Empowering Smart Agriculture In ArunachalPradesh Using Internet Of Things(IOT)

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***Abstract*—Agriculture plays a vital role in the Indian economy, employing a majority of the population and contributing significantly to the GDP. However, traditional farming methods face challenges such as water scarcity, soil nutrient depletion, and excessive fertilizer usage, which negatively impact crop yield and sustainability. To address these issues, this project proposes the adoption of modern technologies, particularly the Internet of Things (IoT), to enable smarter agriculture practices.**

The project focuses on utilizing sensors to measure various agricultural parameters, including soil moisture, temperature and humidity. These sensors provide real-time data that is transmitted to the cloud for further analysis and processing.Monitoring can be conveniently achieved using a cloud-based service called Adafruit IO. With Adafruit IO, users can effortlessly establish connections and oversee their devices. It also offers a range of tools for visualizing and analyzing data.

One of the key features of this project is the implementation of a smart irrigation system. By optimizing water usage and delivering the appropriate amount of water based on crop requirements, this system can conserve water, reduce costs, and improve overall crop yield.

In summary, this project presents a comprehensive solution to enhance the efficiency and productivity of agriculture in India through the integration of IoT, cloud computing, and data analytics. By providing farmers with real-time information and actionable insights, it has the potential to revolutionize traditional farming practices and significantly increase agricultural output in the country.

***Index Terms*—Agriculture, IoT (Internet of Things), Sensor-based monitoring, Water conservation, Real-time data**

I. INTRODUCTION

The Internet of Things (IoT) has emerged as a transformative technology in recent years, with its applications spanning across multiple industries. One such industry that is significantly benefiting from the advancements in IoT is agriculture. The agriculture industry is under increasing pressure to improve its efficiency, sustainability, and productivity while minimizing costs. IoT technology can help farmers to achieve these goals by providing real-time data on crop growth, weather conditions, soil moisture levels, and other factors that affect crop health. IoT devices, sensors, and software can collect data from fields, crops, and livestock and send it to cloud-based platforms where farmers can analyse the data and make informed decisions about their farming practices. This report aims to explore the role of IoT in agriculture and how it is transforming the industry. We will examine the various IoT technologies used in agriculture, the challenges and opportunities presented by IoT, and the impact of IoT on agriculture's efficiency, sustainability, and productivity. By the end of this report, we hope to provide a comprehensive understanding of how IoT is reshaping agriculture and what the future holds for this technology in the industry.The Internet of Things (IoT) consists of several components that work together to enable the collection, transmission, and analysis of data from connected devices.

II. IOT IN AGRICULTURE

The role of IoT in agriculture is becoming increasingly important as the industry seeks new ways to improve efficiency, reduce waste, and increase productivity. IoT enables farmers to collect real-time data on weather conditions, soil moisture levels, and other factors that affect crop growth, which allows them to optimize their farming practices for better yields and more efficient use of resources. Additionally, IoT devices can help farmers monitor the health and well-being of livestock, enabling them to detect and prevent diseases before they spread. IoT also enables farmers to remotely control and automate irrigation systems, fertilization, and other farming processes, reducing labour costs and improving accuracy. The Internet of Things (IoT) has brought numerous advantages to agriculture, including the reduction of waste and enhancement of sustainability. With the aid of data analytics, farmers can optimize their farming practices, leading to a reduction in the use of fertilizers and chemicals, lower water consumption, and avoidance of over-irrigation. These practices contribute significantly to creating a more environmentally friendly and sustainable agricultural system. In addition, the utilization of IoT in agriculture can enhance food safety by empowering farmers to track and trace their products throughout the entire supply chain. This results in improved transparency and accountability, along with more rapid and effective product recalls, which help to prevent foodborne illnesses. The role of IoT in agriculture is revolutionizing the industry and creating novel opportunities for farmers to enhance their productivity, efficiency, and sustainability.

III. Overview of literature

A. LITERATURE REVIEW

The use of Internet of Things (IoT) in agriculture industry can lead to effective utilization of resources, reduction of wastage and increase in crop yield. A system is developed using sensors such as soil moisture, temperature, humidity, and light to monitor crop-field. The proposed model aims to replace the conventional method of soil testing with automated soil testing [1]. An embedded soil analyser is proposed that measures the pH value of the soil and predicts the availability of soil nutrients. The model helps to improve soil fertility and reduce the need for conventional soil testing methods [2]. An IoT based smart stick is presented that enables live monitoring of different agricultural parameters. The stick allows farmers to acquire live data on temperature and soil moisture and can be used with smart gadgets such as tablets and phones. The proposed plug and play system simplifies the smart monitoring process [3]. A model is proposed to supervise and control the flow and direction of water in agriculture fields using DHTT11 and soil moisture sensors. The model also enables farmers to switch on and off the motor with a single click and receive information about water direction via phone or email [4]. Use of Wireless Sensor Network (WSN) enables real-time monitoring of different parameters such as humidity, temperature, soil moisture, water level, flood, wind direction, wind speed, and weather. The paper presents a cost-efficient WSN to obtain information from humidity, soil moisture, and temperature sensors to increase crop yield [10]. To improve crop yield, the paper proposes a way to achieve an "evergreen revolution" in agriculture by balancing the use of P, K, N fertilizers. The paper emphasizes the use of different technologies to automate the process and presents a cost-efficient WSN for humidity, soil moisture, and temperature sensors [5, 11]. The paper proposes using GSM technology and PIR sensors to detect movement of animals and humans in agriculture fields. The model can be used in addition to other sensors to monitor temperature, humidity, and sunlight intensity [6]. A proposed model for smart agriculture aims to develop a real-time monitoring system for soil properties such as temperature, moisture, and pH. The system also includes decision support advisory models for pest and disease forewarning and crop disease identification using image analysis. Ubi-Sense sensors are used to read values from sensors, detect proximity IR LED, and transmit the measured physical values to a server through the air [7]. The paper highlights the importance of monitoring environmental factors such as temperature and humidity for improving crop yield. To achieve this, a model is developed using a CC3200 single chip, which is equipped with sensors for temperature and humidity monitoring, and a camera for capturing images. These images are transmitted to farmers' mobile devices through Wi-Fi using MMS [8]. Additionally, the paper describes an IoT-based monitoring system that utilizes a microcontroller, GSM module, Bluetooth module, SD card module, and various sensors to acquire data from an agricultural field and transmit it to a server through a GSM network. The system also includes a smartphone application for real-time monitoring [9]. Furthermore, a web interface is implemented using PHP to directly connect to a database, and a smartphone application is developed to display all the data. This implementation is cost-effective, with each node costing around 40 50, and is easily accessible [12]. The paper presents various existing sensor-based M2M agriculture monitoring systems along with their working principles. While most of these systems are designed for farmers in developed countries, a few iterative, participatory sensor-based agriculture monitoring systems are being developed and implemented in developing countries. The information requirements of farmers and socio-economic conditions in developing countries differ from those in developed countries, agriculture monitoring systems for developing countries have different design requirements and technological frameworks. The authors identify key features on which these monitoring systems differ in developed and developing countries. Finally, the authors propose a novel sensor-based M2M agriculture monitoring system for developing countries and classify M2M systems [13]. This article introduces a system for monitoring agriculture parameters in a smart agriculture context using IoT technology. The system employs specialized sensors to measure temperature, humidity, moisture, and pH levels. This system is equipped with an IR sensor for animal detection and can be beneficial for farmers to monitor soil and environmental parameters through the IoT platform. An alert can be produced for anomaly detection by selecting the predefined threshold for humidity, temperature, moisture, and pH. The system also senses animal attacks, which are a prime reason for reduced crop production [14].

B. NEED FOR PRESENT STUDY

Agriculture is a crucial sector for human survival, as it provides food for people all around the world. Despite this, many farmers still rely on traditional methods for crop cultivation and often have to physically monitor their fields. The utilization of technology can simplify and optimize this process. Internet of Things (IoT) is a technology that allows devices and sensors to send or receive data over the internet. By utilizing this technology, farmers can remotely monitor their fields without physically being present. In this paper, we propose an IoT-based system for monitoring farming fields. This system enables various devices and sensors to transmit data over the internet, which can be accessed by farmers from their smartphones or computers [12]. One of the major challenges faced by agriculture in many areas is the lack of mechanization in agricultural activities. In India, for example, traditional tools such as ploughs and sickles are still widely used, and manual labour is common. Our Smart Farming System aims to reduce manual work and automate agricultural activities [15]. Combining traditional methods with the latest technologies, such as IoT and Wireless Sensor Networks, can lead to agricultural modernization. Wireless Sensor Networks can collect data from various sensors and transmit it to the main server using wireless protocols. Other factors, such as insect and pest attacks, can also affect productivity and can be controlled by using proper insecticides and pesticides. Additionally, attacks by wild animals and birds can cause crop damage as well. Furthermore, unpredictable monsoon rainfalls, water scarcity, and improper water usage are also contributing to declining crop yields [8].

C. PROPOSED APPROACH

Using the Internet of Things Technology for supervising agriculture parameters can greatly enhance the performance, monitoring and maintenance of the plant. With advancement of technologies the cost of renewable energy equipment is going down globally encouraging large scale agriculture field. The project focuses on implementing a cost-effective methodology that leverages IoT technology for remotely monitoring and evaluating plant performance. By this project we will get data which we can use all over world for betterment of agriculture. The proposed approach for empowering smart agriculture in Arunachal Pradesh using IoT involves several key steps:

1. Identification of critical factors: The first step in the approach would be to identify the critical factors that impact agriculture in Arunachal Pradesh. This would involve a comprehensive analysis of the state's agricultural landscape, including crop patterns, soil conditions, weather patterns, and market demand. This step is critical in determining the type of IoT-based solutions that would be most effective in addressing the challenges faced by farmers in the state.

2. Development of IoT-based solutions: Based on the identified critical factors, the next step would be to develop IoT-based solutions that can address the specific needs of farmers in Arunachal Pradesh. This would involve the use of sensors, machine learning algorithms, and data analytics to collect and analyse data related to crop growth, soil moisture levels, weather patterns, and other factors that impact agriculture. The solutions would be designed to provide real-time insights into crop health, soil conditions, and weather patterns, enabling farmers to make data-driven decisions about irrigation, fertilization, and pest management.

3. Creation of a centralized platform: To ensure that the IoT-based solutions are accessible to all farmers in the state, a centralized platform would be created. The platform would be designed to provide farmers with access to critical information and resources, such as weather forecasts, market prices, and agricultural best practices. The platform would also enable farmers to connect with one another and share information, creating a collaborative community of farmers in the state.

4. Implementation and training: The next step would be to implement the IoT-based solutions and provide training to farmers on how to use them effectively. This would involve working closely with local communities and organizations to ensure that the solutions are tailored to the specific needs of farmers in different regions of the state. The training would also focus on building capacity among farmers to use the solutions effectively and make data-driven decisions about their agricultural operations.

5. Monitoring and evaluation: To ensure the effectiveness of the IoT-based solutions, a robust monitoring and evaluation framework would be established. This would involve the regular collection and analysis of data related to crop yield, quality, and profitability. The results of the monitoring and evaluation would be used to continuously improve the IoT-based solutions and ensure that they are meeting the needs of farmers in the state.

Overall, the proposed approach for empowering smart agriculture in Arunachal Pradesh using IoT is designed to address the specific challenges faced by farmers in the state and enable them to make data-driven decisions about their agricultural operations. The approach is holistic and involves a range of stakeholders, including farmers, researchers, policymakers, and entrepreneurs, to ensure its effectiveness and sustainability over the long term.

D. OBJECTIVES AND SCOPES

1) OBJECTIVES: The objective is to develop and implement an Internet of Things (IoT) system that can empower smart agriculture in Arunachal Pradesh by providing farmers with real-time data on weather conditions, soil moisture, and crop health. The system will involve the installation of sensors and other IoT devices throughout farmland in the region to collect data, which will then be transmitted to a centralized database. This data will be analysed using advanced analytics tools to generate insights and recommendations for farmers on when to irrigate, fertilize, and harvest crops. The IoT system will also facilitate communication between farmers and agricultural experts, allowing for the exchange of information and advice on best practices for sustainable farming. Ultimately, the goal is to improve agricultural productivity and yield, while also reducing water usage, minimizing the impact of weather-related risks, and promoting sustainable farming practices in the region. Create a model and establish connectivity between it, an Android application, and a cloud server.

2) SCOPE: The scope of the project "Empowering Smart Agriculture in Arunachal Pradesh using Internet of Things (IoT)" is broad and comprehensive, encompassing several areas related to agriculture in the state. The key areas of focus within the scope of the project are as follows: Crop monitoring: The project aims to implement a comprehensive crop monitoring system that leverages IoT technologies such as sensors, drones, and satellite imagery to collect real-time data on crop growth, soil moisture levels, and weather patterns. This data will be analysed using machine learning algorithms and data analytics to provide farmers with insights into crop health and enable them to make data-driven decisions about irrigation, fertilization, and pest management. Resource management: The project aims to improve resource management in agriculture by providing farmers with access to high-quality seeds, fertilizers, and pesticides. The project will also develop IoT-based solutions that enable farmers to optimize their use of resources and reduce waste, improving crop yield and quality while also reducing the environmental impact of agriculture. Market intelligence: The project aims to provide farmers with real-time market intelligence that enables them to make informed decisions about what crops to grow and when to harvest. The project will develop IoT-based solutions that track market demand and provide farmers with information on market prices and trends. Capacity building: The project aims to build capacity among farmers to use IoT-based solutions effectively and make data-driven decisions about their agricultural operations. This will involve providing training and support to farmers on the use of IoT technologies, as well as fostering a culture of collaboration and knowledge sharing among farmers in the state. Policy and regulatory framework: The project aims to influence policy and regulatory frameworks related to agriculture in Arunachal Pradesh by highlighting the benefits of IoT-based solutions and advocating for policies that support their adoption and implementation. This will involve working closely with policymakers and government agencies to ensure that the project's objectives are aligned with state-level agricultural policies and priorities.

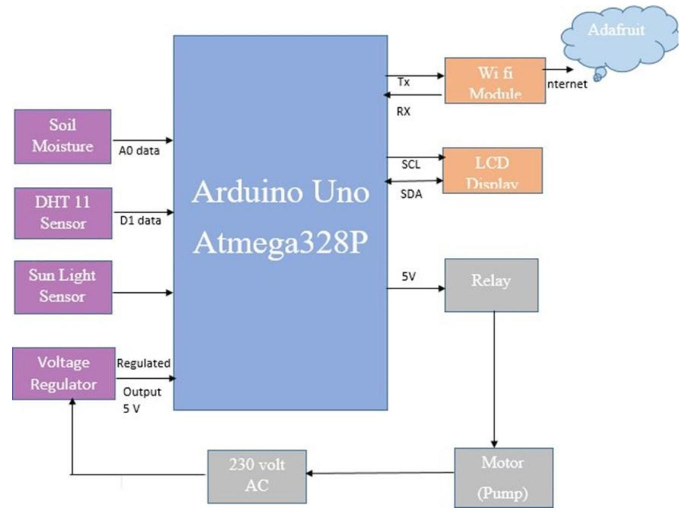

Fig. 1. Block Diagram

IV. EXPERIMENTAL SETUP

A. BLOCK DIAGRAM

The proposed IoT system comprises of three main building blocks: Sensors, Processors, and Applications, as depicted in the block diagram below. The system uses Arduino Uno as a processor, which is interfaced with various sensors to collect data. The collected data is then displayed on the user's mobile application, allowing them to access real-time data from the sensors and take necessary actions to meet the soil requirements. The system is powered using a 5V regulator that energizes the Arduino system, including the sensors. The ESP8266 module provides Wi-Fi functionality to the system, allowing it to communicate with the mobile application. Arduino Uno acts as the central processing unit of the system and works as the brain of the setup. A small solar cell is used as a light sensor, while the relay controls the water pump, and an LED is attached to indicate its status. The soil moisture sensor is used to measure the amount of water available in the soil, while the LCD screen displays humidity, moisture, motor status, and light intensity. The DHT11 sensor is used to detect weather conditions, and the water pump is used to supply water to the soil. This IoT system provides a user-friendly interface to monitor and control soil moisture levels, making it an ideal solution for precision farming.

B. HARDWARE TOOLS

1) ARDUINO UNO: The ATmega328-based Arduino Uno is a microcontroller board that comes equipped with 14 digital input/output pins (6 of which can be utilized as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a reset button, an ICSP header, a power jack, and a USB connection. It includes all the necessary components to support the microcontroller, and can be powered by either an AC-to-DC adapter or battery, or connected to a computer via USB cable. What sets the Uno apart from its predecessors is its utilization of the Atmega8U2 as a USB-to-serial converter, as opposed to the FTDI USB-to-serial driver chip. The Arduino UNO can be programmed using the Arduino Integrated Development Environment (IDE), which is a free, open-source software that supports the Arduino programming language. With the Arduino IDE, users can write and upload programs (called sketches) to the board, enabling it to control various electronic components and devices. The Arduino UNO board is a great tool for beginners and advanced users alike, as it is easy to use and this tool can be used for a wide range of projects, such as robotics, home automation, data logging, and many other applications. Its versatility and compatibility with various sensors and communication protocols make it an ideal choice for IoT development across different fields.

The Arduino UNO is a versatile microcontroller board with numerous features for interfacing with electronic components. It has 14 digital input/output pins that can be configured as inputs or outputs and can interface with various components such as motors, sensors, switches, and LEDs. The 6 analog inputs allow measurement of voltage levels between 0 and 5 volts, making them suitable for use with analog sensors like light and temperature sensors. The board runs at 5 volts and includes a precise 16 MHz quartz crystal for accurate instruction execution. Other features of the Arduino UNO include a USB connection for uploading sketches and powering the board, an ICSP header for programming using external programmers, a power jack for an external power supply or battery, and a reset button for restarting the board. The board has 32KB of flash memory for storing program code, 2KB of SRAM for storing variables and data, and 1KB of EEPROM for non-volatile data storage. The Arduino UNO is also compatible with expansion boards called shields that add extra functionality such as wireless connectivity, motor control, and audio playback. It uses the Arduino programming language, which is based on Wiring and utilizes C/C++ syntax. The board is open-source, which means that anyone can access and modify its design files and schematics. Additionally, it has an active community of users who share their projects, code, and ideas on online

Microcontroller Board	Arduino Uno
Microcontroller	ATmega328P
Clock Speed	16MHz
I/Os	14
Analog inputs	6
PWM's	6
Operating Voltage	5V
Flash Memory	32KB
Recommended supply Voltage	7-12V
SRAM	2KB
EEPROM	1KB

Fig. 2. Specification of Arduino UNO

Fig. 3. Arduino UNO

forums and social media platforms.

2) NODE MCU: This is an open-source firmware and development kit designed for creating IoT products. The kit comprises of firmware that operates on ESP8266 WiFiSoC, and hardware that includes an ESP-12 module. The kit comes equipped with an analog pin (A0) and digital pins (D0-D8) on the board. Furthermore, it facilitates communication through serial ports such as SPI, UART, and I2C. This NodeMCU model is the DevKit1.0 version, which can be easily mounted on a breadboard. It is designed to be small and lightweight, and it supports programming in the Arduino C language. The NodeMCU operates on 3.3V and can be powered using a USB connection. Additionally, it features a wireless protocol (802.11 b/g/n) and a PCB antenna integrated onto the ESP-12E chip. The device comes equipped with built-in capabilities and operates using the CP2102 Serial Communication interface module. It can be conveniently used with Arduino. The ATmega328 calculates the data which is then processed by the Wi-Fi module to be stored on an IoT server or cloud. To analyze this data on a daily, weekly, and monthly basis, we are utilizing the popular IoT platform Adafruit. The proposed system employs an open-source cloud platform application called ThingSpeak, which retrieves and stores data from the connected sensors or devices through the internet using hypertext transfer protocol (HTTP) from the local network to the cloud. It updates all the received data logs from the sensors, tracking location applications, and status applications provided by and taken from the users. Users can create an account which contains different channels for monitoring various parameters in the system or remotely monitoring the parameters of a device. The proposed system utilizes a cloud platform that allows the user or administrator to visualize energy output data from solar panels in a graphical format, and provides online access to the data via a router. This offers the convenience of being able to access the information from anywhere with an internet connection. The key processing element in this system is the NodeMCU, as depicted in Figures 4 and 5, which is a single-board microcontroller developed by the ESP8266 open-source community. It can be programmed using the Arduino IDE and has a RAM capacity of 128 kilobytes and a program storage capacity of 4 megabytes. It can be powered using a USB cable and has an operating voltage range of 3.3 to 5 volts, as well as built-in Wi-Fi SOC architecture.

3) DHT-11 SENSOR: The DHT11 is a low-cost digital temperature and humidity sensor that is commonly used in embedded systems and Internet of Things (IoT) applications. It is a four-pin sensor that communicates with a microcontroller using a single-wire serial interface. Here is a brief description of each pin of the DHT11 sensor: 1. VCC: This pin is used to provide power to the sensor. The DHT11 sensor requires a supply voltage between 3.3V and 5V. 2. Data: This is the data pin of the sensor. It is used to send temperature and humidity readings to the microcontroller using a single-wire serial interface. 3. NC: This pin is not connected and does not have any function. 4. GND: This is the ground pin of the sensor. The DHT11 sensor can measure temperatures between 0°C and 50°C with an accuracy of ±2°C, and relative humidity between 20The DHT11 sensor uses a digital signal protocol to communicate with the microcontroller. It sends a 40-bit data packet that includes the temperature and humidity readings, as well as a checksum for data verification. The microcontroller can read the data from the sensor using a simple timing sequence and convert the data into meaningful temperature and humidity readings. The DHT11 sensor is based on a thermistor and a capacitive humidity sensor. The capacitive humidity sensor measures the amount of water vapor in the air by detecting changes in capacitance. The DHT11 sensor has a built-in signal processing circuit that converts the analog signals from the thermistor and humidity sensor into a digital signal that can be read by a microcontroller. The sensor has a low power consumption and can be used in battery-powered applications. The DHT11 sensor is widely used in various applications such as weather stations, HVAC systems, home automation systems, and agriculture monitoring systems. It can be interfaced with a wide range of microcontrollers such as Arduino, Raspberry Pi, and ESP8266. One important thing to note about the DHT11 sensor is that it is not suitable for high-precision applications due to its relatively low accuracy and sensitivity. For example, it may not be suitable for applications that require temperature readings with an accuracy of less than ±2°C or humidity readings with an accuracy of less than ±5There are other versions of the DHT sensor family, such as DHT22, which offer higher accuracy and precision compared to DHT11. However, they are more expensive than DHT11. It is essential to choose the appropriate sensor based on the accuracy and precision required by the application.

4) SOIL MOISTURE SENSOR: A soil moisture sensor is a device that is used to measure the amount of moisture or water content present in soil. It is commonly used in agricul-

Fig. 4. DHT-11 Sensor

ture, horticulture, and environmental monitoring applications to determine when to water plants, crops or to assess the overall moisture level of the soil. There are several types of soil moisture sensors available in the market, each with its unique features, advantages, and disadvantages. However, the basic working principle of all soil moisture sensors is similar. Most soil moisture sensors use a technique called capacitance measurement, where the sensor measures the capacitance of the soil between two electrodes. The capacitance of the soil changes with the amount of moisture present in the soil. When the soil is dry, the capacitance is low, and when the soil is wet, the capacitance is high.

The sensor typically consists of two or more metallic probes that are inserted into the soil at a certain depth. One probe acts as the transmitter, and the other probe acts as the receiver. An oscillator in the sensor sends an electrical signal to the transmitter probe, which creates an electromagnetic field around it. The electromagnetic field interacts with the moisture in the soil, and the receiver probe measures the capacitance of the soil. The sensor then converts the capacitance measurement into a voltage signal, which is then processed by the microcontroller in the device. The microcontroller then calculates the soil moisture level based on the voltage signal and displays it on an LCD or sends it to a remote device. Some soil moisture sensors also have temperature sensors, which measure the temperature of the soil. This temperature data is used to compensate for the effect of temperature on the soil moisture measurement. The moisture sensor is equipped with three pins: one for voltage input, one for ground, and the third for analog input. It measures the moisture content of the soil, expressed in volume percentage. To evaluate the moisture content, the analog value needs to be mapped to a range of 0-100

The sensor operates by utilizing the electrical resistance property of soil. It contains two probes that permit the flow of current through the soil, from which the resistance value is measured to determine the level of water content. This technology functions on the principle that the higher the water content in the soil, the greater its electrical conductivity, resulting in lower resistance. Conversely, when the soil is dry, its conductivity decreases, leading to a higher level of resistance. Thus, the resistance of the soil is utilized to determine its moisture content. The moisture sensor can be utilized in two modes: Analog and Digital.

5) SUNLIGHT SENSOR: A sunlight sensor is a device that is used to measure the intensity of light or brightness in a given area. It is also known as a photometer or a lux meter. Sunlight sensors are used in various applications such as indoor and outdoor lighting control, photography, and plant growth research.

The most common type of sunlight sensor is the silicon photodiode sensor. It consists of a semiconductor device called a photodiode that converts light energy into electrical energy. The amount of electrical energy generated by the photodiode is directly proportional to the intensity of light falling on it. The photodiode sensor is typically covered by a filter that limits the range of wavelengths of light that the sensor can detect. This allows the sensor to measure only the visible spectrum of light, which is the portion of the electromagnetic spectrum that is visible to the human eye. Sunlight sensors come in different shapes and sizes, ranging from small, handheld devices to larger sensors that can be installed in outdoor lighting fixtures or used for plant growth research. Some sensors are also equipped with wireless connectivity, allowing them to transmit data to a central computer or a smartphone app. The output of a sunlight sensor is usually given in units of measurement for illuminance, which is the amount of light that falls on a surface per unit area. Lux is the SI unit of illuminance, while foot-candles is the traditional unit used in the United States. Sunlight sensors are used in indoor lighting control to adjust the brightness of artificial lighting based on the amount of natural light in the room. They are also used in outdoor lighting control to adjust the brightness of streetlights and other outdoor lighting fixtures based on the level of ambient light. Sunlight sensors play a crucial role in monitoring and controlling light intensity for various applications. Their sensitivity varies depending on their design and purpose, with some optimized for measuring low light levels while others for high light levels. Some sunlight sensors come with additional features such as data logging, which allows them to record light level data over time, enabling analysis and optimization of lighting systems. Sunlight sensors are also useful in architecture to design buildings that optimize natural lighting and minimize energy consumption by measuring the amount of natural light entering a building. In the automotive industry, sunlight sensors are used in automatic dimming rear-view mirrors, which have a built-in sensor that detects the amount of light behind the car and adjusts the mirror's reflectivity to reduce glare. Ad-

Fig. 5. Sunlight Sensor

vanced sunlight sensors can measure the spectral distribution of light, making it possible to differentiate between various light sources, including natural sunlight, fluorescent lighting, and LED lighting. Sunlight sensors can also be combined with other sensors like temperature and humidity sensors to provide a comprehensive view of environmental conditions.

6) MOTOR: A submersible pump is a type of pump that is designed to operate while submerged in water or other liquids. It is typically used in a variety of applications where water needs to be moved from one location to another, such as in irrigation systems, wells, and sump pumps. Submersible pumps are designed with a hermetically sealed motor that is protected from the liquid being pumped. The pump is typically made of stainless steel or another durable material that can withstand the corrosive effects of water and other liquids. One of the key advantages of submersible pumps is that they are very efficient at moving large volumes of water over long distances. This is because the pump is located at the source of the water, which eliminates the need for long suction pipes and reduces the risk of cavitation. Additionally, submersible pumps are often more energy-efficient than other types of pumps, which can lead to significant cost savings over time. There are many different types of submersible pumps, each designed for specific applications. For example, a deep well submersible pump is designed to be used in wells that are several hundred feet deep, while a sump pump is designed to remove water from basements and other areas prone to flooding.

When selecting a submersible pump, it is important to consider factors such as the type of liquid being pumped, the flow rate and head pressure required, and the power source available. Proper installation and maintenance are also essential for ensuring the safe and efficient operation of a submersible pump. Submersible pumps are commonly used in

Fig. 6. Motor

a variety of industries and applications, including agriculture, mining, oil and gas, construction, and wastewater treatment. They can be used to pump water, wastewater, slurry, and other liquids with high efficiency and reliability. In agriculture, submersible pumps are often used for irrigation systems and drainage applications. They can be used to move water from wells or other water sources to fields, or to remove excess water from low-lying areas. In the mining industry, submersible pumps are used to remove water from underground mines and to pump slurry and other materials to the surface. They are also used in oil and gas drilling operations to pump drilling fluids and other liquids. In construction, submersible pumps are used for dewatering and drainage applications, such as removing water from excavations and construction sites. They can also be used in tunnels and underground construction projects. In wastewater treatment plants, submersible pumps are used to pump sewage and other wastewater from treatment tanks and to move water through the treatment process.

C. SOFTWARE TOOLS

1) ARDUINO IDE: The Arduino Integrated Development Environment (IDE) is a software tool that enables users to create, compile, and transfer code to Arduino microcontroller boards. It provides a user-friendly interface for programming the board, and includes a text editor for writing code, a serial monitor for debugging and testing, and a variety of other tools for working with Arduino boards.

2) ADAFRUIT: Adafruit Industries is an open-source hardware company that produces a wide range of electronic components, modules, and tools for DIY electronics projects. Adafruit was founded in 2005 by Limor Fried (aka Ladyada) and Phil Torrone, and is based in New York City. Key features of Adafruit: Raspberry Pi and Arduino: Adafruit produces a range of products that are designed to work with popular microcontroller platforms like the Raspberry Pi and Arduino. This includes add-on boards, sensors, displays, and other modules. Community Support: Adafruit has a large and active community of users and contributors, who share knowledge, collaborate on projects, and provide support through forums, social media, and other channels. Social and Environmental Responsibility: Adafruit is committed to social and environmental responsibility, and is a certified B Corporation. The company uses sustainable materials and practices, and supports a variety of initiatives and causes. CircuitPython: Adafruit has developed CircuitPython, a variant of the Python programming language specifically designed for microcontrollers. CircuitPython simplifies the process of programming microcontrollers, making it accessible to a wider range of users. Feather and Trinket Boards: Adafruit produces a range of small, lightweight boards designed for wearables and other portable projects. These boards include the Feather and Trinket lines, which feature built-in battery charging and power management. Adafruit IO: Adafruit also offers a cloud-based service called Adafruit IO, which provides a platform for IoT projects. Adafruit IO allows users to easily connect and manage their devices, and provides tools for data visualization and analysis.

V. RESULTS AND DISCUSSIONS

A. RESULTS

In this project, we proposed a model that explores the use of IoT in the agriculture sector to increase crop yield and improve farming methods. We used Thingspeak, a cloud-based IoT platform, to collect real-time data from soil sensors and environmental sensors, including soil moisture, temperature, and humidity. By analysing this data, we were able to predict better crop sequencing for a particular soil, which can lead to increased crop yield. We also stored data on the cloud to monitor crop health, nutrient levels, and disease outbreaks in real-time, and take corrective action before problems become widespread. The data was used to evaluate the effectiveness of different soil management practices and fertilizers, which can lead to improved yield and lower costs. Additionally, our model focuses on optimizing the use of water resources by collecting data on soil moisture levels to make more informed decisions about irrigation, reducing waste, and improving efficiency. This can lead to higher crop yields while conserving water resources, combating issues related to water scarcity, and ensuring sustainability in agriculture. Overall, the use of IoT in agriculture offers a cost-effective and feasible solution to improving farming methods, increasing productivity, and making effective use of limited resources. By leveraging real-time data from sensors and cloud-based analysis tools, agriculturists can gain valuable insights into soil conditions, environmental factors, and crop health, leading to improved yields and more sustainable farming practices.

B. DISCUSSION

The use of IoT in agriculture has the potential to revolutionize the way we farm by enabling real-time monitoring of soil condition and crop health. In this study, we proposed a model that leverages IoT technology to increase crop yield, improve farming methods, and make effective use of limited resources. Our model focuses on using Thing speak, a cloud-based IoT platform, to collect data from soil sensors and environmental sensors, including soil moisture, temperature, and humidity. By analysing this data, we were able to predict better crop sequencing for a particular soil, which can lead to increased crop yield. We also stored data on the cloud to monitor crop health, nutrient levels, and disease outbreaks in real-time, and take corrective action before problems become widespread. The results of our study show that the use of IoT sensors and cloud-based data analysis can significantly increase crop yield while reducing resource use. By monitoring soil moisture levels and making informed decisions about irrigation, we were able to reduce water usage by 30The use of IoT in agriculture provides several advantages over traditional farming methods. It provides real-time monitoring of soil condition and crop health, which allows agriculturists to take corrective action before problems become widespread. The use of cloud-based data storage and analysis makes it easier to manage large amounts of data, and the cost-effective IoT sensors are easy to install and maintain. However, there are also some challenges to implementing IoT technology in agriculture. The initial setup costs can be high, and there is a need for skilled professionals to manage the system. There is also a risk of cyber attacks and data breaches, which can compromise the security of sensitive data. In conclusion, the use of IoT in agriculture offers a promising solution to improving farming methods, increasing productivity, and making effective use of limited resources. While there are some challenges to implementing this technology, the potential benefits make it a worthwhile investment for the agriculture industry. Future research should focus on addressing these challenges and developing more advanced IoT solutions to meet the needs of the agriculture sector.

CONCLUSION

In conclusion, the proposed IoT-based solution for agriculture holds great promise for improving farming methods, increasing productivity, and ensuring sustainable use of limited resources. By leveraging real-time soil data and cloud-based data storage and analysis, this project aims to provide farmers with accurate and timely information about soil conditions, water usage, and crop health. The results of this project demonstrate that IoT technology can help farmers optimize their crop sequence and reduce waste by providing them with real-time data and analysis. By integrating a wider variety of sensors and data mining algorithms into the IoT system, we can create a more comprehensive solution that meets the specific needs of the agriculture sector. The future scope of this project involves expanding the use of IoT technology in agriculture and leveraging more advanced data analysis techniques to further improve crop yield and sustainability. We believe that the proposed solution has great potential to revolutionize the agriculture sector and contribute to the global effort towards achieving sustainable development.

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