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IoT Based Solar Powered Multipurpose Agriculture Robot

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Abstract: In India, farming employs 70% of the labor force. In agriculture, there are several methods, including seed sowing and ploughing. The existing methods of seeding, spraying pesticides, and ploughing are inefficient. Costly and unwieldy equipment is necessary for the aforementioned activities. As a consequence, developing a system that decreases the need for labor and time can help India's agricultural sector. The proposed study intends to construct a robot capable of ploughing, seed planting, and water spraying. The suggested robot is powered by solar photovoltaic (PV) panels, eliminating the requirement for an external power source. The whole architecture is restricted by an Android application that interfaces with an IoT ESP8266 and sends signals to the robot for needed activities. As a result, DC motors are used to plough the ground and plant the seeds. Consistent spacing is maintained for seed sowing. To irrigate the crop, a sprinkler with revolving nozzles is used. This mechanical vehicle will save labor costs while also speeding up and improving accuracy. It combines many activities, so it is cost-effective. When compared to tractors or other agricultural instruments such as electric pumps, this equipment requires less energy.

IndexTerms **- Agribot,ESP8266,IoT,Arduino,Solar panel,MIT app.**

I. INTRODUCTION

Agriculture has been around for thousands of years, and its evolution has been shaped by a variety of climates, civilizations, and technologies. As a result, the agricultural system should be upgraded to reduce farmers' efforts. The designed model automatically sows the seeds and sprays insecticides. Based on robotic assistance, the prototype offers innovative technology for optimizing agricultural procedures such as seed planting and pesticide spraying. In today's age, particularly in the agriculture sector, we do not have enough competent laborers. Manual farming takes more time and produces more pollutants. The major goal of creating automation in the agricultural industry is to minimize labor and time necessary to execute procedures on crops, so that human efforts may be reduced by up to 90%. Automation is necessary for worker safety and health, particularly when people are expected to do hazardous tasks. Crop sowing, which includes autonomous precision seeding and integrates robotics and geomapping, is a previously established robotics application. Precision Hawk supplies farmers with a mix of robotic hardware and analytic software to monitor and analyze crops. Other applications include agricultural weeding and spraying systems, autonomous tractors, and harvesting and picking systems.

More and more agricultural enterprises are turning to the Internet of Things (IoT) to increase their capabilities, efficiency, global reach, and a host of other factors. Sensors will continue to become smaller, more complicated, and more inexpensive thanks to this discovery. Because networks are utilized all across the globe, smart farming is a success. Smart farming, which focuses on innovation in the agricultural sector, is the primary answer to the difficulties that businesses are experiencing today. Farmers may get the necessary information and monitor their agricultural sector by using IoT devices and smartphones.

The system is made up of simple components such as a solar panel, a DC motor, a battery, a relay, a motor driver, a relay driver, a WiFi module, and an Arduino controller. The whole process is managed by a microcontroller. The battery is charged by the solar panel. This battery provided electricity to both the vehicle and the motor. The field is ploughed and the seed is planted using a DC motor. The microcontroller regulates and varies the distance between the two seeds. As soon as the robot has completed its mission, we may alter its course using WiFi commands and IP addresses. The benefit of this solar-powered multi-function Agri-robot is that it does not need any fuel or gasoline to operate since it runs on solar energy. Because of the employment of the Aurdino controller, the circuit model is less complicated and compact.

II. RELATED WORK

Agriculture automation may assist farmers in reducing their efforts. Vehicles are being developed for ploughing, seed planting, and sprinkler procedures. All of these duties have yet to be carried out with a single-vehicle. The robots in this project are designed to focus efficiently and to conduct the actions independently. A vehicle is used to do tasks such as ploughing, seed planting, and water spraying in this idea. This machine uses less energy than a tractor, and it also reduces agricultural instrument pollution by using a solar panel to power it. As a result of a lack of useful agriculture equipment. Adapting to new methods is necessary.

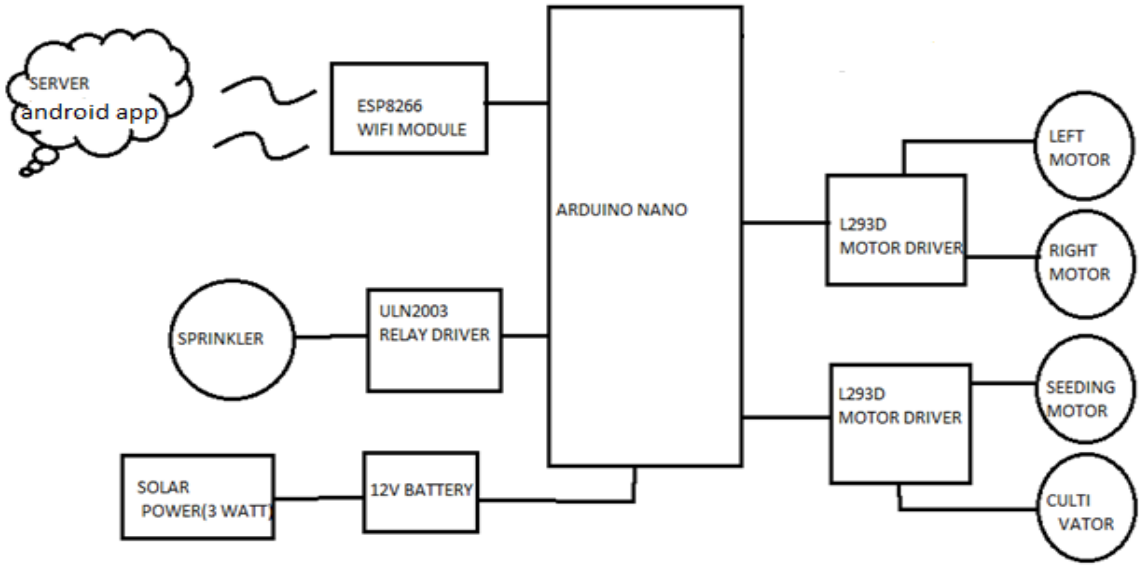
Design options were finalized before the idea was formulated. Here, only a handful of them is mentioned. Anil Karwankar and Saurabh Umarkar outlined in their work "Automated Seed Sowing Agribot Using Arduino" the importance of seed sowing in the agriculture business. The development of high-precision seed planting for a wide range of seed sizes has resulted in consistent seed dispersal across the travel path for numerous crop types. To get data, WiFi is used. Because the robot can only move in one direction, this is the biggest drawback. The power supply is immediately shut off when an obstacle is identified [4]. In "Agribot: Arduino Controlled Autonomous Multipurpose Farm Machinery Robot for Small to Medium Scale Cultivation," researchers M. D. I. Sujon, R. Nasir, and Jayasree Baidya examined the effects of various seeding processes and machinery. Using the concept of ultrasonic detection, the robot uses farming to modify its position. Unfortunately, this method does not work effectively in all kinds of soil [5].

Sowing with bullocks is becoming a necessity since sowing personnel is becoming rare, according to H. Pota, R. Eaton, J. Katupitiya, and S. D. Pathirana. To maximize agricultural production, it is important to consider factors such as planting distance and population density. Using the 8051 microcontroller, input and output devices may interact. This paradigm's primary flaw is that it only utilizes a single mechanism. [3]

"Agriculture machine with several functions" [3]. This research suggests that solar energy might be used in agricultural settings. Agricultural production benefits greatly from solar energy, which is an incredibly potent source of electricity. As a means of delivering water from a well to rural areas without power, this might be utilized in irrigation. Hybrid energy devices are included as part of the mechanism between the power supply and the work. An irrigation machine for sowing, fungicides, pesticides, fertilizer splashing, and plant cutting is the focus of this system. This means it is more cost-effective, time-saving, and versatile for farmers. Mahesh R. Pundkar [4] A sowing, ploughing, and plant-cutting machine might benefit from an image processing algorithm implemented in Flash Magic. Seed depth, seed spacing, miss seeding ratio, percentage, and seeding device were also cited as factors influencing seed germination and yield. An awareness of the numerous challenges posed by agricultural robot research was improved by reading the previous study papers. Locomotion is a problem for the robots developed in the previous literature analysis. These difficulties are dealt with effectively in this book. The newly created robot has three mechanisms, as opposed to the two seen in previous iterations. Additionally, this research sheds light on how robots may be used in the future as well.

III. PROPOSED METHOD

The system's design model and block diagram are covered in this section. An important step after defining detailed software and hardware requirements is designing the system's architecture. Sowing, ploughing, mud leveling, and plant cutting are the key functions of this system. Here, you may examine the system's block diagram (Figure 1). All of the system's components work together to operate the Arduino microcontroller through a solar panel and battery, as well as a power supply charging circuit that provides 5 V for the pic board and 12 V for the DC motors using a relay motor driver module. The whole device may be controlled through a wireless link between an Arduino and an Android smartphone. IoT technology is used to control the movement of the main wheels, which are powered by a DC motor that is regulated by an L293D Motor Driver.



Fig;1 Block Diagram of Agri Bot

Hardware requirements:

- Arduino nano
- esp8266
- uln2003 relay driver
- l293d motor driver
- solar power
- 12v/1.2 amp lead-acid battery
- power supply
- dc motor 10 rpm
- dc motor 100 rpm
- dc water pump

Software requirements:

- Knowledge of Embedded C for programming.
- Arduino IDE.
- IOT SERVER(MIT Android App)

3.1 Microcontroller

The Various components may be shown being controlled by the Arduino Atmega328 microcontroller in Figure 2. Figure 2 depicts the pinout of an Atmega328 microcontroller. There are 28 pins on the Atmega328 microcontroller. In addition to the 13 I/O digital pins, five of them are PWM outputs, while the other five are analog input pins. It may be compared to the brain of the system.

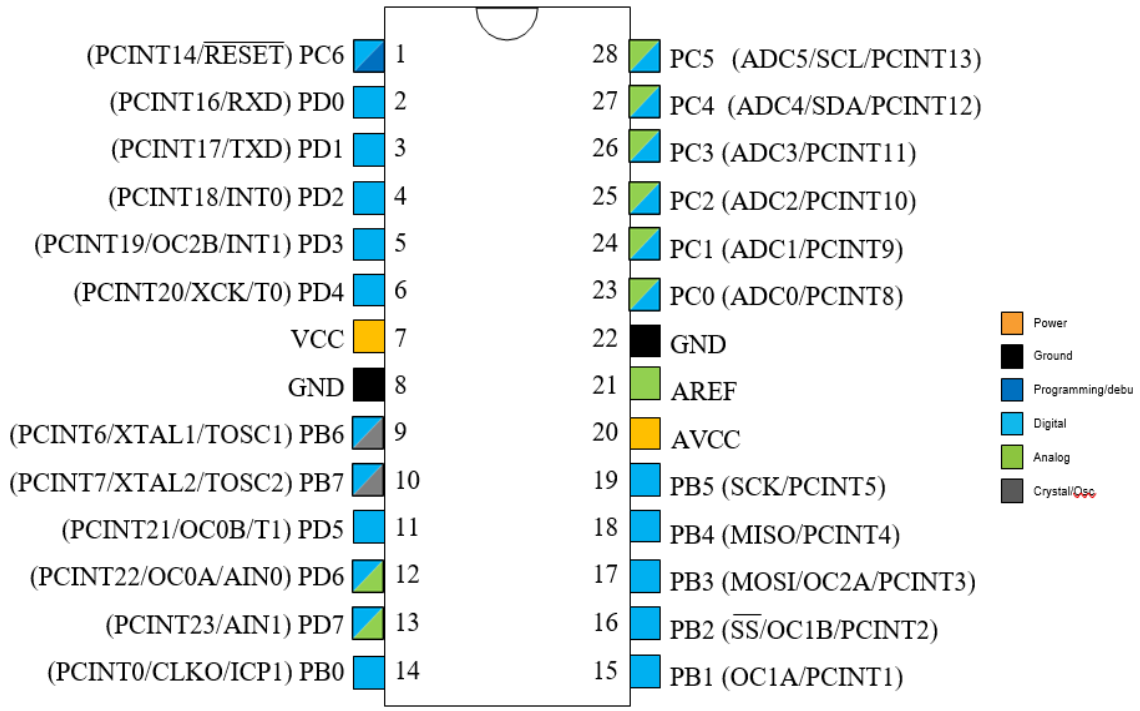


Fig.2; Pin diagram for Arduino(ATMEGA328)

3.2 WiFi Module(ESP8266)

It was designed to address the needs of a digitally connected world using the ESP8266, a highly integrated chip. With the option to host the program or offload all Wi-Fi networking activities from another CPU, the wireless network solution is self-contained and complete. Due to its on-board processing and storage capabilities, the ESP8266 may be coupled to sensors and other application-specific devices with little development and runtime burdens. On-chip integration means that this system and its front-end module may be built with as minimal PCB space as possible. WiFi Modules are often used in IoT (Internet of Things) applications that transmit and receive data over wifi and upload it to a cloud platform. Using cloud platforms, we may send and receive data from any location in the world.

3.3 ULN2003

High voltage and current capabilities are provided by the ULN2003 Darlington transistor array, which is monolithic. It uses a common-cathode clamp diode and seven NPN Darlington pairs to switch inductive loads. One Darlington pair's collector current is 500mA. Darlington couples may be paralleled together to improve current capacity. Drivers for relays, hammers, lights, displays (LED gas discharge), lines, and logic buffers are all examples of uses. ULN2003 Darlington pairs come with a 2.7k series base resistor, so they may be used with 5V CMOS or TTL devices. For the robot's sprinklers, the ULN2003 serves as a relay module, turning on and off the water pump's relay module as needed.

3.3.1 logic diagram

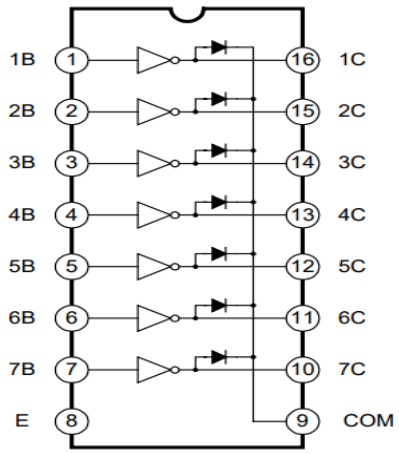


Fig.3; Logic Diagram of ULN2003

3.3.2. Features

* The collector's rated current is 500mA. (Single output)
* 50 volts is the maximum output voltage.
* A variety of logic inputs are compatible with these inputs.
* An application for a relay driver.

3.4 Solar Panels

Cells are put into a framework to create an array of photovoltaic cells that may be used to generate electricity. Sunlight is used to generate direct current power through solar panels. Arrays and panels are both collections of PV modules, but the two are distinct. Photovoltaic arrays power electrical equipment using the sun's beams. Using the photovoltaic effect, solar photovoltaic modules may create electricity by collecting solar light energy (photons). There are two types of cells utilized in most modules: thin-film and wafer-based. Structural (load-bearing) components in modules may be included in either the top or bottom layers. Cells must be protected against mechanical and moisture damage. A few semi-flexible thin-film cell modules are available, although the great majority of them are rigid. To provide the requisite voltage and subsequently increase the current, the cells are commonly electrically connected in series and then in parallel. The wattage of a module is calculated by multiplying its voltage (in volts) by its current (in amps) (in amperes). The robot's batteries are recharged using solar panels, which are the project's principal energy source. To save money, the robot uses a battery supply.

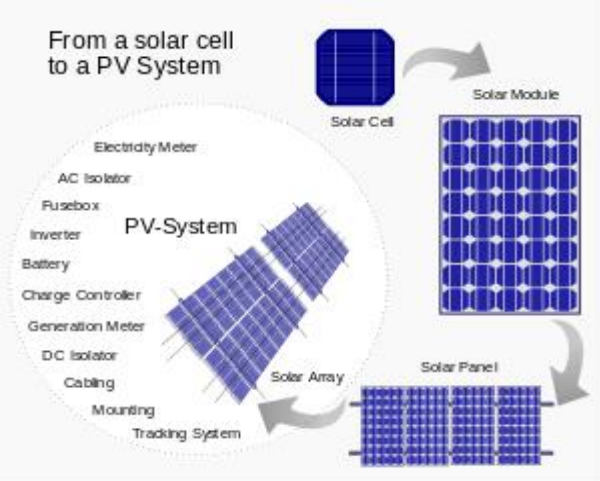


Fig.4; Solar cell PV System

3.5 Lead Acid Battery

A battery that stores electrical energy as chemical energy and then converts it to electrical energy when required is known as a "storage battery" or "secondary battery." An external source of electricity may be used to charge a battery, transforming electricity into chemical energy. It is the process of converting chemical energy into electricity for use by an external load that is called secondary battery discharge. Electrocution causes chemical changes in a battery when it is charged. These chemical reactions need a lot of energy while they are being produced. For external loads, a battery's chemical processes invert, releasing the stored energy as electricity and providing it to the load. We use a 12V lead-acid battery to power the vehicle.

3.6 Motor Driver IC L293D

You may control the speed and direction of two motors at the same time with a motor driver module. The L293D IC is used to design and build the motor driver. There are 16 pins on the L293D, which may be shown in Figure 5. It has a voltage range of 5 to 36 volts and provides bidirectional driving currents. The L293D is an eight-pin integrated circuit that can simultaneously operate two DC motors. All four input and output ports of a motor are connected to two enable pins.

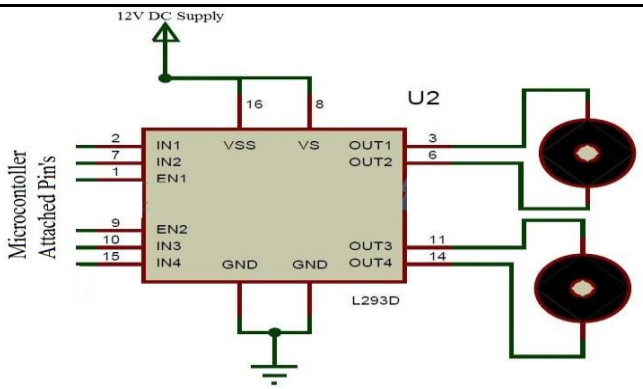


Fig.5; Schematic Diagram of L293D

3.7 Software Requirements

Arduino Ide software is used to program the agribot, and an Android app uses an IoT connection through an IP address to operate the device.

IV. Schematic Diagram

The schematic diagram of the Agriculture Robot is shown in fig.6 below

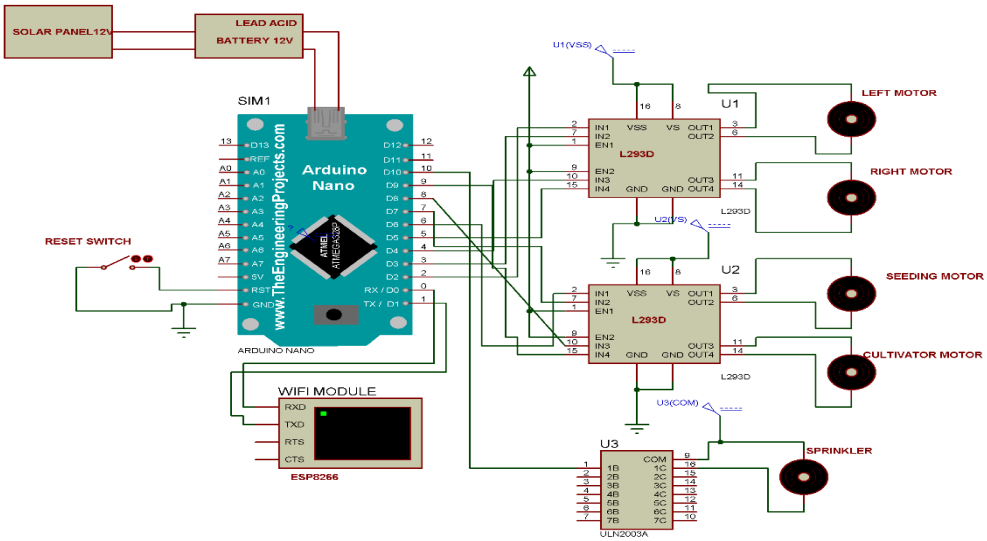


Fig.6; Schematic Diagram of Agri Bot

V. Implementation Of Algorithm

Fig.7 shows the flowchart of the android app-based automated seed sowing and pesticide sprayer robot, which is detailed in detail. The following is the robot's algorithm: -

Step 1: Start

Step 2: Switching on the robot

Step 3: Initialize WiFi Module and generate IP Addresses

Step 4:Initialize all output modules and wait for data

Step 5: If it receives the signal, the robot works accordingly

Step 6: If the signal is not received go to step 4

Step 7: universal OFF signal is used to deactivate.

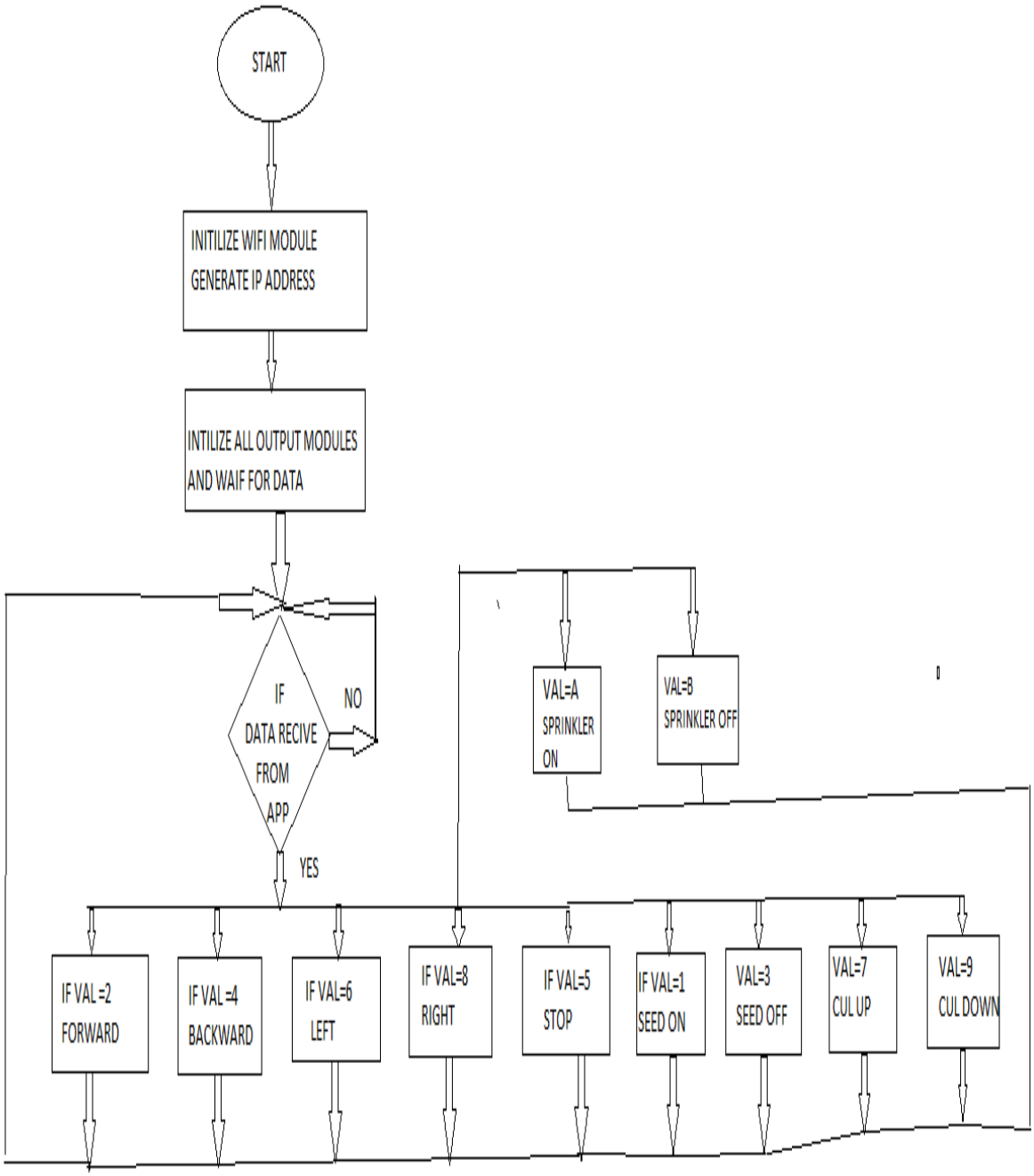


Fig.7; Flow chart for IoT Agri-BoT

VI. Results and Discussion

A solar panel converts sunlight into electricity to operate the robot. Using this electricity, the battery is charged to 12 volts via the charging circuit. Batteries like this one power the controller as well as the motor driver. Seed sowing and pesticide spraying will be done simultaneously by the new robot. Sunlight is absorbed by a solar panel when it is heated, and this energy is then used. The charging circuit transmits this electricity. To charge and power the Arduino simultaneously, the battery is bidirectional. The Arduino is provided with an oscillating voltage source through a high-pass filter. All the mechanisms are powered by the channel relay. The robot's DC motors are controlled by the motor driver. The model uses an Android app and a WiFi module to transmit and receive IoT signals. The robot sits and waits for the app to provide it with signals. Each time a command is sent to it, the robot performs its associated action. The main notion of the work is realized in the prototype's multiple output sections. Figure 8 depicts the whole app-controlled automated multifunctional robot prototype in all its glory. On all sorts of farms, it concurrently executes seed planting, ploughing, and pesticide spraying. The pesticide solution is stored in a container in the pesticide sprayer mechanism. A submersible ultra-compact pump for transferring pesticide from a tank to a sprayerFig.7 shows the pesticide sprayer.

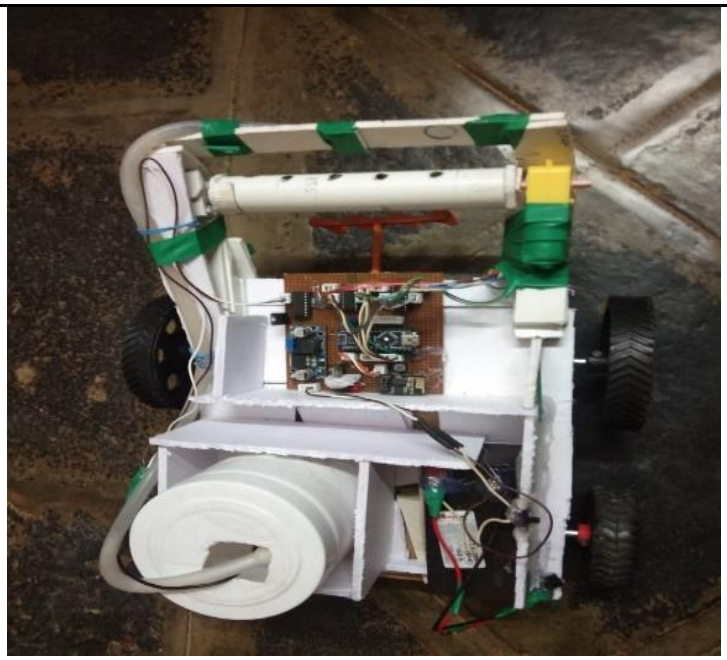


Fig.8; Prototype design of Agri-BoT

A drum is used to store seeds in the seed sowing process. To plant the seeds in the ground at regular intervals, a rotating axis drum with a hole is supplied. The drum rotates with the assistance of a DC motor that is attached to the robot through a supporting stand frame, as illustrated in Fig.9.

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Fig.9; Seed sowing Mechanism of Agri-BoT

The prototype was tested on regular agricultural soil with several kinds of seeds such as wheat, rice, and gram. These seeds are stored in a drum. As demonstrated in fig.10, all robot actions are controlled by an android app through a wifi module and an IP address.

Fig.10; Android App for Agri-BoT

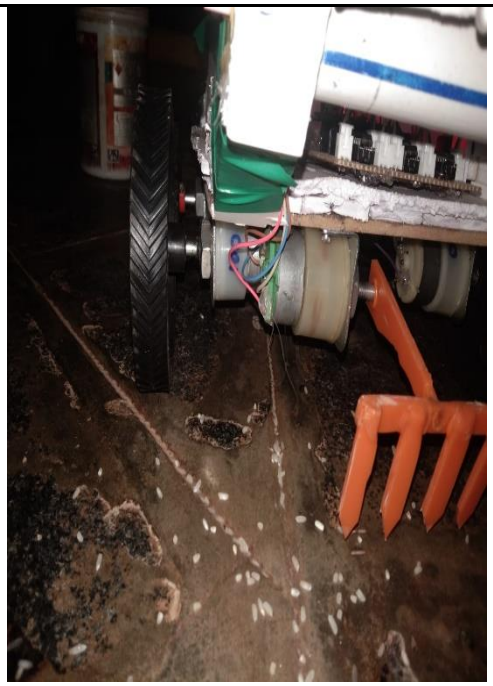

Fig.11; ploughing and seeding Execution

Firstly it paired the app with the ESP8266 module. The movement of the robot is controlled by following commands,

2: Forward movement,

4: Backward movement,

6: Right turn,

8: Left turn

5:Stop

When we send "1" and "3" commands, the robot starts to seed, simultaneously dispensing seeds side by side as shown in fig:10. For ploughing operations, the plough is tilted in a downward direction at a specific angle to provide proper depth for rows. A command of '9' and '7' is provided to move the plough to a UP and DOWN position. In this operation, seeds were distributed in rows; however, the distance between seeds was uniform. A container is provided to store the water. 'A' is sent to sprinkle water on the field. "B" is used to stop sprinkling.

From the above results, we conclude the robot has performed ploughing, seed sowing, water sprinkling operations properly.

VII. ADVANTAGES

1. Battery operated device (pollution-free)
2. Easy to operate, anyone operated(user friendly)
3. Multifunctionalities with a single robot
4. One person handles all the activities
5. Maintainance easy
6. Charging by either solar or normal power

VIII. DISADVANTAGES

1: endurance is less time max 30 mins
2. Wifi is necessary

IX. CONCLUSION

The solar-powered farm robot is a new feature of this system. It consists of mostly seeding, ploughing, and sprinkling. The agriculturist may benefit from using this framework in agriculture throughout the sowing, ploughing, and watering of farming. Farmers who are interested in farming but are unable to hire enough workers would greatly benefit from this approach. An investigation into the employment of tiny and light machines in agricultural chores may be carried out using this tool. Work on path-following robot control algorithms and field testing for diverse operations will be the focus of the next phase of development. With a few tweaks, implementing a real-time system in agricultural settings may be feasible. Sensors for soil moisture and temperature may also be included in the future. Farmers may save time and money on labor by using this smart technology.

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