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AN AUTOMATED LOW COST IOT BASED FERTILIZER INTIMATION SYSTEM FOR SMART AGRICULTURE

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***Abstract*— Smart agriculture is revolutionizing crop production by integrating advanced technologies like the Internet of Things (IoT). One crucial aspect of smart agriculture is the efficient management of fertilizers, which optimize plant nutrition and increase crop yield. This paper proposes an automated low-cost IoT-based fertilizer intimation system to address the challenges faced by farmers in monitoring and managing fertilizer levels in their fields. The system uses IoT technology to collect real-time data on soil moisture, temperature, and nutrient levels, which are then transmitted to a central control unit using wireless communication protocols. The control unit processes the data and generates alerts and notifications to farmers regarding fertilizer requirements. The system is designed to be low-cost, accessible to small-scale farmers with limited resources, and scalable for deployment in larger farming areas or multiple fields. The benefits of the system include improved fertilizer management, reduced fertilizer wastage, increased crop yield, and minimized environmental impact. By leveraging IoT technology, farmers can make informed decisions regarding fertilizer application, leading to increased crop productivity and more sustainable farming practices.**

***IndexTerms*— Smart agriculture,IoT,fertilizer management, wireless sensors, crop productivity,IoT, Arduino Microcontroller, sustainable farming.**

I. INTRODUCTION

India's agriculture is crucial for the economy, with 17-18% of GDP coming from agriculture. Traditional farming uses traditional methods and machinery, while smart farming uses advanced technologies like IoT and sensor nodes. This paper introduces a new method based on IoT to increase production and improve crop quality.

The paper discusses the importance of agriculture in global food production and sustainability, highlighting the challenges faced by traditional farming practices such as climate change, resource limitations, and population growth. It introduces the concept of smart agriculture as a solution to optimize farming techniques and increase agricultural productivity. Fertilizer management is crucial for plant growth and crop yield, but farmers face challenges in effectively managing them, including overuse, underuse, and inefficient application methods. Improper fertilizer management can impact crop productivity, cost efficiency, and environmental sustainability.

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The Internet of Things (IoT) is introduced as a potential solution to address these challenges. The proposed automated low-cost IoT-based fertilizer intimation system aims to address these challenges by providing real-time monitoring, data collection, fertilizer requirement analysis, alert and notification systems, and cost-effectiveness. The system uses wireless sensors to monitor soil moisture, temperature, and nutrient levels, providing real-time data for effective decision-making.

The benefits of implementing the proposed system in smart agriculture include improved fertilizer management, optimized nutrient uptake by plants, increased crop yields, cost savings, enhanced profitability for farmers, and reduced environmental impact through minimized fertilizer wastage and pollution. The paper also highlights the significance of the study in the context of smart agriculture, its potential contributions to agricultural productivity, sustainable farming practices, and food security, and how it aligns with current trends and advancements in the field of agriculture.

We discusses the importance of cost-effectiveness in smart agriculture solutions, emphasizing the affordability and scalability of the proposed fertilizer intimation system. It also addresses the importance of sustainable agriculture practices and their impact on long-term food production and environmental health. The proposed system contributes to sustainability by reducing fertilizer wastage, preventing nutrient runoff, and minimizing pollution, promoting precision farming and targeted fertilizer application, resulting in reduced environmental footprint.

II. LITERATURE REVIEW

B Sindhuja, Mukka Manmadha, V Gari Gowthami, Bajantri Devi, B Madhavi, Ettam Varsha, and Dr T Syed Akheel, and published in Journal of Engineering Science and Technology 05,2023 ISSN:0377-9254.
IoT enhances smart farming by predicting soil moisture and humidity, enabling irrigation system monitoring and control. It improves time efficiency, water management, crop monitoring, soil management, and control of insecticides and pesticides. This system simplifies farming techniques, minimizes human effort, and helps grow markets with minimal effort. It also helps in reducing human efforts and simplifying farming techniques.

Sumathi .P Assistant Professor/ ECE, Unnamalai Institute of Technology, Suba Nagar and published in International Journal of Novel Research and Development in 7 July 2023 ISSN: 2456-4184 IJNRD.ORG 2023.

The IoT-based farming method offers efficient output compared to conventional methods, enabling real-time data collection. This system benefits both experienced and inexperienced farmers. The IoT can be adopted in various fields, improving existing outcomes. AGR IoT can help farmers overcome critical challenges in farming, making it a valuable tool for improving agricultural outcomes.

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Amjad Rehma , Tanzila Saba, Muhammad Kashif, Suliman Mohamed Fati , Saeed Ali Bahaj and Huma Chaudhry and published by Data-Driven Agricultural Innovations 5 January 2022.

The study explores the use of sustainable communication technologies and IoT sensors to boost agricultural productivity. It highlights the practical applications of wireless sensors, unmanned aerial vehicles, and cloud computing in ensuring long-term productivity. Smart devices can automate processes like irrigation, soil sampling, fertilizer control, yield monitoring, forecasting, and harvesting, enhancing crop quality and growth capacity. The study also explores key features, applications, and open barriers in IoT-based smart agriculture technology and equipment.

Abdennabi Morchid , Rachid El Alami , Aeshah A. Raezah , Yassine Sabbar and published in Ain Shams Engineering Journal in 30 September 2023, 102509 .

The Internet of Things (IoT) and sensor technology offer significant potential for enhancing food security and sustainable agricultural methods. This study presents four layers of IoT architecture for smart agriculture, including perception, network, cloud, and application layers. It also discusses the global market size for smart agriculture from 2021 to 2030. IoT technologies can be used for irrigation monitoring systems, fertilizer administration, crop disease detection, monitoring, forecasting, harvesting, climate conditions monitoring, and fire detection. Various sensors can detect soil, moisture, pH, and more. The advantages of IoT in smart agriculture include superior efficiency, expansion, reduced resources, cleaner methods, agility, and product quality improvement. However, infrastructure, training, and research costs must be addressed for widespread use. Collaboration between governments, private sector players, and stakeholders is crucial for successful integration of IoT and sensor technologies in agriculture..

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III. PROPOSED SYSTEM

The proposed system is an automated low-cost IoT-based fertilizer intimation system for smart agriculture. It uses sensors like soil moisture, temperature, and nutrient sensors to monitor soil conditions in real-time, providing accurate data on soil moisture, temperature, and nutrient levels. The data is transmitted wirelessly to a central control unit, which processes the collected data and performs data analysis algorithms to determine crop fertilizer requirements. The system generates customized fertilizer recommendations based on factors like crop type, growth stage, soil conditions, and specific nutrient needs. An alert and notification system is also included, sending timely messages to farmers about the optimal timing, type, and quantity of fertilizers to be applied. The system is cost-effective, using low-power IoT sensors and a cost-effective IoT platform. It is scalable, allowing farmers to monitor specific zones and make localized fertilizer decisions. The system can be adapted to different crop types, enabling farmers to customize fertilizer management based on their specific practices. By leveraging IoT technology, the proposed system empowers farmers with accurate information about fertilizer requirements, enabling them to optimize fertilizer usage, enhance crop productivity, and reduce environmental impact.

IV. Block Diagram

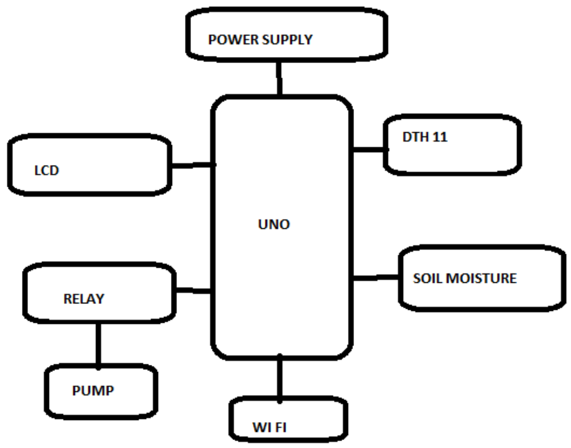

Fig 1- Main Block Diagram

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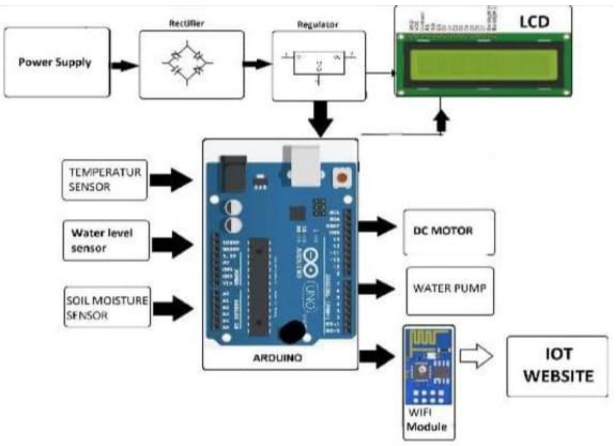

Fig 2- Augmented Reality

V. COMPONENTS DESCRIPTION

A.Arudino UNO

The Arduino Uno is a microcontroller board based on the ATmega328, featuring 14 digital input/output pins, 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It can be connected to a computer via USB cable or powered with an AC-to-DC adapter or battery. The Uno differs from previous boards by not using the FTDI USB-to-serial driver chip and instead uses the Atmega16U2 (Atmega8U2 up to version R2) as a USB-to-serial converter. The board also has a resistor that pulls the 8U2 HWB line to ground, making it easier to put into DFU mode. The Uno board has new features such as 1.0 pin out, stronger reset circuit, and replacing the 8U2 with Atmega 16U2. The name "Uno" signifies the upcoming release of Arduino 1.0, which will serve as the reference versions of Arduino. The Uno is the latest in a series of USB Arduino boards and the reference model for the Arduino platform.

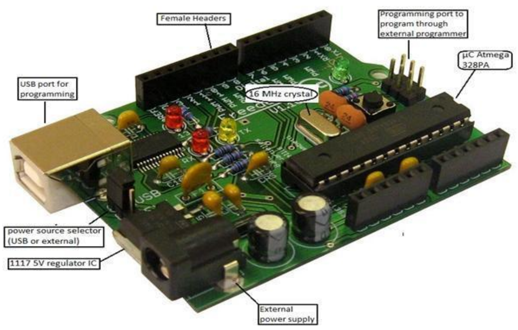

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Fig 3- Arduino Board

B.LCD(Liquid Cristal Display)

A liquid crystal display (LCD) is a flat, color or monochrome display device with a column of liquid crystal molecules suspended between two transparent electrodes and two polarizing filters. These filters allow light to pass through one filter without blocking the other. LCD displays are commonly used in microcontroller devices to output visual information. They are inexpensive, easy to use, and can produce readouts using the 5X7 dots plus cursor. For 8-bit data buses, the display requires a +5V supply and 10 I/O lines, while for 4-bit data buses, it requires supply lines and 6 extra lines.

Fig 4-LCD

C. Soil Moisture Sensor

Ardunio's Soil Moisture Meter, Soil Humidity Sensor, Water Sensor, and Soil Hygrometer uses two probes as variable resistors to measure the volumetric content of water in plants. The sensor can be used in a home automated watering system, connected to IoT, or for identifying plant needs. The sensor has dual output modes, a fixed bolt hole for easy installation, and features a power indicator and digital switching output indicator. It also has a stable LM393 comparator chip.

Fig 5- Soil Moisture Sensor

D. Temperature & Humidity Sensor

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DHT sensors are basic, slow sensors designed for hobbyists to log data. They consist of a capacitive humidity sensor and a thermistor, with a chip that converts analog to digital signals. The digital signal is easy to read using a microcontroller. Humidity, a measure of water vapor in the air, affects various processes and is crucial in industries like semiconductors and control systems. Humidity sensors are divided into relative and absolute humidity sensors, with DHT11 being a digital temperature and humidity sensor.

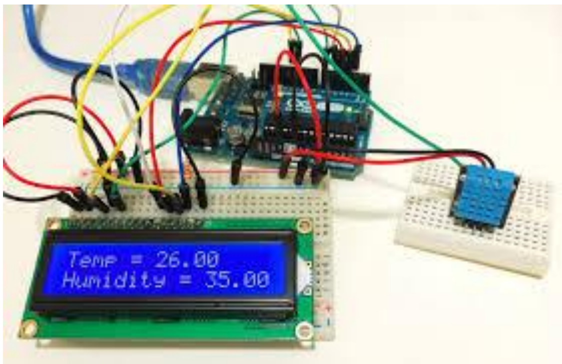

Fig 6- Temperature & Humidity Sensor

E.WIFI Module(ESP8266)

The ESP8266 is a low-cost Wi-Fi microchip produced by Espressif Systems in Shanghai, China. It features a TCP/IP stack and microcontroller capability, allowing microcontrollers to connect to a Wi-Fi network. Initially undocumented, the low price and minimal external components attracted hackers to explore the chip and its software. The ESP8285 and ESP32 family of chips follow.

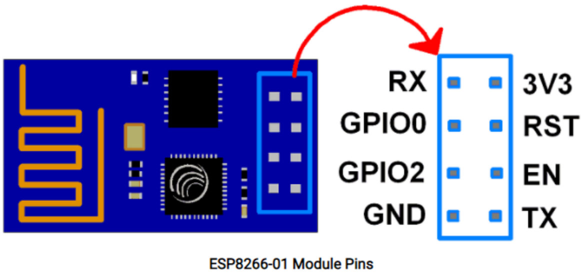

Fig 7- WIFI Module

F. POWER SUPPLY

At the coordinator end and sensor node, many components are used. These components have different operating voltage such as controller operates at 3.3 – 5v. ZigBee transceiver operates at 1.8 V to 3.8 V, LM 35 and LCD display operates at 5 V. To meet these requirements of different operating voltage ranges a proper arrangement of power supply is required. The 7805 voltage regular is used to provide 5 V regulated power supply.

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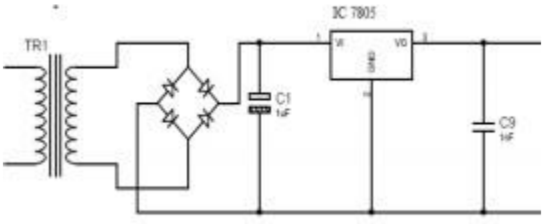

Fig 8-Power Supply

F. Relay Module

Relay modules are circuit boards that house one or more relays, typically rectangular in shape. They contain other components like LEDs, protection diodes, transistors, and resistors. A relay is an electrical switch that controls devices and systems using higher voltages, typically using an electromagnet. The input voltage is usually DC, but the electrical load can be AC or DC. Relay modules come in various input voltage ratings, such as 3.2V or 5V for low power switching or 12 or 24V for heavy-duty systems. They also amplify the control signal for higher current switching.

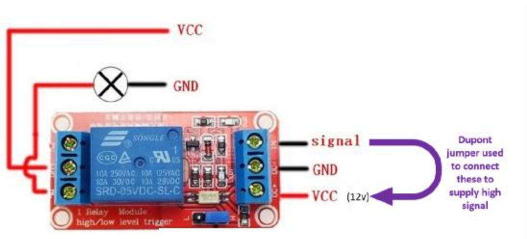

Fig 9-Relay Module

G. DC Water Pump

The Micro DC 3-6V Micro Submersible Pump is a low-cost, small submersible pump for fountain gardens, capable of circulating up to 120 liters per hour with a 220mA current consumption. It requires a constant water level to avoid damage and noise.

Fig 10-DC Water Pump

H.Water Level Sensor

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The water level sensor is a device that measures the liquid level in a fixed container that is too high or too low. According to the method of measuring the liquid level, it can be divided into two types: contact type and non-contact type. The input type water level transmitter we call is a contact measurement, which converts the height of the liquid level into an electrical signal for output. It is currently a widely used water level transmitter.

Fig 11-Water level Sensor

VI. OPERATIVE BENEFITS

The smart agriculture monitoring system uses a soil moisture sensor to test soil for various climatic conditions and interpret results. The moisture output readings are updated using Wi-Fi for wireless transmission. The sensor's values depend on the soil's resistivity, with a maximum threshold value of 1023 for dry soil. When the sensor's value reaches this threshold, the microcontroller triggers a relay and motor pump. The project aims to implement modern technology in agriculture, utilizing IoT technology for easy monitoring and water and labor savings. The sensor network in agriculture facilitates clever irrigation and sends information to clients via the cloud, enabling easy identification of crop changes and early analysis. The mobile telnet APP displays measured and monitored parameters like temperature, humidity, and soil moisture. The system aims to maximize water and labor savings in the current agricultural situation. Soil testing is crucial for predicting crop nutrient requirements and analyzing soil chemically and fertility. An Arduino Uno board connects Moisture Sensor, DHT11 sensor, and water level sensor to create a system. The Thingspeak.com cloud server receives DHT11 sensor data, which is displayed in the Arduino IDE Serial Monitor. Data from temperature, humidity, moisture is also provided, and an alert is sent if temperature exceeds 27°C. Farmers can make decisions based on the data and estimate suitable pesticides based on temperature values.

VII. RESULT

Farmers can monitor agricultural conditions using moisture readings from sensors, which can be viewed on the ThingSpeak cloud platform and an Arduino IDE's serial monitor. The output of temperature and humidity sensors generates related graphs on the cloud server

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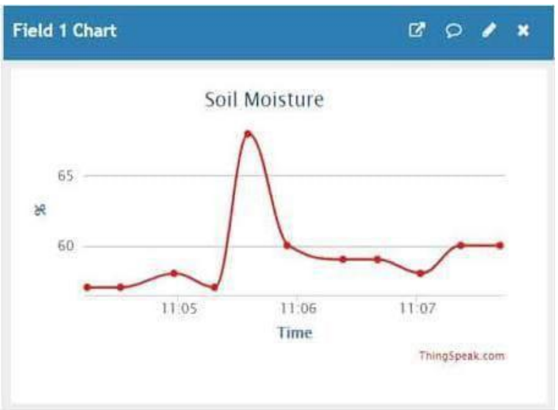
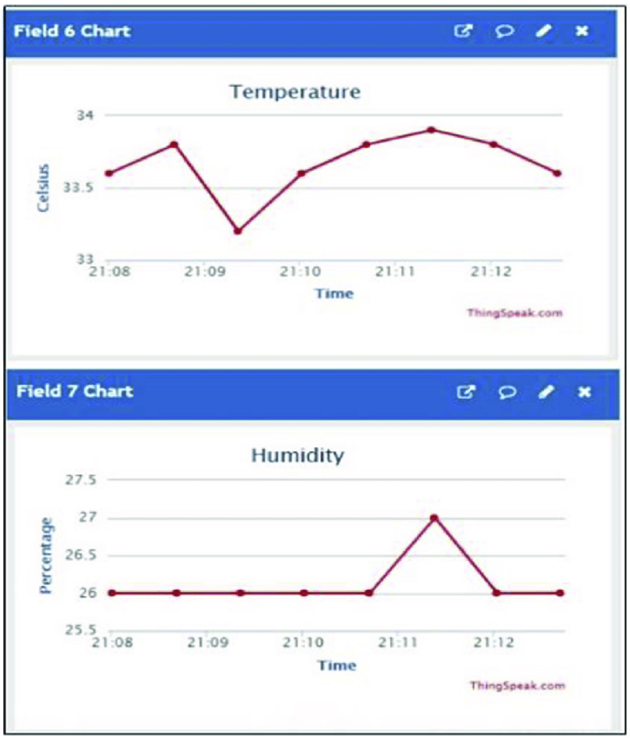


Fig 12-Graph of Soil Moisture



. Fig 13-Graph of Temperature & Humidity

VIII. CONCLUSION

The proposed low-cost IoT-based fertilizer intimation system for smart agriculture offers a significant advancement in fertilizer management. It provides real-time monitoring of soil parameters like moisture levels, temperature, and nutrient content, enabling farmers to make informed decisions about fertilizer application. The data collected from IoT sensors is processed and analyzed using algorithms considering factors like crop type, growth stage, and specific nutrient requirements. This analysis generates customized

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fertilizer recommendations, delivered to farmers through an alert and notification system. Implementing the system optimizes fertilizer usage, reducing the risk of over-application or under-application, leading to improved crop productivity, cost savings, and enhanced profitability. The system promotes environmental sustainability by minimizing fertilizer wastage and nutrient runoff on soil and water resources. The system is designed to be cost-effective and scalable, making it accessible to small-scale farmers with limited resources. The system empowers farmers with the tools and information needed to optimize fertilizer usage, improve crop yields, and promote sustainable agricultural practices. By embracing this innovative technology, farmers can contribute to more efficient and productive farming practices, contributing to food security and environmental stewardship.

IX. FUTURE SCOPE

The project aims to develop a user-friendly system for crop management, including capturing crop photos through a webcam, implementing speech-based options for less literate individuals, integrating GPS for precise farmer location and weather reports, and implementing a regional language feature for farmers who only speak their local language. The system also includes a speech-based option for those who are less literate. The goal is to improve the overall efficiency of the system.

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