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MULTIPURPOSE SMART AGRICULUTRE ROBOT CONTROLLED BY SMART PHONE

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Abstract— Agriculture is a fundamental sector that requires continuous innovation to improve productivity and reduce manual labor. This paper presents the design and implementation of a multipurpose smart agriculture robot controlled using a smartphone. The proposed system integrates modern technologies such as wireless communication, sensors, and automation to perform multiple farming operations efficiently. The robot is capable of executing tasks such as seed sowing, irrigation, pesticide spraying, and soil monitoring with minimal human intervention. A mobile application is used to control and monitor the robot in real time, providing flexibility and ease of operation to farmers. The system utilizes components such as microcontrollers, motor drivers, and environmental sensors to ensure accurate and reliable performance. Experimental results demonstrate that the robot improves operational efficiency, reduces labor costs, and enhances precision in agricultural practices. This smart solution contributes to sustainable farming and supports the advancement of modern agriculture.

Keywords— Smart agriculture, automation, smartphone control, agricultural robot, IoT, sensors.

I. INTRODUCTION:

Agriculture plays a vital role in the economic development of many countries, particularly in developing nations like India. However, traditional farming methods often involve extensive manual labor, time consumption, and inefficiencies in resource utilization. With the increasing demand for food production and the shortage of agricultural labor, there is a growing need to adopt modern technologies to improve productivity and sustainability in farming practices.

Recent advancements in Robotics and Internet of Things (IoT) have opened new possibilities for automation in agriculture. Smart farming systems enable real-time monitoring, precise control, and efficient management of agricultural operations. These technologies help farmers reduce human effort, minimize errors, and optimize the use of resources such as water, fertilizers, and pesticides.This paper presents the design and development of a multipurpose smart agriculture robot controlled using a smartphone. The proposed system is capable of performing multiple agricultural tasks, including seed sowing, irrigation, pesticide spraying, and soil condition monitoring. The robot is equipped with sensors and actuators that allow it to interact with the environment and execute tasks accurately. A smartphone-based application provides a user-friendly interface to control and monitor the robot remotely through wireless communication technologies such as Bluetooth or Wi-Fi.

The primary objective of this project is to develop a cost-effective, efficient, and easy-to-use solution that can assist farmers in automating routine agricultural activities. By integrating automation and smart control, the system aims to increase productivity, reduce labor dependency, and promote precision agriculture. The proposed model contributes to the advancement of modern agricultural practices and supports sustainable farming.

II. SYSTEM AND METHODOLGY:

2.1 METHODOLOGY:

The proposed multipurpose smart agriculture robot is designed to automate essential farming activities through a smartphone-based control system. The methodology involves system design, hardware integration, software development, and task execution. The overall workflow of the system is illustrated through sequential stages as follows.

A. System Architecture:

The system consists of a central control unit based on a microcontroller, which coordinates all operations of the robot. The hardware components include motor drivers, wheels, water pump, seed dispensing mechanism, pesticide spraying unit, and various environmental sensors. A wireless communication module such as Bluetooth or Wi-Fi is used to establish a connection between the robot and the smartphone.Smartphone-Based Control:

A mobile application is developed to provide a user-friendly interface for controlling the robot. The application sends commands to the microcontroller via wireless communication. The user can control the movement of the robot (forward, backward, left, and right) and activate different modules such as irrigation, seeding, and spraying in real time.

B. Sensor Integration and Data Acquisition:

Sensors such as soil moisture sensors and temperature sensors are integrated into the system to monitor environmental conditions. These sensors continuously collect data and send it to the microcontroller. Based on predefined conditions, the system can either alert the user through the mobile application or automatically trigger specific actions, such as activating the irrigation system when the soil moisture level is low.

C. Task Execution Modules:

The robot is equipped with multiple functional units to perform different agricultural operations:

- Seed Sowing Unit: Dispenses seeds uniformly into the soil.
- Irrigation System: Uses a water pump to supply water based on soil moisture levels.
- Pesticide Spraying Unit: Sprays chemicals evenly across crops to protect them from pests.
- Mobility Mechanism: DC motors with wheels enable smooth navigation across the field.

D. Control Algorithm:

The microcontroller executes programmed instructions to manage all operations. The algorithm processes input from the smartphone and sensors, then controls actuators accordingly. The system operates in both manual mode (user-controlled) and semi-automatic mode (sensor-based decisions), ensuring flexibility and efficiency.

E. Power Supply:

The robot is powered by a rechargeable battery that provides sufficient energy to run motors, sensors, and control units. Power management is implemented to ensure efficient utilization and longer operating time

2.2 SYSTEM:

The block diagram of the proposed Multipurpose Smart Agriculture Robot Controlled by Smartphone consists of several hardware modules interconnected with the NodeMCU ESP8266 microcontroller, which acts as the central processing unit of the system. The complete system is designed to automate agricultural operations such as ploughing, cutting, seed sowing, irrigation, and monitoring

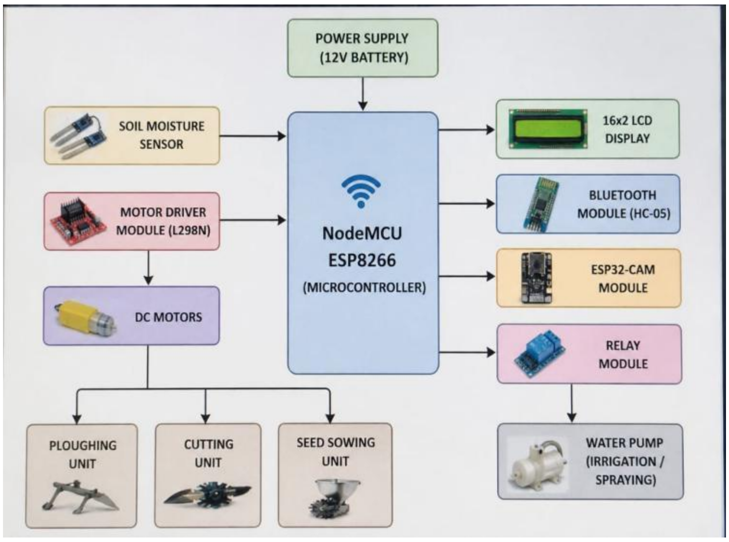

Fig.1: System Block Diagram
Multipurpose Smart Agriculture Robot Controlled by Smart Phone

A. Power Supply:

The power supply unit provides electrical energy to all the components of the smart agriculture robot. It converts the battery or external power source into suitable voltage levels required for the NodeMCU, sensors, motors, relay, and other modules. A stable power supply ensures proper functioning of the entire system.

B. NodeMCU ESP8266:

The NodeMCU ESP8266 is the main controller of the system. It acts as the brain of the agriculture robot and controls all operations. It receives input data from sensors and sends commands to output devices such as motors, pumps, and displays.

Functions:

- Processes sensor data
- Controls robot movement
- Activates irrigation pump
- Communicates with smartphone through Bluetooth/Wi-Fi
- Controls agricultural operations

C. Moisture Sensor:

The soil moisture sensor measures the water content present in the soil. It helps determine whether the soil is dry or wet.

Working:

- If soil moisture is low, the sensor sends data to the NodeMCU.
- The controller automatically turns ON the pump for irrigation.
- When sufficient moisture is detected, the pump turns OFF.

Advantages:

- Saves water
- Prevents over-irrigation
- Improves crop growth

D. 16×2 LCD Display:

The LCD display is used to show the status of the system and sensor readings.

Displayed Information:

- Soil moisture level
- Pump status
- Motor status
- Robot operation details

The LCD helps the user monitor the robot operation easily.

E. Bluetooth Module:

The Bluetooth module enables wireless communication between the smartphone and the robot.

Functions:

- Receives commands from smartphone
- Allows remote control of robot movement

- Controls operations like irrigation, ploughing, and seed sowing
- Using Bluetooth, the farmer can control the robot from a safe distance.

F. ESP32-CAM Module:

The ESP32-CAM module is used for live video monitoring and image capturing in the agricultural field.

Functions:

- Captures field images
- Provides live monitoring
- Helps observe crop conditions remotely
- Improves field surveillance

This module helps farmers monitor farming activities through mobile devices.

G. Motor Driver Module:

The motor driver acts as an interface between the NodeMCU and the DC motors. Since the controller cannot directly drive motors, the motor driver provides the required current and voltage.

Functions:

- Controls motor direction
- Controls motor speed
- Enables forward and backward movement
- The motor driver ensures smooth operation of the robot.

H. DC Motor:

DC motors are used for robot movement and operating agricultural tools.

Functions:

- Moves the robot forward and backward
- Rotates wheels
- Operates ploughing and cutting mechanisms
- The motors provide mobility to the robot in the agricultural field.

Agricultural Operations

I. **Ploughing Unit:**

The ploughing mechanism loosens and turns the soil before cultivation.

Advantages:

- Improves soil aeration
- Helps seed growth
- Prepares land for farming

The ploughing tool is connected to the motor system for automatic operation.

J. Cutting Unit:

The cutting mechanism is used to remove weeds or unwanted grass from the field.

Functions:

- Cuts unwanted plants
- Maintains clean farming area
- Reduces manual labor

This improves crop health and field maintenance.

K. Seed Sowing Unit:

The seed sowing mechanism places seeds into the soil at proper distances.

Advantages:

- Uniform seed distribution
- Reduces seed wastage
- Improves crop productivity Automatic seed sowing saves time and labor.

L. Relay Module:

The relay module works as an electronic switch to control high-power devices like pumps.

Functions:

- Switches pump ON/OFF
- Receives control signal from NodeMCU

- Provides safe isolation between controller and pump

M. Pump:

The pump is used for irrigation and pesticide spraying.

Working:

- Activated automatically when soil moisture is low
- Supplies water to crops
- Can also spray pesticides or fertilizers

Advantages:

- Efficient irrigation
- Water conservation
- Reduced human effort

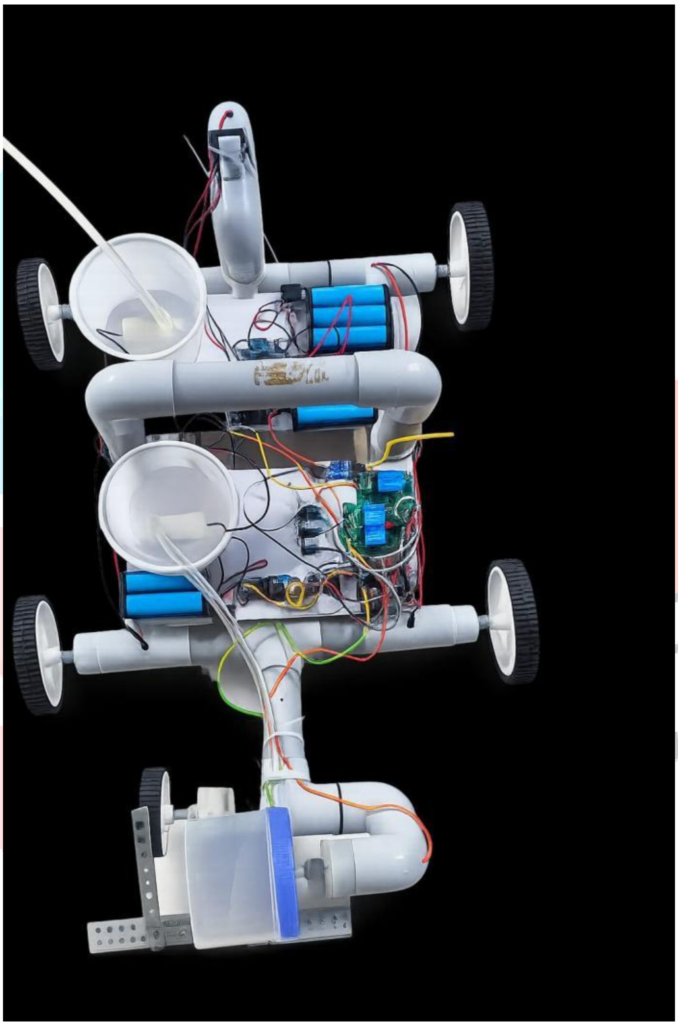

Fig.2: Model Photo "Multipurpose Smart Agriculture Robot Controlled by Smart Phone"

III. CONCLUSION:

1. The power supply energizes all modules.
2. The moisture sensor checks soil moisture levels.
3. Sensor data is sent to the NodeMCU.
4. The NodeMCU processes the information.
5. If soil is dry, the relay activates the pump.
6. The farmer controls robot movement using a smartphone through Bluetooth.
7. DC motors move the robot in the field.
8. Ploughing, cutting, and seed sowing operations are performed.
9. The ESP32-CAM provides live field monitoring.
10. System status is displayed on the LCD screen.

The proposed system automates farming activities, reduces manual labor, saves water, and improves agricultural productivity

IV. RESULTS:

The proposed Multipurpose Smart Agriculture Robot Controlled by Smartphone was successfully designed and tested for various agricultural operations such as ploughing, cutting, seed sowing, irrigation, and field monitoring. The robot was controlled wirelessly using a smartphone through the Bluetooth module, and all modules operated effectively under the control of the NodeMCU ESP8266 microcontroller.

The soil moisture sensor accurately detected the moisture content in the soil and automatically activated the water pump whenever the moisture level became low. This helped in efficient water management and reduced unnecessary water usage. The relay module successfully controlled the pump operation based on sensor input.

The motor driver and DC motors enabled smooth movement of the robot in forward, backward, left, and right directions. The ploughing, cutting, and seed sowing units performed agricultural operations effectively with reduced manual effort. The ESP32-CAM module provided live monitoring and image capturing of the agricultural field, which improved remote observation capability.

The 16×2 LCD display showed real-time system information such as moisture level, pump status, and robot operation status. The entire system worked reliably with low power consumption and demonstrated efficient performance in agricultural applications.

The experimental results proved that the proposed system can reduce human labor, save water, improve farming efficiency, and support modern smart farming techniques. The robot is suitable for small and medium-scale agricultural fields and can be further improved with advanced technologies such as GPS navigation and artificial intelligence.

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