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Smart Agriculture Monitoring System

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ABSTRACT: The use of IoT in agriculture is a new idea because IoT sensors can provide information about agriculture and respond to user input. The designer's goal is to take advantage of the Internet of Things and automated smart farming technology. The Internet of Things (IoT) technology has penetrated into every aspect of human life, making everything smarter. IoT is the Internet of Things that forms a self organizing network. With the development of different smart IoT products, the face of agriculture is changing day by day. This not only increases efficiency, but also increases cost effectiveness and reduces losses. The Internet of Things (IoT) has revolutionized the agricultural industry by allowing farmers to solve problems in the field with a variety of techniques, including tillage and processing farm. The design proposes an IoT based smart farm that allows farmers to receive real-time data such as soil moisturizer level, temperature and humidity for better monitoring, smart farming practices and all results, aiming to improve the quality of the product. The main components proposed in this project are Nodemcu integrated with breadboards, cables and different sensors and allow real-time online access to data from your phone with the help of internet. This Project can startout to be revolutionary in the Indian agriculture field. The suggested method aids in the process of remote monitoring and water conservation. agriculture and respond to user input. The designer's goal is to take advantage of the Internet of Things and automated smart farming technology. The Internet of Things (IoT) technology has penetrated into every aspect of human life, making everything smarter. IoT is the Internet of Things that forms a self organizing network. With the development of different smart IoT products, the face of agriculture is changing day by day. This not only increases efficiency, but also increases cost effectiveness and reduces losses. The Internet of Things (IoT) has revolutionized the agricultural industry by allowing farmers to solve problems in the field with a variety of techniques, including tillage and processing farm. The design proposes an IoT based smart farm that allows farmers to receive real-time data such as soil moisturizer level, temperature and humidity for better monitoring, smart farming practices and all results, aiming to improve the quality of the product. The main components proposed in this project are Nodemcu integrated with breadboards, cables and different sensors and allow real-time online access to data from your phone with the help of internet. This Project can startout to be revolutionary in the Indian agriculture field. The suggested method aids in the process of remote monitoring and water conservation.

KEY WORDS: Smart Agriculture, Internet Of Things (IoT), Arduino, ESP 32 Node MCU, Sensors.

I. INTRODUCTION

The main idea of IoT is to connect what is not connected. A world where everything is online and enables new services that improve our lives by communicating with others and people. The world we live in is on the brink of major technological changes, from self-driving drones to grocery delivery to covering your health with clothing sensors. IOT connects physical thing via internet this helps us to control things even we are far away. As all technologies, IOT saves our energy, time and money.

Precision agriculture follows a defined set of rules. they collect farming data and send it to your android device. Protection of cultivated plants is very important. Therefore, we need to monitor the data and this data must be in real time. Farming is simple, cost-effective and labor-efficient through the use of smart farming, which also increases crop yields and increases production. The use of many technologies and gadgets, including the Internet and IoT devices, is referred to as smart agriculture. To feed so many people, we have to increase our production.^[10] The agricultural labor force is also declining in most countries. As a result of the dwindling agricultural workforce, internet connectivity has started to be used in agriculture to reduce the need for human labour. With the promising adoption of IoT, most of the connected devices around us have made their way into almost every aspect of our lives. Also agriculture, healthcare, education, manufacturing, fitness, home automation, transportation, law and order, the possibilities are endless. We will mainly talk about agriculture as a stream where the Internet of Things plays an important role. With centuries of agriculture updates, IoT is now reimagining the way agriculture is seen in India. Over the past few decades, agriculture has undergone massive changes in the way it operates, with cutting-edge approaches and the operation of ultra-smart

devices. Agriculture is now innovative, strategic and technology-driven and efficient with intelligent IoT and automated operations.

INTERNET OF THINGS (IoT)

The Internet of Things (IoT) describes physical objects (or groups of such objects) with sensors, processing capabilities, software, and different technologies that connect and exchange information with different gadgets and structures over the Internet or different communication networks. This field has advanced due to the convergence of several technologies together with ubiquitous computing, commodity sensors, and a growing number of efficient embedded structures. The traditional fields of embedded systems, Wi-Fi sensor networks, control systems, automation (along with home and building automation) individually and collectively enable the Internet of Things. In the client market, IoT technology is maximally synonymous with goods referring to the idea of "smart home", along with gadgets and appliances (along with lights, thermostats, home security structures, cameras and various home appliances) that guide a person. or larger conventional ecosystems and can be managed through gadgets related to that ecosystem, together with smart phones and smart audio systems. IoT is also used in healthcare structures. IoT has profoundly impacted modern life across diverse sectors. In smart homes, it offers convenience through remotely controlled appliances and enhanced security with connected devices like cameras and locks. Healthcare benefits from IoT-enabled wearables and monitoring systems, enabling remote patient monitoring and personalized care. Transportation sees improved safety and efficiency through connected vehicles and intelligent traffic management systems. Smart city initiatives leverage IoT for resource management, urban mobility, and public safety enhancements. Retail and supply chain management benefit from IoT applications such as inventory tracking and predictive maintenance. Industrial IoT optimizes manufacturing processes, reduces downtime, and enhances supply chain visibility. In agriculture, IoT enables precision farming techniques for increased productivity and resource efficiency. Overall, IoT continues to revolutionize daily life, driving innovation and improving quality of life through its pervasive connectivity.

SMART FARMING

Smart agriculture is a broad term that encompasses the practice of agriculture and food production using the Internet of Things, big data and advanced analytics technology. IoT communication generally refers to the addition of sensing, automation and analytics technologies to modern agricultural approaches. The IoT solution focuses on helping farmers bridge the gap between supply and demand by providing excess yields, profitability and inherent security. The technique of using IoT technology to make the most profitable use of resources, achieve high yields and reduce operating costs is known as precision agriculture. IoT technologies in agriculture include specific devices, wireless connections, software and IT services. The global smart agriculture market supply is expected to triple to US\$15.3 billion by 2025 (compared to more than \$5 billion in 2016).

Traditional farming methods are no longer efficient and cannot meet the growing demand for food production. The agriculture sector needs to modernize and adopt technology to meet the challenges. Precision agriculture is a new approach that uses technology to optimize crop production while minimizing resource use. IoT-based smart farming systems have the potential to revolutionize the agricultural sector by providing real-time crop and environmental data. Such systems can help farmers make informed decisions about irrigation, fertilization and other critical aspects of farming.^[11]

Smart agricultural technology includes:

- Sensors that monitor soil quality, soil moisture, and temperature.
- Communication systems such as NavIC and GPS
- Data analysis tools for making decisions and making predictions.
- Smart devices such as drones and satellites to collect image data to improve tracking from above.

II. APPLICATIONS OF IoT IN AGRICULTURE [8][9]

- Precision Farming -- Precision Agriculture / Precision Farming is one of the most well-known IoT applications in agriculture. This is done to give you more control over your farming practices by enabling smart farming applications such as livestock tracking, vehicle tracking, field observation and inventory tracking. The goal of precision agriculture is to analyze data generated by sensors and react accordingly. Precision agriculture helps farmers use sensors to generate data and analyze that information to make smart, fast decisions. There are many precision farming

technologies that play an important role in increasing efficiency and effectiveness, such as irrigation control, livestock and vehicle tracking. Using precision agriculture, soil conditions and other related parameters can be analyzed to increase farm efficiency. In addition, you can see the working conditions of the connected equipment in real time to know the water and nutrient content.

- **Drones** -- Agricultural drones, also known as UAVs (Unmanned Aerial Vehicles) or UAS (Unmanned Aerial Systems), are remotely piloted aircraft equipped with various sensors and imaging capabilities used in agriculture. These drones are designed to collect data and monitor crop health, soil conditions and field variability. They can capture high-resolution aerial imagery, multispectral or hyperspectral data, enabling farmers to assess crop health, detect pest infestations and identify areas in need of irrigation or fertilization. Agricultural drones offer farmers valuable insights into crop management and enable precision farming practices that optimize yields, reduce input costs and minimize environmental impact. In addition, drones can effectively cover large agricultural areas and provide timely and accurate information for decision-making purposes.

Livestock Monitoring -- Livestock monitoring encompasses a set of technologies and methodologies that aim to provide a comprehensive view of animal welfare and management in agricultural settings. These technologies include advanced sensors, GPS tracking systems, RFID tags and even satellite imaging. Health monitoring includes continuous monitoring of vital signs such as body temperature, heart rate and rumination patterns, enabling early detection of illness or distress. Activity tracking provides valuable data on movement patterns, restlessness, or unusual behavior that may indicate health problems or environmental stressors.

Reproduction management uses monitoring systems to track estrus cycles, fertility and gestation periods, assisting in breeding programs and ensuring optimal reproductive health. In addition, environmental monitoring includes the assessment of factors such as temperature, humidity, air quality and light conditions in livestock facilities, thereby optimizing living conditions for animal welfare and performance. Livestock tracking technologies are constantly evolving, and innovations such as artificial intelligence and machine learning are improving data analysis and decision-making for farmers and ranchers. These advances not only improve animal care and productivity, but also contribute to sustainable and efficient livestock farming practices.

Smart Green House -- Greenhouse farming is a technique for improving the yield of crops, vegetables, fruits, etc. Greenhouses control environmental parameters in two ways; either by manual intervention or by a proportional control mechanism. However, since manual intervention has disadvantages such as loss of performance, loss strength and labor costs, these methods are less effective. The smart greenhouse not only intelligently monitors but also controls the climate through the built-in IoT system. This eliminates any need for human intervention. Various sensors are used to control the environment in smart greenhouses, which measure environmental parameters based on plant needs. A cloud server is then created to remotely access the system when connected via IoT. Inside the greenhouse, a cloud server helps process data and apply control actions. This design provides farmers with an optimal and cost-effective solution with minimal and almost zero manual intervention. Through these sensors, the status of the greenhouse and water consumption can be monitored by sending SMS alerts to farmers through an online portal. The sensors of the IoT system in the greenhouse provide information on temperature, pressure, humidity and light level.

Monitor Climate Conditions -- Climate plays a very important role in agriculture, and a lack of understanding of climate will greatly reduce the quantity and quality of agricultural production. But IoT solutions allow us to know weather conditions in real time. Sensors are placed throughout the farmland. They collect environmental data that is used to select suitable crops that can grow and sustain in specific climates. The entire IoT ecosystem consists of sensors that are capable of sensing real-time weather conditions such as humidity, precipitation, temperature and more precisely. There are sensors that detect all these parameters and configure them accordingly to suit our smart farming needs. These sensors monitor the condition of the crops and the weather conditions around them. If unusual weather conditions are detected, an alert will be sent. It eliminates the need for physical presence during unusual weather conditions, which ultimately increases yields and helps farmers get more out of farming.

Remote Sensing -- IoT-enabled remote sensing in agriculture is revolutionizing traditional farming methods by deploying sensor networks and connected devices to collect real-time data on soil moisture, temperature, crop health and environmental conditions. Through integration with drones or satellites, this data is transmitted wirelessly to centralized systems, allowing farmers to make data-driven decisions for precision agriculture. By optimizing irrigation,

fertilization and pest control practices, farmers can maximize yields, reduce input costs and minimize environmental impact. In addition, early detection of pest infestations and disease outbreaks allows early intervention and mitigation of crop losses. IoT-enabled remote sensing is transforming agriculture by providing scalable, affordable and sustainable solutions to increase productivity and ensure food security in a changing climate.

Crop Assessment: These sensors are placed at different corners of the farm assessing crops to monitor any changes in soil moisture, humidity and temperature. Any deviations detected by the sensors are evaluated and the farmer get notified. As a result, remote sensing helps prevent the spread of diseases as well as monitor the progress of crops without go directly to the farmland.

Smart Irrigation On Agriculture Land -- Automatic irrigation systems use IoT technology to monitor and manage irrigation schedules for agricultural crops, landscaping and gardens. These systems usually consist of sensors, actuators, valves and actuators connected to a central control unit. Soil moisture sensors measure soil moisture content, while weather sensors collect data on temperature, humidity and precipitation levels. This information is transmitted to a central controller, which uses algorithms to determine the optimal irrigation schedule based on specific plant needs and environmental conditions. The controller then activates the irrigation valves to deliver water to the plants as needed, ensuring efficient water use and preventing overflow or water logging. Automatic irrigation systems improve water efficiency, reduce labor costs and promote healthier plant growth by providing the right amount of water at the right time. Additionally, these systems can be remotely monitored and controlled using smart phone apps or web interfaces, allowing farmers and gardeners to adjust settings and respond to changing conditions in real time.

III. PROBLEM STATEMENT

Aim: The aim of our project is to built a Smart Irrigation System , a subpart of Smart Farming. It will collect the temperature , humidity , soil moisture and water level readings and will switch on and off the pump if necessary.

Apparatus

- ESP32 node MCU
- Breadboard
- Jumper wires
- Temperature humidity sensor
- Soil moisture sensor
- Water level sensor
- 6 volt D.C. motor pump
- 1channel relay module
- Smart phone with installed Blynk app

IV. CIRCUIT DIAGRAM

Block Diagram

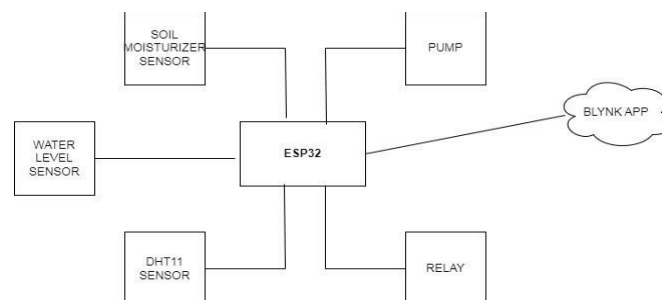


Fig -1: Block Diagram

Actual Circuit Diagram

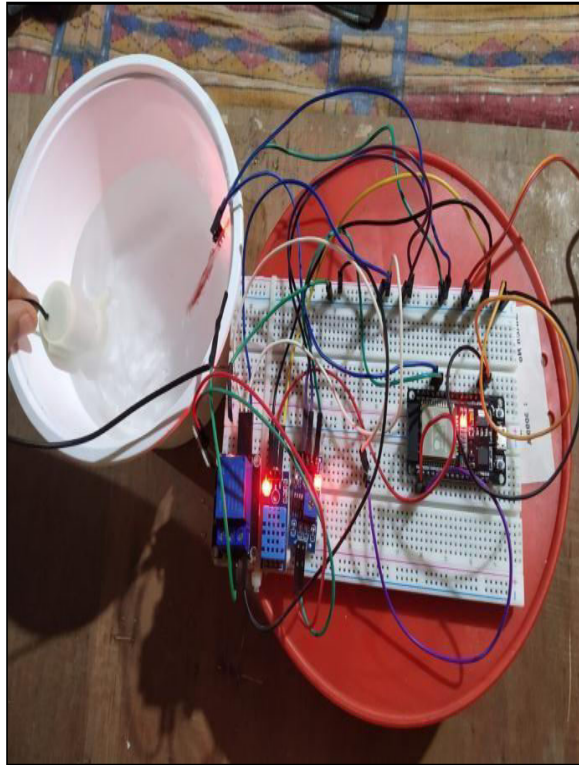


Fig -2: Actual Circuit Diagram [3][4]

V. METHODOLOGY

Working Principle

The title of the project is “SMART AGRICULTURE MONITORING SYSTEM” ESP32 NODE MCU microcontroller is the heart of the project. Sensors are primary elements to collect data. We can refer to Fig. 1 and Fig. 2 to understand the working along with the components. The temperature humidity sensor (DHT11) is used here to collect the temperature and humidity of the surrounding atmosphere. Soil moisture sensor collects the moisture level of the soil and water level sensor senses the water level of the reservoir. All these sensors collect the data from the surroundings and convert them into electrical signal to feed the data to the system as input. Then the data is sent to the ESP32 NODE MCU .NODEMCU process the data and make output.

ESP32 NODE MCU will connect to the internet using WIFI network and will send the data to the Blynk server using the authentication code and password provided in the code, which is uploaded into the node MCU and code can be write using Arduino software^[6]. Then the readings collected by the node MCU is visible in the Blynk app^[5] in our smart phone and we are able to monitor the reading from the sensors as well as the pump status. The code is written in such a way, that whenever the soil moisture level falls below 30 and water level of the reservoir is above 50 then the pump will be on and it will water the plants and soil for 10seconds and these levels can be altered as need. After that it will be off.

The code written in the Arduino IDE is uploaded in NODE MCU using USB cable, so that ESP32 works according the code.

NODEMCU/ESP32

NodeMCU is an open source platform based on the ESP32 that enables Wi-Fi connectivity and data transmission. Additionally, it can fulfil many of the project's requirements on its own by providing some of the most features, like GPIO, PWM, ADC, and others transmission.



Fig:3

SOILMOISTURESENSOR

A soil moisture sensor is a device that monitors the current moisture content of the soil. The irrigation system's sensor helps schedule water supply and distribution considerably more effectively. These gauges help in reducing or increasing irrigation for optimal plant growth.

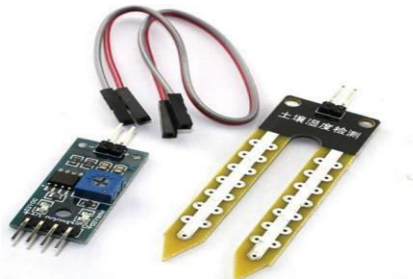


Fig:4

TEMPERATURE AND HUMIDITY SENSOR

A fairly straight forward and in expensive digital temperature and humidity sensor is the DHT11. It measures the surrounding air and outputs a digital signal to the data pins.

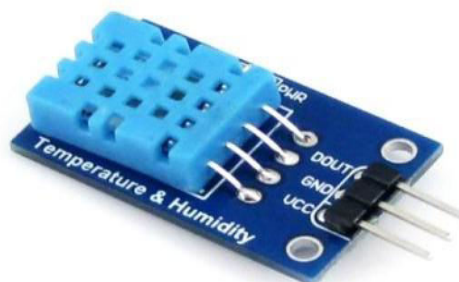


Fig:5

WATER LEVEL SENSOR

A water level sensor is a device designed to detect and measure the depth or height of water in a reservoir, tank, well,

or other water storage system. This is an analog sensor.



Fig:6

MOTOR PUMP

A motor pump is a mechanical device used to move liquids, typically water, from one location to another. It consists of an electric motor and a pump unit, often combined into a single assembly. The electric motor provides the necessary power to drive the pump, which creates suction to draw water from a source, such as a well, reservoir, or storage tank, and then pressurizes and directs it through pipes or hoses to the desired destination, such as irrigation systems, water distribution networks, or industrial processes.



Fig:7

RELAY

A relay module for a motor is a device that allows you to control the operation of an electric motor using low-voltage signals from a microcontroller, sensor, or manual switch. The relay module typically consists of one or more relays, which are electrically operated switches, along with necessary circuitry for protection and control.



Fig:8

VI. RESULT ANALYSIS

As shown in the first figure, temperature and humidity sensor is showing its reading . The soil moisture level is zero here so the pump should work but as the tank water level is also zero the pump is not working and the status is zero .



Fig:9

In the next figure, water level is sufficient, so the pump works.

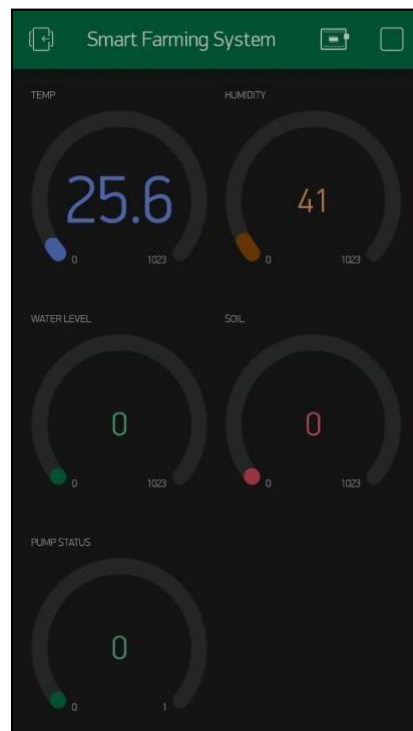


Fig:10

VII. CONCLUSIONS

Markets rise and fall, disruptive business models appear or disappear, but people always have to eat and drink. For this reason, development in areas such as food and agriculture is always a priority, especially considering the dynamics of today's world. IoT used in agriculture therefore has a very promising future. By using IoT in agriculture, you can improve your current farming scenario by upgrading it to achieve better results such as increased productivity. IoT creates a virtuous cycle that makes agriculture more efficient, makes food more accessible to consumers, saves farmers time and money, and brings process sustainability to the agricultural environment.

In summary, the proposed system is an innovative solution to address the challenges faced by the agricultural sector in India. By providing farmers real-time data and control over their crops, the system has the potential to increase crop yields, reduce resource wastage and improve environmental sustainability. Simplicity, affordability and availability make it a valuable tool for farmers in rural areas of India where access to advanced agricultural technologies is often limited. The proposed system represents a significant step towards the development of smart and sustainable farming practices in India and has the potential to significantly improve the livelihoods of farmers and the overall health of the agricultural sector^[11]

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