DESIGN AND FABRICATION OF MULTIPURPOSE AGRICULTURAL ROBOT

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DHAKA, BANGLADESH

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A Graduation Exercise Submitted to the Department of Mechanical Engineering in Partial Fulfillment of the Requirements for the Degree of Bachelor of Mechanical Engineering

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MAY 2026

DECLARATION

We do hereby solemnly declare that, the work presented here in this project report has been carried out by us and has not been previously submitted to any University Organization for award of any degree or certificate

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Certification

This is to certify that this project entitled "Design and fabrication of multipurpose agricultural robot" is done by the following students under my direct supervision. This project work has been carried out by them in the laboratories of the Department of Mechanical Engineering under the Faculty of Engineering, Sonargaon University (SU) in partial fulfillment of the requirements for the degree of Bachelor of Science in Mechanical Engineering. Supervisor Prof. Md. Mostofa Hossain Head of Department, Department of Mechanical Engineering (ME) Sonargaon University (SU)Dhaka-1215, Bangladesh.

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ABSTRACT

The Agricultural Robot project aims to develop mechanically driven robot to assist in basic farming tasks, focusing on efficiency, time-saving, and labor reduction. This robot relying on a pre-designed mechanical system and motorized movement to navigate farmland and perform agricultural activities such as planting, watering, and soil tilling. It uses a simple motor-driven wheel system combined with gears, pulleys, and programmable movement paths to ensure coverage of the field in a structured and consistent manner. The robot's design emphasizes reliability, low maintenance, and cost-effectiveness, making it suitable for small to medium-scale farms. By automating repetitive tasks, it minimizes human effort while maintaining productivity and uniformity in crop care. The project demonstrates a practical approach to mechanized agriculture, showing how mechanical and electrical integration can improve farm operations without relying on complex electronics or sensors. This robot represents an accessible solution for farmers seeking to modernize their practices, increase efficiency, and reduce manual labor through simple, robust automation.

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CHAPTER - 1

INTRODUCTION

Overview

Agriculture is the cultivation of animals, plants, and fungi used to sustain and enhance human life agriculture was the key development in the rise of sedentary human civilization. Agriculture has been around for thousands of years, and its evolution has been shaped by vastly different climates, cultures, and technologies. Modern agronomy, plant breeding, agrochemicals such as pesticides and fertilizers, and technological advances have in many cases dramatically increased crop yields while causing widespread ecological damage. Agricultural food production and water conservation are becoming increasingly global concerns. Mechanized agriculture is the method of using agricultural machinery to mechanize agricultural work, significantly increasing farm worker productivity in modern times, and powered machinery has replaced many farm jobs previously performed by manual labor or by working animals like oxen, goats, and mules Many examples of the use of implements, such as the hoe and plough, can be found in agricultural history. However, the continuing integration of machinery since the industrial revolution has enabled farming to become much less labor intensive. Today's mechanized agriculture entails the use of tractors, trucks, combine harvesters, and a plethora of farm implements, airplanes and helicopters, and other vehicles. Mechanization was a major contributor to rapid urbanization and the development of modern economies. Mechanization, in increase production productivity, allows large-scale production and, in some cases, can enhance the quality of farm produce; however, it can displace unskilled farm labor and affect environmental destruction, especially if used in a short-sighted rather than holistic manner.

Agriculture is the backbone of Bangladesh. The history of agriculture in Bangladesh dates back to ancient times, with rice cultivation being central part of the country's economy and culture for centuries. Today, Bangladesh is among the leading countries in farm productioninSouthAsia.Specialvehiclesandmechanizedsystemsplayamajorrolein various fields such as industrial, medical, and military applications, and their use in agriculture is gradually increasing productivity. Some of the major problems in Bangladeshi agriculture include rising input costs, shortage of skilled labor, limited water resources, and challenges in crop monitoring. To address these issues, automation and mechanization technologies are being adopted in agriculture, helping farmers improve efficiency, reduce labor dependency, and optimize resource use.

The agricultural census gives vital information on the distribution of land holdings in our country. According to the census majority of the farmers are having the land less than 1 hectare . This is one of the major drawbacks for the mechanization in agricultural sector in India.

The vehicles are being developed for the processes for ploughing, seed sowing, leveling, water spraying. All of these functions have not yet performed using a single vehicle. In this the robots are developed to concentrate in an efficient manner and also it is expected to perform the operations autonomously. The proposed idea implements the vehicle to perform the functions such as ploughing, seed sowing, mud leveling, water spraying.

Problem Statement

Traditional agricultural practices are labor-intensive, time-consuming, and often inefficient, especially for small and medium-scale farmers who lack access to advanced machinery. Manual farming methods lead to inconsistent results, increased physical strain, and higher operational costs. Additionally, the shortage of skilled labor and rising demand for food production present significant challenges. There is a pressing need for a cost-effective, automated solution that can perform multiple farming tasks with precision and minimal human intervention. The development of a multipurpose agriculture robot addresses these issues by integrating various functions—such as sowing, spraying, and monitoring—into a single, efficient, and sustainable robotic platform.

Objectives

The objective soft his project are:

- To design and construct Multipurpose Agriculture Robot.
- To fabricate a robot vehicle put the seeds and close the mud to spray water.
- To save human energy.

CHAPTER - 2

LITERATUREREVIEW

2.1 Literature Review

Firas B. Ismail et. Al this research has the conventional grass cutters have been widely used recently by workers in the gardening and agricultural industries [1]. However, the manual handled grass cutters are consuming a lot of energy and producing air pollution which can directly affect the workers' health. The conventional grass cutters are also creating a high level of noise and vibration which can cause serious health issues such as grip strength, decreased hand sensation and dexterity, finger blanching or 'white fingers and carpal tunnel [2]. In order to address these issues, a new design of a grass cutter machine has been proposed. This device can be fueled by solar energy and smartly controlled, which has been named as a Smart Solar Grass Cutter that has three main systems which are smart control system, solar system, and the grass cutter. According to the national air space association (NASA), there is a1.361 kW/m²ofsolar irradiance received at the top of Earth's atmosphere [3].

T. Koppel et.al the aim of this study was to compare vibration and noise characteristics caused by different types of lawn maintenance machines in association with the risk factors to workers' health [4]. in the present study, the method connecting vibration hazard, health damages and risk levels is presented. Three types of agriculture machines were investigated: all-terrain vehicles (ATV), simple lawn-mowers, ride-on mowers. These machines are used not only in occupational settings, but also by the inhabitants for cutting grass [5]. the gardeners and maintenance workers of the municipal authorities use them daily, sometimes8 hours a day. The protective equipment against noise is used in occupational settings, but hardly by the public. Noise was evaluated using a Sound Level Meter (TES 1358) following the standard ISO 9612:2009. Vibration was determined as acceleration, velocity and amplitude – measured using a Vibration Dosimeter & Analyzer (SV 100) following the standards ISO 2631-4, EVS-EN 5349-2. The risk to the health is assessed by the original flexible risk assessment method worked out in TTU. On the basis of this flexible model the scheme for connecting the local and whole-body vibration hazards and possible health damages was worked out [6]. the results showed that there are differences in the noise and vibration generated by the ATV, lawn-mowers and ride-on mowers. The safest was ride-on mower (localvibrationbelow1.15 m(s2)-1). Lawnmowers gave high vibration levels (over 3 m (s2) -1). The personal protective equipment (PPE) has to be worn by all users of the investigated machines. The noise spectral content by these three types of machines is presented and it is different [7]. this enables to choose the right type of ear-muffs by the frequency of noise. The PPE against vibration is also available.

R. V. Sanjana Arunas et.al grass cutter machines have become very popular today. Most common machines are used for soft grass furnishing. This project aims at developing the Grass cutter operation and construction [8]. The main parts of the Grass cutting machines are DC motor of 75HP capacity, relay switch for controlling motor, Battery for charging it through solar panel. It is placed in a suitable machine structure. The motor has 18000 rpm and it is connected to the electric supply by the use of a roll of wire. The motor rpm increased by the help of gears. Motor controlled by an electric switch for easy operation. The tempered blades are attached in this machine [9]. The raw materials mainly used are GI sheet, motor, switch, wheel, wire, aluminum sheet, square pipe, paint, insulating material and other standard item like nuts, bolts and reverts. The machines required for manufacturing includes welding machine, grinding machine etc. Working principle of the grass cutter is providing a high speed rotation to the blade, which helps to cut the grass. The blade will get kinetic energy while increasing the rpm. The cutting edges are very smooth and accurate. Also Electric Grass Cutting Machines are much easier to be used in garden, lawn and grass fields [10].In order to enhance the beauty of home- lawns and gardens, Grass cutting machines are the best available option in the industry. With the help of a lawn mower which is a machine with revolving blades to help us cutting lawns at even length, people can easily maintain and beautify their lawns and gardens without any hassle. Now-a-days, there are plenty of options starting from the simplest push along mower to the most advanced electric grass cutting machine. According to world energy report, we get around 80% of our energy from conventional fossil fuels like oil (36%), natural gas (21%) and coal (23%). It is well known that the time is not so far when all these sources will be completely exhausted. So, alternative sources should be used to avoid energy crisis in the nearby future [11].

Aibak, A., Kamer et.al approximately one million agricultural tractors are used in Turkey for crop production and about one-third of the population lives in rural areas. The objectives of this study was to determine sound pressure levels, A-weighted sound pressure levels, and the permissible exposure time for tractors without cabins, field-installed cabins, and original cabins at ear level of agricultural tractor operators for following machines: plows, cultivators, top soil cultivators, rotary tillers, tool combinations (harrow þ roller), mechanical drills, pneumatic drills, chemical applicators, fertilizer applicators, drum mowers, balers, and forage harvesters. Variance analyses showed that type of operation, type of cabins, and operation cabin interactions were statistically significant ($P < 0.01$) both for sound pressure levels and equivalent(A-weighted) sound pressure levels [12]. The use of original cabins had a greater effect in decreasing average sound pressures and resulted in more efficient noise insulation, especially at higher center frequencies compared to field installed cabins whereas field-installed cabins proved to be more favorable compared to tractors without cabins. Sound pressure level sat 4000Hzcenter frequency was reduced2–13 dB and 4–18 dB by using a field-installed cabin and an original cabin, respectively [13]. The measured A-weighted equivalent sound pressure levels were compared to the threshold limit level, and was concluded that depending on the cabin types used, the operators could usually work from 4 to6h away without suffering from noise induced inconveniences while 2–3 h is permissible for plowing and forage harvesting on tractors without cabins. Due to timeliness considerations in agricultural machine operations, a farmer would not be willing to interrupt the operation based on permissible exposure time set by the standards [14].

CHAPTER-3

METHODOLOGY

Methodology

Our methodologies for the project:

- Creating an idea for design and construction of a **Multipurpose Agriculture Robot**. And designing a block diagram & circuit diagram to know which components we need to construct it.
- Collecting all the components and programming the micro controller to control the whole system.
- Setting up all the components in a PCB board & then soldering. Lastly, assembling all the blocks in a board and to run the system & for checking purposes.

Work Flow Diagram

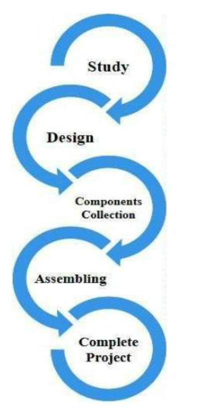

Figure1.1: Working Flow Diagram

Working Principle

The multipurpose agricultural robot operates using a DC power supply provided by a rechargeable battery, which can be charged through an AC to DC transformer. Buck converter is used to step down the voltage to safe levels for the on-board components. The robot is controlled by a Node MCU, which acts as the main control unit, managing all movements and farming operations. Four gear motors provide locomotion and are controlled via motor driver to ensure smooth movement across the field. The plowing function is now operated using a servo motor, allowing precise control over soil tilling. Additional gear motors handle seed sowing, powered through a separate motor driver. Irrigation is carried out by a water pump motor, which is controlled via a relay. The robot is fully remote-controlled using Node MCU-based transmitter and receiver modules. Commands sent from the transmitter is received and processed by the onboard Node MCU, which executes the corresponding motion and farming tasks. This system allows efficient seed sowing, plowing, and watering, providing a cost-effective and practical automation solution for small-scale farming.

Cost Analysis

Table1: List of Component with Price

Sl. no	Particulars	Specification	Qty.	Unit Price (Taka)	Total Price (Taka)
1	Node MCU	ESP32	2	700	1400
2	Battery	12V	1	1200	1200
3	Buck Converter	LM2596	2	200	400
4	Gear Motor	37GB	4	1000	4000
5	Gear Motor	25GB	1	600	600
6	Motor Driver	LM298N	2	250	500
7	Transformer	220v50Hz	1	350	350
8	Water Pump	5v	1	250	250
9	Relay		1	150	150
10	Wheel		4	150	600
11	Battery	3.7V	2	100	200
12	Servo Motor	MG995	1	500	500
13	Others				2000
				Total	12,150/=

CHAPTER -4

HARDWARE& SOFTWAREANALYSIS

4.1 Components List

Hardware Part

1. Node MCU
2. Battery-12v
3. Buck Converter
4. Transformer
5. Gear Motor
6. Motor Driver
7. Pump Motor
8. Relay
9. Servo Motor

4.2 Node MCU

Node MCU V3 ESP32 ESP-12E is Wi-Fi development board that helps you to prototype your IoT product with few Lua script lines, or through Arduino IDE. The board is based on ESP32 ESP-12E variant, unlike other ESP-12E, you won't need to buy a separate breakout board, sub to serial adapter, or even solder it to a PCB to get started, you will only need a usb cable (Micro USB).

Figure: Node MCU

4.3 Battery

A twelve-volt battery has six single cells in series producing a fully charged output voltage of 12.6 volts. A battery cell consists of two lead plates a positive plate covered with a paste of lead dioxide and a negative made of sponge lead, with an insulating material (separator)in between.

Figure:12V Battery

Quick Details

- NominalCapacity:200AH
- rechargeable12vdcbatterypack:1PCS/CTN (accordingtotheactualsituation)
- Production Capacity : rechargeable12vdcbatterypack:50000PCS/Month
- Maintenance Type: Free
- Voltage:12V

4.4 Buck Converter

A buck converter (step-down converter) is a DC-to-DC power converter which steps down voltage (while drawing less average current) from its input (supply) to its output (load).It isa class of switched-mode power supply (SMPS) typically containing at least two semiconductors (a diode and a transistor, although modern buck converters frequently replace the diode with a second transistor used for synchronous rectification) and at least one energy storage element, a capacitor, inductor, or the two in combination. To reduce voltage ripple, filters made of capacitors (sometimes in combination with inductors) are normally added to such a converter's output (load-side filter) and input (supply-side filter). It is called a buck converter because the voltage across the inductor “bucks” or opposes the supply voltage.

Figure: DC-DC Buck Converter

4.5 Transformer

A transformer is an electrical device used to change the value of an alternating voltage. Transformers are widely used in electrical work. They are encountered daily, in industrial, commercial and domestic situations. They vary in size from miniature units used in electronics to huge units used in power stations. The efficient transmission and distribution of electricity throughout the country would be impossible without the use of power transformers. Center Tapped Step Down Transformer is a general-purpose chassis mounting mains transformer. Transformer has 230V primary winding and center tapped secondary winding. The transformer has flying colored insulated connecting leads (Approx 100 mm long). The Transformer act as step down transformer reducing AC - 230V to AC - 12V.The Transformer gives outputs of 12V, 12V and 0V.

Figure: Transformer

4.6 Gear Motor

A DC motor is any motor within a class of electrical machines whereby direct current electrical power is converted into mechanical power. A 12v DC motor is small and inexpensive, yet powerful enough to be used for many applications.

Figure: DC Gear Motor

Specification

- Voltage:12VDC
- Gearratio:1/31
- No-loadspeed:200RPM
- RatedSpeed:65RPM
- Ratedtorque:10kg.cm
- Ratedcurrent:2.5Amp
- Length of Motor (including spindle):106mm/4.17″
- Diameter:37mm/1.45″
- Shaftlength:21mm/0.82″
- Shaftdiameter:6mm/0.24″

4.7 Relay

A relay Is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays reused where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

4.8 Pump Motor

This is a low cost, small size Submersible Pump Motor which can be operated from a 2.5 ~ 6V power supply. It can take up to 120litters per hour with very low current consumption of 220mA. Just connect tube pipe to the motor outlet, submerge it in water and power it. Make sure, that the water level is always higher than the motor. Dry run may damage the motor due to heating and it will also produce noise.

Figure: Pump Motor

Feature
OperatingCurrent:130~220mA
FlowRate:80~120L/H
Maximum Lift: 40~110mm
Continuous Working Life: 500 hours
Driving Mode: DC, Magnetic Driving
Material: Engineering Plastic
OutletOutsideDiameter:7.5mm
OutletInsideDiameter:5mm

4.9 Motor Driver

The LM298N is a popular 16-Pin Motor Driver IC. As the name suggests itis mainly used to drive motors. A single LM298N IC is capable of running two DC motors at the same time; also, the direction of these two motors can be controlled independently.

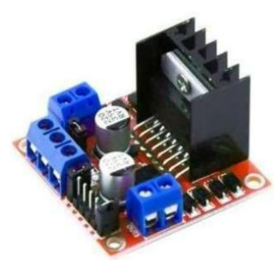

Fig: Motor Driver

4.10 Servo Motor

A servo motor is an electrical device that can push or rotate an object with great precision. If you want to rotate and object at certain angles or distances, you use servo motors. It is made by a simple motor which is driven by a servo mechanism. If the motor is DC driven thenitiscalledDCservomotorandifitisACdrivenmotorthenitiscalledACservomotor. We can get a very high torque servo motor in a small and light weight package. These are being used in various applications like toy cars, RC helicopters and planes, robotics, machines etc.

Figure: Servo Motor

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CHAPTER - 5

RESULT ANALYSIS

5.1 Data calculation

Design Calculation for Ploughing Tool

- **Depth of cut**=5cm
- **Speed of the tool**=12m/s=speed of the vehicle
- **Number of teeth**=5
- **Speed(N)**=65rpm (of the motor)
- **Feed rate=**speed of the tool ÷ speed of the motion

Feed rate, FR= (12×60) ÷ 65

=11.07m/rev

Design Calculation for Seed Sower

- **Speed of the motor**=65rpm
- **Row spacing**=2cm
- **Seed sowing time**=2sec/per seed
- **Number of openings**=9perrow
    - 3×9=27openings

Seed dropping per minute:

= (65×27) ÷ 54

=32seed

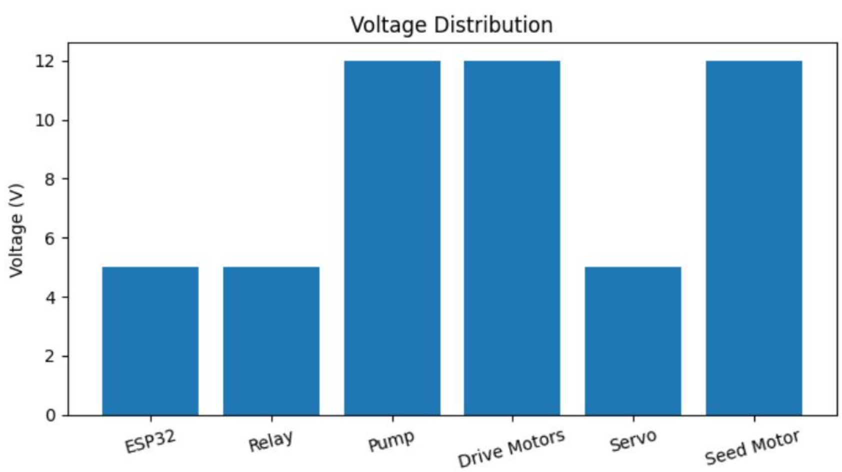
5.2 Load, Voltage and Power System Analysis

The following graphs are prepared from the electrical system used in the Multipurpose Agricultural Robot project.

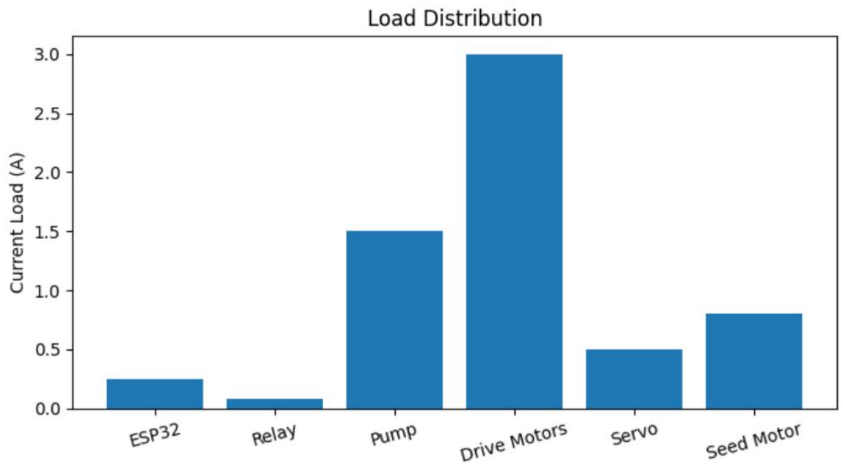
Electrical Parameters Table

Component	Voltage (V)	Current (A)	Power (W)
ESP32	5	0.25	1.25
Relay	5	0.08	0.40
Pump	12	1.5	18.00
Drive Motors	12	3.0	36.00
Servo	5	0.5	2.50
Seed Motor	12	0.8	9.60

Voltage Graph

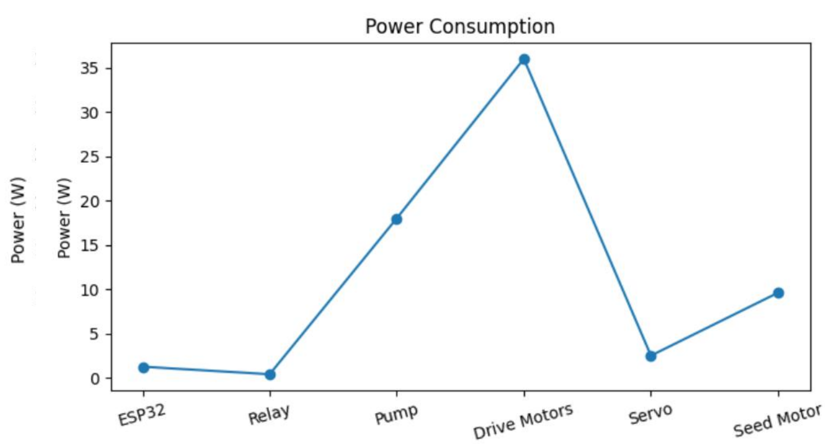


Load Graph



Load Distribution
Current Load (A)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ESP32
Relay
Pump
Drive Motors
Servo
Seed Motor

Power Graph



The drive motors and pump consume the highest electrical power in the system. The ESP32 controller and relay modules require comparatively low power.

5.3 Project Outcomes

After finally completing this project, we ran it & we observed the output of this project. We can see that it is working well as expected. After making our project we observe it very careful. It works as we desire. Our project give output perfectly and all equipment are work perfectly. We check how much it works and we get perfect output from this project.

- The robot successfully performs three key farming tasks: seed sowing, plowing, and watering.
- Servo motor control for plowing offered precise soil tilling compared to traditional gear motor use.
- The water pump motor with relay switching delivered consistent irrigation output.
- The robot reduced manual labor effort, offering cost-effective alternative for repetitive farming operations.
- Remote Control Functionality works effectively with in the teste derange, enabling smooth operation of movement and farming tasks.

5.4 Complete Project Prototype

Figure5.4: Our Final project

5.5 Advantage

There are many advantages soft he projects. Some of the seared given below:

- No need of human effort in the agricultural field.
- 3 operation is done at single time, hence increases production and saves time.
- Using battery hence no chance of pollution.
- Farmar can operate this robot through remote by sitting at one side.

5.6 Applications

This project has applications in many fields due its necessity. We have selected a few of them and they are given below:

Used for automatic Digging, so wing, made lasing and water sprinkling
purpose.

Al souse for pesticide sprinkling.

Automatic flow of
seed(controllable).

Al soused for soil inspection

Suitable for rural are asunder ban areas.

CHAPTER - 6

CONCLUSION

Conclusion

The multipurpose agricultural robot project successfully highlights the potential of simple automation in modern farming. Designed with Node MCU as the central controller, the system integrates gear motors for mobility and seed sowing, a servo motor for plowing, and a water pump motor for irrigation. This configuration ensures reliable operation while reducing the need for complex sensors or costly technologies. The use of a Node MCU-based transmitter and receiver allow smooth wireless control, enabling farmers to manage operations from a distance with ease. The prototype effectively demonstrates how seed sowing, plowing, and watering can be performed in an efficient, time-saving, and cost-effective manner. By reducing dependency on manual labor, the robot offers a practical solution to challenges faced in small-scale farming, such as rising labor costs and time management. Overall, this project contributes toward promoting agricultural mechanization, improving productivity, and showing how low-cost automation can play a vital role in sustainable farming practices.

Future Recommendation

As we have already discussed about the advantages, applications of our project
So definitely there's room for improvement. Some of these are listed below:

- Infuturedevelopmentthisprojectcanbedevelopbymoresensor&alar msystem. In Future we will add extra power system.
- In future develop Control on IoT System.
- In the future, add a GSM module to send an SMS alert system

REFERENCES

[1] Firas B. Ismail, Nizar F.O. Al-Muhsen, Fazreen A. Fuzi, A. Zukipli, "Design and Development of Smart Solar Grass Cutter", International Journal of Engineering And Advanced Technology, pp 4137-4141, ISSN: 2249 – 8958, Volume-9, Issue-2, December2019

[2] T. Koppel, P. Tint, G. Karajeva, K. Reinhold, and S. Kalle, \"Vibration and noise A used by lawn maintenance machines in association with risk to health, \" Agronomy Research, vol. 10, pp. 251-260, 01/01 2012.

[3] R. V. Sanjana Arunesh, Shreyas Arunesh, Nivetha N., \"Design and Implementation Of Automatic Lawn Cutter, \"IJSTE-International Journal of Science Technology & Engineering, vol. 2, no. 11, 2016, doi:http://www.ijste.org/articles/IJSTEV2I11065

[4] Aybek, A., Kamer, H.A., Arslan, S. 2010. Personal noise exposures of operators of agricultural tractors. Applied Ergonomics, 41, (2), 274–291.

[5] B. P. Dilip, N. B. P. , V. S. U. , S. W. , and P. S. M. , \"Design And Implementation of Automatic Solar Grass Cutter,\"International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, vol. 6, no.4, 2017, doi:http://www.ijareeie.com/volume6-issue-4

[6] F.D.W.PrafulP.Ulhe,ManishD.Inwate,KrushnkumarS.Dhakte, \"Modification of Solar Grass Cutting Machine,\"IJIRST–International Journal

for Innovative Research in Science & Technology, vol. 2, no. 11, 2016,doi: http://www.ijirst.org/articles/IJIRSTV2I11261.pdf.

[7] O. A. Tanimola, Diabana, P. D, Bankole, Y. O., \"Design and Development of a Solar Powered Lawn Mower,\" International Journal of Scientific & Engineering Research, vol. 5, no. 6, 2014, doi: https://www.ijser.org/researchpaper/DESIGN-ANDDEVELOPMENT-OF-A-SOLAR-POWERED-LAWN-MOWER.pdf.

[8] H. A. B. Y.M.Gaikwd, Pooja.S.Ighe, Vishakha.S.Birari, \"Solar based Automatic GrassCutter,\"IJSTE-InternationalJournalofScienceTechnology&Engineering, vol.3,no.7,2017,doi:http://www.ijste.org/articles/IJSTEV3I7045.pdf

[9] SmartSolarGrassCutterRobotforGrassTrimming\"byAshishkumarchaudhari, Yuvrajsahu, Pramodkumarsahu, SubhashChandraverma

[10] Arkin,E.M.,Fekete,S.P.,Mitchell,J.S.B.“Thelawnmowerproblem”, Proceedings of the 5th Canadian Conference on Computational Geometry, 1993, 461-466

[11] Reid, J.F., Zhang. Q., Noguchi, N., and Dickson, M. “Agricultural Automatic Guidance Research in North America.” Computers and Electronics in Agriculture. Vol. 25, 2000, pp. 155-167.

[12] AvitalBechar,ClementVigneault“Agriculturalrobotsforfieldoperations: concepts and components” Biosystems Engineering, 2016

[13] Morton Lillomo.; Caruso, L.; Cerruto, E.; Emma, G.; Schillaci, G. A Prototype of Self Propelled Sprayer to Reduce Operator Exposure in Greenhouse Treatment. In Proceedings of the Ragusa SHWA International Conference: Innovation Technology to Empower Safety, Health and Welfare in Agriculture and Agro-food Systems, Ragusa, Italy, 15–17 September 2008

[14] Mohammad Thariq Hameed Sultan, Binod Poudel, Ritesh Sapkota, Ravi Bikram Shah, Navaraj Subedi, Anantha Krishna G.L, Design and fabrication of solar powered semi-automatic pesticide sprayer

[15] Shiva Gorijin Harshit Jain,Nikunj Gangrade, Sumit Paul, Harshal Gangrade, Jishnu Ghosh, Design and fabrication of Solar pesticide sprayer

APPENDIX

ProgrammingCode:

//**Transmitter**///

```
#include <WiFi.h>
#include<HTTPClient.
h>

//Buttonpinconfigurati
on const int btnUp =21
; //constintbtnDown=4;
const int btnLeft = 18;
const int btnRight =
19;
const int ledPin = 2;       //WiFistatusLED
#define btnDown 4          // Fan Relay

const int btnu =34 ;
const int btnd =32 ;
const int btnp =35;
const int btnr =39 ;

// Add these global variables at the top of your code
int pState = 0;          // Current toggle state (0 or 1)
int lastPButton = 0;     // Previous raw button read
bool pChanged = false;// To detect new press

// Add these global variables at the top of your code
```

```
int rState = 0;          // Current toggle state (0 or 1)
int lastrButton = 0;     // Previous raw button read
bool rChanged = false;// To detect new press

// WiFitarget
String targetSSID = "ESP_SERVER";
String targetIP = "192.168.4.1";

//Functionto connecttoserver
void connectToESPServer() {
  Serial.println("Scanning for ESP_SERVER...");
  int n = WiFi.scanNetworks();
  boolfound=false;

  for(inti=0;i<n;++i){
    if (WiFi.SSID(i) == targetSSID) {
      Serial.println("ESP_SERVER found. Connecting...");
      WiFi.begin(WiFi.SSID(i).c_str());

      unsignedlongstartTime=millis();
      while (WiFi.status() != WL_CONNECTED && millis() - startTime < 10000) {
        delay(500);
        Serial.print(".");
      }

      if (WiFi.status() == WL_CONNECTED){
        Serial.println("\nConnected!
        "); found=true;
      }
      break;
    }
  }

  if(!found)Serial.println("ESP_SERVERnotfound!");
}

void setup() {
  Serial.begin(115200);
  WiFi.mode(WIFI_ST
  A);

  //Setupbuttons
  pinMode(btnUp,
  INPUT_PULLUP);
  pinMode(btnDown,INPUT_PUL
  LUP);
  pinMode(btnLeft,
  INPUT_PULLUP);
  pinMode(btnRight,
  INPUT_PULLUP);
  pinMode(ledPin, OUTPUT);
```

```
 pinMode(btnu,
 INPUT_PULLUP);
 pinMode(btnd,
 INPUT_PULLUP);
 pinMode(btnp,
 INPUT_PULLUP);
 pinMode(btnr,
 INPUT_PULLUP);
 connectToESPServer();
}

voidloop(){
 //Readbuttons(RAWvalues)
 intup=digitalRead(btnUp)==LOW?1:0;
 intdown=digitalRead(btnDown)==LOW?
 1:0;
 int left = digitalRead(btnLeft) == LOW ? 1 :
 0;int
 right = digitalRead(btnRight) ==LOW ? 1 : 0;
 int
 u = digitalRead(btnu) == LOW ? 1 : 0;
 intd=digitalRead(btnd)==LOW?1:0;

 //=====TOGGLEforp=====
 int pRaw = digitalRead(btnp) == LOW ? 1 : 0; // raw press detection
 if (pRaw == 1 && lastPButton == 0) {          // button just pressed
 pState = !pState;                       // toggle state
   pChanged=true;                           //markchange
 }
 lastPButton=pRaw;//storelastread

 // UsepState instead of pRaw for sending
 int p = pState;


//=====TOGGLEforr=====
 int rRaw = digitalRead(btnr) == LOW ? 1 : 0; // raw press detection
 if (rRaw == 1 && lastrButton == 0) {          // button just pressed
 rState = !rState;                       // toggle state
   rChanged=true;                           //markchange
 }
 lastrButton=rRaw;//storelastread

 // UsepState instead of pRaw for sending
 int r = rState;
//intr=digitalRead(btnr)==LOW?1:0;

 //ShowonSerial
 Serial.printf("Up:%d Down:%d Left:%d Right:%d u:%d d:%d p:%d r:%d\n",
           up, down, left, right, u, d, p, r);
```

```
  if(WiFi.status()==WL_CONNECTED){
    //PrepareJSON
    String payload = "{\"up\":" + String(up) + ",\"down\":" + String(down) +
                ",\"left\":" + String(left) + ",\"right\":" + String(right) +",\"u\":"
                + String(u) + ",\"d\":" + String(d) +
                ",\"p\":"+String(p)+",\"r\":"+String(r)+"}";

    //HTTPPOST
    HTTPClienthtt
    p;
    http.begin("http://" + targetIP + "/data");
    http.addHeader("Content-Type","application/json");
    int httpCode = http.POST(payload);

    if(httpCode>0){
      String response = http.getString();
      Serial.println("Response: " +
      response);

      digitalWrite(ledPin,HIG
    H); }else{
      Serial.println("POSTfailed
      "); digitalWrite(ledPin,
      LOW);
    }
    http.end()
  ; }else{
    Serial.println("WiFi disconnected.
    Reconnecting..."); digitalWrite(ledPin, LOW);
    connectToESPServer();
  }

  delay(10);//Shorterdelayforbetterbuttonresponse
}
```

//**Reciver**//

```
#include <WiFi.h> #include
<WebServer.h>
#include<ArduinoJson.h>
#include<ESP32Servo.h>//Servolibr
ary

// ===== Motor Pins =====
const int IN1 = 12;
const int IN2 =13;
const int IN3 =14;
constintIN4=27;
```

```
//=====RotorPins=====
const
int r_IN3 = 25;
constintr_IN4= 33;

//=====Servo forPlow =====
Servo
plowServo; constintplowPin=18;
int plowAngle = 60;// initial position
const
int plowMin = 0;
constintplowMax=90; const int
plowStep = 5;

//=====PumpPin=====
constintpumpPin=26;//ChooseanyfreeGPIOpinforpumpcontrol

//=====WiFi=====
const char* ssid = "ESP_SERVER";
WebServer server(80);

//=====rotorControlFunctions=====




voidmoverotorStop(){
 digitalWrite(r_IN3,LOW);digitalWrite(r_IN4,L
OW); } voidmoverotorStart(){
 digitalWrite(r_IN3,HIGH);digitalWrite(r_IN4,LOW);
}

// ===== Motor Control Functions
===== void moveStop() {
 digitalWrite(IN1, LOW); digitalWrite(IN2,
 LOW);
 digitalWrite(IN3,LOW);digitalWrite(IN4,LO
 W);
}
voidmoveForward()
{
 digitalWrite(IN1, HIGH); digitalWrite(IN2,
 LOW);
 digitalWrite(IN3,HIGH);digitalWrite(IN4,LO
 W);
}
voidmoveBackward(
){
 digitalWrite(IN1, LOW); digitalWrite(IN2,
 HIGH);
 digitalWrite(IN3,LOW);digitalWrite(IN4,HIG
 H);
}
```

```
voidmoveLeft()
{
 digitalWrite(IN1, LOW); digitalWrite(IN2,
 HIGH);
 digitalWrite(IN3,HIGH);digitalWrite(IN4,LO
 W);
}
voidmoveRight()
{
 digitalWrite(IN1, HIGH); digitalWrite(IN2, LOW);
 digitalWrite(IN3,LOW);digitalWrite(IN4,HIGH);
}

// =====Web Request Handler =====
void handleButtonControl() {
 if(!server.hasArg("plain")){
  server.send(400, "text/plain", "Bad Request");
  return;
 }

 String body =server.arg("plain");
 StaticJsonDocument<200> doc;
 DeserializationError err = deserializeJson(doc,
 body);
 if (err) {
  server.send(400, "text/plain", "JSON Error");
  return;
 }

 intup=doc["up"];
 intdown=doc["down"
 ];
 int left = doc["left"];
 intright=doc["right"];
 int
 u = doc["u"];




 intd=doc["d"];
 intp=doc["p"];
 intr= doc["r"];

 Serial.printf("Up:%d|Down:%d|Left:%d|Right:%d|U:%d|D:%d|P:%d|
R:%d \n",
        up,down,left,right,u,d,p,r);

 //Motorcontrol
 if(up==0)moveForward
 ();
```

```
  elseif(down == 0)moveBackward();
  else
  if (left == 0) moveLeft(); elseif(right
  == 0)moveRight(); else
  moveStop();

  //Pumpcontrol
  if (p == 0) digitalWrite(pumpPin, HIGH);
  else digitalWrite(pumpPin, LOW);

  //Rotorcontrol
  if(r==0)moverotorStart();
  else
  moverotorStop();

  // Servo control → increase / decrease
  angle if (u == 0) {
    plowAngle+=plowStep;
    if (plowAngle > plowMax) plowAngle =
    plowMax; plowServo.write(plowAngle);
  }
  else if (d == 0) {
    plowAngle-=plowStep;
    if (plowAngle < plowMin) plowAngle = plowMin;
    plowServo.write(plowAngle);
  }

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

//=====Setup===== void
setup() {
Serial.begin(115200);
WiFi.softAP(ssid);
  Serial.print("ESP32 AP IP: ");
  Serial.println(WiFi.softAPIP());

  //Motorpins
  pinMode(IN1, OUTPUT); pinMode(IN2, OUTPUT);
  pinMode(IN3, OUTPUT); pinMode(IN4, OUTPUT);
  moveStop();


  //Rotorpins
  pinMode(r_IN3, OUTPUT); pinMode(r_IN4, OUTPUT);
  moverotorStop();

  // Servo pin
  plowServo.attach(plowPin);
  plowServo.write(plowAngle);//initialposition
```

```
  // Pump
  pinpinMode(pumpPin,OUT
  PU T);
  digitalWrite(pumpPin,LOW);//DefaultPumpOFF

  //Webserver
  server.on("/data", HTTP_POST, handleButtonControl);
  server.begin();
}

// ===== Loop =====
void loop() {
server.handleClient();
```