EDGE COMPUTING IOT BASED AGRI-ROBOT

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ABSTRACT

Farmers today invest significantly in machinery to reduce labour and enhance crop yield. To address this, we introduce the Edge Computing IoT-Based Agri-Robot, an automated machine designed for ploughing, seeding, and water spraying. This system integrates DHT11 sensors to monitor temperature and humidity, alongside a soil moisture sensor, with all data uploaded to an IoT application for real-time monitoring.

The Agri-Robot is controlled using an Arduino Uno microcontroller, which supervises the entire process. Initially, the robot tills the field and proceeds to plough while dispensing seeds simultaneously. A water sprinkler is also integrated to automate irrigation. The system is equipped with an IoT module for remote control, allowing users to navigate the robot and monitor its operations. DC geared motors are used to drive the ploughing mechanism, release seeds, and activate the sprinkler for efficient agricultural practices.

This solar-powered robot leverages IoT technology for continuous monitoring and control, offering a cost-effective and efficient solution for modern farming. The Arduino Uno microcontroller, programmed using the Arduino IDE and Embedded C, ensures seamless operation and coordination of all hardware modules, powered by a regulated 5V DC supply. This innovative approach minimizes labour while maximizing agricultural productivity.

Keywords: IOT, Agri Robot, Arduino Uno Microcontroller, Moisture sensors, DHT11

1. INTRODUCTION

The project is an innovative smart agricultural automation system utilizing Arduino Uno, aimed at modernizing traditional farming methods by integrating IoT, sensor technology, and robotics. The system is designed to automate crucial agricultural tasks such as ploughing, seeding, and sprinkling, reducing manual labour and increasing farming efficiency. By leveraging renewable energy, real-time monitoring, and automation, this project addresses the growing need for precision agriculture and sustainable farming practices.

Agriculture has been the backbone of human civilization for centuries, providing essential resources for sustenance and economic growth. However, traditional farming methods face numerous challenges, including labour shortages, climate variability, inefficient resource utilization, and increasing demand for food production. This project presents an advanced smart agricultural automation system utilizing Arduino Uno, IoT technology, sensor integration, and robotics to modernize conventional farming practices. By implementing automation, real-time monitoring, and sustainable energy solutions, this system enhances productivity, optimizes resource

usage, and promotes environmentally friendly farming methods.

The proposed system incorporates Arduino Uno as its central processing unit, controlling and managing various agricultural operations. It integrates multiple sensors, including the DHT11 sensor for temperature and humidity monitoring, and a soil moisture sensor to assess soil conditions. These sensors continuously collect environmental data, enabling precise decision-making for irrigation, planting, and fertilization. The real-time data provided by these sensors ensures that crops receive the necessary water and nutrients, improving overall yield and reducing resource wastage.

To power the system efficiently, it utilizes a renewable energy source in the form of solar power. A solar panel charges a battery that supplies energy to the entire setup, making the system self-sufficient and ideal for rural areas with limited access to electricity. The use of solar energy reduces operational costs and aligns with sustainable farming initiatives, minimizing the carbon footprint of agricultural activities. the Arduino-based system and the application, ensuring efficient farm management. By utilizing cloud-based data storage and processing, farmers can analyze historical data, identify trends, and optimize their farming strategies accordingly.

Automation plays a crucial role in this smart farming system, reducing manual labour and increasing operational efficiency. The system includes a robotic mechanism capable of performing essential agricultural tasks such as ploughing, seeding, and sprinkling. These automated processes ensure uniform distribution of seeds and water, eliminating human errors and enhancing crop quality. The robotic system operates based on predefined algorithms and sensor inputs, enabling precise execution of tasks and reducing the time required for field operations.

With the rapid advancement of technology, precision agriculture is becoming a crucial aspect of modern farming. The proposed system aligns with this trend by incorporating smart sensors, automated processes, and IoT connectivity to create a sustainable and efficient farming model. By reducing dependency on manual labour and enhancing decision-making through real-time data, this system paves the way for future advancements in agricultural automation.

The integration of a robotic mechanism in farming operations ensures consistency in seed placement, ploughing depth, and irrigation distribution. This level of precision enhances crop uniformity, leading to better yield quality and higher market value. By automating repetitive tasks, farmers can allocate their time and effort to other critical areas such as crop selection, market analysis, and financial planning. Furthermore, the scalability of this system makes it suitable for different types of farming, including small-scale farms, commercial agriculture, and greenhouse farming.

The future of agriculture lies in the convergence of technology and farming expertise. This project exemplifies how technological innovations can be leveraged to tackle traditional agricultural challenges, making farming more productive and efficient. By integrating renewable energy, IoT, and automation, the system lays the foundation for a more resilient and adaptive agricultural ecosystem.

In conclusion, this Arduino-based smart agricultural automation system is a game-changer in modern farming. It integrates renewable energy, real-time monitoring, IoT connectivity, and robotic automation to create an innovative and sustainable solution for contemporary agricultural challenges. By addressing key concerns such as labour shortages, inefficient resource utilization, and environmental impact, this system enhances productivity, reduces costs, and promotes eco-friendly farming practices. With continued advancements in technology, smart agricultural solutions like this will play a pivotal role in

shaping the future of global food production and security.

2. LITERATURE SURVEY

The development of our agricultural robot and the idea used to implement them, started with he study of various papers. Designing, employing, and examining an autonomous multipurpose vehicle[1] with safe, reliable and economic operation. This autonomous vehicle goes through the crop lines of Agricultural land and performs duties that are tiresome and/or unsafe to the farmers. First, it's been prepared for spraying, but other configurations are also designed, such as: a seeding, plug system to reach the most notable area of the plants to execute different tasks (pruning, harvesting, etc.), and a truck to move the fruits, crops and crop waste products. The wheels of this robot are designed so that it can travel easily in soft and wet soil.

An automatic robot for agricultural purposes[2]. As one of the styles of development on automation and cleverness of agricultural equipment in the 21st century, all types of agricultural robots have been explored and developed to apply lots of agricultural development in many countries. This bot carries out primary functions like picking, harvesting, weeding, pruning, planting, grafting. They developed a robot to perform various activities in farm like cutting and picking. Image processing is used to identify grass in the field and also the height of the crop. A container is used to place the cut grass and harvested crops. Pesticide spraying is also equipped in the robot.

Improvement in agriculture techniques like automatic planting of seed products on ploughed land by using automatic robot[3]. A robotic vehicle having four tires and steered by DC motors was developed. The seed planting device is fixed on the automobile to seed the seed products in even manner. The device will cultivate the plantation by considering particular rows and specific column at predetermined distance depending on different seed products. The obstacle recognition is considered and sensed by an infrared sensor. The complete assemblage is driven by a 12V rechargeable battery pack. The battery pack can be recharged by using solar power which is also attached to robot. This robot can perform bed preparation, seed mapping, seed placement and reseeding operations.

The design, development and the fabrication of the automatic robot [4] which can dig the ground, put the seed products, leveller to close the soil and sprayer to apply water, these complete systems of the automatic robot works together with the power supply and the solar powered energy. Steering operation of robot is done using rack and pinion mechanism. Relay switch regulates power input for motor. Obstacle detection is done using IR sensor. A lot more than 40% of the populace on earth selects agriculture as the principal occupation; lately the introduction of the autonomous vehicles in the agriculture has experienced increased interest.

An automatic robot [5] capable of carrying out procedures like programmed seeding, irrigation, and fertilization. In addition, it provides manual as well as auto control. The primary component is ARDUINO that supervises the complete process. Currently, robots are significantly being built-into working tasks to displace humans especially to execute repetitive job. Seeding is mainsteps in farming. In this process seeding is carried out in every row of the farming plot. In irrigation process, the soil sensor is used for monitoring environmental condition. It checks this level and alerts the farmer, then gradually applies little bit of water to the planted seed in every rows of the farming plot. The fertilization process is identical to irrigation process however, many plants need fertilizers when the seed germinates and the seed starts to develop. The automatic robot works on solar technology.

An automatic robot which targets employing all the farming process especially on onion crop [6]

within a bot by using firebird V automatic robot. The fire bird V robot uses ATMEGA 2560 as master controller, ATMEGA 8 as slave controller, IR, gripper design and other accessories. The suggested system prototype is applied by selecting an area which taking into consideration the agricultural field of any sort of onion crop. The automatic robot picks up the planting area by using detectors and seed products to be planted in the related field using gripper set up of the automatic robot.

Amritansh srivasatava [6] etal, these worked on DTMF Based Intelligent Farming Robotic Vehicle. The main objective of machine can also be used to reach the places where farmers make harder efforts for farming such as hill areas, mountains etc. where land is not plane. This is how we can use this robot in different fields as well as for research purpose by further manipulation in programming it can be modified accordingly. R. suresh [7] etal, this extensive work on automatic feeding device in rotary cultivator blade shaft welding equipment. It can achieve automation of grab, feeding and placement of all blade holders and assures that the blade holder feeding device and other devices in welding equipment work coordinate automatically. it can replace a universal robot to realize welding automation of the shaft weldment. Moreover the biggest advantage of it is easy to operate and low cost. Amrotasneja [8] etal, in this research paper agricultural robot for automatic ploughing and seeding. The concept of fruit picking and pesticide spraying is described under the process domain. Farmers today spend a lot of money on machines that help them decrease labour and increase yield of crops but the profit and efficiency are very less. Hence automation is the ideal solution to overcome all the shortcomings by creating machines that perform one operations and automating it to increase yield on a large scale.

Simon balckmore [9] etal, in this paper robotic agriculture the future of agricultural mechanisation. Developed agriculture needs to find new ways to improve efficiency. One approach is to utilize available information technologies in the form of more intelligent machines to reduce and target energy inputs in more effective ways than in the past. Precision Farming has shown benefits of this approach but we can now move towards a new generation of equipment. The advent of autonomous system architectures gives us the opportunity to develop a complete new range of agricultural equipment based on small smart machines that can do the right thing, in the right place, at the right time in the right way. Sajjadyaghoubi [10] etal, autonomous robots for agricultural tasks and farm assignment and future trends in agro robots. This article is the logical proliferation of automation technology into bio systems such as agriculture, forestry, green house, horticulture etc. Presently a number ofresearches are being done to increase their applications. Some of the scientist contributions are mobile robot, flying robot, forester robot, Demeter which are exclusively used for agriculture. A brief discussion is being done about the types of robots which increase the accuracy and precision of the agriculture.

3. PROPOSED SYSTEM

The proposed system is an Arduino Uno-based smart agricultural automation system that integrates IoT, sensor technology, robotics, and renewable energy to enhance farming efficiency. The system automates essential agricultural tasks such as ploughing, seeding, and sprinkling while continuously monitoring environmental conditions. It utilizes sensors like the DHT11 for temperature and humidity detection and a soil moisture sensor to assess soil conditions, ensuring optimal irrigation management. The system is powered by a battery charged through solar energy, making it sustainable and suitable for remote areas with unreliable electricity. An IoT module connects the system to a mobile application, allowing farmers to remotely monitor and control farming activities in real-time. The Arduino Uno

processes sensor data and sends appropriate commands to execute tasks efficiently. A robotic mechanism carries out automated operations, reducing manual labour and improving precision in farming. An LCD display provides real-time updates on sensor readings, battery status, and system operations for on-field

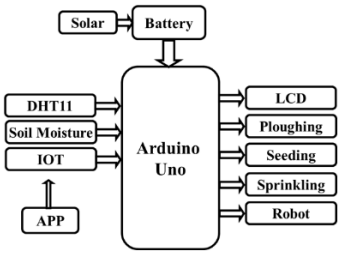

Fig 1: Block Diagram

monitoring. The proposed system enhances productivity, optimizes resource usage, and promotes sustainable farming practices by integrating automation, remote accessibility, and renewable energy sources. The block diagram represents an Arduino Uno-based smart agricultural automation system integrating various components for efficient farm management. The system is powered by a battery charged through solar energy, ensuring sustainability and uninterrupted operation. Sensors such as the DHT11 and soil moisture sensor continuously monitor environmental conditions, providing real-time data to the Arduino Uno for precise irrigation and climate management. The IoT module enables remote access via a dedicated mobile application, allowing farmers to monitor and control farming activities from any location. The Arduino Uno processes the sensor inputs and executes automated tasks, including ploughing, seeding, and sprinkling, through a robotic mechanism. An LCD display provides real-time updates on sensor readings, system status, and ongoing operations, enhancing user accessibility. By integrating renewable energy, automation, and IoT connectivity, this system optimizes resource usage, reduces labour dependency, and promotes sustainable agricultural practices.

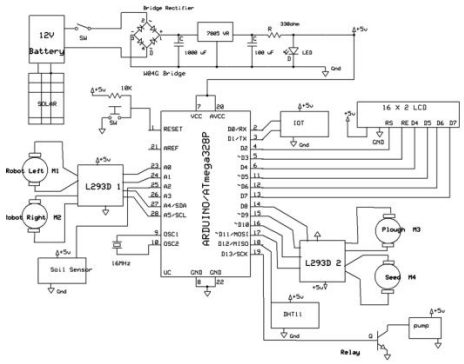

Fig 2: Schematic Diagram

The circuit diagram represents an Arduino-based smart agricultural automation system integrating various electronic components for efficient farming operations. The system is powered by a 12V battery charged via a solar panel, ensuring continuous and sustainable operation. A bridge rectifier and voltage regulator (7805 VR) convert and stabilize the power supply to 5V for the Arduino and other components. The Arduino ATmega328P microcontroller acts as the central processing unit, controlling multiple modules. It receives environmental data from sensors, including the DHT11 for temperature and humidity monitoring and a soil moisture sensor to assess soil conditions. The IoT module enables remote monitoring and control through a dedicated mobile application.

The L293D motor driver modules control the movement of robotic components. One L293D module operates the left and right motors for robot movement, while the second L293D drives the ploughing (M3) and seeding (M4) motors. A relay module is connected to a water pump, enabling automated irrigation based on soil moisture readings. The 16x2 LCD display provides real-time system updates, including sensor values and operational status. The circuit includes multiple input/output connections, ensuring seamless interaction between components. The use of a 16MHz oscillator stabilizes the Arduino's clock frequency, enhancing processing accuracy.

Pin Configuration Points:

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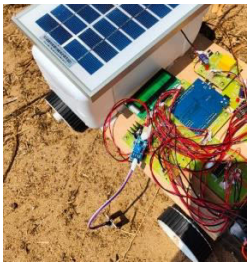
- Power Supply: 12V battery with solar charging, regulated to 5V for components.
- Arduino ATmega328P:
  - Analog Pins: A0–A3 connected to sensors for data acquisition.
  - Digital Pins: D0–D13 used for communication, motor control, and LCD interface.
  - PWM Pins: D3, D5, D6, D9, D10 handle motor speed and actuator control.
- Motor Driver (L293D 1 & 2): Controls motors for robotic movement, ploughing, and seeding.
- Sensors:
  - DHT11: Connected to a digital pin for climate data.
  - Soil Moisture Sensor: Linked to an analog pin for irrigation decisions.
- IoT Module: Connected via UART (TX/RX) for remote monitoring.
- Relay Module: Controls the water pump based on soil moisture readings.
- LCD Display: 16x2 LCD connected to digital pins for real-time data display.

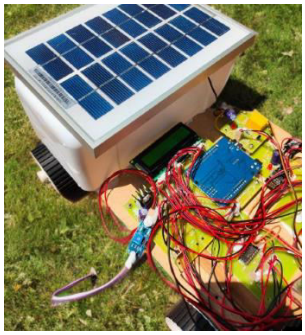
This configuration ensures that the system operates efficiently, integrating automation, IoT, and renewable energy to optimize agricultural productivity.

4. RESULTS

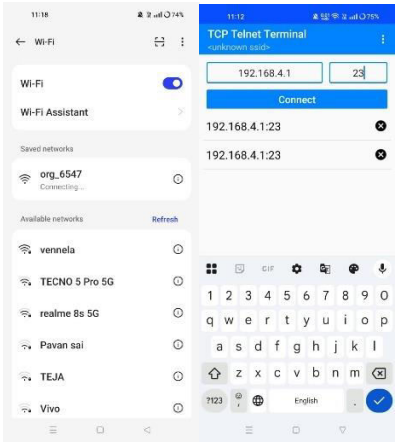
Agri-Robot under sunlight with solar energy power on

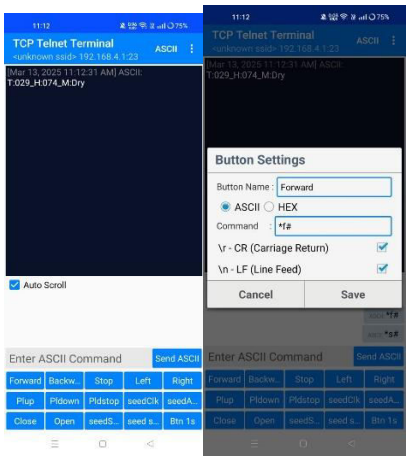
Pictures of LCD display when the soil moisture is Dry or Wet





Screenshots





5. CONCLUSION

The proposed system effectively integrates automation, IoT, and renewable energy to enhance agricultural productivity and efficiency. By utilizing an Arduino Uno as the central controller, the system monitors environmental parameters through DHT11 and soil moisture sensors, enabling real-time decision-making for irrigation and other farming activities. The incorporation of IoT technology allows remote monitoring and control via a mobile application, ensuring ease of operation. The automation of ploughing, seeding, and sprinkling processes reduces manual labour while increasing precision and consistency. Powered by a solar-charged battery, the system ensures sustainability and uninterrupted functionality. The LCD provides real-time feedback on system operations, further improving user convenience. This smart farming system represents a step toward modernized agriculture, optimizing resources while making farming more efficient, cost-effective, and eco-friendly.

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