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Autonomous Agricultural Robot Based on IOT

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ABSTRACT

Climate change, a lack of soil nutrients, a decrease in pollinators, plant diseases, and water waste from conventional irrigation techniques that cause water clogging on top soil are all contributing factors to our nation's food issue. The issues are resolved by the suggested model, which contributes to a rise in agricultural irrigation efficiency. Microcontroller VEGA AS1061 is used in this system. The purpose of the spack fun soil moisture sensor is to periodically measure the soil's moisture content and nutrients in order to develop a workable and reasonably priced model. DHT11 is used to measure temperature and humidity. And PH of soil is measured by PH sensor.

With the help of sim900 GSM module the status of soil moisture, PH level, soil nutrients and temperature is sent to the farmers' phone. Farmers are provided with information using machine learning object recognition and picture classification, which may identify pests, animals, and birds.

This project addresses agricultural challenges like climate change, soil nutrient loss, declining pollinators, plant diseases, and inefficient irrigation. It uses the VEGA AS1061 microcontroller with sensors to monitor soil moisture, pH, nutrients, and environmental conditions. Data is sent to farmers via the SIM900 GSM module for timely action. Machine learning enhances the system by identifying pests, animals, and birds through image classification.

INTRODUCTION

Agriculture is the backbone of the economy in many countries, but traditional farming relies heavily on manpower and outdated methods.
These include the use of synthetic fertilizers, pesticides, and genetically modified organisms.
To enhance efficiency, agricultural robotics (Agribots) are introduced.
Agribots can detect plant diseases, insect infestations, weeds, and other stress conditions.
They are lightweight and can be monitored and controlled using an Android application.
This supports farmers by improving productivity and reducing labor costs.
However, current automated systems for plant phenotyping in greenhouses are limited.
There is a need for field-ready systems that collect real-time, multi-modal plant data.
This requires integration of plant biology, crop science, robotic vision, and computer engineering.
Such systems will help link plant genotypes with environmental responses to optimize crop performance.
These advanced systems enable precise monitoring and analysis of crop health in real-time, even under complex field conditions.
Ultimately, they help improve yield, reduce resource usage, and empower farmers with data-driven decision-making tools.

Agricultural robots enhance productivity by reducing dependency on manual labor and minimizing human error. They can navigate fields autonomously, detecting and addressing issues like pests, weeds, and nutrient deficiencies.

Using sensors and cameras, Agribots collect high-quality phenotypic data for detailed crop analysis.

Real-time monitoring through an Android app allows farmers to make timely interventions.

These robots are designed to be lightweight and adaptable to different terrains and crop types.

Integration of machine learning and computer vision improves accuracy in disease and pest identification.

Such smart systems support sustainable farming by optimizing input usage like water and fertilizers.

By bridging technology and agriculture, Agribots play a vital role in ensuring food security and modernizing farming practices.

I. EXISTING SYSTEM

Current agricultural systems mainly depend on manual labor and conventional tools.

Tasks like planting, monitoring, and harvesting are performed manually.

These processes are time-consuming and require significant human effort.

Traditional methods often lead to inefficiencies in farm operations.

They lack the ability to gather real-time data from the field.

This limits farmers' ability to make informed decisions quickly.

Without automation, precision in resource use and crop management is low.

Overall, productivity and sustainability are hindered by outdated practices.

These methods are time-consuming, labor-intensive, and often lack precision.

They have limited capabilities for real-time data collection and analysis to optimize farming practices. As a result, efficiency and productivity in conventional farming are often low

PROPOSED SYSTEM

The proposed system utilizes IoT technology to build an autonomous agricultural robot.

This robot is integrated with various sensors for real-time data collection.It connects to an IoT network for continuous monitoring and analysis.

The system tracks soil conditions, crop health, and environmental factors.

Automated decision-making improves accuracy in farming activities.

Tasks like planting, irrigation, and harvesting are optimized efficiently.

This reduces manual labor and enhances resource management.

Overall, the system boosts productivity and supports smart farming practices.

II. METHODOLOGY

The robot uses IoT-enabled sensors to gather real-time data on soil moisture, pH, temperature, and crop health.

Collected data is transmitted through a network for processing and analysis.

Based on sensor inputs, the system makes automated decisions for irrigation, fertilization, and pest control.

An Android application allows farmers to monitor and control the robot remotely.

The system begins with deploying the robot in the field equipped with necessary sensors and a microcontroller.

Soil moisture, pH, temperature, and environmental data are continuously collected.

The data is sent via the SIM900 GSM module to a cloud server or directly to the farmer's phone.

Machine learning algorithms analyze captured images to detect pests, animals, or crop diseases.

Based on analyzed data, the robot performs necessary actions like irrigation or alerting the farmer.

An Android application provides real-time monitoring and manual control options for the farmer. The system integrates multiple sensors, including soil moisture, pH, temperature, and humidity sensors, to provide comprehensive field data.

Data from these sensors is processed by the VEGA AS1061 microcontroller to ensure timely and accurate decision-making.

The Android application interface is user-friendly, providing visual data summaries and control options.
The system reduces water waste by automating irrigation based on actual soil moisture levels.
It also minimizes the use of chemicals by targeting pest control only when necessary.
All collected data is stored and analyzed over time to track crop growth and soil health trends.
This historical data helps in making long-term decisions and improving farming practices.
Overall, the methodology combines IoT, robotics, and AI to create a smart, efficient, and sustainable agricultural system.

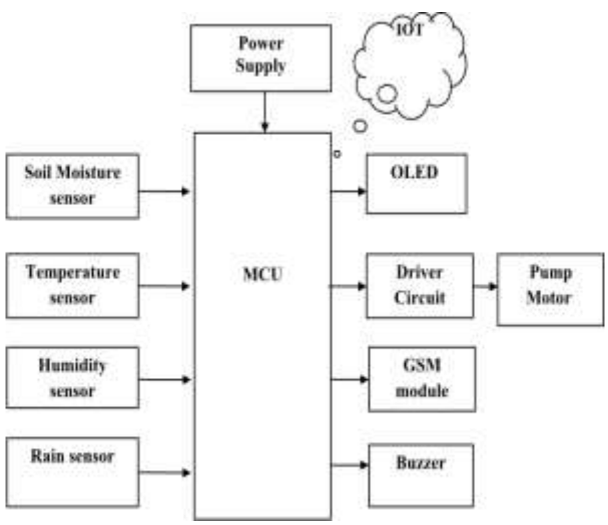

Fig.1 BLOCK DIAGRAM OF AUTONOMOUS AGRICULTURAL ROBOT BASED ON IOT

Applications

- **Precision Irrigation:** Automatically waters crops based on real-time soil moisture data, reducing water waste.
- **Pest and Disease Detection:** Identifies pests and diseases early using machine learning-based image analysis.
- **Soil Health Monitoring:** Continuously tracks soil pH and nutrient levels to optimize fertilizer use.
- **Crop Growth Monitoring:** Collects data on environmental conditions to monitor and enhance crop development.
- **Remote Farm Management:** Enables farmers to monitor and control farming activities remotely via a mobile app.**Automated Fertilization:** Applies fertilizers precisely where and when needed, improving yield and reducing chemical usage.

III. HARDWARE DETAILS

VEGA AS1061 Microcontroller

The VEGA AS1061 microcontroller acts as the central processing unit of the agricultural robot. It is responsible for receiving data from various sensors, processing this information, and making decisions to control the robot's actions such as irrigation, fertilization, and movement. Known for its low power consumption and reliability, it ensures efficient operation of the entire system even in remote field conditions.

Soil Moisture Sensor

The soil moisture sensor measures the volumetric water content in the soil. This data is critical to determine whether crops need watering, helping to avoid both underwatering and overwatering. By monitoring soil moisture levels accurately, the system optimizes irrigation schedules, conserving water and enhancing crop health.

DHT11 Temperature and Humidity Sensor

The DHT11 sensor measures ambient temperature and humidity in the farming environment. These factors significantly influence plant development and the prevalence of pests or diseases. Real-time monitoring allows the system to account for environmental changes and adjust farming practices accordingly.

SIM900 GSM Module

The SIM900 GSM module provides wireless communication capabilities to the system. It sends real-time data, alerts, and updates about soil conditions, pest detection, or irrigation needs directly to the farmer's mobile phone via the GSM network. This feature enables remote monitoring and timely decision-making.

Motor Driver and Motors

The motor driver controls the motors that move the robot across the agricultural field. It enables precise navigation and maneuvering to perform tasks such as watering, fertilizing, and monitoring crops autonomously. The motors are designed to be efficient and durable to handle different terrains.

Relay Module

Relay modules control high-power devices such as pumps or valves for irrigation systems. They allow the microcontroller to switch these devices on or off safely.

OLED Display Module

OLED (Organic Light Emitting Diode)

display module can be integrated into the agricultural robot system to provide a compact, energy-efficient visual interface. It displays real-time data such as soil moisture levels, temperature, pH readings, and system status directly on the device. OLED screens offer high contrast and brightness with low power consumption, making them ideal for outdoor use in varying light conditions. This allows farmers or operators to quickly check sensor readings and alerts without needing a separate device or smartphone.

IV. SOFTWARE DETAILS

Program written using arduino software are called sketches.These sketches are written in the text editor and are saved with the file extension.The editor has features for cutting/pasting and for searching/replacing text.The editor has features for cutting/pasting and also display errors.The bottom right hand corner of the windows displays the configured board and serial port.

MicroPython : is a compact implementation of Python 3 designed to run directly on embedded devices like the Raspberry Pi Pico. It offers an interactive prompt (REPL) for instant command execution and includes modules to access low-level hardware features.

Thonny IDE : is a beginner-friendly Python development environment that comes pre-installed with Python 3.10. It features a simple interface, variable tracking, step-by-step debugging, syntax error highlighting, and integrated package management, making it ideal for programming and debugging MicroPython code.

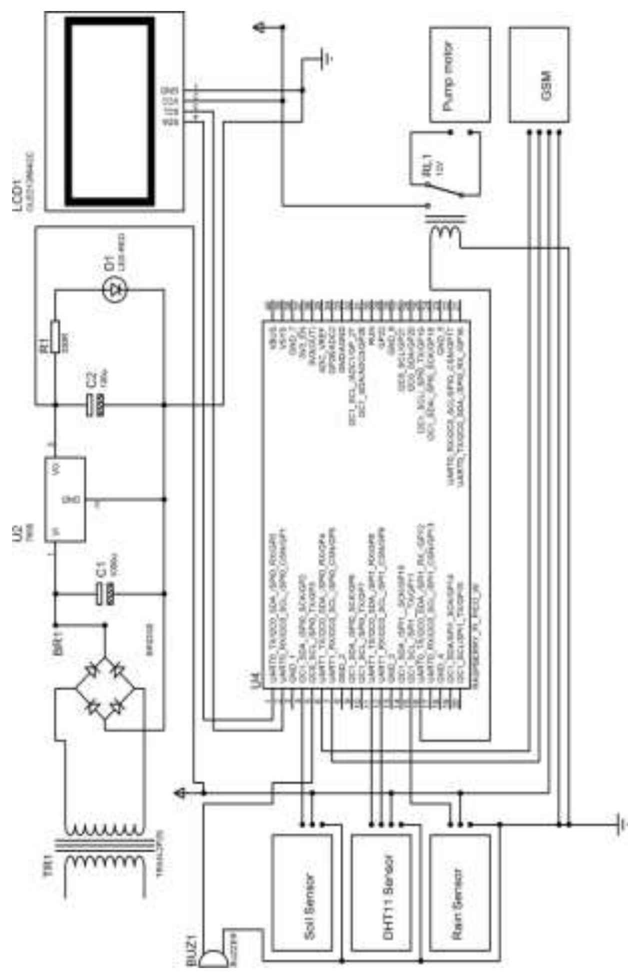

Fig.2 SCHEMATIC DIAGRAM OF AUTONOMOUS AGRICULTURAL ROBOT BASED ON IOT

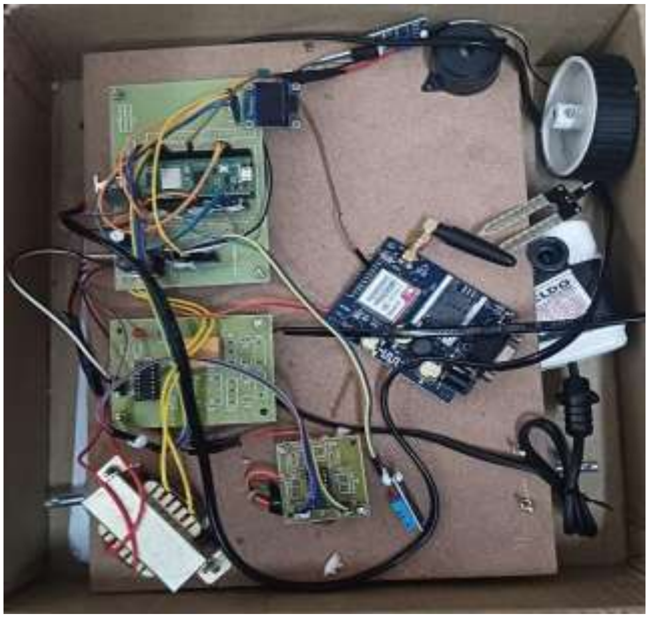

Fig 3: PROTOTYPE OF AUTONOMOUS AGRICULTURAL ROBOT BASED ON IOT

CONCLUSION

The proposed IoT-based agricultural robot presents a modern, efficient, and sustainable approach to farming. By integrating multiple sensors, it enables real-time monitoring of soil moisture, pH, temperature, and other environmental factors. The system uses machine learning and image processing to detect pests, animals, and diseases early, allowing timely intervention. Automated functions such as irrigation, fertilization, and crop monitoring reduce manual labor and improve precision in farming practices.

The inclusion of a GSM module ensures that farmers receive instant updates on their mobile phones, while an Android application provides easy control and data visualization. This smart system minimizes resource wastage, supports sustainable agriculture, and enhances crop yield. Additionally, the use of data analytics aids in long-term planning and better farm management. Overall, the model empowers farmers by improving productivity, reducing effort, and promoting technology-driven agriculture.

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