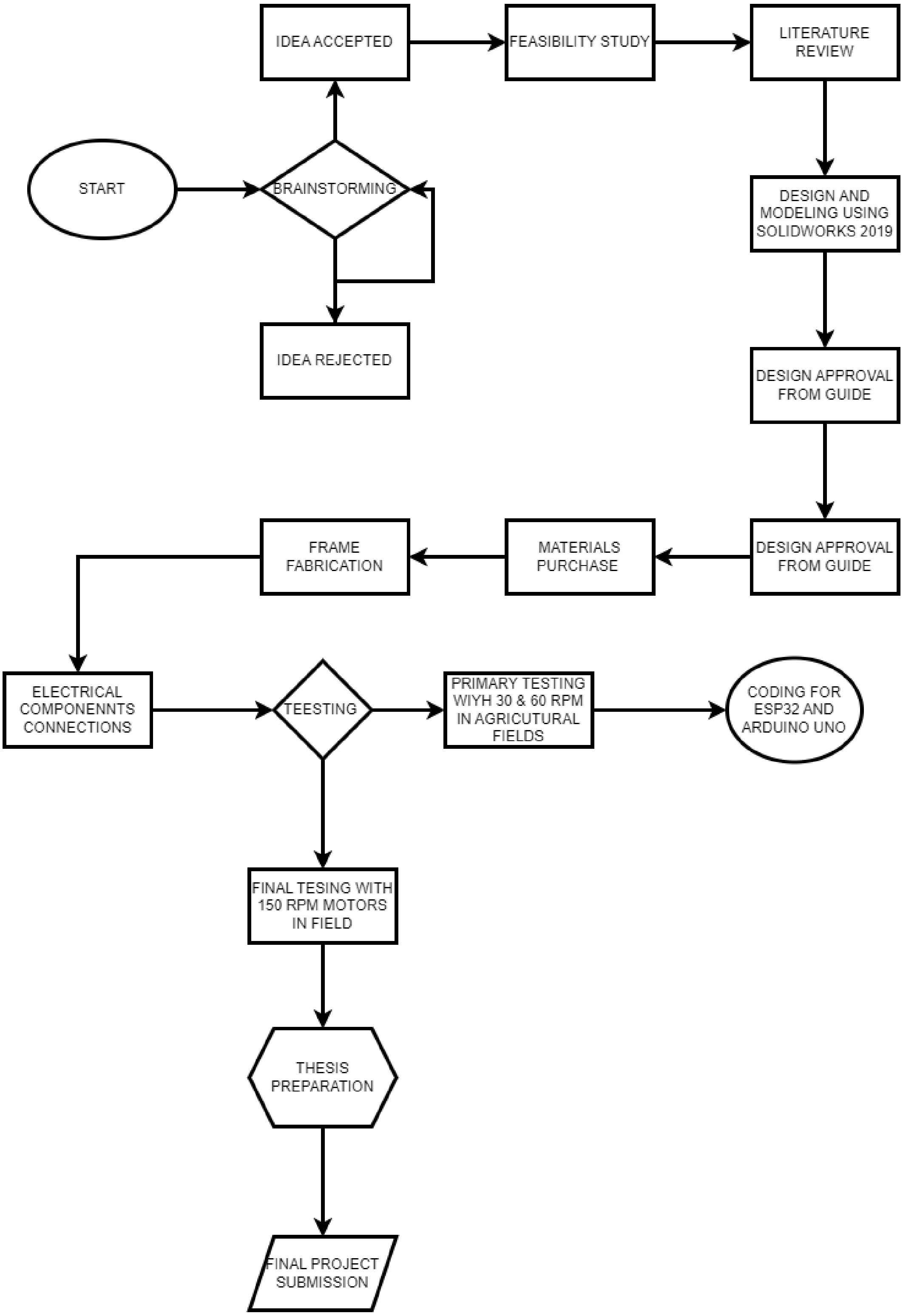


Figure 3.1 Methodology of work

3.2 DESIGN OF THE PROJECT

3.2.1 ISOMETRIC VIEW

The Isometric view of the AGV is shown in figure which has the solar panels placed on the top of the vehicle to power the electronic components along with battery, Arduino uno , ESP 32,water and pesticides tanks and motor drivers.

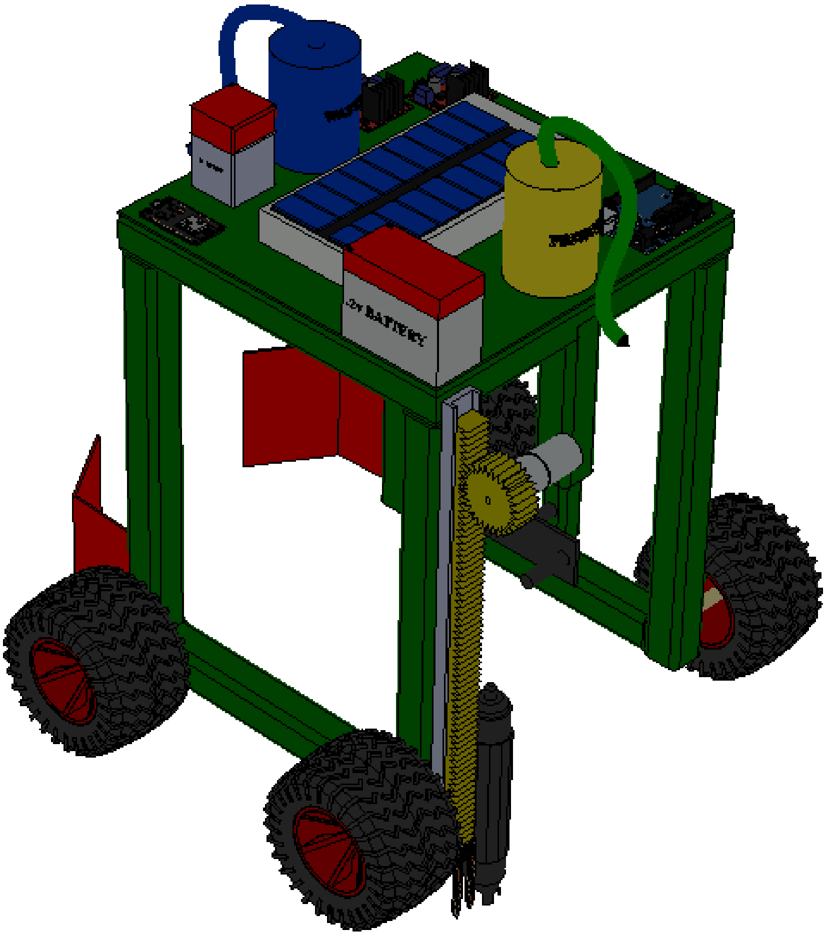


Figure 3.2 Isometric View

3.2.2 TOP VIEW

The figure 4.2 shows the top view of the project with all the components such as solar panel ,ESP 32 , Arduino uno, motor drivers and battery.

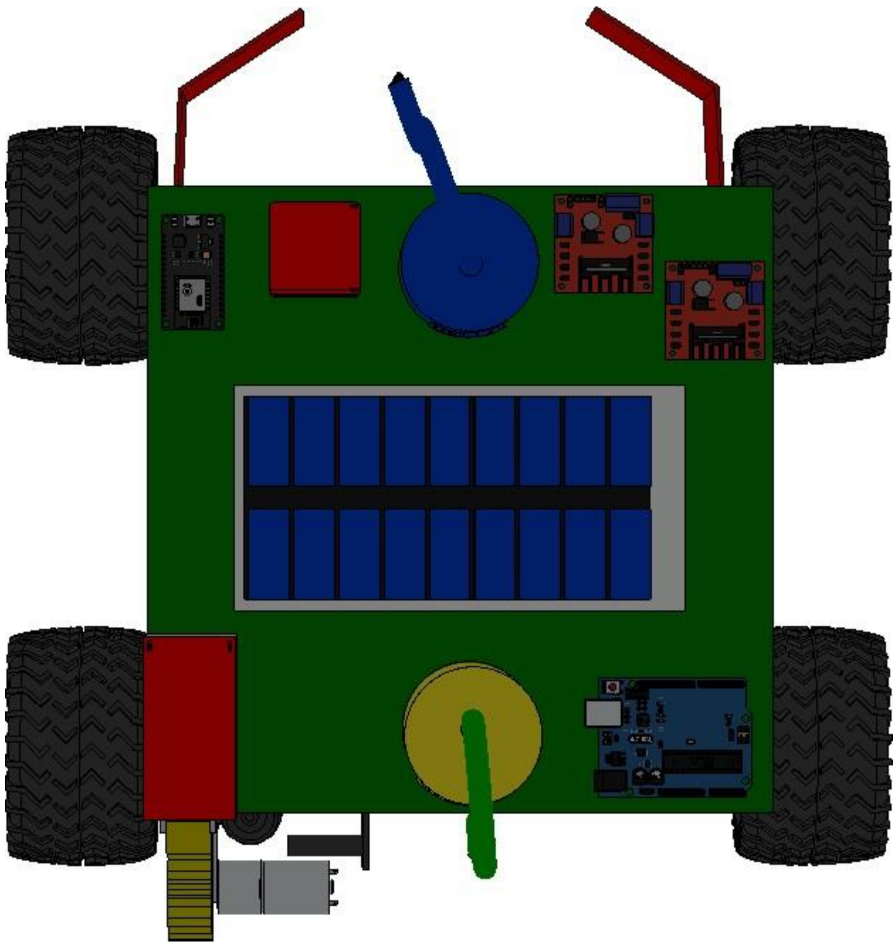


Figure 3.3 Top view

3.2.3 RIGHT VIEW

The right view of the AGV is designed in solidworks and shown in figure. 4.3 with clear view of the rack and pinion and soil closure mechanism.

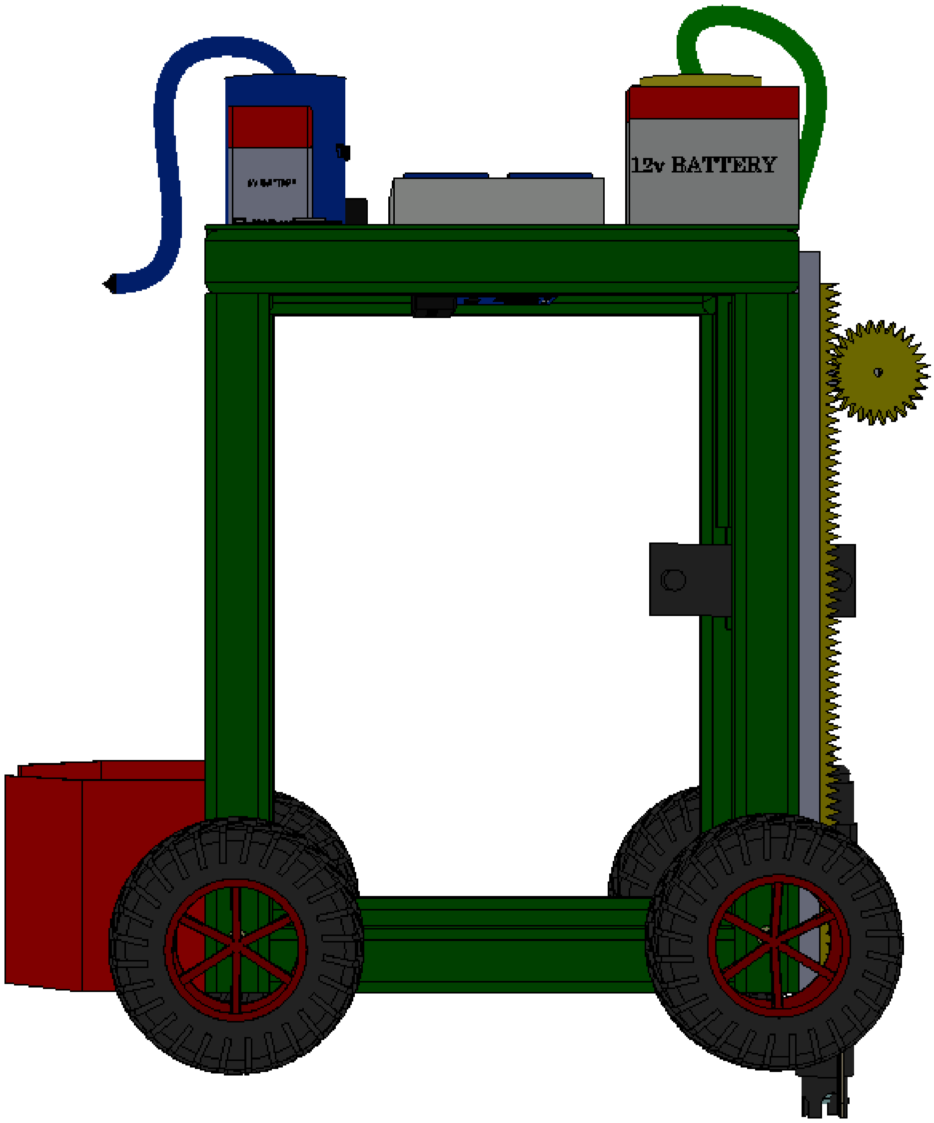


Figure 3.4 Right view

3.2.4 FRONT VIEW

The figure 4.4 shows the front view of the project with the clear view of the rack and pinion mechanism in which the soil PH sensors and Moisture sensor is placed which will be activated by 12v 30 rpm DC motor.

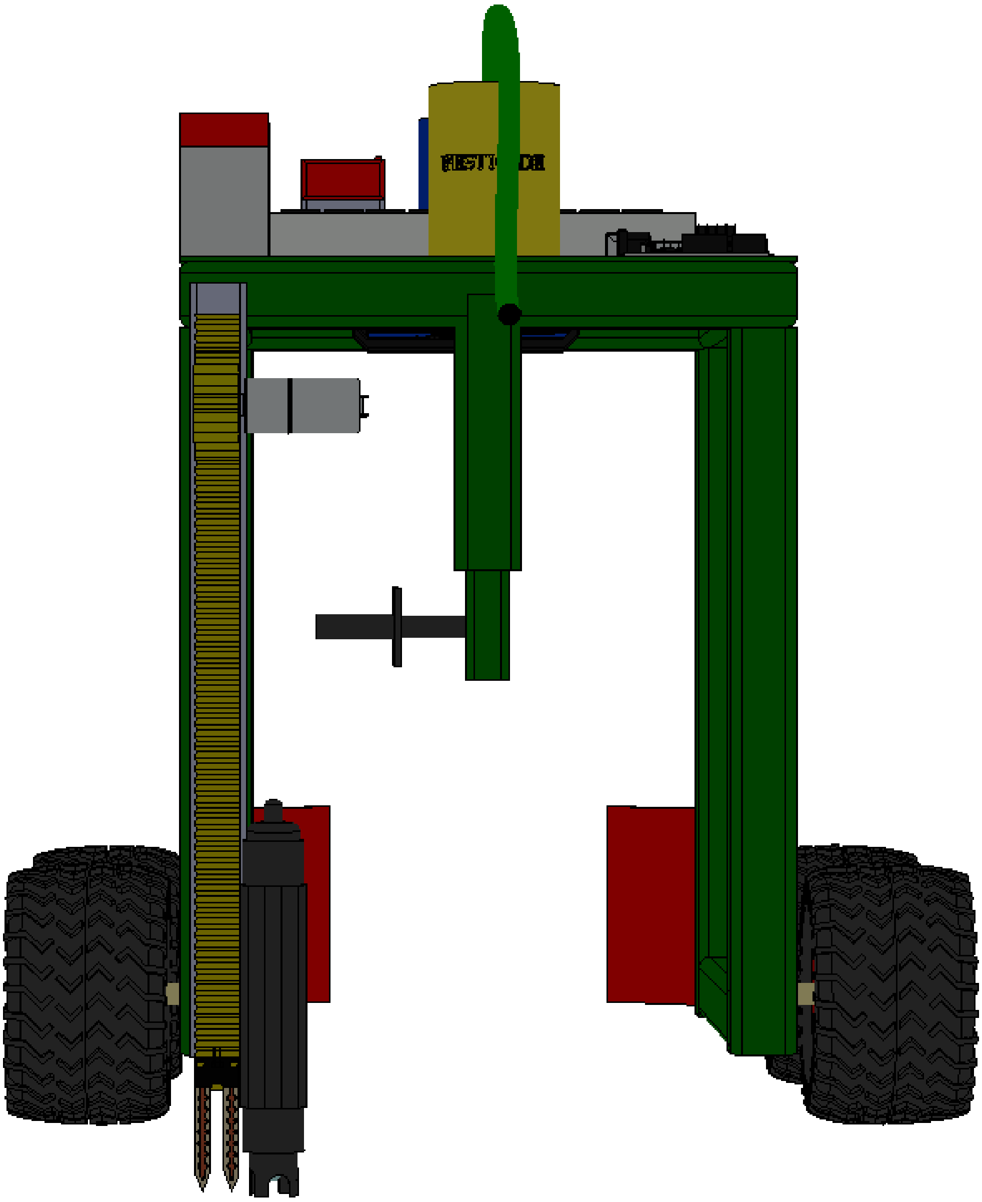


Figure 3.5 Front View

3.2.5 BOTTOM VIEW

Here the bottom view of the project is shown in figure 4.5 with the Solar charge controller placed in the bottom.

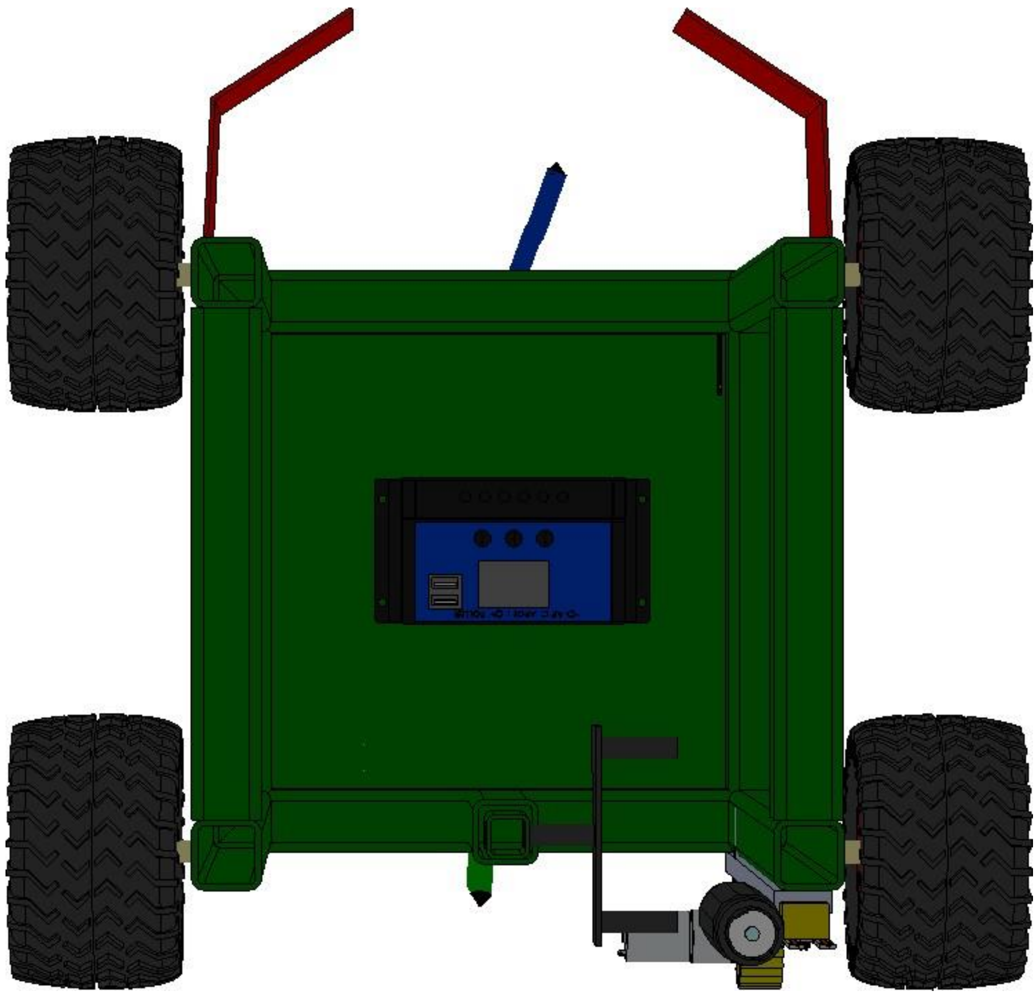


Figure 3.6 Bottom view

3.2.6 OFF ROAD TYRES

Figure 3.7 offroad Tyres

3.2.7 PESTICIDE AND WATER TANK

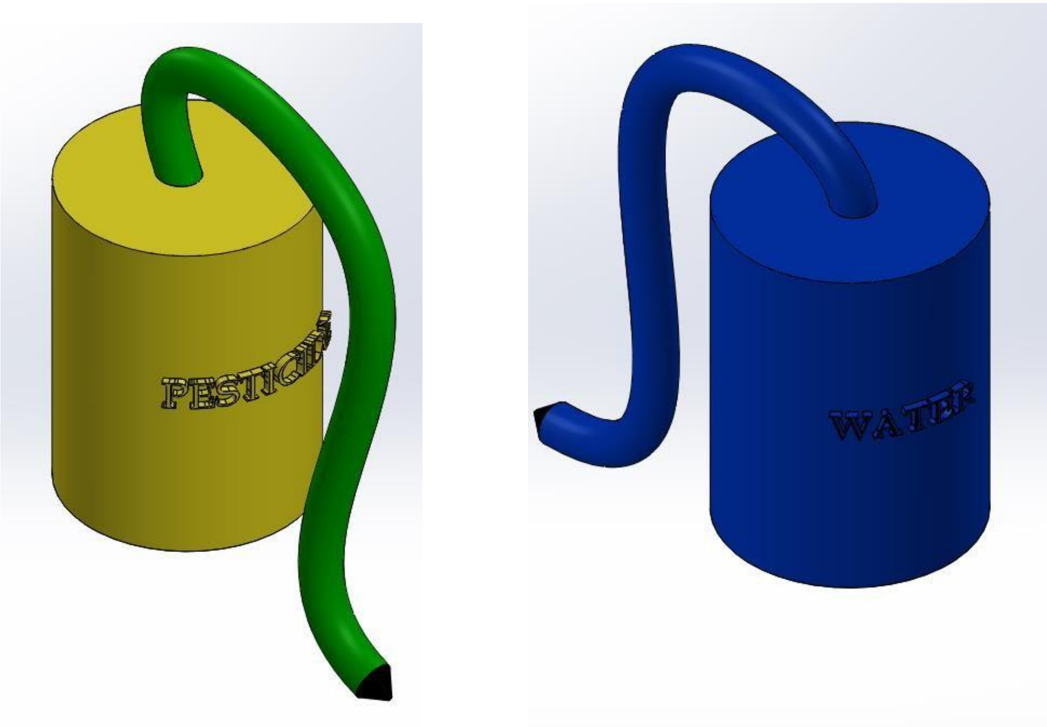


Figure 3.8 Pesticide and Water Tank

3.2.8 DC MOTOR

The figure 4.8 shows 12v 150 r.p.m geared motor which powers all the four off road wheels

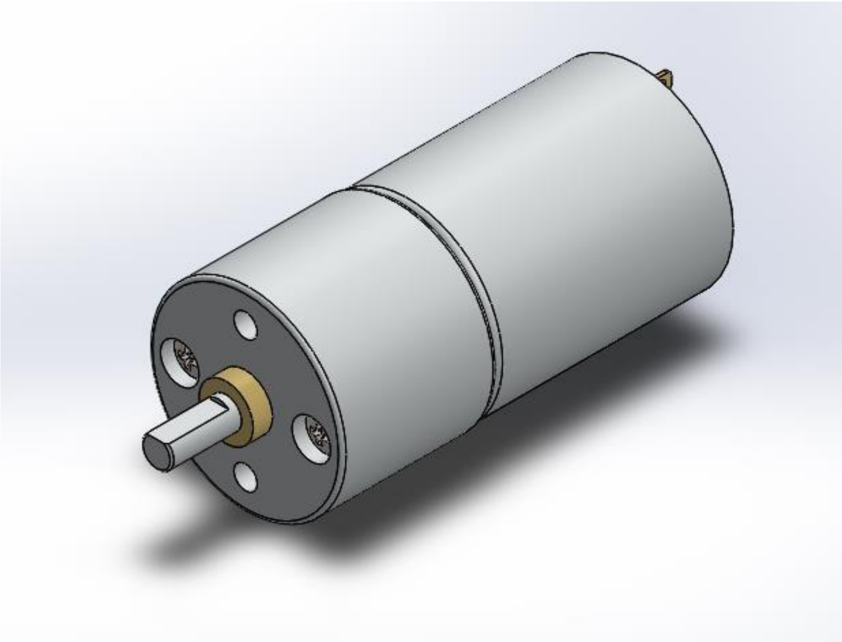


Figure 3.9 Dc Motor

3.2.9 SOLAR PANEL

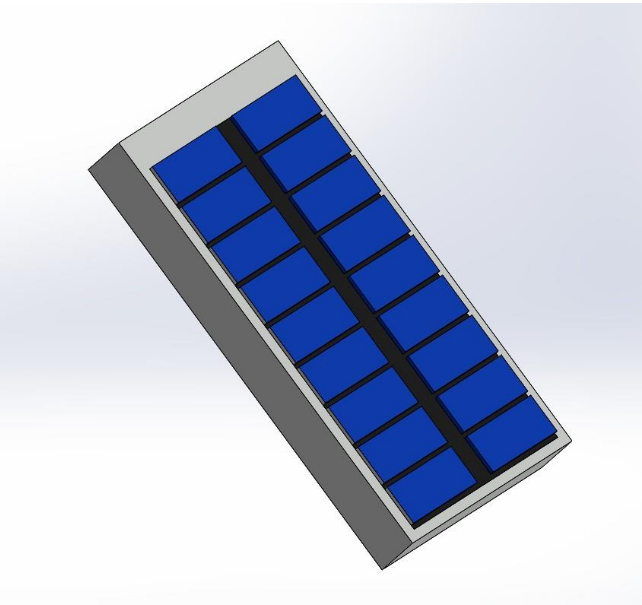


Figure 3.10 Solar Panel

3.2.10 RACK AND PINION

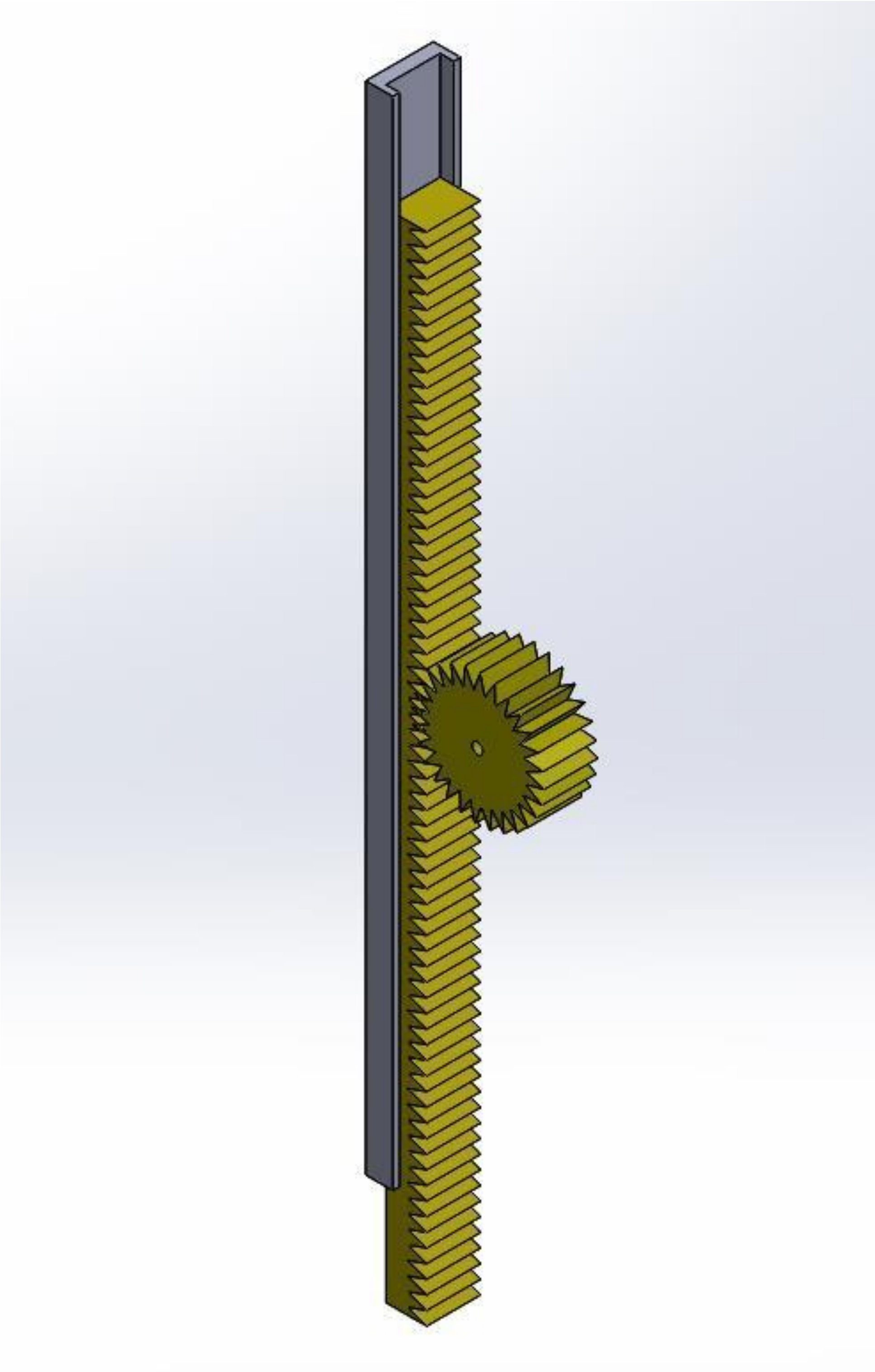


Figure 3.11 Rack and pinion design

3.2.11 DRAFTED IMAGES OF THE PROJECT

2D DRAFTING

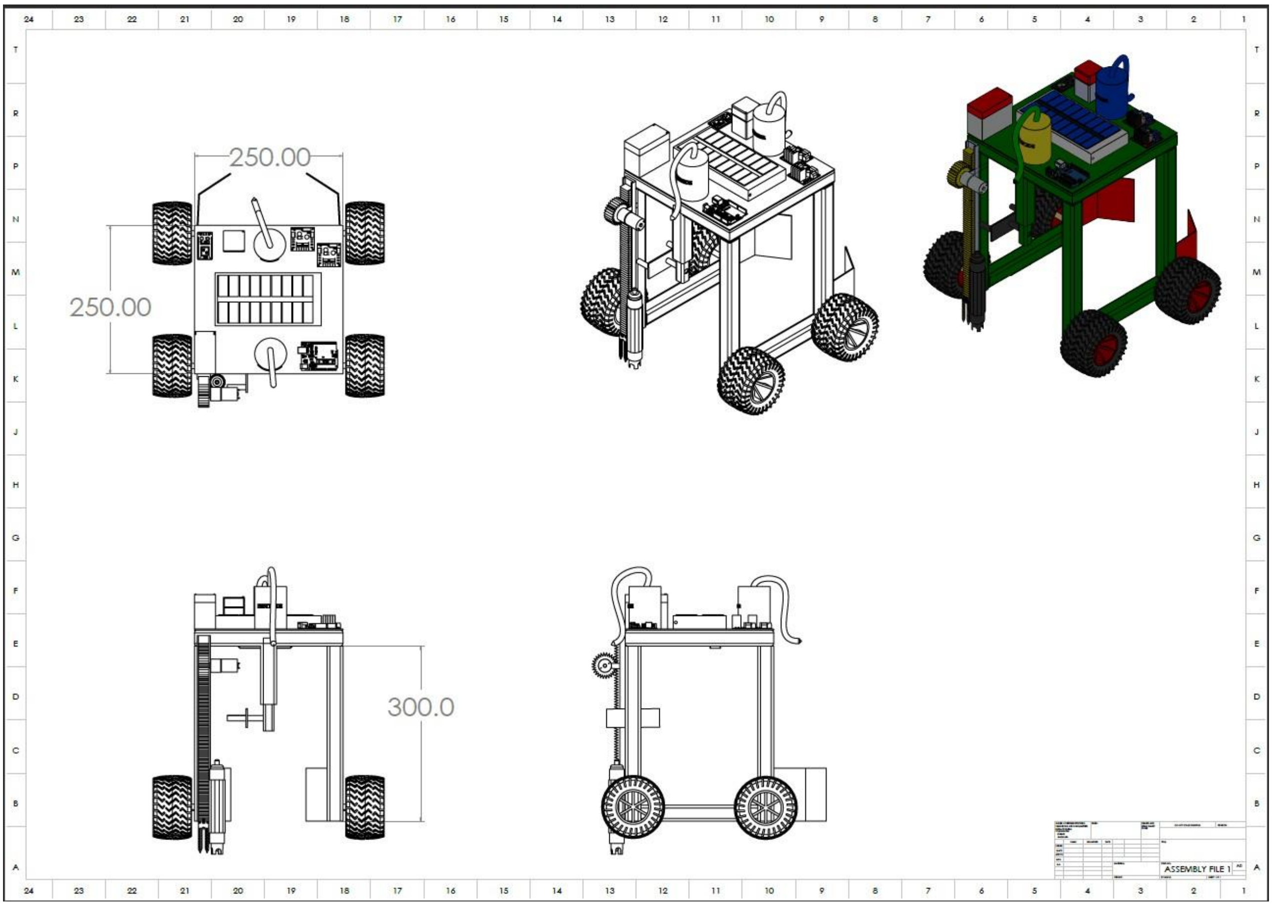


Figure 3.12 2D Drafting of the prototype

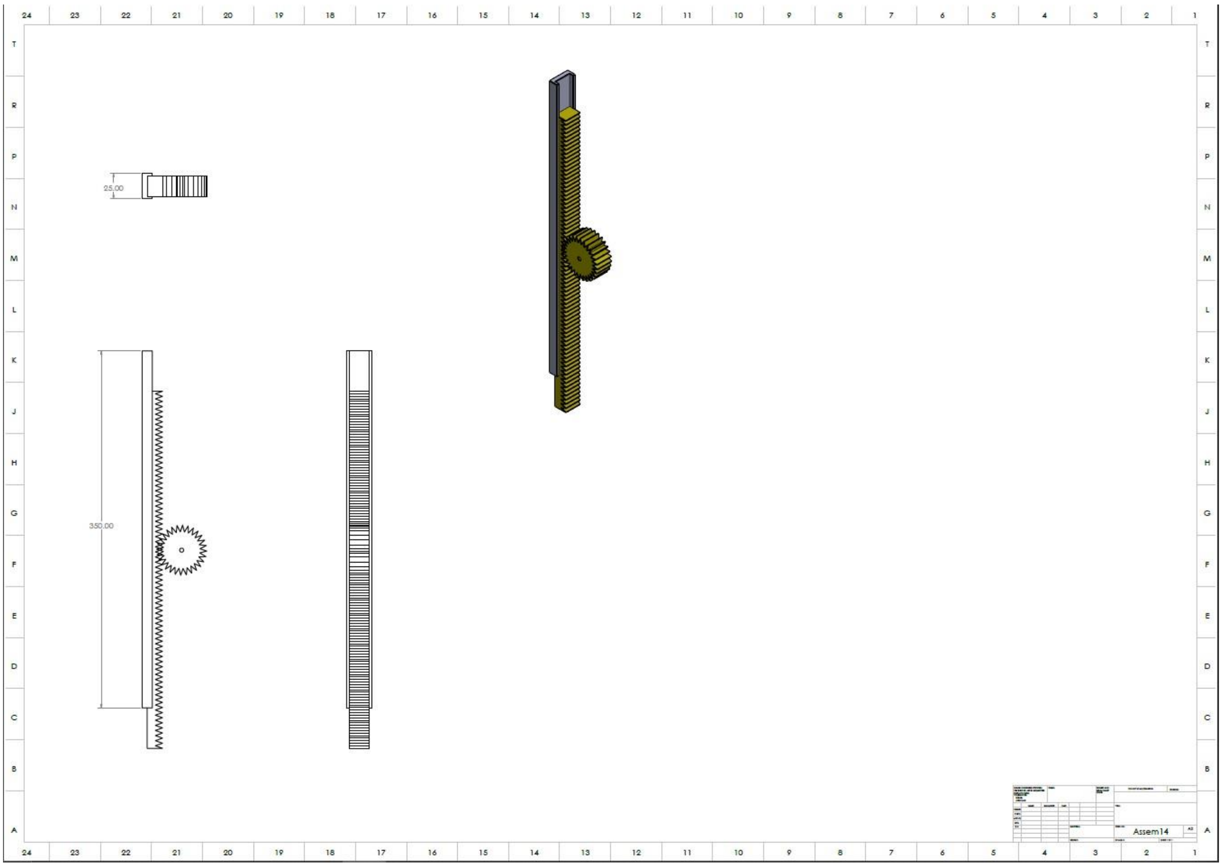


Figure3.13 2D Drafting of the rack and pinion

3.3 COMPONENTS AND DESCRIPTION

3.3.1 MAJOR COMPONENTS

- ARDUINO UNO BOARD
- JHONSON GEARED DC MOTOR
- PH SENSOR
- BATTERY
- PUMP
- SOLAR PANEL
- SOIL MOISTURE SENSOR
- ESP 32
- RACK AND PINION
- MOTOR DRIVER
- SOLAR CHARGE CONTOLLER
- WATER AND PESTICIDE TANK

a) ARDUINO UNO BOARD

Arduino Uno as shown in figure 4.4 is one type of microcontroller board, and it is designed by Arduino.cc. It can be built with a microcontroller like Atmega328. This microcontroller is also used in Arduino UNO. It is a small size board and also flexible with a wide variety of applications. Other Arduino boards mainly include Arduino Mega, Arduino Pro Mini, Arduino UNO, Arduino YUN, Arduino Lilypad, Arduino Leonardo, and Arduino Due. And other development boards are AVR Development Board, PIC Development Board, Raspberry Pi, Intel Edison, MSP430 Launchpad, and ESP32 board.

The components of the Arduino UNO board are

- **ATmega328 Microcontroller-** It is a single chip Microcontroller of the ATmel family. The processor code inside it is 8-bit. It combines **Memory (SRAM, EEPROM, and Flash), Analog to Digital Converter, SPI serial ports, I/O lines, registers, timer, external and internal interrupts, and oscillator.**

- **Vin:** Input voltage to Arduino when using an external power source (6-12V).
- **5V:** Regulated power supply used to power microcontroller and other components on the board.
- **3.**3V: 3.3V supply generated by on-board voltage regulator. Maximum current draw is 50mA.
- **GND:** Ground pins.
- **RESET:** Resets the microcontroller.
- **ANALOG PINS (A0-**A7): Used to measure analog voltage in the range of 0-5V.
- **INPUT/OUTPUT PINS (digital pins D0 - D13):** Can be used as input or output pins. 0V (low) and 5V (high).
- **SERIAL:(RX, TX):** Used to receive and transmit TTL serial data.
- **EXTERNAL INTERRUPTS (2,3):** To trigger an interrupt.
- **PWM (3,5,6,9,11):** Provides 8-bit PWM output.
- **TX and RX LED's-** The successful flow of data is represented by the lighting of these LED's.
- **AREF-** The Analog Reference (AREF) pin is used to feed a reference voltage to the Arduino NANO board from the external power supply.
- **Reset button-** It is used to add a Reset button to the connection.
- **USB-** It allows the board to connect to the computer. It is essential for the programming of the Arduino UNO board.

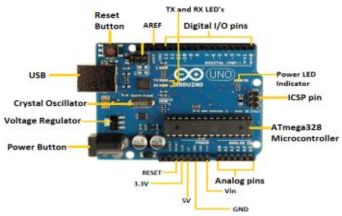


Figure 3.14 Arduino UNO

b) JHONSON GEARED DC MOTOR

The Johnson geared motor is famous for its compact size and massive torque. A torque as much as x3 as compared to center shaft or side shaft geared motor. The motor comes with a metal gearbox and off centered shaft, also shaft has a metal bushing for wear resistance. Apart from robotic application they are also used in industrial applications, vending system, hygiene and cleaning industry, and household electric appliance. Specifications - RPM - 500 shaft diameter - 6mm (with internal hole), shaft length - 15 mm. Dimensions: Gearbox diameter - 37mm, motor diameter - 28.5 mm, length (body only) - 63mm, weight - 300 gms, torque - 6 kg cm, voltage - 6 to 24 (nominal voltage - 12v), no-load current = 800 mA(max), load current = 9A(max).This motor is used to power our AGV since and it can easily pull up to 20kg load with the supplied power.

Figure 3.15 Jhonnson geared motor

c) PH SENSOR

Analog pH sensor is designed to measure the pH value of the soil and show the acidity or alkalinity of the substance. It is commonly used in various applications such as agriculture, wastewater treatment, industries, environmental monitoring, etc. The module has an on-board voltage regulator chip which supports the wide voltage supply of 3.3-5.5V DC, which is compatible with 5V and 3.3V of any control board like Arduino. The output signal is being filtered by hardware low jitter.

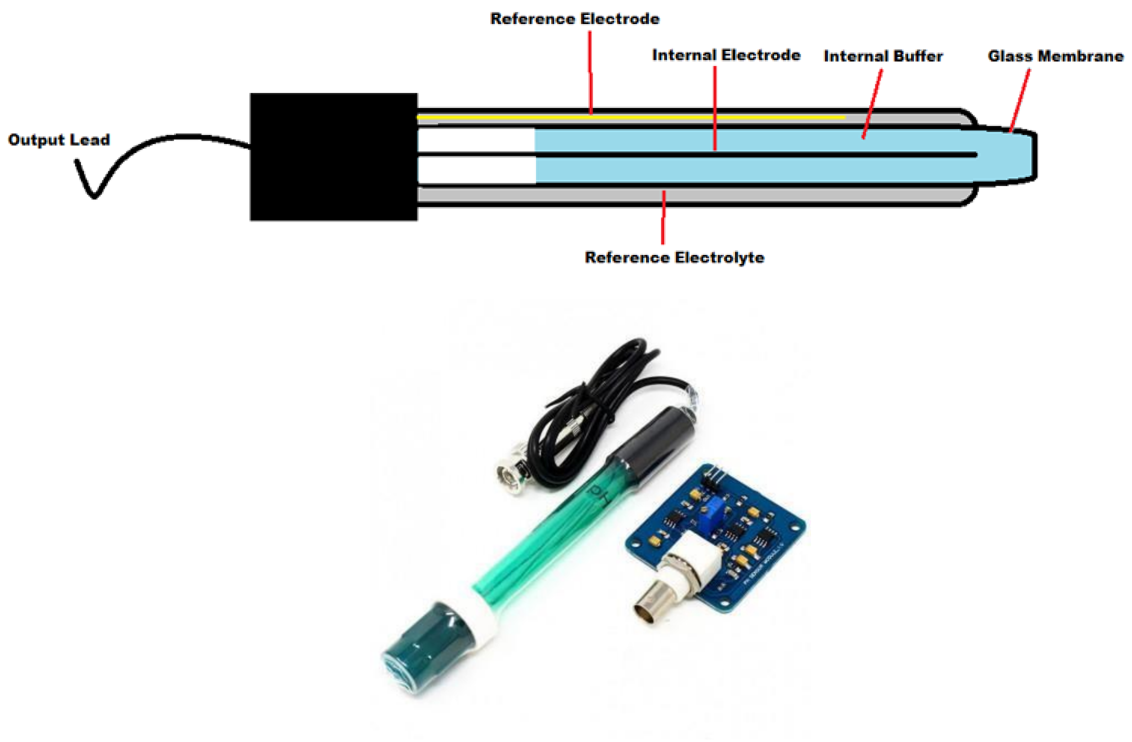


Figure 3.16 Ph sensor

d) BATTERY

A 12-volt battery is a type of lead-acid battery that is commonly used in a wide range of applications such as automobiles, boats, and off-grid solar power systems. It is also used in various other devices such as security systems, portable electronics, and power tools. A 12-volt battery typically consists of six cells, each with a voltage of approximately 2.1 volts. When connected in series, the voltage of the cells is added together, resulting in a total voltage of 12.6 volts. The capacity of a 12-volt battery is typically measured in amp-hours (Ah), which is the amount of current the battery can provide over a period of time. One of the main advantages of using a 12-volt battery is its versatility and wide range of applications. They are relatively inexpensive and widely available, making them a popular choice for various applications. They are also easy to maintain and can be recharged using a standard battery charger. However, it is important to note that 12-volt batteries can be heavy and bulky, making them difficult to transport and install in some applications. In this project we have used 2 batteries one 12v battery which supplies current to all the components and one 6v battery which helps in charging from solar panel.

Figure 3.17 Battery

e) PUMP

When pumping liquids and no direct contact with the liquid is required. Unlike most pumps, peristaltic pumps squishes a silicone tube to produce the pump-action instead of impelling it directly, thus no direct contact with the liquid. This pump as shown in figure 5.7 requires a 12 V DC supply and can produce a flow rate up to 55ml per minute. The pump is used to pump up the pesticide from the tank to the sprayer.

Figure 3.18 Pump

f) SOLAR PANEL

Solar energy begins with the sun. Solar panels (also known as "PV panels") are used to convert light from the sun, which is composed of particles of energy called "photons", into electricity that can be used to power electrical loads. In this project we are using polycrystalline LOOM 12v solar panel to power the electronic components used in the project as shown in figure. Here we have used a solar panel along with solar charge controller which controls efficient chraging of the battery and prevents overcharging.

Figure 3.19 Solar Panel

g) SOIL MOISTURE SENSOR

A moisture sensor is an electronic device used to measure the amount of moisture or water content in a substance. Moisture sensors can be used to detect moisture in soil, air, or other materials, and are commonly used in agricultural, environmental, and industrial applications. Moisture sensors can be used to monitor soil moisture levels in agricultural settings to help optimize irrigation and prevent over or under-watering. In industrial applications, moisture sensors can be used to monitor moisture levels in materials such as wood, paper, or textiles to prevent damage from moisture. In environmental monitoring, moisture sensors can be used to track moisture levels in the air, which can help predict weather patterns and inform meteorological research.

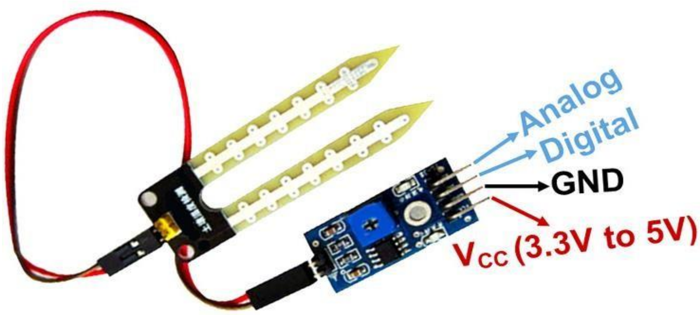


Figure 3.20 Moisture sensor

h) ESP 32

The ESP32 is a highly integrated and versatile system-on-chip (SoC) that combines Wi-Fi and Bluetooth connectivity, dual-core processing, and a wide range of input/output peripherals. Developed by Espressif Systems, the ESP32 is widely used in a variety of applications such as home automation, robotics, and Internet of Things (IoT) devices. It features a powerful processor with a clock speed of up to 240 MHz, low-power modes for energy-efficient operation, and extensive support for various programming languages and development environments. The ESP32 also offers a rich set of connectivity options including Wi-Fi, Bluetooth Classic, and Bluetooth Low Energy.

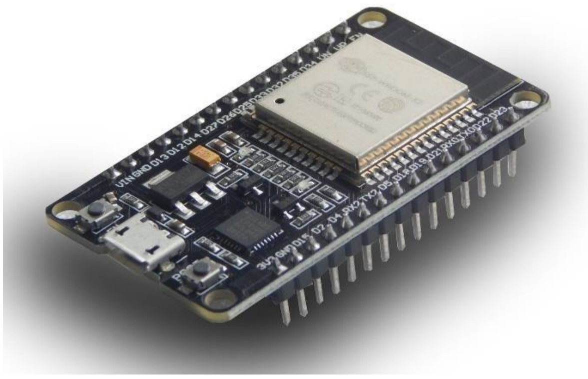


Figure 3.21 ESP 32

i) RACK AND PINION

Rack and pinion is a type of gear mechanism used to convert rotational motion into linear motion. It consists of a gear with teeth (the pinion) that meshes with a long, straight bar with teeth (the rack). When the pinion rotates, it drives the rack in a linear direction. Rack and pinion systems offer several advantages over other types of gear mechanisms such as simplicity, high efficiency, and easy maintenance. They also offer precise and accurate motion control, making them ideal for applications where accuracy is crucial. However, they can be prone to wear and tear, especially if used under high loads or in harsh environments. Therefore, proper lubrication and regular maintenance are important to ensure their longevity and reliable operation.

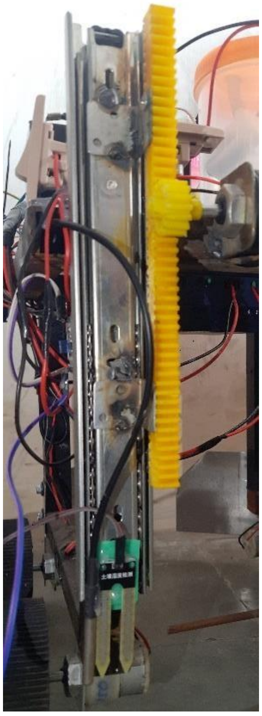
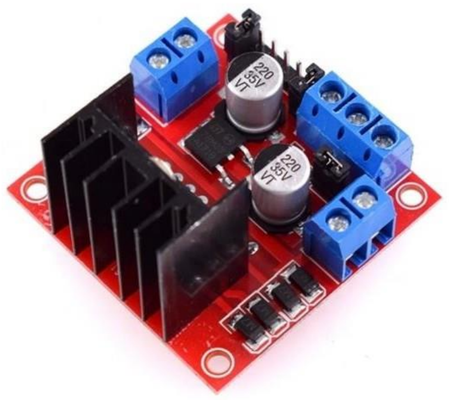


Figure 3.23 Rack and Pinion

j) MOTOR DRIVER(L298)

The L298 is a dual full-bridge motor driver integrated circuit that is commonly used to drive DC motors and stepper motors in a wide range of applications. Developed by STMicroelectronics, the L298 provides a convenient and cost-effective way to control the speed and direction of two motors simultaneously. The L298 motor driver is capable of delivering up to 2 amps of continuous current per channel and a peak current of up to 3 amps per channel. It also includes built-in protection features such as thermal shutdown, over-current protection, and under-voltage lockout to ensure safe and reliable operation. One of the main advantages of the L298 motor driver is its versatility and ease of use. It can be easily connected to a variety of motors and power sources, and its built-in protection features help to ensure safe and reliable operation.



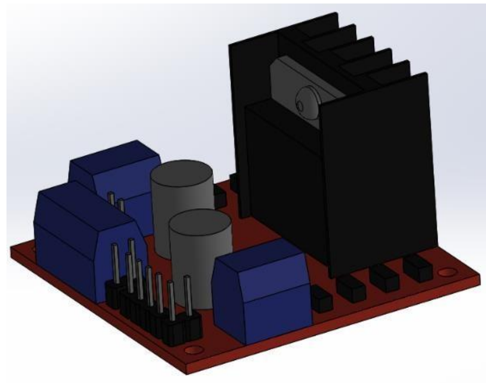


Figure 3.24 Motor Driver(L298) **Figure 3.25 Motor driver design**

k) SOLAR CHARGE CONTROLLER

A luminous solar charge controller is a device that regulates the power generated by a solar panel in a solar power system. It ensures that the solar panel is charged optimally and prevents overcharging or undercharging of the battery. The Luminous solar charge controller is designed to work with both lead-acid and lithium-ion batteries, making it compatible with a wide range of solar power systems. The Luminous solar charge controller features various protection mechanisms to prevent damage to the battery and solar panel, including overcharging, over-discharging, and short-circuit protection. It also offers various charging modes such as boost mode, float mode, and trickle mode, ensuring that the battery is charged optimally and efficiently. The Luminous solar charge controller can be easily integrated into a solar power system and features a user-friendly interface that allows users to monitor and adjust charging parameters such as battery voltage, charging current, and charging mode. One of the main advantages of using a Luminous solar charge controller is that it helps to increase the efficiency and lifespan of the battery and solar panel. By regulating the charging process, it ensures that the battery is charged optimally, thereby reducing the risk of damage to the battery and prolonging its lifespan. It also helps to maximize the power generated by the solar panel, ensuring that the solar power system is running at peak efficiency.

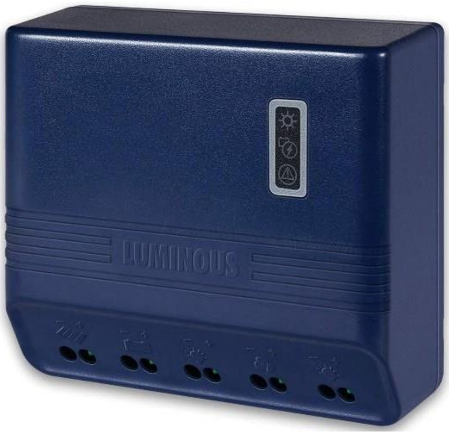


Figure 3.26 Luminous Solar charge controller

l) WATER AND PESTICIDE TANKS

The water and pesticide tanks are used to store water and pesticides which will be sprayed to the field with pump inside each tank.

Figure 3.27 Water and Pesticide tank

CHAPTER 4

4.1 FABRICATION

STEP 1:

The materials that has been purchased for frame fabrication is cut according to the dimensions.

STEP 2:

The square frame which is cut is welded properly with arc welding process and made ready to fix the motors.

STEP 3:

The 12v DC motors are fixed on both sides of the AGV and the also fixed with off road rc tyres.

STEP 4:

Then the 12v battery and Arduino Uno board are fixed on the top of the frame and the motor is tuned to 30 rpm for primary testing.

STEP 5:

The other electrical components such as solar panel, solar charge controller, motor drivers, ESP 32 are fixed firmly on the frame.

STEP 6:

Now the Arduino Uno is coded with the assumed dimensions of the field and the output is tested.

STEP 7:

After testing with the Arduino code the water and pesticide tanks are fixed along with the nozzle and pipes.

STEP 8:

The ESP 32 is coded via the Arduino Uno and it feeds the data to the Thing speak website.

STEP 9:

Finally all the connections to the electrical components are verified and the dc motor is tuned to 150 rpm with the help of motor drivers.

Figure 4.1 12v Battery

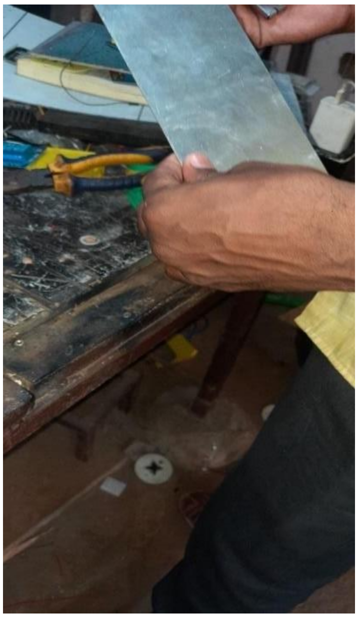


Figure 4.2 Sheet metal

Figure 4.3 Solar panel

Figure 4.4 Prototype view of rack and pinion

Figure 4.5 Welded frame

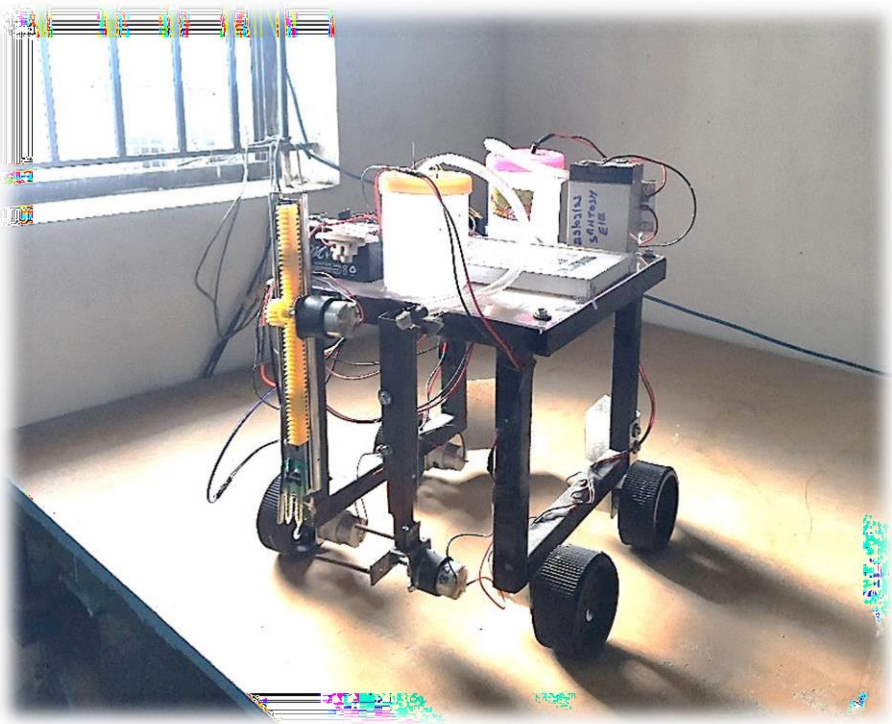


Figure 4.6: Final prototype of the project

4.2 CODING FOR ESP 32

```
#include <ESP8266WiFi.h>

#include "ThingSpeak.h"

WiFiClient client;

const char* ssid = "KJJOHNSON5G_EXT"; // your network SSID (name)

const char* password = "99339933John#"; // your network password

unsigned long myChannelNumber = 1766612;

const char * myWriteAPIKey = "1VE3TCZDBMOYR6XR";

int threshold = 50;

int flag = 0;

int ph = 0;

const int motor1pin1 = 2;

const int motor1pin2 = 3;

const int motor2pin1 = 4;

const int motor2pin2 = 5;

int pump = 6;

void setup ()

{

  Serial.begin(9600);

  while (WiFi.status() != WL_CONNECTED) {

    WiFi.begin(ssid, password);

    delay(5000);

  }

  Serial.println("\nWiFi is Connected, Good to Go!");

  ThingSpeak.begin(client); // trying to begin the thingspeak connection

}

void loop () {
```

```
  analogRead(ph);
  for (int i = 0; i < 1000; i++) forward();
  for (int i = 0; i < 200; i++) left();
  for (int i = 0; i < 1000; i++) forward();
}
void sensor() {
  if (flag<15000 && map(analogRead(A0),0,1023,0,100) > threshold)
  {
    ThingSpeak.setField(1, "Pumping water");
    digitalWrite(pump, 1);
    delay(1);
    flag++;
  }
  if(flag>=15000)
  {
    flag =0;
    digitalWrite(pump, 0);
  }
}
void forward()
{
  digitalWrite(motor1pin1,  HIGH);
  digitalWrite(motor1pin2,  LOW);
  digitalWrite(motor2pin1,  HIGH);
  digitalWrite(motor2pin2,  LOW);
  delay(1);
  sensor();
```

```
}
void backward()
{
  digitalWrite(motor1pin1,  LOW);
  digitalWrite(motor1pin2, HIGH);
  digitalWrite(motor2pin1,  LOW);
  digitalWrite(motor2pin2, HIGH);
  delay(1);
  sensor();
}
void halt()
{
  digitalWrite(motor1pin1, LOW);
  digitalWrite(motor1pin2, LOW);
  digitalWrite(motor2pin1, LOW);
  digitalWrite(motor2pin2, LOW);
  delay(1);
  sensor();
}
void left()
{
  digitalWrite(motor1pin1,  LOW);
  digitalWrite(motor1pin2, HIGH);
  digitalWrite(motor2pin1,  LOW);
  digitalWrite(motor2pin2,  LOW);
  delay(1);
  sensor();
```

```
}
void right()
{
  digitalWrite(motor1pin1,  LOW);
  digitalWrite(motor1pin2,  LOW);
  digitalWrite(motor2pin1,  LOW);
  digitalWrite(motor2pin2, HIGH);
  delay(1);
  sensor();
}
```

4.3 CODING FOR ARDUINO UNO

```
const int motor1pin1 = 2;
const int motor1pin2 = 3;
const int motor2pin1 = 4;
const int motor2pin2 = 5;
int pump = 6;
void setup ()
{
  Serial.begin(9600);
  digitalWrite(6, 0);
  digitalWrite(7, 1);
  delay(1000);
  digitalWrite(7, 0);
  delay(3000);
  digitalWrite(6, 1);
  delay(1000);
```

```
  digitalWrite(6, 0);
  delay(10000);
}
void loop () {
  for (int i = 0; i < 1000; i++) forward();
  for (int i = 0; i < 200; i++) left();
  for (int i = 0; i < 1000; i++) forward();
  halt();
}
void forward()
{
  digitalWrite(motor1pin1,  HIGH);
  digitalWrite(motor1pin2,  LOW);
  digitalWrite(motor2pin1,  HIGH);
  digitalWrite(motor2pin2,  LOW);
  delay(1);
}
void backward()
{
  digitalWrite(motor1pin1,  LOW);
  digitalWrite(motor1pin2,  HIGH);
  digitalWrite(motor2pin1,  LOW);
  digitalWrite(motor2pin2,  HIGH);
  delay(1);
}
void halt()
{
```

```
  digitalWrite(motor1pin1, LOW);
  digitalWrite(motor1pin2, LOW);
  digitalWrite(motor2pin1, LOW);
  digitalWrite(motor2pin2, LOW);
  delay(1);
}
void left()
{
  digitalWrite(motor1pin1,  LOW);
  digitalWrite(motor1pin2,  HIGH);
  digitalWrite(motor2pin1,  LOW);
  digitalWrite(motor2pin2,  LOW);
  delay(1);
}
void right()
{
  digitalWrite(motor1pin1,  LOW);
  digitalWrite(motor1pin2,  LOW);
  digitalWrite(motor2pin1,  LOW);
  digitalWrite(motor2pin2,  HIGH);
  delay(1);
}
```

4.4 WORKING OF AGV

The AGV or agribot made using Arduino is used to sense the Ph level of the soil and sprinkle/spray the pesticides to the crops. At first the AGV is programmed according to the dimensions of the field. Then the AGV moves along the preprogrammed path and takes readings using the Ph sensors provided in five necessary areas of the field. Then the input obtained by the Ph sensors are fed to the Arduino uno which then computes the average Ph value of the soil for initial stage. Then the Arduino takes the decision whether to spray the pesticide or spray water. The values given to the Arduino is then transferred to the ESP 32 which will update the ph values, moisture and humidity values in the Thing speak website were all the values are depicted in the form of graph. If the soil is acidic the Arduino will not initiate the bot to spray pesticide. If the soil is alkaline the Arduino gives input to the motors which make the vehicle to propel forward. The pump is now activated and sprays the pesticides all over the field as by the programmed route.

The solar makes the agriculture AGV indigenous without the need of charging it again and again. The solar charge controller is used to control the charge which is obtained from the solar panel without damaging the battery. The Luminous solar charge controller features various protection mechanisms to prevent damage to the battery and solar panel, including overcharging, over-discharging, and short-circuit protection. Here two motor drivers are used, the L298 provides a convenient and cost-effective way to control the speed and direction of two motors simultaneously. It also includes built-in protection features such as thermal shutdown, over-current protection, and under-voltage lockout to ensure safe and reliable operation. The pH sensor and soil moisture sensor are attached to the rack and pinon mechanism which is activated by a 30 rpm motor. The rack and pinion is made by 3d printing. Thus this project helps the farmers to take proper readings of their soil condition which in turn helps the farmers to determine which crop to harvest in the upcoming season and how much amount of pesticide and water to be applied to the field.

CHAPTER 5
TESTING AND RESULTS

5.1 TESTING

The testing of an agriculture robot project typically involves several stages to ensure the robot is functional, safe, and effective for use in farming operations. The following are some of the typical testing stages involved in an agriculture robot project:

1. Functional Testing: This stage involves testing the robot's basic functions such as movement, sensing, and manipulation. The robot is tested in a controlled environment to ensure it can perform its intended tasks, such as watering plants, charging of solar panels, pesticide application and soil tilling.
2. Field Testing: After successful functional testing, the robot is tested in a real-world environment, such as a farm or greenhouse. This stage involves testing the robot's ability to navigate through the field, avoid obstacles, and perform its intended tasks in different weather conditions.
3. Performance Testing: This stage involves testing the robot's performance in terms of accuracy, efficiency, and productivity. The robot's ability to perform tasks consistently and reliably is tested to determine its effectiveness in a farming operation. Here we encountered a major problem with the speed of the motor which has been changed form 30 rpm to 60 rpm.
4. Endurance Testing: This stage involves testing the robot's ability to operate for extended periods without downtime or failure. The robot is subjected to long-term testing to evaluate its durability and reliability under normal operating conditions. The weight distribution of the electrical components mainly the solar panel, solar charge controller and the batteries.
5. Final Testing: The problems encountered with the motor speed is now solved by increasing the speed from 30 rpm to 60 rpm and finalizing to 150 rpm with the motor drivers.

The agriculture robot project was tested extensively to evaluate its ability to accurately measure the pH, moisture, and humidity levels in the field and apply water and pesticides according to the measured values. The results of the testing showed that the robot was able to collect accurate and reliable data from the field sensors and use it to make informed decisions about the application of water and pesticides.

During the functional testing stage, the robot was able to perform its basic functions such as movement, sensing, and manipulation without any issues. The field testing stage involved testing the robot in real-world farming conditions, and it was able to navigate through the fields and perform its tasks in different weather conditions.

The performance testing stage showed that the robot was able to apply water and pesticides accurately and efficiently, leading to improved crop health and yield. The endurance testing stage showed that the robot was able to operate for extended periods without downtime or failure, indicating its durability and reliability under normal operating conditions.

The user testing stage involved evaluating the robot's usability and user interface, and it was found to be easy to operate and integrate into farming operations. The cost-benefit analysis showed that the robot had a high potential return on investment due to its ability to improve crop health and yield while reducing the amount of water and pesticides used.

5.2 RESULTS

Overall, the results of the testing showed that the agriculture robot project was successful in accurately measuring the pH, moisture, and humidity levels in the field and applying water and pesticides according to the measured values. The robot had a high potential to improve crop health and yield while reducing the use of water and pesticides, making it a valuable tool for modern farming operations

Figure 5.1 water spraying from nozzle testing

Figure 5.2 Rack and pinion

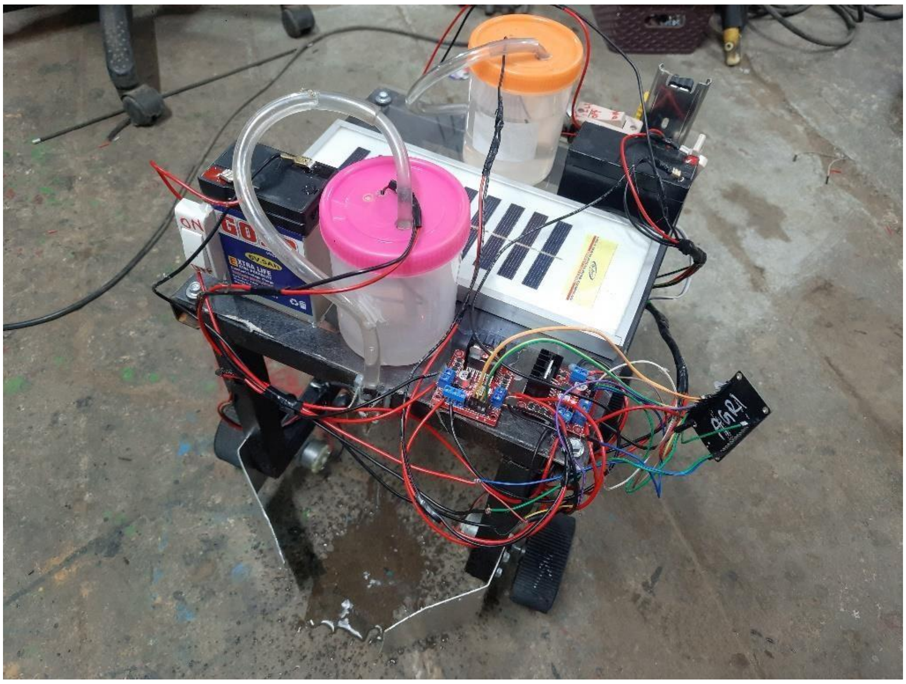


Figure5.3 Final Testing of the project

5.3 LAYOUT OF THE AGV SETUP

The layout of the project that consists of an Arduino Uno, ESP 32, solar panel, solar charge controller, motor driver, battery, and DC motors is designed to create an agriculture AGV (Autonomous Ground Vehicle). The solar panel will provide the necessary power to charge the battery, which will then power the AGV's motors. The solar charge controller is responsible for regulating the power supplied by the solar panel to ensure that the battery is charged optimally and efficiently.

The Arduino Uno and ESP 32 are the main control boards responsible for controlling the AGV's movements and operations. They will receive inputs from various sensors, including the pH sensor and moisture sensor, to determine the appropriate actions to take. The motor driver will drive the DC motors, which will control the movement of the AGV.

The AGV's layout will consist of the solar panel mounted on top of the AGV, which will be connected to the solar charge controller and battery. The motor driver will be connected to the DC motors, and the Arduino Uno and ESP 32 will be connected to the motor driver and various sensors. The AGV will be designed to be autonomous and will be programmed to navigate the agricultural fields and collect data using the sensors. Overall, the project layout is designed to create an efficient, sustainable, and autonomous agriculture AGV that can help farmers monitor and maintain their crops more effectively. Here there are two 30 rpm DC motors which powers the Rack and pinion and the other motor powers the soil tiller mechanism. The ESP 32 is used to input data to the Thing speak website where all the data’s like Ph data, moisture and humidity graphs are monitored.

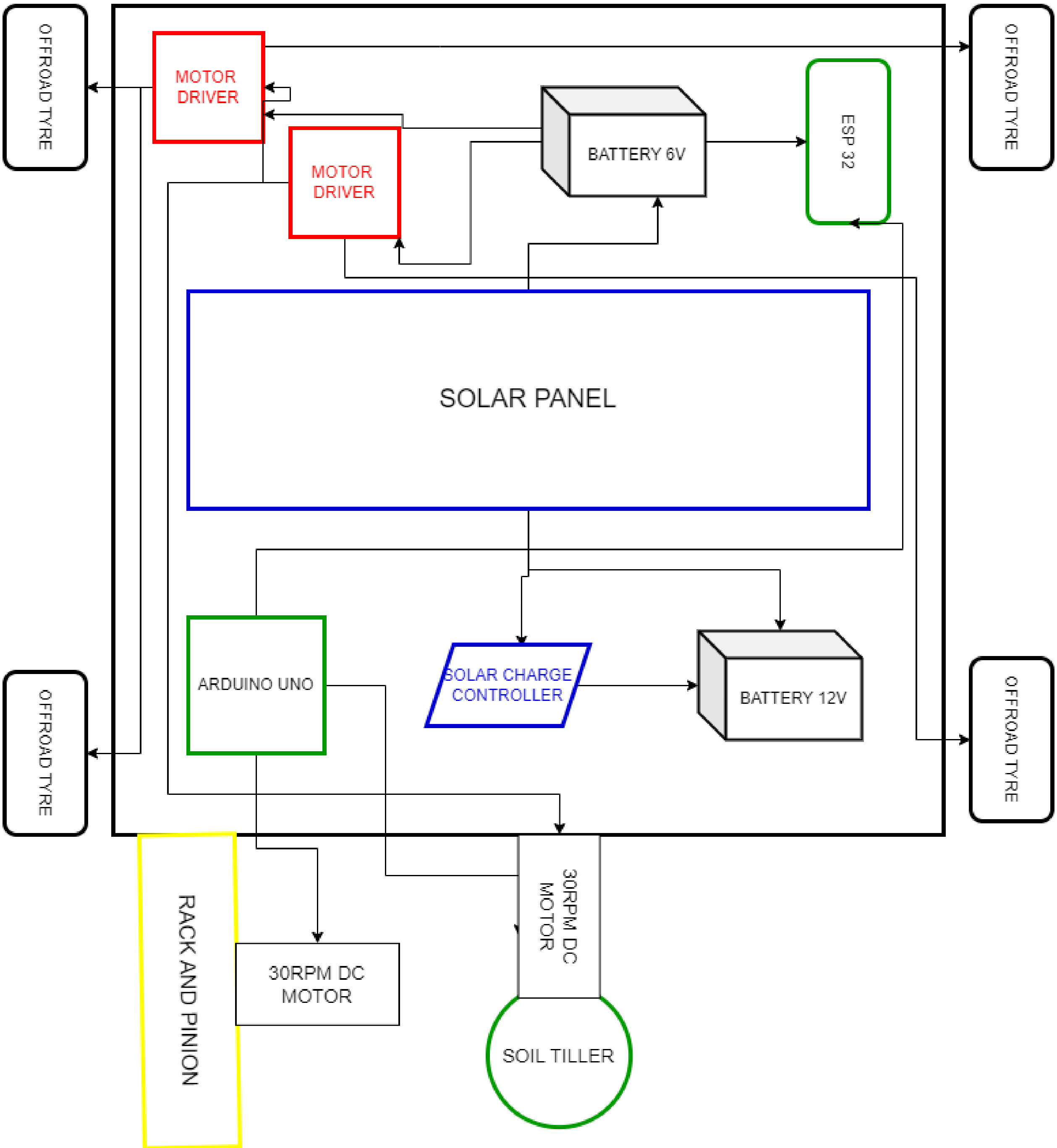


Figure 5.4 Layout of the AGV Setup

5.4 COST ESTIMATION

Table 5.1 Cost Estimation

Sl.no.	Activity	Expenditure amount (RS)
1	Transportation	780/-
2	Material/components purchase	8518
3	Fabrication/experiment	2040
4	Testing/characterization	400
5	project outcome activity expenditure (attending conferences, technical event, etc..)	-
6	Miscellaneous	450
	Total Cost	**12,188/-**

5.5 COST ESTIMATION-COMPONENTS BREAKDOWN

Table 5.2 Components Breakdown

SI NO	COMPONENTS	PRICE
1	ESP	450
2	MOTOR DRIVER	350
3	SOLAR PANEL (12V 10WATTS)	500
4	JHONSONS GEARED MOTOR	789(4)
5	MOISTURE SESNOR	250
6	OTHER PARTS	1812
7	SOLAR CHARGE CONTOLLER	2000
	TOTAL	**8518**

5.6 TIME UTILIZATION

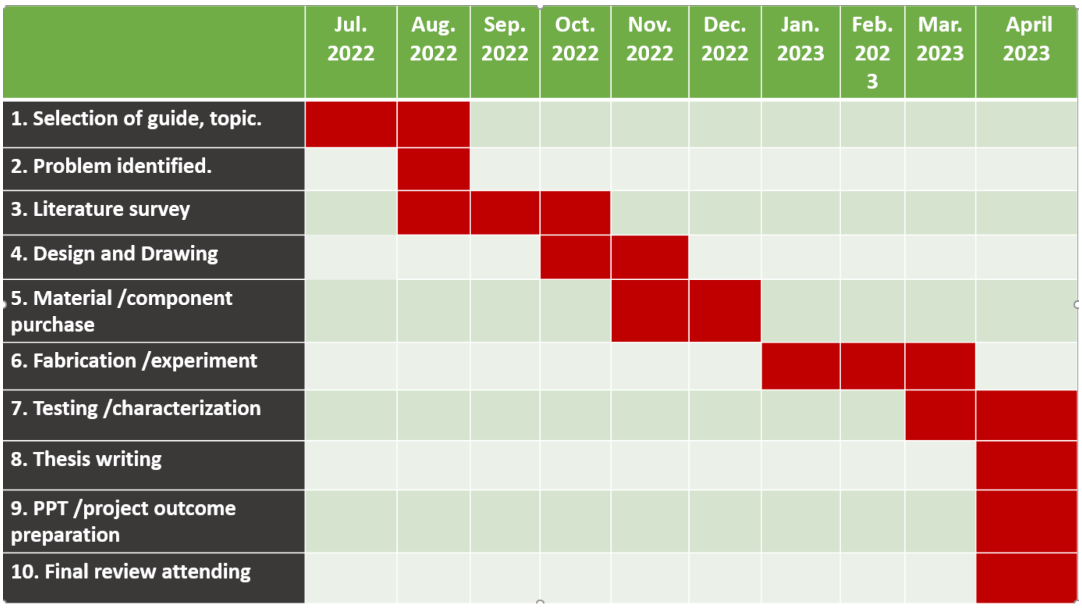


Figure 5.5 Time utilization

CHAPTER 6

CONCLUSIONS

With the implementation and application of the project, the difficulties raised due to the lack of the automation in the agricultural sector will be reduced in a large time. The AGV applications eases the work for the farmers and provide protection against the harmful pesticides. As per the estimate, with the help of AGV the work can be done in a couple of hours while the manual method takes approximately a Day. The risk of human error while spraying is also neglected. If the working farm area is in acres the AGV can also complete the task within a limited period of time with maximum efficiency. The number of social, economic, and environmental issues with agricultural based vehicles such a profitability, operation cost and efficiency, high cost and health related issues. It is identified that risk of accidents is high with agricultural vehicles and operations. Soil impact and environmental impact is also highlighted. It is also found that automation in agriculture is foreseen as having potential to solve challenges with implementation of AGV vehicles in Agriculture Fields. Robots are relied upon to assume a noteworthy part in satisfying the need of agriculture to accomplish more with less or in other words enhance the effectiveness by improving the utilization of natural assets like water and soil.

This study tries to add to the utilization of robots in agriculture by the design and advancement of an AGV incorporated with a robotic arm to spray pesticide using sprinkles nozzles. Here the implementation of ESP 32 helps the farmers to know their data at regular intervals which in turn helps the farmers to determine which crop to cultivate in upcoming season according to the fertility of the soil. Also the usage of solar panel makes this project indigenous without the need to charge the batteries again and again. It ensures that the solar panel is charged optimally and prevents overcharging or undercharging of the battery. The Luminous solar charge controller features various protection mechanisms to prevent damage to the battery and solar panel, including overcharging, over-discharging, and short-circuit protection. It also offers various charging modes such as boost mode, float mode, and trickle mode, ensuring that the battery is charged optimally and efficiently.

LIST OF PROJECT OUTCOMES

a. <u>List of patents</u>

1. Design patent applied

b. <u>List of conferences</u>

1. “International conference on “Advances in Chemical Synthesis and Material Sciences”(ICACSMS-2K23)

c. <u>Project competition</u>

1. Core Design contest, REC

REFERENCES

[1] Lothar Schulze, Alexander Wtillner, “The Approach of Automated Guided Vehicle Systems”, February 21,2006,IEEE.

[2] Gobi Krishnan P, Chyril fredrhic A, Nivas V M, “Automated Guided Car (AGC) for IndustrialAutomation”,978-1-4673-6725-7/16/$31.00 ©2016 IEEE. International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering(IJAREEIE)

[3] Yi-fei TAO, Jun-ruo CHEN, Mei-hong LIU, Xian-xi LIU, Ya-li FU,“Research of Unidirectional Automated Guided Vehicles System Based on Simulation”, 29 November 2010,IEEE 17Th International Conference on Industrial Engineering and Engineering Management.

[4] J. Sankari, R. Imtiaz, “Automated Guided Vehicle (AGV) for industrial sector”, 03 November, 2016, 10th International Conference on Intelligent Systems and Control (ISCO).

[5] S. G. M. Hossain , Hasnats Jamil ,Muhammad Yakut Ali ,Md. Zahurul Haq, “Automated guided vehicles for industrial logistics Development of intelligent prototypes using appropriate technology”,19 April ,2010, The 2nd International Conference on Computer and Automation Engineering(ICCAE).

[6] Edan, Y., Han, S., Kondo, N., 2009. Automation in Agriculture, Springer Handbook of Automation. Springer Berlin Heidelberg, Berlin, Heidelberg. https://doi.org/10.1007/978-3-540-78

[7] D. Ronzoni, R. Olmi, C. Secchi and C. Fantuzzi, "AGV global localization using indistinguishable artificial landmarks," 2011 IEEE International Conference on Robotics and Automation,Shanghai,2011,pp.287292,doi:10.1109/ICRA.2011.597975983 1-7_63

[8] Birajdar, Basavraj. (2018). Design and Fabrication of Fertiliser Spreading Machine. International Journal for Research in Applied Science and Engineering Technology. 6. 238-245. 10.22214/ijraset.2018.7032.

[9] Hague, T., Marchant, J.A., & Tillett, N.D. (2000). Ground based sensing systems for autonomous agricultural vehicles. Computers and Electronics in Agriculture, 25, 11-28

[10] Philippe Martinet, Pierre Bonton, Jean Gallice, Michel Berducat, Christophe Debain, et al.. Automatic Guided Vehicles in Agricultural and Green Space Fields. FIR'98 - 4th French Isralei Symposium on Robotics, May 1998, Besançon, France. pp.87-92.

[11] Jafari, Saeid & Barenji, Reza & Hashemipour, Majid. (2013). Towards an Automated Guided Vehicle (AGV) in Sprinkler Irrigation. International Journal of Environmental Science and Development. 4. 456-460. 10.7763/IJESD.2013.V4.393.