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Smart Farming Robot [Agribot]

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Abstract
The research paper focuses on developing a next-generation agricultural robot that will revolutionize traditional farming practices. The Agri robot is designed to help farmers perform most of the critical tasks, such as planting, irrigation, and weed management, with high precision and efficiency. With state-of-the-art sensors and autonomous navigation incorporated, the robot brings out a smart, efficient alternative to laborious manual work, thereby increasing productivity and resource utilization in the agricultural sector. The Agri robot is designed to meet the most compelling needs of modern agriculture: how to bring efficiency and sustainability into practices. Its autonomous functions enable the robot to navigate various terrains and perform tasks without human intervention, thereby reducing labor costs and enhancing operational effectiveness. Integration of such state- of-the-art technology allows for real-time monitoring and data collection, thereby providing a lot of insight for farmers to make informed decisions. Further, this Agri robot is an environmentally friendly solution; it minimizes the impact on the environment by managing resources precisely. Its capability of performing targeted actions limits the overuse of water and chemicals and enables eco-friendly farming practices. This is a landmark in the development of sustainable agriculture, providing tangible tools to assist farmers in improving yields and the quality of crops while preserving natural resources.

Keywords: Agricultural Automation, Precision Agriculture, Sustainable Farming, Resource Optimization

INTRODUCTION

The system brings the objective of developing an Agri robot that combines robotics and agriculture to aid farmers in planting, watering, and managing weeds. Advanced sensors, combined with this robot's autonomous capabilities, make it a very effective alternative to human labor, greatly enhancing productivity and resources in farming. The program dovetails the efficiency and sustainability issues in agriculture with the smart assistance of a farm robot, which can move through fields to do various tasks independently. Our Agri robot works toward feeding the world by using leading-edge technology available today in optimizing the use of resources and minimizing ecological footprint.

1. PREVIOUS WORK

2. A Multipurpose Intelligent Robotic solution for Maximizing Crop Yields in Large Agricultural Projects [2022]

Md. Robiul Islam, Sohel Rana , Mohammod Abul Kashem , Maisha Islam , Mst. Atia Tamanna,

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The research introduces a multifunctional intelligent agricultural robot designed to improve crop production by automating sowing, pesticide spraying, and weather- based watering. This robot, equipped with mobility, seeding, and spraying components, along with a weather station, aims to enhance efficiency and productivity in agriculture. It addresses the challenges of manual labor in large fields and is expected to revolutionize modern farming by optimizing tasks based on real-time weather data, ultimately increasing production and reducing resource waste. The research developed a low-cost agricultural robot that effectively performs basic farming tasks. It demonstrated high accuracy in seed sowing and reduced need for human intervention due to its obstacle detection sensors. The inclusion `of a weather station helps optimize seeding times.

3. Design and analysis of photovoltaic powered battery-operated computer vision based multi-purpose smart farming robot." Agronomy 11, [2021].Chand, Aneesh A., Kushal A. Prasad, Ellen Mar, Sanaila Dakai, Kabir A. Mamun, F. R. Islam,UtkalMehta, and Nallapaneni Manoj Kumar.

The authors present an entirely new dual-purpose intelligent farming robot MpSFR, which could be used in both pesticide spraying and water spraying. The robot proposed in this paper is a new type of multi-purpose smart farming robot (MpSFR) for automating water sprinkling and pesticide spraying. MpSFR, driven by photovoltaic (PV) panels with a battery, uses IoT sensors and computer vision to determine soil moisture and the health monitoring of plants, allowing intelligent autonomous decisions on water and pesticide application. The robot has a water storage tank, programmable pumping device, and servo motors controlled precisely. It can be remotely operated at 5 meters away. The experimental field tests are effective; automation of water and pesticide application is successful. The MpSFR prototype demonstrated its ability to autonomously handle irrigation and pest control using sensors and a photovoltaic-powered battery system. It shows promise for the reduction of water and energy costs in agriculture. However, there are still challenges, mainly in applying such technologies in developing regions, ensuring cost- effectiveness, and improving the system's user-friendliness and affordability for remote operations.

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It deals with identifying the hand movements and using these actions for commanding various devices that surround us. The main motivation is to create more interaction between humans and machines in a natural, intuitive, and seamless way. This system can be built using various technologies like image processing, ultrasonic, sensor, electrodes, accelerometer, Flex sensor, EMG sensor. Each division has their pros and cons. Depending on the application, appropriate mediums can be used to create a justified seamless system. The researchers have successfully carried out this system in various fields with high accuracy and impact by using a highly feasible system

1. METHODOLOGY

The Agribot project is a structured process that starts with identifying farming challenges such as labor shortages and inefficiencies. After detailed research, the design of the robot is developed, integrating sensors, motors, and AI for automation. Programming allows navigation and execution of tasks,

followed by testing to optimize performance.

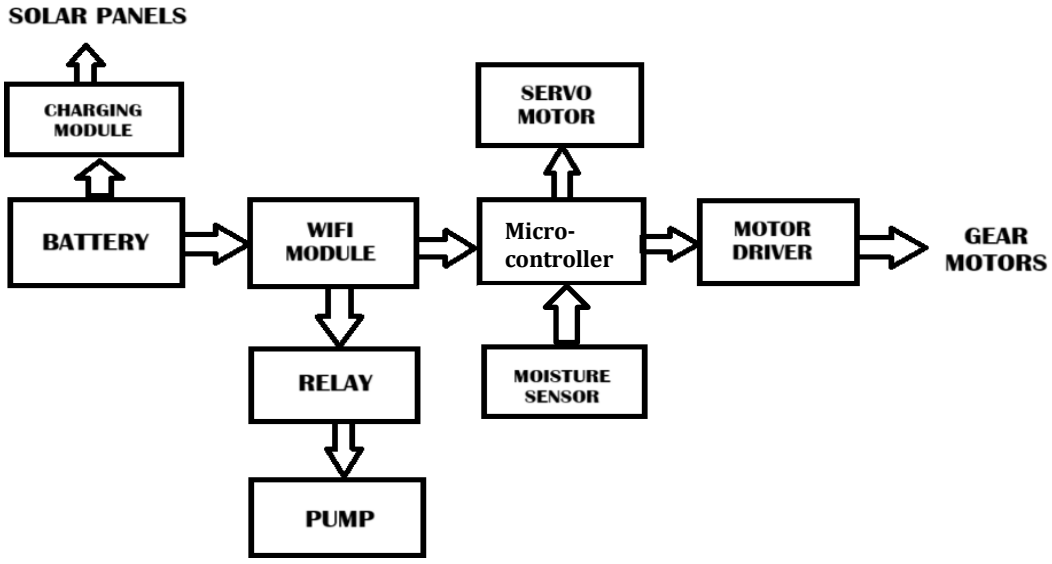

Fig.1 :- Block Diagram of a System

1. **Microcontroller (U1):**
   - **Central Controller:** The Arduino Uno microcontroller acts as the brain of the Agribot, processing inputs from sensors and executing control commands for the motors and other components.
2. **Switch (SW1):**
   - **Power Control:** This switch is used to turn the Agribot on and off, controlling the main power supply to the Arduino.
3. **Servo Motor (SERVO1):**
   - **Actuation:** This motor is controlled by the Arduino and is responsible for precise movements, such as operating planting arms or other mechanical components**.**
4. **Soil Moisture Sensor (SEN1):**
   - **Soil Monitoring:** This sensor continuously monitors soil moisture levels and sends real-time data to the Arduino, which can then adjust irrigation needs accordingly.
5. **Motor Driver (U2)**
   - **Motor Control:** This IC manages the power supply to four motors (M1, M2, M3, M4), enabling the Agribot to move and perform tasks. It receives control signals from the Arduino to drive the motors efficiently.
6. **Motors (M1, M2, M3, M4):**
   - **Movement:** These motors provide the necessary motion for the Agribot, allowing it to navigate the fields and execute agricultural tasks.
7. **Relay (K1):**
   - **Switching:** This relay module controls high-power components, likely managing the power supply to certain systems based on commands from the Arduino.
8. **LED Indicator (D1):**
   - **Status Display:** The LED provides visual feedback on the operational status ofthe Agribot, such as power levels and system readiness.
9. **Power Supply (BAT3+, BAT4+, SC1, SC2):**

- **Energy Source:** The batteries and power sources provide the necessary electrical energy to operate the entire system, ensuring all components function correctly.

10. ESP8266(NodeMCU,WifiModule)

The ESP8266 enables wireless control of a bot via Wi-Fi, allowing remote operation through a mobile app, web interface, or IoT integration.

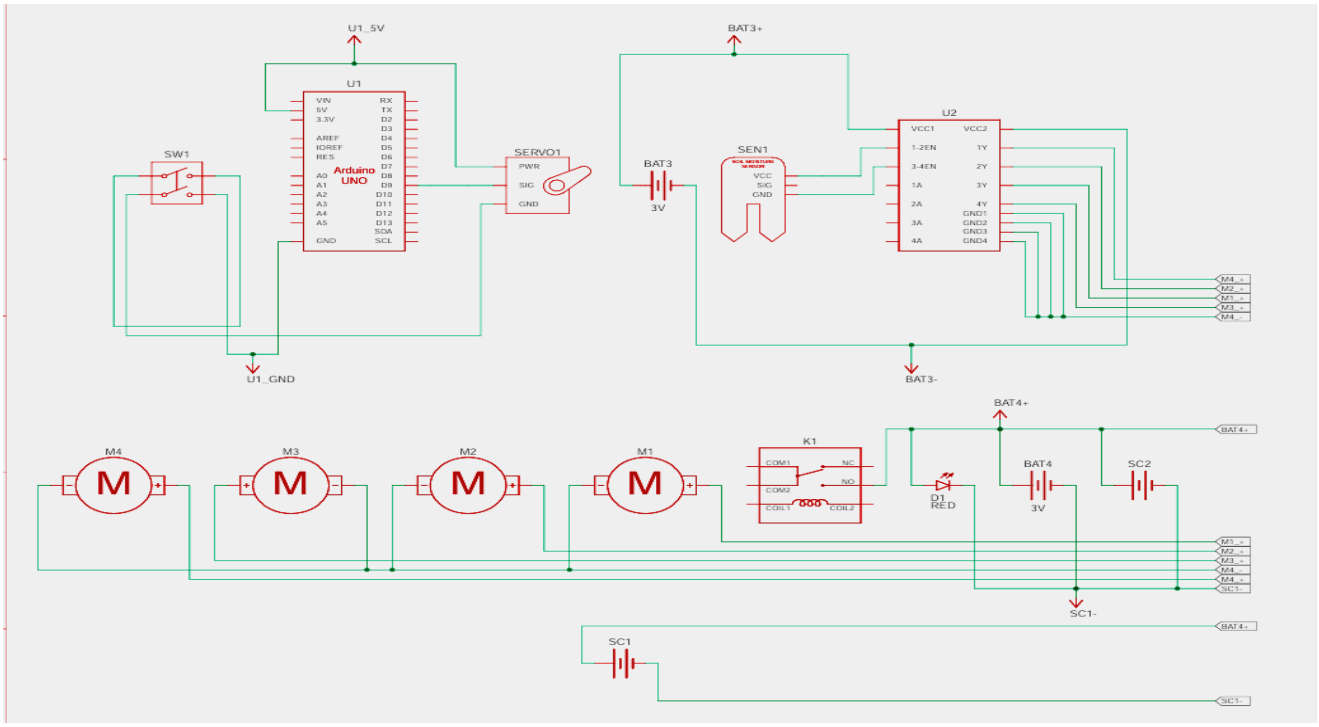

Fig 2:- Schematic Diagram of a System

II. Design Details:

1. Mechanical Design:

Chassis and Structure:

- **Material:** The Agribot's chassis is constructed from durable, lightweight materials like sunboard and high-strength plastic to ensure robustness and ease of mobility.
- **Wheels/Tracks:** Equipped with all-terrain wheels or tracks to navigate various types of agricultural fields.

2. Seed Planting Technology:

Precision Planting Mechanism:

- **Automated Seed Dispensers:** Mechanisms that control the release of seeds, ensuring uniformplanting.

3. Fertilizer Technology:

Manual Fertilizer Distribution:

- **Fertilizer Dispenser:** A system capable of storing and precisely distributing fertilizer based onreal-time soil nutrient analysis.
- **Distribution Control:** Mechanism to control the amount and area of fertilizer distribution,reducing wastage and ensuring optimal nutrient supply.

4. Moisture Sensing Technology:

Soil Moisture Sensor:

- **Sensors:** Advanced soil moisture sensors integrated into the Agribot, monitoringsoil moisture levels.
- **Data Processing:** Real-time data collection and analysis to determine irrigation needs, ensuringefficient water usage.

5. Control System:

Wifi Module ESP8266:

- **Main Control Unit:** this enables wireless control of a bot via wifi, allowing remote operation through a mobile app, web interface, or Iot Integration.

Arduino UNO Microcontroller :

- **Main Control Unit:** The Arduino UNO microcontroller acts as the central processing unit, coordinating various functions and tasks of the Agribot.
- **Programming:** Customized programming to manage autonomous navigation, sensor data processing, and task execution.

6. WiFi Control:

Remote Operation:

- **WiFi Module:** Enables remote control and monitoring of the Agribot via a WiFi connection.
- **User Interface:** User-friendly interface accessible from smartphones, tablets, or computers to control and monitor Agribot functions.

7. Power Supply:

Batteries (BAT3, BAT4, SC1, SC2):

- **Power Source:** The Agribot is powered by rechargeable batteries, ensuring sufficientoperational time for field tasks.
- **Energy Management:** Efficient power management system using solar panels to optimize battery usage andextend operational time.

8. Control and Signaling:

Relay:

- **Relay:** Controls power distribution to various components, ensuring coordinated operation.

RESULTS

Development of the Agribot started by creating a simulation using Tinkercad, which allowed us to visualize the design and testsome key components in a simulated environment, such as motors, sensors, and actuators. The simulation proved that the motor system was feasible for navigation and showed that the ultrasonic sensors could work for obstacle detection. It also demonstrated the feasibility of collecting environmental data using soil moisture and camera sensors, which can be applied to tune the design before physical implementation. We then designed the layout of the Agribot framework, specifying all the components, such as motors, sensors, and the microcontroller. The framework specified placement for optimum performance, ensuring the stability of the bot on uneven ground and the efficient routing of wires. It served as a base for assembling the physical bot and integrating all hardware needed to perform tasks like data collection.

CONCLUSION

The Agribot is a groundbreaking innovation in agricultural technology, designed to enhance farming efficiency and sustainability through automation and precision. Integrating features such as seed

planting, fertilizer application, moisture sensing, andWiFi control, the Agribot optimizes crop yield and conserves resources, while significantly reducing manual labor. The Agribot's advanced capabilities ensure precise seed placement, adaptive fertilizing, and efficient water management. Its remote operation and data integration provide farmers with flexibility and valuable insights for informed decision-making. Suitable forfarms of all sizes, the Agribot demonstrates its versatility and potential to revolutionize farming practices. In conclusion, the Agribot represents a major leap forward in modern agriculture, promoting efficiency, sustainability, and adaptability. As we continue to refine its functionalities, the Agribot will play a crucial role in securing a sustainable agriculturalfuture.

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