International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 04 | April - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

DESIGN AND DEVELOPMENT OF FERTILISER SPRAYING AGRICULTURAL ROBOT

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Abstract - Modern agriculture is ensured by the development and dissemination of agricultural automation and intelligence. The current focus of agricultural robot research is autonomous navigation, which can significantly improve labor productivity while effectively reducing labor requirements. It is the most successful robot in the agricultural field. The main functions of the robot are chassis control, navigation control, and mechanical design for fertilization and spreading. The main theme of robots is to reduce work, workload, burden and stress. Agriculture is an extremely resource- and labor-intensive industry. Therefore, farmers are increasingly turning to technology and automation to address this problem. Future recommendations include making agricultural robots fully autonomous.

Key Words: Fertilization, agricultural robots modern agriculture, autonomous navigation.

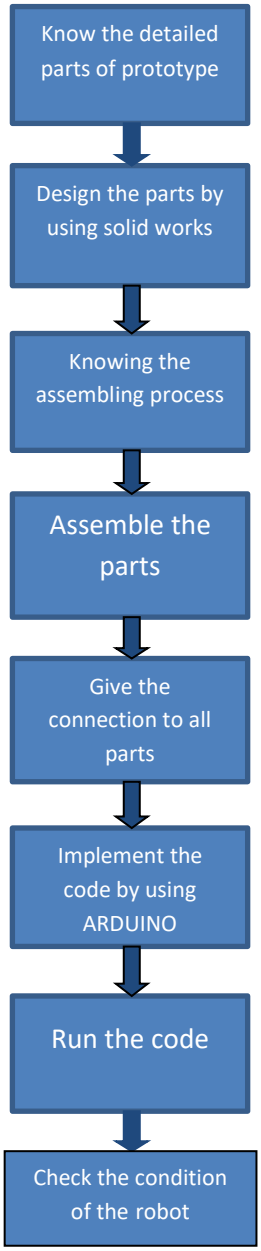
1. INTRODUCTION

Farmers in developing countries are turning to technology to address a range of serious challenges in the agricultural industry, including growing global food shortages and a shrinking agricultural workforce. Agricultural robots automate time-consuming, repetitive, and tedious tasks for farmers, allowing them to focus on increasing crop yields while increasing agricultural efficiency and reducing labor costs. Agricultural robots enable precision farming and use resources more efficiently, leading to significant resource savings. Today, modern robotic systems are used to harvest and pick plants, manage weeds, mow, plant, and sort and package produce. Agriculture is a perfect field for the use of robots. To maintain yields, plants require regular treatment with fertilizers and pesticides. Manual application of fertilizers and pesticides by workers using backpack sprayers is an outdated technology that is not only inefficient and time-consuming, but also labor-intensive and expensive to treat large fields. It costs a lot of money. The

fertilizer and pesticide application robot can transport large storage containers and operate safely and even autonomously, at a fraction of the cost of traditional methods. In fact, it is predicted that agricultural robots can save up to five times as much effort applying fertilizers and pesticides compared to humans using backpack sprayers. There are already some agricultural robots on the market that can perform some of these tasks, and more will be coming soon. Agricultural robots, on the other hand, are too complex, time-consuming, and expensive to be widely adopted. As a result, Malaysia's agricultural industry, despite contributing significantly to the country's economy, continues to operate using traditional methods, and the high cost of these systems has led to the introduction of modern technology such as agricultural robots. Technology integration is slow.

The purpose of this research is to develop a low-cost agricultural robot that can spray fertilizers and pesticides on farmland. The prototype fertilizer and pesticide application robot was made from recycled materials such as liquid containers and robot frames to keep costs down. The agricultural robot developed for this research focuses on two applications: fertilizer and pesticide application and general crop monitoring.

2. METHODOLOGY:



2.1 Hardware Implementation

1. **ESP12E BASE BOARD:**

TZe ESP12E is a popular WiFi module based on the ESP8266 microcontroller chip. It is widely used in Internet of Things (IoT) projects due to its low cost, built-in Wi-Fi capabilities, and ease of use. The ESP12E module itself is a surface mount module.

ESP8266 chip and necessary supporting components such as flash memory and antenna. The ESP12E Base Board is basically a breakout board or development board designed to make it easier to use the ESP12E module in your projects.

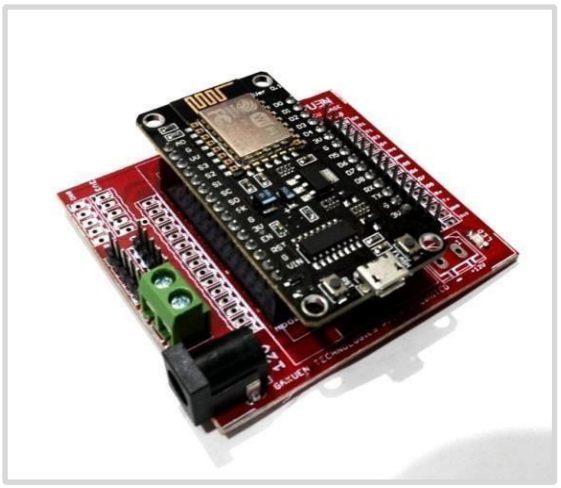


Fig 2.1 ESP12E Base board

2. ESP12E Microcontroller:

ESP12E is a popular microcontroller module developed by Espresso Systems. It is part of the ESP8266 microcontroller family known for its low cost, Wi-Fi connectivity, and compatibility with Arduino IDE. The ESP12E module contains the ESP8266 chip and other necessary components such as flash memory, power control, and antenna.

• The ESP8266 chip integrated into the ESP12E module provides Wi-Fi connectivity, allowing devices to connect to the Internet or local networks wirelessly.

• SP8266-based modules are known for their affordability, making them a popular choice for hobbyists, enthusiasts, and developers working on Internet of Things (IoT) projects.

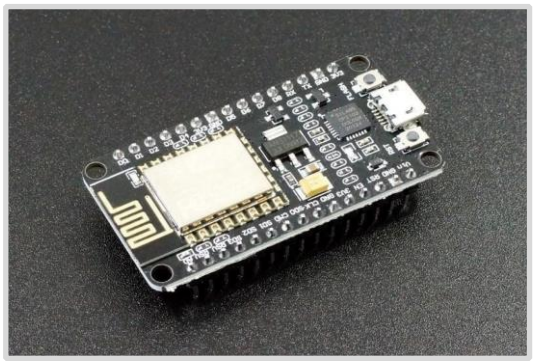


Fig 2.2 ESP12E Micro controller

3. Direct Current Motor:

A direct current (DC) motor is an electrical machine that converts electrical energy into mechanical energy. They work on the principle of electromagnetic induction, where the interaction between a magnetic field and a current-carrying conductor generates a force that causes rotational motion. In these motors, the armature and field windings are connected in series.

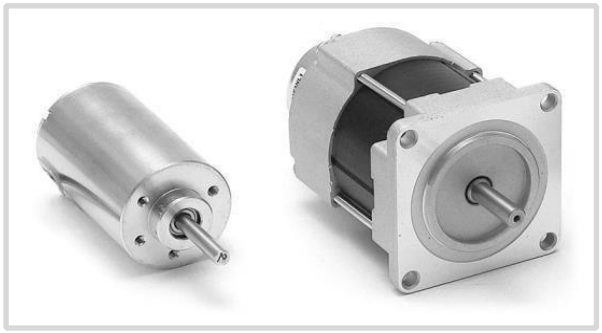


Fig. 2.3: DC Motors

4. DC Pump:

A DC pump is a type of pump that operates on direct current (DC). These pumps are commonly used in a variety of applications where precise flow or pressure is required. DC pumps have several advantages over alternating current (AC) pumps, including:

• Energy Efficiency: DC pumps are often more energy efficient than AC pumps because they can be designed to operate at variable speeds, allowing for better control of flow rate and volume. Reduce energy consumption.

• Quiet operation: DC pumps tend to run quieter than AC pumps, making them suitable for applications where noise is a concern, such as aquariums and residential areas.

• Compact size: DC pumps are typically more compact than AC pumps, making them easier to install in tight spaces or applications where space is limited.

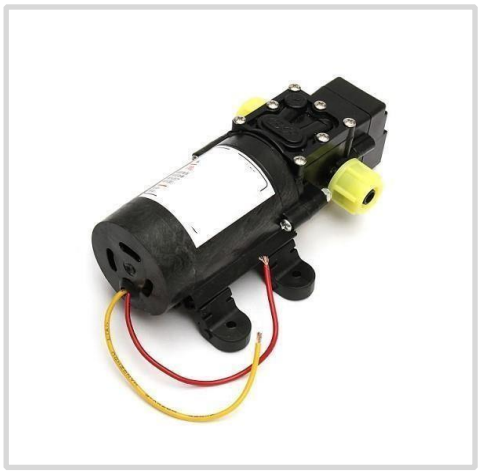


Fig. 2.3: DC Pump

5. Motor Drive:

A motor drive, also known as a motor controller, is an electronic device or circuit that controls the speed, torque, direction, and/or position of an electric motor. It essentially acts as an intermediary between the motor and the power source, regulating the flow of electrical energy to the motor based on various control inputs. Motor drives are widely used in a variety of applications in a variety of industries, including robotics, automation, automotive, aerospace, and industrial machinery. They play a key role in optimizing engine performance, increasing efficiency and allowing precise control of engine operation.

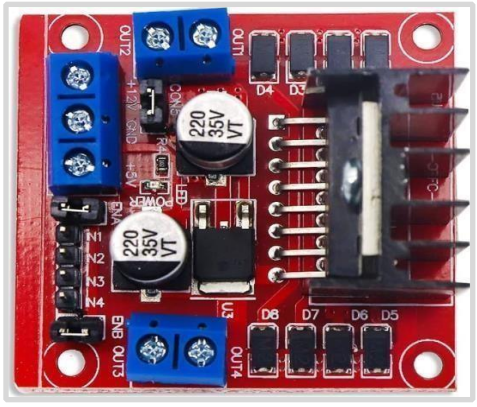


Fig 2.4 Motor drive

2.2 Wheel Design in Solid Works:

1. Click New.

2. Click Parts, OK.

3. Click "Front Layer" and click "Sketch".

4. Click Circle and sketch the center of the circle at the origin. Click Smart Dimension, click the sketched circle, and set the diameter to 1.0 inch.

5. The sketch is complete. Let's create a function from here.

6. Click Front and click Normal Close.

7. Click Front, then click Sketch.

8. Click Centerline to sketch a vertical centerline.

9. Click Line to sketch the outline of the gear teeth.

EAR9. Click Smart Dimension and dimension the sketch, such as sketch bel

10. Click Finish Sketch and change the view to Isometric.

11. Click the mouse scroll button and rotate the part backwards. Click on the back and select "Normal

12. Transfer the final sketch to this surface. While doing this, hold down the CTRL key and click on all the sketch lines, then click Convert Element. Now we need to remove all relationships between this sketch and other sketches. Click View/Remove Relationships, then click Remove All. Click and drag to select the entire sketch line. Click Rotate Element, click the Center of rotation box, and click Origin (Center). In the parameter options, enter 10 degrees of rotation. Rotate Box

13. Click Finish Sketch to change the view to Isometric.

14. Click Features > Raised Booth/Base to open the parts tree and double-click Sketch 2 and Sketch 3 to add the Raised feature. Make sure the two green dots are on the same edge as the other sketch. If not, drag to move it.

15. Click Loft 1 (Gear Teeth) and click Circle Pattern.

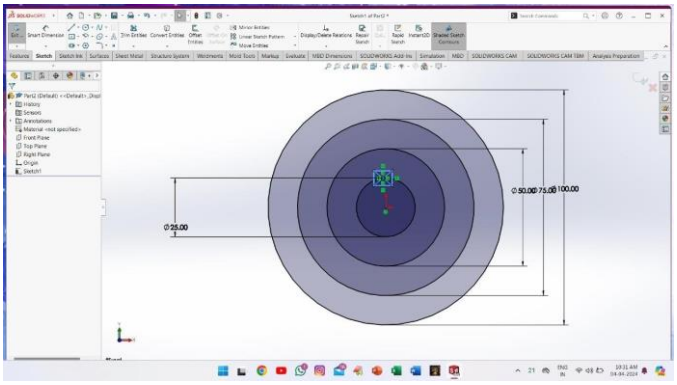


Fig. 2.5 Front View of a Wheel

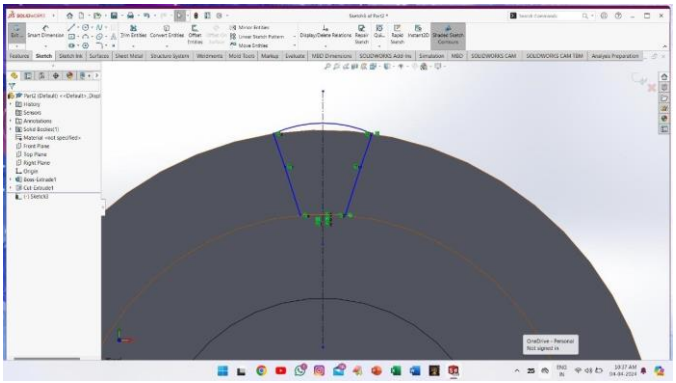


Fig. 2.6: Cutting angle of Wheel Grip

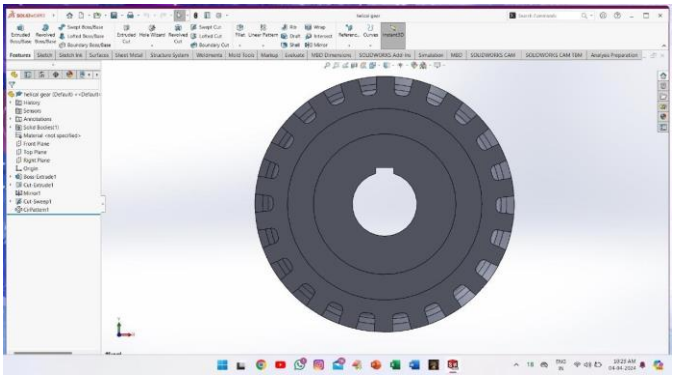


Fig 2.7: Front view of Wheel

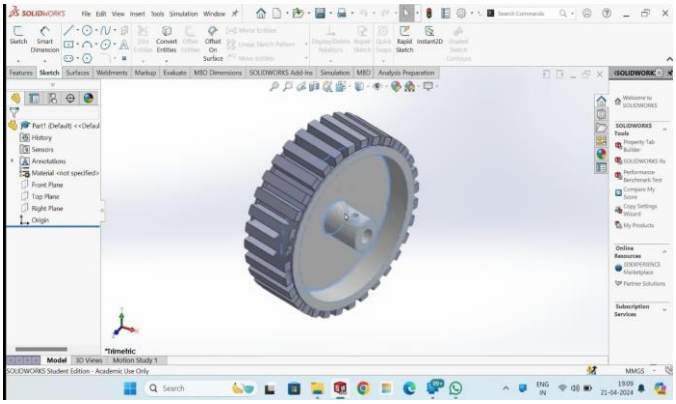


Fig. 2.8: Isometric view of Wheel

2.3 Chassis Design:

1. Click New.

2. Click Parts, OK.

3. Click "Front Layer" and click "Sketch".

4. Draw a rectangular field.

5. Specify the dimensions of the rectangular box.

6. Select the component and extrude it to the required dimensions.

7. Combine the wheels and frame.

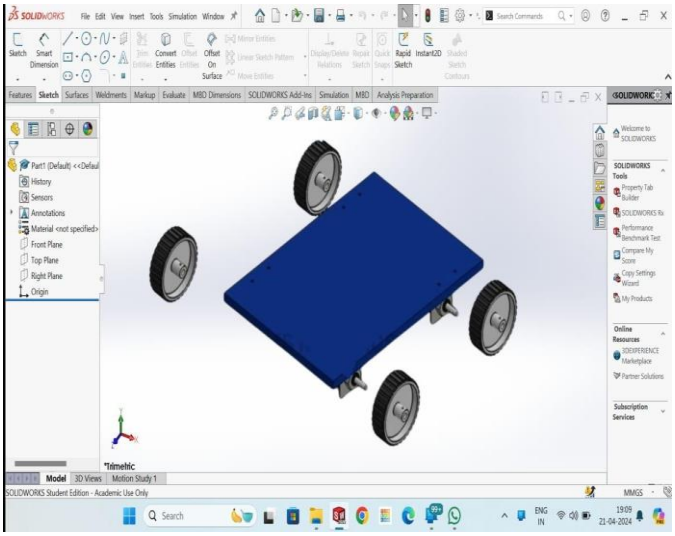


Fig. 2.9: Chassis

2.3 ARDUINO:

Arduino is an open source electronics platform consisting of both hardware and software components. Intended for hobbyists, students, and professionals interested in creating interactive and programmable electronic projects. This platform provides a simple and user-friendly way to develop projects with sensors, actuators and various electronic components.

Arduino is an open source electronics platform based on user-friendly hardware and software. The Arduino board can read an input (like a light on a sensor, a finger on a button, or a Twitter message) and convert it into an output (start a motor, turn on an LED, post something online). You can tell the board what to do by sending a series of instructions to the microcontroller on the board. To do this, we use the Arduino programming language (based on Wiring) and the Arduino software (IDE).

Fig. 2.10: ARDUINO

2.4 Programming:

```
#include <ESP8266WiFi.h>

#include <WiFiClient.h> #include
<ESP8266WebServer.h>

const char *ssid  =  "test";  const char
*password = "password"; int s1=70,
s2=90;

ESP8266WebServer server (80);
String page =""; //For the Web Server

String page2="“; //For updating Status of

robot int sensor=10; String mstr; void

setup () {


page = " < center > < h 1 > chittith
e robot < / h 1 > < body > < p > <

href=\"B\"><button>backward</button><
/a></p><center><p><a

href=\"R\"><button>right</button></a></p

><center><p><a href = \" L \" > < butto

n > left < / button > < / a > < / p > < p > <

center > < a href = \" S \" > < button

> Stop < / button > < / a > < / p > < p > <

a href = \" bullet \" >

< button > bullet < / button > < / a >

< / p > < p > < a

href=\"bulletO\"><button>bullet_OFF</butt

on></a></p></body>";

        delay (1000); pinMode(D3,OUTPUT);

pinMode(D4,OUTPUT); pinMode(D5,

OUTPUT);   // inputs for motor 1

pinMode(D6,OUTPUT);

pinMode(D7,OUTPUT);

// inputs for

motor 2 pinMode(D8,OUTPUT);

pinMode(LED_BUILTIN,OUTPUT);  // For

status of WiFi  connection


digitalWrite(D5,LOW);          digitalWrite(D6,LOW);
                               digitalWrite(D7,LOW);

digitalWrite(D8,LOW);
Serial.begin(115200);

Serial.println();

Serial.print("Configuring access point…");
WiFi.softAP(ssid, password);

IPAddress myIP = WiFi.softAPIP();
Serial.print("AP IP address: ");

Serial.println(myIP);  server.begin();

Serial.println("HTTP server started");
server.on("/", webpage);   server.on("/
F",Forward);

server.on("/B",Backward);
server.on("/L",Left);      server.on("/R",Right);

server.on("/S",stop1);

server.on("/bullet",bullet);// turns all the
```

```
motor input pins low

server.on("/bulletO",bullet_OFF);

delay(200); server.begin();

Serial.println("Web server started!");
}                    void

          loop     ()         {

          //mstr=String(sensor);

server.handleClient();

//server.send(200,"text/plain",mstr);

} void webpage()

{          server.send(200,          “text/html",

                                }

void Forward()

{

//analogWrite(D3,60);                  //analogWrite(D4,80);
                                       digitalWrite(D5,LOW);

digitalWrite(D6,HIGH);
digitalWrite(D3,HIGH);
digitalWrite(D4,LOW);

Serial.print('F');

page2="<center

><p> Robot

Status : Forward

</p></center>”;

Left()

{

page2="<center><p>

Robot

Status

Left</p></center>”;
server.send(200,"text/html",page+page2);

//    analogWrite(D3,s1);  //

analogWrite(D4,s2);

digitalWrite(D5,LOW);

digitalWrite(D6,LOW);

digitalWrite(D3,HIGH);

digitalWrite(D4,LOW); delay(200);

}          void
Right()

{

//analogWrite(D3,s1);

          //analogWrite(D4,s2);

page2="<center><p>  Robot  Status  :

Right</p></center>”;

server.send(200,"text/html",page+pag

e2);

digitalWrite(D5,HIGH);              digitalWrite(D6,LOW);

digitalWrite(D3,LOW);
digitalWrite(D4,LOW);  delay(200);

          Serial.print('R');

}      void  Backward()  {  page2="<center><p>  Robot
Status  :
Backward</p></center>”;
server.send(200, "text/html",
page+page2);

//analogWrite(D3,s1);          //analogWrite(D4,LOW);
                                  digitalWrite(D5,HIGH);

digitalWrite(D6,LOW); digitalWrite(D3,
LOW); digitalWrite(D4,HIGH); delay(200);
stop1()
```

```
{
page2="<center><p> Robot Status :
Stop</p></center>"; //
page3="<center><p> motor 2

Status : off</p></center>";
server.send(200,"text/html",page+page2);

//analogWrite(D3,s1);

        //analogWrite(D4,LOW);

        digitalWrite(D5,LOW);

digitalWrite(D6,LOW);

digitalWrite(D3,LOW);

digitalWrite(D4,LOW);


Serial.print('S');

{

String page5="<center><p> Bullet
firing</p></center>";
server.send(200,"text/

html",page+page5);                digitalWrite(D5,HIGH);
                                  digitalWrite(D6,LOW);

digitalWrite(D3,LOW);
digitalWrite(D4,HIGH); delay(3000);

}                 void

bullet_OFF()

{

String

page6="<cen

ter><p>

Bullet firing

stopped</p>

</center>";

server.send(

200,"text/ht

ml",page+pa

ge6);

digitalWrite(

D3,LOW);

        digit

alWrite(D4,L

OW);

}
```

3. Result:

The design and development of fertilizer spreading agricultural robots promises to revolutionize modern agricultural practices. Such innovations address major challenges in agriculture, including labor shortages, inefficient use of resources, and environmental issues. This report describes the results achieved with current prototypes and outlines the potential for further improvements and adoption in the future. The design and development of agricultural robots for fertilizer spreading is yielding promising results. Equipped with advanced sensor technology such as GPS, LiDAR, and cameras, these robots enable precise navigation and fertilizer spreading.

Why did you choose this agricultural robot?

1. Minimization of labor

2. Amount of work

3. Cost

4. Stress

Minimization of work: Introducing an agricultural robot requires a large amount of money at first. over time, you can reduce labor costs by automating tasks traditionally

performed by humans. be executed. This reduction in labor costs can lead to increased efficiency, productivity, and profitability for farmers.

4. Conclusion:

The aim of this study was to develop a low-cost agricultural robot for fertilizer application in the field and general crop monitoring. The prototype system is a two-wheeled robot consisting of a mobile base, a dispersing mechanism, a wireless controller to control the robot's movement, and a camera to monitor plant health and growth and detect the presence of pests in agricultural fields. Tests conducted on a prototype agricultural robot showed that it can deliver the required performance in real-world usage scenarios.

ACKNOWLEDGEMENT:

We wish to convey our sincere thanks to our internal guide **Mr. N. YADAGIRI,** Assistant Professor, Department of Mechanical Engineering and for his professional advice, encouragement in starting this project, and academic guidance during this project.

We wish to convey our sincere thanks to **Dr. B. VIJAYA KUMAR**, Professor & Head of Department, Department of Mechanical Engineering and COE of GNIT for his masterly supervision and valuable suggestions for the successful completion of our project.

We wish to express our candid gratitude to Principal **Dr. S. SREENATHA REDDY,** and the management for providing the required facilities to complete our project successfully. We convey our sincere thanks to the staff of the Mechanical Engineering Department and the Lab Technicians for providing enough stuff which helped us in taking up the project successfully.

We are also grateful to our well-wishers and friends, whose co-operation and some suggestions had helped us in completing the project. Finally, we would like to thank us parents for their exemplary tolerance and for giving us enough support in our endeavors.

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