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Automated Agri Robot

Ms. Namrata S Hiremath[1], Ms. Preeti B Paschapuri[2], Ms. Apeksha M Naidu[3], Ms. Shweta V karadi[4], Dr. Sridhar Iyer[5]

[1,2,3,4] Dept. of Electronics and Communication Engineering, S. G. Balekundri Institute of Technology, Belagavi, Karnataka, India.

[5] Head of the Department, Dept. of Electronics and Communication Engineering, S. G. Balekundri Institute of Technology, Belagavi, Karnataka, India.

A B S T R A C T

Agricultural activities such as seed sowing, irrigation and crop cutting often require repeated manual work and the use of separate tools. The project presents an Automated Agri Robot that combines these operations on a single mobile platform. The prototype integrates a seed-dispensing mechanism, a water-sprinkling unit and a motor-driven crop-cutting arrangement. An Android application developed using MIT App Inventor allows the user to control the robot wirelessly, which are communicated through an ESP8266 Wi-Fi module to a PIC16F877A microcontroller. The controller coordinates the output devices through a ULN2803A driver and relay circuit. A 12 V, 9 Ah rechargeable battery supplies the system, while a small solar photovoltaic panel is included to demonstrate renewable-energy support. The design is intended to reduce repetitive manual effort, simplify the operation of basic farming tasks and provide a compact, low-complexity prototype for small-scale agricultural applications. The report describes the system architecture, hardware, software, operating sequence and prototype outcome. Performance figures such as field coverage, seed-spacing accuracy, water-use efficiency and battery endurance require further experimental measurement.

Keywords: Agricultural robot; seed sowing; water sprinkling; crop cutting; PIC16F877A; ESP8266; Android application; solar energy.

1. INTRODUCTION

Agriculture remains a major source of livelihood and food production in India. Several routine operations, including planting, watering and cutting vegetation, involve physical effort and time. These tasks may become difficult when labour or suitable machinery is not readily available. A multifunctional agriculture machine can help simplify these tasks by performing several operations using single platform.

The Automated Agri Robot described in this paper combines seed sowing, water sprinkling and crop cutting on a single wheeled platform. The user sends operating commands from an Android application. An ESP8266 Wi-Fi module transfers the commands to a PIC16F877A microcontroller, which controls the relevant motors and pump through driver and relay circuits. A battery provides the principal electrical supply, and a solar panel is incorporated as a renewable-energy support element.

The work focuses on the design and integration of the mechanisms and control electronics into a student-built prototype. It is intended as a practical demonstration of embedded control and wireless operation in basic agricultural applications rather than a fully autonomous field machine.

2. SYSTEM DESIGN

The Automated Agri Robot is developed by combining mechanical components, electronic circuits, wireless communication, and a power supply system. It is designed to perform seed sowing, water sprinkling, and crop cutting using a single robotic platform. Each unit has a specific function and works with the other units to support the overall operation of the robot.

1. Mechanical Unit

The mechanical unit consists of a chassis, wheels, motors, and agricultural attachments. The chassis provides support for the system components, while the wheels and motors enable the robot to move. The seed sowing, water sprinkling, and crop cutting mechanisms are arranged on the platform to perform their respective operations.

2. Control Unit

The PIC16F877A microcontroller manages the robot’s control operations. It processes the received commands and controls the connected components according to the selected operation. This unit coordinates the robot's functions based on the cont

3. Wireless Communication Unit

The ESP8266 Wi-Fi module provides wireless communication between the robot and an Android application. The user selects commands through the application, which are transmitted to the robot's control system. This enables remote operation of the robot's movement and agricultural functions.

4. Power Supply Unit

The power supply unit consists of a battery and a solar panel. The battery provides electrical power to the system, while the solar panel is incorporated to utilize solar energy. This arrangement supports the electrical requirements of the robotic platform.

5. System Operation

The system operates according to commands provided through the Android application. The wireless module receives the commands and communicates them to the controller. The controller then activates the appropriate components to perform the selected task. The integrated design brings multiple agricultural functions together in one platform.

3. PROBLEM STATEMENT

Agricultural activities such as seed sowing, watering, and crop cutting require time, effort, and suitable equipment. Carrying out these tasks individually may increase the workload and make farm management more challenging. Small-scale farmers may experience additional difficulties because of limited financial resources and a lack of access to modern agricultural machinery. Furthermore, the unavailability of sufficient labour can delay important farming activities.

To address these difficulties, the proposed Automated Agri Robot combines seed sowing, water sprinkling, and crop cutting within a single robotic platform. The robot uses an Android application and a Wi-Fi module for wireless operation. A solar panel is also incorporated into the power system to utilize renewable energy. The proposed design aims to simplify routine agricultural work, reduce manual effort, and support the automation of multiple farming operations.

4. OBJECTIVES

1. To Design a Multifunctional Agricultural Robot

The main objective is to develop a robotic platform that combines seed sowing, water sprinkling, and crop cutting within a single system. Combining multiple farming functions into one robot can make routine agricultural work easier and eliminate the need for different tools for individual tasks.

2. To Enable Wireless Operation Through an Android Application

The robot is designed to receive commands from an Android application through a Wi-Fi module. The controller processes the received instructions and activates the appropriate motors and agricultural mechanisms to carry out the selected operations.

3. To Incorporate Solar Energy into the Power System

A solar panel is included in the robot's power arrangement to make use of renewable energy. Its contribution to powering the system depends on the electrical configuration and operating conditions of the robot.

4. To Reduce Manual Work in Farming Activities

The project aims to reduce the physical effort involved in selected agricultural tasks. By combining multiple farming functions with wireless control, the system provides an integrated approach to performing basic agricultural operations.

5. PROPOSED METHODOLOGY

The robot combines several farming functions, such as planting seeds, spraying water, cutting crops, and travelling across the field. The system integrates mechanical components, electronic control, wireless communication, and a solar-based power arrangement into a single robotic platform. Its operation is intended to simplify routine farming tasks and reduce the physical effort required from farmers.

The robot receives operating instructions through an Android application connected via a Wi-Fi module. These instructions are processed by the control unit, which activates the appropriate motors and agricultural mechanisms to perform the selected task. A solar panel is incorporated into the power system to make use of renewable energy. Through the integration of these functions, the proposed system aims to provide a practical approach to agricultural automation

5.1 Flowchart Explanation

1. Start: Switch on the robot.

2. Initialize System: Start the microcontroller and control circuit.

3. Check Power: Check the battery and solar power supply.

4. System Ready: Make sure the battery has enough power.

5. User Input: Select the required operation using the switches or Android app.

6. Robot Movement: DC motors move the robot.

7. Seed Sowing: The mechanism drops seeds into the soil.

8. Water Sprinkling: The pump sprays water through the nozzle.

9. Crop Cutting: The cutting mechanism cuts crops or weeds.

10. Repeat: Select the next operation or switch off the robot.

Flow Chart

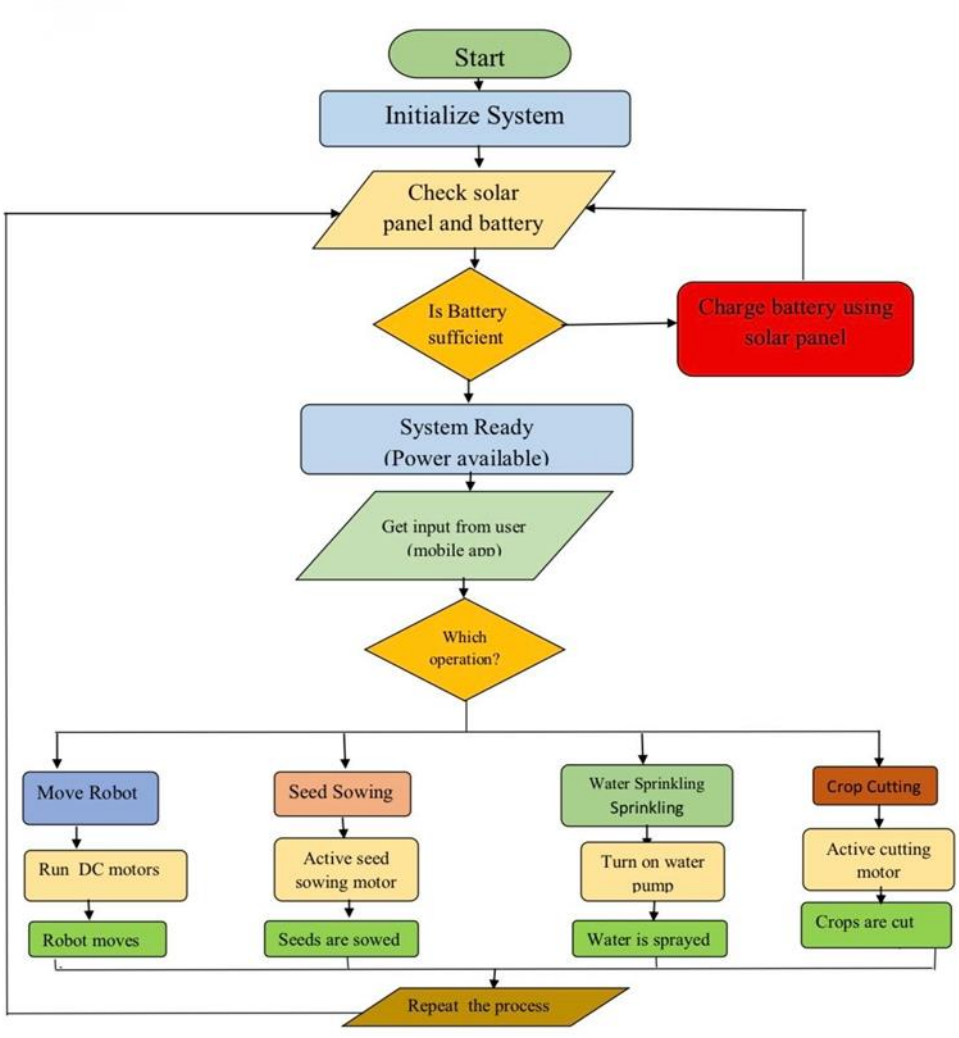


Fig: 5.1 Flow Char

5.2 Working

The Automated Agri Robot is developed to carry out agricultural tasks such as sowing seeds, sprinkling water, cutting crops, and moving across the field. The robot is operated through an Android application that sends instructions to the Wi-Fi module. These instructions are passed to the controller, which controls the required motors, relays, and water pump through the control circuit. The DC motors enable the robot to move around the field, while the seed-sowing and crop-cutting mechanisms perform their respective functions.

Water is distributed to the plants by a pump connected to a sprinkler nozzle. The robot's electrical components receive power from a battery, while a solar panel captures sunlight and converts it into electricity for battery charging through an appropriate charging circuit. Using the Android application, the operator can select the farming function to be performed. The system aims to minimise physical effort, reduce task completion time, and make routine farming activities easier.

5.3 Block Diagram

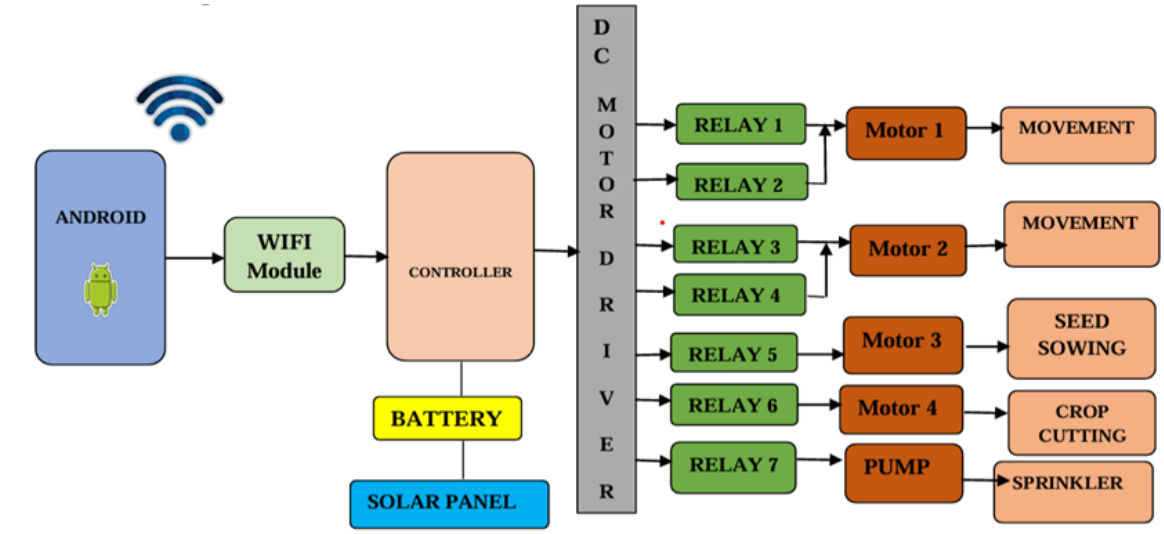


Fig: 5.3 Block Diagram

1. Android Application and Wi-Fi Module

The user sends commands through an Android application. The Wi-Fi module receives these commands and communicates them to the controller. This enables the robot to be operated wirelessly.

2. Controller

The controller processes the commands received from the Wi-Fi module. It sends control signals to the required circuit components to perform the selected task.

3. Driver Circuit and Relays

The driver circuit and relays help control the connected motors and other devices. According to the controller's signals, the relays switch the required devices ON or OFF.

4. Movement Control

DC motors provide movement to the robot. They operate according to the control signals, allowing the robot to move through the agricultural field.

5. Seed Sowing Mechanism

The seed-sowing mechanism releases seeds into the soil as required. This reduces the manual effort involved in planting seeds.

6. Crop Cutting Mechanism

The crop-cutting mechanism uses a motor-driven arrangement to perform cutting operations. It helps reduce the physical effort required for this agricultural task.

7. Water Sprinkling Mechanism

The water pump supplies water to the sprinkler arrangement. When the watering function is selected, the controller activates the pump through the control circuit, allowing water to reach the plants.

8. Battery and Solar Panel

The battery provides electrical power to the robot's components. The solar panel converts sunlight into electrical energy and can support battery charging when connected through a suitable charging circuit.

5.4 Circuit Diagram

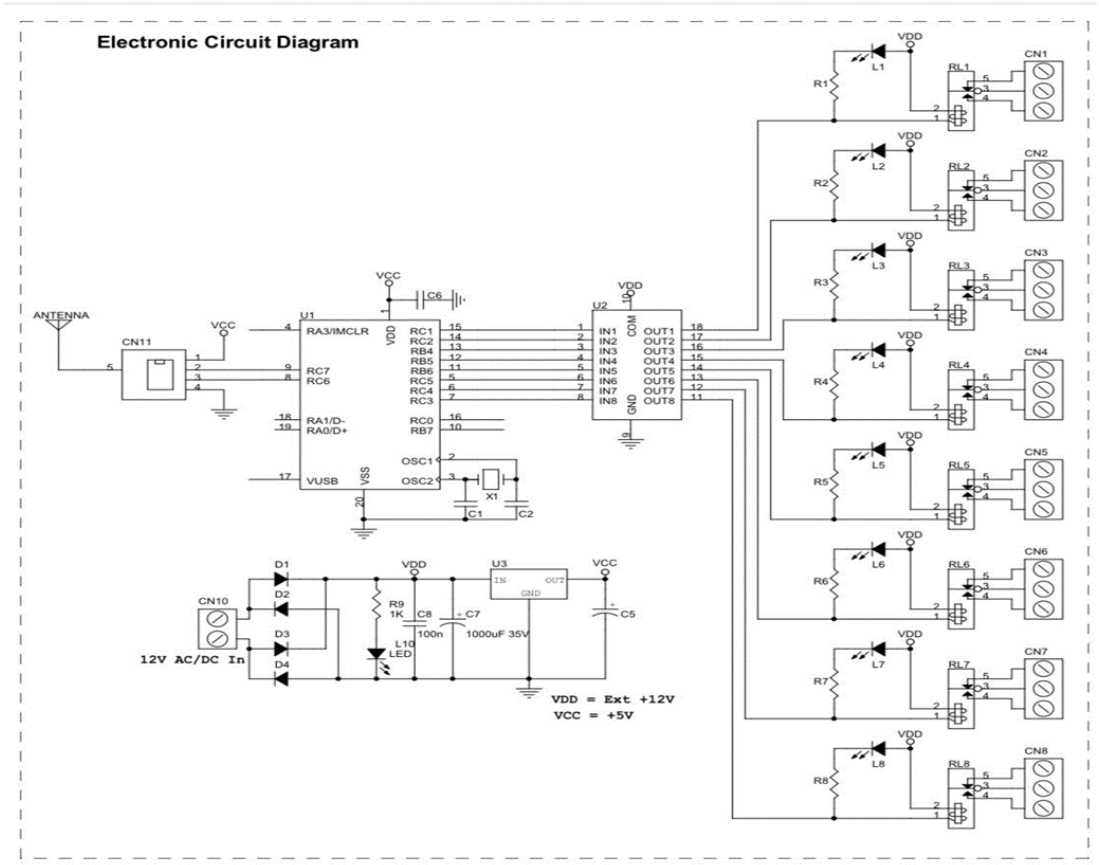


Fig: 5.4 Circuit Diagram

5.5 Hardware Specifications

1. SPDT Relay

Specifications:

- Type: Single Pole Double Throw (SPDT) relay
- Coil voltage: 6 V DC
- Terminals: Common (COM), Normally Open (NO), and Normally Closed (NC)
- Contact rating: Depends on the relay model

Function:

An SPDT relay is an electrically operated switching device. When voltage is applied to its coil, it changes the connection between the COM, NO, and NC terminals.

Application in the Automated Agri Robot:

The relay acts as an electrically controlled switch that responds to signals from the control circuit. Depending on the wiring arrangement, it can turn the water pump or crop-cutting motor on and off.

2. Wi-Fi Module

Specifications:

- Module: ESP8266 Wi-Fi module
- Operating voltage: 3.3 V

- Frequency band: 2.4 GHz
- Wi-Fi standard: IEEE 802.11 b/g/n

Function:

The ESP8266 provides Wi-Fi connectivity between the mobile application and the robot. It receives operating instructions sent by the user and forwards them to the microcontroller for execution.

Application in the Automated Agri Robot:

The Wi-Fi module enables the user to operate the robot remotely using an Android application. The received commands control the robot's movement and the selected agricultural operations according to the programmed instructions.

3. PIC16F877A Microcontroller

Specifications:

- Type: 8-bit PIC microcontroller
- Total pins: 40
- Input/output pins: Up to 33
- Operating voltage: 4.0–5.5 V
- Maximum operating frequency: 20 MHz
- Program memory: 8K × 14-bit words

Function:

The PIC16F877A is a programmable integrated circuit that processes instructions and controls electronic devices. It receives input signals and generates corresponding outputs based on the program stored in its memory.

Application in the Automated Agri Robot:

The microcontroller serves as the main processing unit of the robot. It interprets commands received through the Wi-Fi control system and sends appropriate signals to operate the connected components for the required agricultural tasks.

4. ULN2803A IC

Specifications:

- Total pins: 18
- Input channels: 8
- Output channels: 8
- Common pin (COM): 1
- Ground pin (GND): 1
- Maximum output voltage: 50 V
- Type: Darlington transistor array IC

Function:

The ULN2803A is an electronic driver IC with eight Darlington transistor pairs. It allows a microcontroller to operate compatible electrical loads using low-current control signals.

Application in the Automated Agri Robot:

The ULN2803A acts as an interface between the microcontroller and compatible loads. It helps operate connected relays and other suitable devices while reducing the current demand placed directly on the controller's output pins.

5. Capacitors (100 µF and 1000 µF)

Specifications:

- Capacitance: 100 µF and 1000 µF

- Type: Electrolytic capacitor
- Voltage rating: Depends on the capacitor model
- Polarity: Positive (+) and negative (−)

Function:

Capacitors store electrical charge and help minimize short-term voltage variations in electronic circuits.

Application in the Automated Agri Robot:

Capacitors in the power supply circuit help minimise voltage variations and maintain a steady supply of electricity for the microcontroller and other electronic parts.

6. 12 V DC Water Pump

Specifications:

- Operating voltage: 12 V DC
- Type: DC submersible water pump
- Power supply: Compatible 12 V DC source
- Material: Plastic body, as specified
- Input: Water inlet
- Output: Water outlet

Function:

The pump converts electrical power into mechanical action to transfer water to the required location. When powered, it draws water through the inlet and delivers it through the outlet.

Application in the Automated Agri Robot:

The pump performs the water-sprinkling operation. It draws water from the storage tank and sends it through a pipe to the sprinkler nozzle. The control circuit switches the pump on or off according to the selected operation.

7. 12 V DC Motor

Specifications:

- Operating voltage: 12 V DC
- Type: Brushed DC motor with gearbox
- Power supply: Compatible 12 V DC source
- Speed: Indicates how fast the motor rotates.
- Torque: Determined by the motor design and gearbox configuration.
- Output: Rotational mechanical motion

Function:

A DC motor uses electrical power to produce mechanical rotation. When supplied with the appropriate voltage, it rotates and produces mechanical movement. If a gearbox is fitted, it can reduce the output speed and increase the available torque.

Application in the Automated Agri Robot:

The motor provides mechanical movement for the robot and may operate other agricultural mechanisms, depending on its installation. It can drive the wheels or support the seed-sowing and crop-cutting mechanisms. Its operation is controlled by the associated control circuit.

8. 12 V, 9 Ah Battery

Specifications:

- Rated voltage: 12 V DC
- Capacity: 9 Ah

- Type: Rechargeable sealed lead-acid battery
- Output voltage: 12 V nominal
- Terminals: Positive (+) and negative (−)

Function:

The battery provides the DC electricity needed to operate the robot's connected components. Its rated voltage indicates the nominal supply level, while its ampere-hour capacity represents its rated charge-storage capability.

Application in the Automated Agri Robot:

The battery supplies power to the robot's compatible motors, water pump, relay circuit, and other electronic components. It allows the robot to function without requiring a continuous connection to an external power source.

9. Solar Panel

Specifications:

- Voltage: 5–6 V
- Current: 100–300 mA
- Power: Approximately 0.5–1.8 W
- Type: Solar photovoltaic panel

Function:

A photovoltaic panel uses solar radiation to generate DC electricity. Its output depends on the intensity of sunlight and the panel's rated specifications.

Application in the Automated Agri Robot:

The solar panel provides a renewable source of energy for the system. When connected to a suitable charging circuit, it can contribute to battery charging. The power generated varies with the available sunlight and the robot's electricity usage.

10. Resistor (1 kΩ)

Specifications:

- Resistance: 1 kΩ (1000 ohms)
- Type: Fixed resistor
- Tolerance: Depends on the component, commonly ±5%
- Power rating: Depends on the model, commonly ¼ watt

Function:

A 1 kΩ resistor limits the current flowing through an electrical circuit. Depending on its connection, it can also help establish appropriate electrical conditions for specific circuit functions.

Application in the Automated Agri Robot:

The resistor is used in the electronic control circuit according to the circuit design. It may limit current and help protect connected components. Its specific purpose depends on its position and connection within the circuit.

5.6 Software Specification

Mobile Application Development Using MIT App Inventor

MIT App Inventor is an Android application development platform developed for beginners, students, and researchers. It provides a Designer window for creating the user interface and a Blocks Editor for programming the application logic.

Instead of typing code line by line, the programmer connects graphical blocks representing actions, conditions, events, variables, and procedures. The power generated varies with the available sunlight and the robot's electricity usage.

1. **Role of MIT App Inventor in Automated Agri Robot**

In our Smart Agriculture Robot, MIT App Inventor is used to develop a mobile application for controlling the robot. The application provides a simple interface through which the user can send commands to control the robot's movement and agricultural operations.

The application communicates wirelessly with the robot's controller using the configured communication method. The controller processes the received commands and operates the corresponding motors and water pump through the control circuit.

2. Features of MIT App Inventor

- Simple visual design using drag-and-drop tools.
- Block-based programming instead of conventional text-based coding.
- Support for Wi-Fi, Bluetooth, and web communication.
- Integration with microcontrollers such as ESP32 and Arduino through suitable communication interfaces.
- Real-time monitoring of sensor information.
- Development and testing of Android applications.
- Support for buttons, labels, notifications, images, and other interface components.

3. Application Development Procedure

Step 1 — Create a New Project

Open the official MIT App Inventor website, sign in, and create a new project using the project name.

Step 2 — Design the Application Interface

In the Designer section, arrange the required application components, such as buttons, labels, images, and status indicators.

Step 3 — Develop the Programming Logic

Open the Blocks section and create programs using event-handling blocks, conditional statements, variables, and communication components.

Step 4 — Establish Communication

Configure the application to communicate with the hardware system using Wi-Fi, Bluetooth, or another supported interface, depending on the project.

Step 5 — Test the Application

Test the application using the MIT AI2 Companion application or a suitable development device. Verify that every control operates correctly.

Step 6 — Build the Application

Generate an Android APK file, install it on a compatible device, and test the final application.

5.7 Result/Output

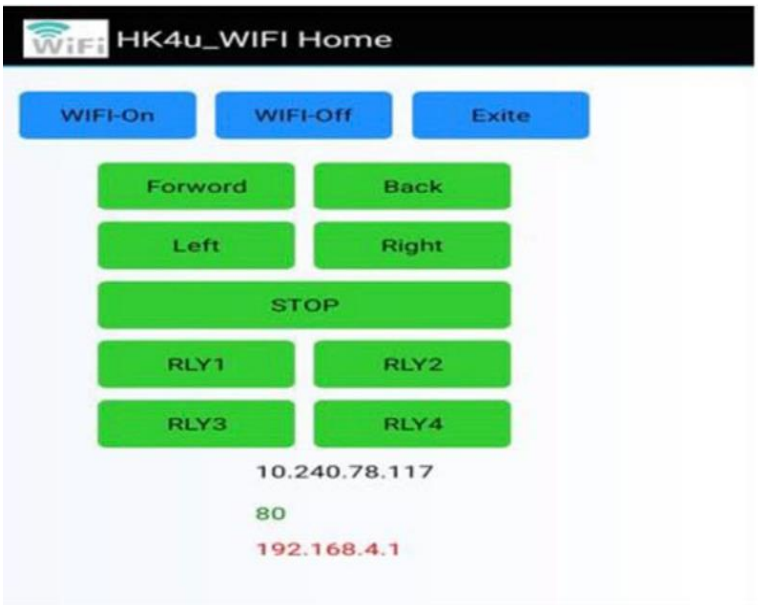


Fig: 5.7 Result/Output

6. CONCLUSION

The Automated Agri Robot combines seed planting, water spraying, crop cutting, and field movement in one system. The user can operate the robot through a wireless mobile application created with MIT App Inventor. A microcontroller works with the Wi-Fi module, relays, motors, and water pump to carry out the selected tasks.

A solar panel is included to explore the use of renewable energy in farming. The project demonstrates how electronic components and wireless control can be used together to assist with routine agricultural work. The robot aims to reduce farmers' physical workload and make basic farming activities easier. Its performance relies on the proper operation of the hardware and an adequate power supply.

7. FUTURE SCOPE

The Automated Agri Robot can be improved by adding advanced technologies to make agricultural activities easier and more efficient. A camera can be installed to monitor crops and farmland through a mobile phone. Soil-moisture sensors can also be added to measure soil moisture and control water sprinkling according to the plants' requirements.

Obstacle-detection sensors can help the robot identify objects in its path and improve safe movement. GPS technology can be introduced to support navigation in agricultural fields. The existing mobile application can also be upgraded with additional features to improve control and make the robot easier to operate.

In the future, the robot can be developed with improved automation and energy management. A suitable solar charging system can support the use of renewable energy. Further improvements and field testing could make the robot more reliable and useful for modern farming while reducing farmers' manual effort.

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