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A Review on Plant Monitoring System using ESP8266

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Abstract: *Every nation has engaged in agriculture for a very long time. The science and skill of growing plants is called agriculture. The main factor in the rise of sedentary human civilization was agriculture. Agriculture has always been done by hand. Since the world is moving toward new technology and applications, it is imperative that agriculture follow suit. However, there are currently obstacles in agriculture as a result of rural-to-urban migration. Therefore, we have suggested an IOT and smart agriculture solution to address this issue. Agriculture, which is considered a science and a skill of plant cultivation, has been practiced throughout history in every nation. Technology is evolving in today's world, and agriculture must likewise keep up with the times. A key component of smart agriculture is IoT. Sensors from the Internet of Things (IoT) are utilized to supply the data that is required for agricultural areas. Using wireless sensor networks to monitor agriculture and gather data from multiple sensors placed at different locations and transmitted over wireless protocols is the primary function of the Internet of Things. Node MCU powers smart agriculture through the use of IoT systems. The increasing demand for effective water management in agriculture in recent years has drawn a lot of attention to smart farming systems. Water use, crop output, and sustainability have all increased as a result of the integration of Internet of Things (IoT) technologies with farming systems, which has created new opportunities for real-time monitoring and control. The farming system uses the PIR (Passive Infrared Sensor) to identify the presence of animals nearby. Determining the soil's water content is mostly dependent on the soil and moisture sensor. By keeping an eye on the outside temperature, the temperature sensor offers important information about the surrounding environment. IoTbased smart agriculture is a cutting-edge method of farming that makes use of technology to maximize agricultural productivity. Manual labor and antiquated methods, which were frequently labor-intensive and ineffective, were key components of the conventional agricultural approach.*

Keywords: PIR Sensor, Temperature and Humidity Sensors, Water Level Sensor, Real-Time Data, Crop Yield Improvement, Crop Health Monitoring, Sensor Technology in Agriculture

I. INTRODUCTION

As the globe adopts new technologies and practices, it is imperative that agriculture follow suit. Since agriculture is the primary source of food grains and raw materials, it is regarded as the foundation of human life. where it is essential to the expansion of the national economy. Additionally, it offers people a wide range of job prospects. The development of the nation's economic situation depends on the growth of the agriculture sector. Sadly, a lot of farmers continue to cultivate using outdated techniques, which leads to poor crop and fruit yields. However, the yield has increased wherever automation has been used and automated machinery has taken the position of humans.It is everyone's responsibility to establish a setting that allows farmers to be comfortable, produce well, and, most importantly, keep their fields safe from various animals [1].

Agriculture is one of India's largest livelihood industries. Agriculture has a vital role in supporting human existence. The population growth is directly correlated with the level of agricultural output. In essence, agriculture manufacturing depends on seasonal conditions, which currently lack sufficient water supplies. IoT-primarily based smart agriculture devices are used to get the best results in agriculture and to solve the issues. The goal of regional and global agricultural monitoring systems is to provide current information on food production. IoT-based smart farming uses sensors such as light, humidity, temperature, soil moisture, and others to build a device that monitors agricultural discipline.

The field requirements can be viewed by farmers from any location. Compared to the traditional method, IoT-based smart farming is quite effective. The ESP8266 NodeMCU Module and DHT11 Sensor are used in the suggested Internet of Things-based fully irrigation system.[2] Agriculture provides a living for more than 58 percent of the rural population, and 10 percent of the nation's exports come from this sector. Therefore, if there are no adequate yields because of ignorance about the nature of the soil and water availability, farmers and even the country's economy will suffer.

A. Methods and Materials Used

The DHT11 sensors use a capacitive humidity sensor and a thermistor to offer digital readouts for tempera ture and humidity.

- Water Level Sensor: A water level sensor measures liquid levels in tanks, reservoirs, or other containers. It works using conductive, ultrasonic, or float-based technologies. Commonly used in agriculture, industries, and household applications, it ensures efficient water management, prevents overflows, and automates systems like pumps or alarms, enhancing safety and resource conservation.
- Relay Module: Enables the low-power Arduino to regu late high-power equipment, such as fans, in response to sensor data in order to preserve the storage environment.
- PIR Sensor: A Passive Infrared (PIR) sensor detects motion by measuring infrared radiation changes in its environment. It is commonly used in security systems, automatic lighting, and occupancy sensing. PIR sensors are energyefficient, compact, and reliable, detecting movement through heat emitted by living beings, making them ideal for various indoor and outdoor applications.
- The ESP8266 Wi-Fi Module allows real-time data trans mission to cloud services or IoT platforms for remote moni toring by enabling internet connectivity.
- LCD Screen: Instantaneously provides a summary of storage conditions by displaying current temperature, humid ity, and gas levels
- Water Pump: A water pump is a mechanical device used to move water from one location to another. It operates using electricity, fuel, or manual effort. Commonly used in agriculture, irrigation, industries, and households, it ensures efficient water distribution, supports plumbing systems, and aids in draining, supplying, or circulating water effectively.

II. LITERATURE SURVEY

The current method, which is one of the oldest in agriculture, is the manual method of checking the parameters; farmers themselves verify all the parameters and calculate the reading [1]. India is one of the five largest producers of over 80 percent of the rural generation worldwide. The development of smart agricultural IoT devices has changed the face of agriculture by improving the quality of agriculture as well as increasing its cost-effectiveness and waste reduction [8]. It focusses on creating devices and gadgets to monitor, display, and alert the clients using the points of interest of a wireless sensor network. As the demand for food increases due to population and income growth, agricultural advancements help to extend global trim yields up to 67 percent. It suggests using IOT advancements and robotization to advance agribusiness [4].

Crop health monitoring systems have been greatly enhanced by the combination of Internet of Things (IoT) technology with microcontrollers such as the NodeMCU8266. This integration allows for real-time data collecting and analysis to optimise agricultural methods. An IoT-based smart agricultural system using the NodeMCU8266 is shown in a paper published in[9]. To track several soil factors, this system uses sensors including motion, rainwater, temperature and humidity, and soil wetness. By transferring the gathered data to a smartphone application, farmers may remotely operate irrigation systems, saving water and improving crop development.

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IoT technology and a NodeMCU8266 smart plant monitoring system are covered in [10]. To evaluate the health of plants, this system combines sensors for temperature, humidity, and soil moisture. The device automatically turns on a water pump to irrigate the plants when the soil moisture levels drop below a certain threshold, guaranteeing ideal growing conditions. The difficulties and possibilities of using IoT for real-time plant health monitoring are covered in detail in [11]. They emphasise how the NodeMCU8266 may be used to integrate sensors such as the LDR, DHT11, and soil moisture sensors in order to gather information on temperature, humidity, light intensity, and soil moisture. For real-time monitoring, automated irrigation, and effective plant care, the data is sent to cloud platforms like ThingSpeak.

All of these research show that NodeMCU8266-based IoT-based crop health monitoring systems provide economical, scalable, and effective solutions for contemporary agriculture. They make it possible for automated interventions, datadriven decision-making, and real-time monitoring, all of which enhance agricultural yields and promote sustainable farming methods.

III. METHODOLOGY

The suggested system uses sensor technology and the Internet of Things (IoT) to track environmental factors that are important for agricultural management. A DHT11 sensor for temperature and humidity, a PIR sensor for motion detection, and a water level sensor for reservoir level tracking are all integrated with the NodeMCU ESP8266 microprocessor. This approach offers a thorough framework for putting the system into practice, covering data processing, software development, hardware configuration, and cloud-based platform integration. The goal is to maximize resource utilization and improve crop output through automation and real-time monitoring.

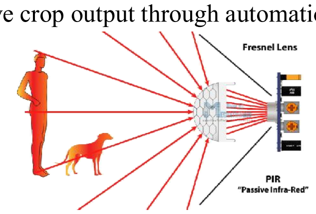

Fig. 1. Detection Mechanism of PIR Sensor

The main controller and communication hub is the NodeMCU ESP8266. This low-cost, Wi-Fi-capable microcontroller makes it easier to gather, process, and send data to distant platforms. The device is a good option for Internet of Things-based agricultural monitoring because it works with a variety of sensors and can be programmed using the Arduino IDE [12]. The environment's temperature and humidity are measured via the DHT11 sensor. These factors are essential for evaluating crop health and spotting circumstances that could encourage illnesses or pest infestations. Digital output from the sensor guarantees precise and simple data integration with the NodeMCU [13].

Motion is detected using the Passive Infrared (PIR) sensor, which is mostly used to detect animal presence or unwanted entry. This protects crops from possible harm from trespassers or wildlife. When motion is detected within its range, the sensor sends a signal to the NodeMCU [14].

To guarantee that crops receive enough irrigation, the water level sensor keeps an eye on the water reservoir. This element enables automated irrigation system activation based on realtime data and is crucial for reducing water scarcity or waste [15].

For environmental and security monitoring, the system combines NodeMCU ESP8266 with DHT11, PIR, and water level sensors. The NodeMCU is set up as the primary controller and uses GPIO pins to interface with sensors. Strategically positioned sensors include the DHT11 for measuring temperature and humidity, Software development entails using the Arduino IDE to program the NodeMCU and add libraries for Wi-Fi and sensor functionality.

Automated data acquisition gathers motion, water level, temperature, and humidity measurements. Algorithms are used to process data and generate alerts for anomalies such as motion detection or extreme circumstances. Wi-Fi is used to facilitate data transmission and visualization, sending data to cloud platforms such as Firebase or ThingSpeak using the MQTT or HTTP protocols. Actionable insights are obtained by visualizing real-time data using intuitive interfaces. Notifications are provided by SMS, email, or applications when important events like motion detection, low water levels, or hot or low temperatures occur.

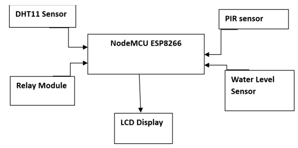

Fig. 2. Bsaic Block Diagram

With sensors calibrated for environmental conditions and performance validated in controlled environments, testing and calibration guarantee accuracy. Testing is followed by threshold and data interval optimization. For long-term functionality and feature enhancements, deployment and maintenance include extensive field deployment, regular sensor cleaning, hardware inspections, and software upgrades. This methodology describes a scalable and effective way for agricultural monitoring that makes use of sensor and Internet of Things technology to increase sustainability and productivity. The NodeMCU ESP8266 is a useful tool for contemporary agriculture since it integrates with DHT11, PIR, and water level sensors to provide precise, real-time data collecting and actionable insights.

IV. FUTURE DEVELOPMENT

IoT-based agricultural monitoring systems that use parts like NodeMCU ESP8266, DHT11, PIR sensors, and water level sensors have a lot of potential for future development as agriculture moves towards more efficient and sustainable methods. Future development can make use of cutting-edge technologies, incorporate sophisticated analytics, and increase scalability to solve a wider range of agricultural concerns, whereas present implementations concentrate on fundamental environmental and security monitoring. We list several prospective improvements to this system below, emphasising their significance and potential methods of implementation.

Machine Learning and Predictive Analytics: The predictive power of agricultural monitoring systems is increased by integrating machine learning (ML). To estimate crop development phases and production, machine learning algorithms can examine past data, weather forecasts, and environmental factors [17]. Models can be trained using sensor data to spot early indicators of illnesses or insect infestations, allowing for prompt preventative measures. Additionally, by examining crop requirements, weather information, and soil moisture trends, predictive analytics optimises irrigation programs. These developments facilitate proactive agricultural decision-making, increase production, and enhance resource management.

Integration of Advanced Sensors: In order to expand quantifiable parameters, future systems can integrate sophisticated sensors to improve functionality. By enabling precise fertilisation, soil nutrient sensors reduce the abuse of chemical inputs. CO2 sensors help in greenhouse management by tracking atmospheric levels that are essential for photosynthesis. Using spectral imaging, multispectral and hyperspectral sensors identify crop health and stressors including pest infestations and nutrient shortages. These developments offer more precise, focused data for enhancing crop productivity and agricultural practice optimisation [16].

Enhanced Connectivity and Data Management: Future developments should take into account more scalable options, even though the crop health monitoring systems that are currently in use rely on Wi-Fi and cloud platforms like Firebase or ThingSpeak. In rural locations with spotty Wi-Fi, LoRa and NB-IoT technologies can enhance connection [18]. By processing data locally on NodeMCU or specialised edge devices, edge computing lowers latency and dependence on continuous internet connectivity. Large-scale farming operations require secure and impenetrable data storage, which blockchain technology can provide. These advancements have the potential to greatly improve agricultural monitoring systems' dependability and effectiveness.

Integration with Automated Systems: Smart agriculture requires integration with automated systems in order to respond to sensor data in real time. Irrigation Automation: Delivers water according to moisture levels using drip systems or solenoid valves. Pest Control: When the PIR sensor detects motion or pest activity, it automatically applies pesticides or repellents. Climate Control: To maintain ideal growing conditions in greenhouses, the system modifies fans, heaters, or humidifiers in response to DHT11 sensor readings. By increasing productivity, decreasing manual labour, and guaranteeing accurate control over the farming environment, this automation makes agriculture more intelligent and sustainable.

Renewable Energy Integration: To ensure continuous operation in remote places, future agricultural IoT systems should be powered by renewable energy sources, such as solar panels, for its NodeMCU and sensors. By adding energy collecting methods like wind or kinetic energy, solar power can continue to work even in inclement weather.

Real-Time Collaboration and Advisory Platforms: By connecting with advisory platforms, future IoT systems will be able to provide recommendations in real time. Farmer Networks: Exchange anonymised data with farmers in your area to work together on crop health, irrigation, and pest management. Agricultural Advisory Services: Input information into advisory systems to provide customised suggestions based on local patterns and professional evaluation.

Scalability and Cost Optimization: Scalability and cost are critical as IoT adoption in agriculture grows. Modular design lowers initial costs by enabling farmers to tailor their systems to particular requirements. In bulk Smallholder farmers may now afford technology thanks to the production of parts like sensors and NodeMCU. CloudBased Partnership subsidies with cloud service providers can give free or reasonably priced agricultural data storage options, further reducing expenses and encouraging broad adoption.

Environmental Sustainability: By measuring emissions and implementing eco-friendly practices, IoT devices improve sustainable farming by tracking carbon footprints. Conserving water: Cutting-edge analytics pinpoint water waste and recommend effective irrigation. trash management: IoT encourages recycling within the farm ecosystem by tracking composting and trash breakdown..

Integration with AI-Powered Robotics: By taking over some duties, AI-powered robotic devices can improve IoT monitoring in agriculture. Weeding and Planting: Robots equipped with Internet of Things sensors are capable of effective weed eradication and precise planting. Harvesting: IoT data can be used by automated harvesting robots to determine when it is ideal to harvest crops. These connections result in more sustainable and effective farming methods by increasing precision, lowering labour costs, and optimising resource utilisation. By combining AI, robots, and the Internet of Things, conventional farming is transformed into an intelligent, automated process that boosts sustainability and productivity.

Integration with AI-Powered Robotics: For successful adoption, future IoT advances in agriculture must be in line with governmental frameworks and involve communities. Widespread and successful implementation depends on integrating with government initiatives [19], teaching farmers, and creating systems that satisfy global sustainability and food security objectives

V. CONCLUSION

IoT is essential to improving smart farming because it makes sophisticated agricultural process automation and monitoring possible. IoT systems enable accurate data gathering and control over irrigation, water management, crop monitoring, soil maintenance, and pesticide application through the use of sensors for temperature, humidity, soil moisture, and motion detection. This technology encourages effective resource use, reduces human labour, and streamlines farming practices.

Automatic irrigation management is made possible by smart agricultural systems' ability to forecast climatic factors like temperature and humidity. They increase productivity overall, safeguard crops, and improve time efficiency. Mobile gadgets allow farmers to remotely monitor agricultural data, guaranteeing smooth supervision from any location. By optimising water use and reducing labour costs, the combination of IoT and automation in agriculture promotes sustainable farming methods.

Anywhere in the world, this device can assist in monitoring agricultural data. Based on this intelligent irrigation system, it can be said that irrigation can advance significantly with the use of automation and Internet of Things technologies. As a result, this technology addresses the issues with the current irrigation procedure. The implementation of a smart farming or irrigation system is economical and maximises water resources for agricultural output. This project's primary goal is to use a smartphone or other mobile device to monitor the plants and turn off the water supply. Since this technology automates and regulates or modifies the water without the need for human interaction, its usefulness may be demonstrated. The creation of novel techniques to enhance crop quality and save lives of the farmers.

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