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Application of IoT for Developing Sustainable and Smart Farming

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ABSTRACT

Traditional farming is labour-intensive, and the need to constantly check crops may be a strain on farmers. On another side, agricultural yield space is shrinking by the day. So, without a question, managing a huge amount of food that is legally right for us is a very difficult problem for any human being. There may always be a footprint available to meet the high demand. By achieving the idea of smart farming based on new technology by using the Internet of Things (IoT), the authors have presented a strategy in this study work by which a farmer may manage water irrigation, detect the total amount of brightness, and monitor the moisture level of soil and current status of crops using IoT. By utilizing such a technology, the farmer would obtain an auto lighting system, an auto water irrigation system, prohibit external vehicles, and conserve electricity by utilizing real-time data obtained from various types of sensors and utilizing a Wi-Fi system. The suggested system's hardware is all directly linked to the NodeMCU ESP8266. An algorithm has been created to manage the entire project. The solar panel will supply the entire system's necessary electric power, allowing us to save money, conserve electricity, and make the total system more environmentally friendly. This work's suggested system can identify meteorological conditions that are beneficial to agriculture. This proposed concept has exceptional performance potential as an interface between sensors as input and the IoT as an output medium. The suggested system is compared to other existing systems in a variety of ways.

Keywords: Internet of Things (IoT), Smart Agriculture, Motion Detector Sensor, and Solar Power System.

INTRODUCTION:

The popularity of Internet-connected electronic devices is growing at an exponential rate, emphasizing the significance of the Internet of Things (IoT). IoT connectivity is following the 3A (Anytime, Any-one, Anything) paradigm. Tech Smart Homes & Cities, IoT Retail Shops, Farming, Smart Grids, Smart Supply-chain Management, and other industries are incorporating IoT. Agriculture is one of the most prominent sectors in today's world. Farming and its associated employment play an important role in a nation's economic and commercial growth. According to FAO statistics, agriculture employs 60 percent of the world's population, with the major number of those employed coming from South and South-East Asia.

According to IoT Total Available Market (TAM) projections, the number of IoT-connected devices in the world can increase from 7.6 billion to 24.1 billion, with revenue increasing from USD 465 billion to more than USD 1.5 trillion. There is a rapid transition from traditional agriculture to farm management controlled by completely different IoT companies. The adoption of advanced IoT technologies assists growers in producing higher yields from farms in response to rising demand. According to new Meticulous research, the smart agriculture of IoT market will grow at an Annual Rate of Growth (CAGR) of

15.2 percent from the year 2020 to $32.7 billion by the year 2027. Exactness agriculture is constantly evolving in tandem with advancements in basal IoT technologies. This evolution aims to achieve several key options for increasing potency and crop yields. These characteristics include (a) information metrics for observance, (b) a higher cognitive process, (c) crop protection and managing, (d) waste reduction and operational value, (e) crop variable rate, (f) information trend for many use-cases, and (g) pest control. Chargeable core features for creation and comparison Precision agriculture Key Performance Indicators (KPIs) rely on technological various factors like sensors, mobility, time monitoring, connectivity, and simple application deployment. **Fig.1** presents a comprehensive view of the framework that takes into account the quality level of IoT data throughout the application life cycle (Tamanna *et al*., 2022; Fizza *et al*., 2022).

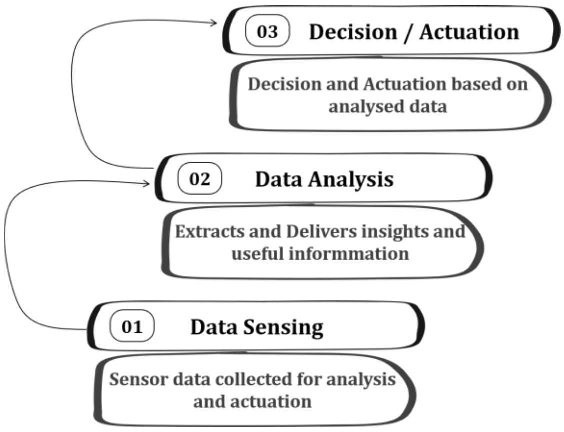


Fig. 1: Lifecycle of a generic smart IoT application.

Research Contribution

In that topic, a yield of a monitoring system including a pleasing design interface, a high level of convenience and a wireless communication system has been designed by this research work. The goal of this work is to create a friendly environment for farmers so that they can easily efficiently maintain their fields. They don't need any high or mid-level technical knowledge to maintain this system because the whole system is very simple and user-friendly. Thus, when compared to other existing manual works, the entire system is cost-effective and eco-friendly, and the farmer can reliably produce more foods while also saving energy costs. The following are the main contributions of this research work

1) The solar panel to provide power to the entire system has been introduced in this work, the entire system is both cost effective and environ mentally friendly. As a result, the cost is significantly reduced.
2) An Automatic Lighting System has been attached in this work. As we all know, many plants require over 12 hours of lighting.
3) Various sensors, like the DHT22 (Dihydro-testosterone 22) sensor for measuring temp. and counting humidity, the Soil Moisture Sensor for measuring soil moisture, the Raindrop Sensor for detecting rain, the PIR (Passive infrared) Motion Sensor for detecting external objects in the field, and the Water Pump for irrigation.

Literature Review

The authors proposed a Smart AgroTech model in Podder *et al.* (2021). They considered humidity measurement sensor, temperature measurement sensor, and soil-moisture measurement sensor in this model. They categorize their components into five distinct sections: technology, controller, sensor, relay module, and water pump. They used a switch plat-form called Relay Module in the modern AgroTech model. They used an electric water pump motor in the final section. The relay module ensures that the conditions for turning ON/OFF the pump motor are met. Podder *et al*. (2021) considered a moisture level of 55 percent to measure moisture in the soil, and the control is dependent on a moisture level below or above 55 percent. In this model, they use the ESP8266 as a controller for the systems and sensors. To quantify their model, they attempted to determine the error rate between genuine and noticed inform-ation in a variety of situations.Some underground and above-ground sensors are included in Almalki *et al*. (2021). Data that comes from the sensors is collected every 1 hour and then sent to the cloud, where it is analyzed every 12 hours. The authors of Almalki *et al.* (2021) attempted to implement a low-cost platform using sensors and a flying drone, all of which are linked via cloud computing technology. The segments are referred to as space segment and ground segment. Their drone technology in the space segment includes a camera to capture the area. There is an under-ground sensor gateway that collects and combines the data from sensors installed under-ground, and a HOBO U30 is a weather-station starter kit that collects and combines the whole data from sensors installed aboveground. Rohith *et al.* (2021) proposed smart irrigation-based cultivation. Watering preparation was computerized in their proposed frame-work, reducing manual labor. Different plant and soil parameters, such as temperature, dampness, and mugginess, were detected using unique sensors and the Arduino UNO. Their demonstration worked well in a small field, but in a larger field, it might run into trouble. IoT-based automated greenhouse farm-ing concentrated in Tripathy *et al.* (2021). In that paper, the authors used numerous sensors like as tem-perature, humidity, UV light, pH measurement, CO2 level, EC value, and insecticide or pesticide mea-surement, and they provide a system called Deci-sion-Support System in short (DSS) that controls all system activity. The main goal of this paper is primarily on rose cultivation. In a data acquisition system, there are many types of different sensors and a machine learning classifier called Support Vector Machin (SVM) for specimens to pre-vent diseases. In the actuator management system, there is a Central Actuator manager who receives all DSS instructions and controls all actuators. Accor-ding to the DSS, there is an interface for the end-user to view and control everything, and the user can receive an in-app notification or SMS for any type of interaction. In their case study, they attempted to demonstrate the distinction between the trivial app-roach and their proposed "MyGreen" approach.

Atmaja *et al*. (2021), describe the communication system between the sensor and the database. All of the sensors' data will be sent to the database, and they will use the Wireless Sensor Network (WSN) to do so. As a microcontroller, they proposed the Rasp-berry Pi. They used soil pH sensors and moisture sensors in their proposed model. Water pumps and sluice gates were also used, and everything can be controlled via web and mobile apps. The collected data from the sensors will be processed by Arduino and sent to the server via ESP8266 in their research method. To evaluate Raspberry Pi, they tried it at various distances with and without a barrier to determining whether it succeeded or failed. Izzuddin *et al.* (2021) concentrated on urban farming methods in Indonesia. The population rate of other cities around the world is increasing daily, just as it is in developed countries. However, land area is shrink-ing. As the result, the urban farming technique is critical for meeting the food needs of a huge number of people. In that paper, they used Arduino UNO as a microcontroller, and the whole system also in-cludes many sensors like a humanity sensor, a tem-perature sensor, a soil moisture sensor, and so on. All types of sensors are wired directly to the micro-controller, which is linked to a single-board com-puter (SBC). The sensor then collected a huge amount of data and converted it into an electric signal, transforming it into a digital data unit. Solar power was used as an alternative source of electricity throughout the entire system. Collected data directly sent to the web server and SQL server, where it is reserved. The web part displays and reserves all of the collected data. The area may be irrigated based on sensor data. Sensors collect data on their own and send it to the Raspberry Pi. The data will be pro-cessed and fed into the two main components of the Raspberry Pi. The primary goal of Ariffin *et al.* (2020) is to cultivate mushrooms using modern agri-culture method that is linked to the IoT. Other farmers may be able to produce various types of seasonal vegetables or crops by utilizing their smart process, thereby increasing the efficiency and productivity of their farm. Optimal temperature and perfect humidity are required for mushroom cultivat-ion. A pump is installed in the house to control the temperature and adjust the humidity levels inside.

The climate control system is automatically included in the IoT control box. The water pump, which in-cludes an exhaust fan, is powered by electricity. It must have sensors like as humidity, water level, and temperature sensors that are linked to an internet gateway via a wireless fidelity network system. This gateway is resistant to ISP connections such as Asymmetric Digital Subscriber Line (ADSL) or Long-Term Evolution (LTE). They can expertly utilize the MCU ESP8266 as a microcontroller to regulate the climatic system.The writers of Yaseen *et al.* (2020) addressed certain agricultural criteria like Water Administration, Climate Data, and Sun-powe-red Vitality. A temperature sensor, mugginess sen-sor, dampness sensor, a Wi-Fi module (ESP8266 module), and other electrical devices were included in their projected keen green development. When the sensor's degree falls inside the physical boundaries of the surrounding environment, the analog flag is changed to a computerized flag. In Sarma *et al.* (2020), the NodeMCU received moisture, rate of humidity, and level of temperature readings from Arduino through a serial connection, as well as LDR values from sensors, and then transferred the data to Firebase (a Google database). The authors offered a work that could determine the real-time wetness of the soil with humidity, the level of temperature in a specific region, the lowering light intensity, the nit-rogen (N), phosphorus (P), and potassium (K) con-tent of the soil, and a climate report for the next five days.The study by Anupama *et al.* (2020) is pri-marily concerned with a water management sys-tem and storing a certain amount of water so that the farmer can use and reuse it as needed. The entire process is fully integrated with smart IoT. This kit includes soil, coriander seeds, and a plastic tray. Soil is well mixed and strewn into the pan. Water is being saved at the farm's base. When water is required, the plants absorb it, and the excess water drains into the farm's foundation. In this farm, a moisture sensor collects data and determines how much water is required in the farm air. Water supplied to the farm depends on the sensor measurement, which is referred to as a Predefined Threshold Value (PTV). The Liquid Crystal Display (LCD) is utilized for live monitoring of the farm's present state. Santos *et al*. (2019) introduces a novel agricultural method. This research taught us how Wireless Sensor Network technologies and mobile computing platforms might assist farmers to increase their output. Santos *et al.* (2019) also mentioned how future planning and time liness aid in improved productivity, allowing a farmer to take the appropriate actions. The end phase of this paper's prototype model is the proposed agri-cultural production method. This model can forecast the present temperature, soil, human population, and air pressure. This might mean that the entire modern agricultural model is built on a low-power WAN method and an agriculture pre-diction server. Data is transported from the low-power WAN to the Long-Range Radio (LoRa) Low-power Wide-Area Network (LPWAN) during this operation. To avoid any form of anomaly, the methodology additionally included a 24x7 alarm system and a sort messaging mechanism.

A new method to modern agriculture method using IoT and Extreme Learning Machines (ELM) has been pro-posed by Kale *et al*. (2019). This research explored plant disease (PD) and nutrient deficiency (ND) prevention, as well as food preference. Some sensors capture the essential data, which is then used to determine the amount of fertilizer to be applied. Because unbalanced fertilizer reduces production value and is far more effective for human and animal health. The initial step is to capture some photo-graphs using any type of digital camera. The humi-dity and temperature sensors are then used to gather data, which is then immediately linked to the Ardu-ino. Collected data is stored in a database. The data was then begun to be evaluated. The approach was modified to work with a high-dimensional biological dataset.

METHOLODOGY:

The developed system is divided into two sections: Section 1 (Automated Sensor-Based Smart Farming) and Section 2. (Automated LDR-based Lighting Sys-tem). The suggested system's heart is surrounded by the main hardware known as Node MCU ESP-8266. NodeMCU is ideal for developing open-source hard-ware projects like this work. This hardware is mostly utilized for circuit board effectiveness and is linked with a USB cable controller and a tiny set-up board containing the MCU. The DIP (Dual In-line Pack-age) configuration allows for clean prototyping on breadboards. The Node MCU is directly program-med with a one-of-a-kind program that implements the system. All sensors are directly linked to the NodeMCU. **Fig. 2** represents the block diagram.

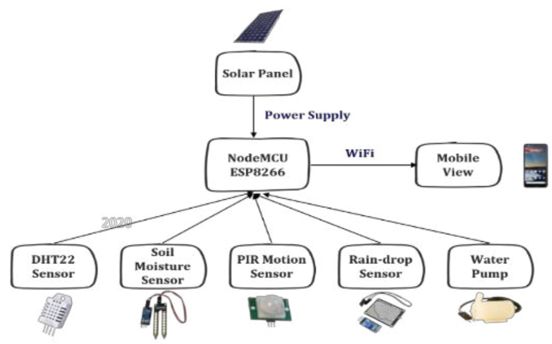


Fig. 2: Block Diagram of proposed system.

Section 1 (Automated Sensor-Based Smart Farming) collects and combines data from all sensors for the environment, which is subsequently read by the NodeMCU. When NodeMCU evaluates the rate from the Temperature sensor and finds it to be more than or equal to 35-degree calculus, the motor is on; otherwise, the motor is turned OFF. When the rain sensor senses rain, the motor pump turns OFF. Additionally, it notifies the program user that "Rain Detected." When NodeMCU analyses the PIR Mo-tion sensor data and finds an external object in the region, it notifies the application with the message "External object identified." Wi-Fi is used to operate the total system by a user of a mobile application. Furthermore, this suggested system's principal energy source is the Solar Power system. In Section 2 (Automated LDR-based Lighting System), an LDR sensor is installed to identify the sunlight. When the

LDR detects high intendancy sunlight, the sun is approaching; nevertheless, the light is turned OFF at this moment. The light is ON when the LDR detects a low intendancy light, indicating that night is approaching. Section 2, the auto lighting unit, represents the major part of the work. **Fig. 3** shows the working procedure of this proposed system.

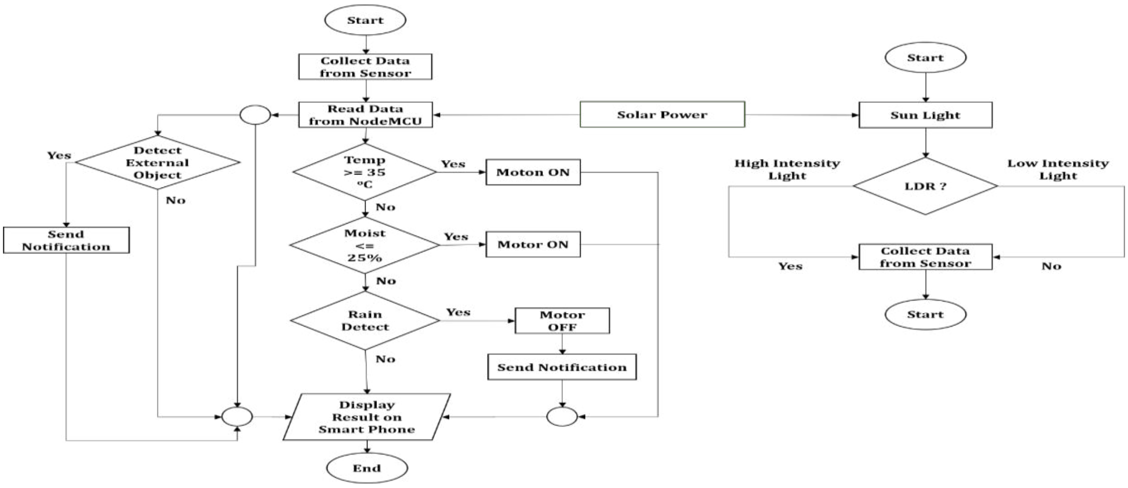


Fig. 3: Flow-chart of proposed system.

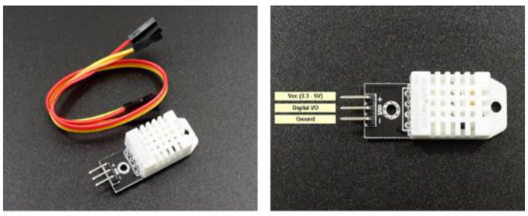
Section 1

Automated Sensor-Based Smart Farming

This Automated Sensor-Based Smart Farming section is divided into multiple components. Each unit is described in detail below (Al Mamun *et al*., 2021).

Temperature and Humidity Unit

The DHT22 generates a calibrated digital receiving signal. To maintain dependability and stability, it employs proprietary digital signal collecting technology as well as moisture detecting technology. Its sensor parts are linked to a single-chip computer with an 8-bit processor. Every sensor in this model is temperature adjusted and calibrated in a precision calibration chamber, and the calibration coefficient is saved in the OTP memory in the program type; when the sensor detects, the coefficient is retrieved from memory. **Fig. 4(a)** depicts a graphical depiction of DHT22, and **Fig. 4(b)** depicts pin details of DHT22.

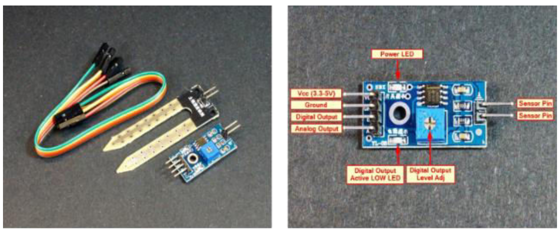


(a) (b)

Fig. 4: (a) Graphical representation of DHT22, and (b) Pin details of DHT22.

Soil Moisture Unit

Soil moisture sensors detect or estimate the rate of the presence of water in the soil. These sensors might be fixed or mobile, such as hand-held probes. Stationary sensors are set in the field at predetermined locations and depths, whereas movable soil moisture probes assess soil moisture at several sites. When a crop begins to experience stress, it is critical to understand the condition of the soil water content for irrigation scheduling. Most crops begin to experience stress when soil water depletion/deficiency reach 30-50 percent of Accessible Water-holding Capability (AWC). This is also called the irrigation trigger point or acceptable Management Depletion (MAD). **Fig. 5(a)** depicts a graphical display of the Soil Moisture Sensor in **Fig. 5(b)** depicts module details for the Soil Moisture Sensor.



(a) (b)

Fig. 5: (a) Graphical representation of Soil Moisture Sensor, (b) Module details of Soil Moisture Sensor.

Rain Drop Unit

A raindrop sensor is a rain detecting instrument that always brings two modules: a rain board that detects rain and an impact module that compares the analog value and transforms it to a digital and modern value. In vehicles, a raindrop sensor is used automatically control the wipers. **Fig. 6** depicts the raindrop sensor, which shows the metal strips which have been left exposed. This metal possesses Ohmic resistance that is bound. When this metal is dropped into water, its resistance changes. The more exposed it is to water, the more physical phenomena it exhibits or the less resistance it exhibits. When a raindrop falls into the sensor this time the resistance power of the sensor decreases. According to Algorithm 1, the NodeMCU immediately monitors this data and sends a short SMS to the user through Wi-Fi. When the user receives a rain notice, he or she will have clear information about his or her farming area and be able to take the appropriate actions.

Fig. 6: Raindrop Sensor with Pin details.

Algorithm 1: Algorithm for Alerting from Rain Detect Sensor

Input: Detect rain through Raindrop sensor.
Output: Notification on Blynk Software
rd = dht.autoDetectRain();
if (rd == 0) **then**
Relay module: NC Position and send notification via WiFi
else
No action performed

PIR Motion Unit

PIRs show an electrical phenomena device in **Fig. 7(a)** as the spherical metal container with an oblong crystal in the middle), which can detect quantities of infrared radiation. An extremely motion detector's sensor is divided into two parts. The two parts are connected in a way that they cancel each other out. When it detects a particular level of infrared radiation, it may communicate data to the NodeMCU through Wi-Fi. According to Algorithm 2, the system alerts the user via a brief message on the user's smartphone. **Fig.7 (b)** depicts the specifics of the PIR motion sensor module connection.

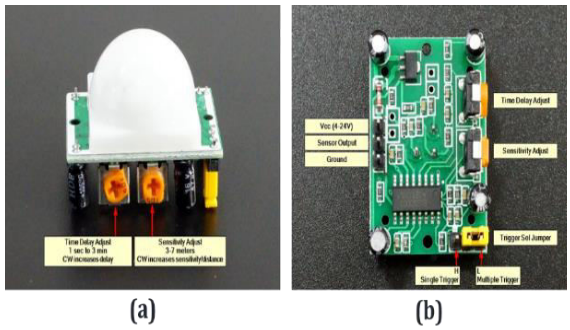


Fig. 7: (a) PIR Motion Sensor, (b) Pin details of PIR Motion Sensor.

Algorithm 2: Algorithm only for identify the External Objects / Wild Animals

Input: Detect motion through PIR sensor.
Output: Notification on Blynk Software
motion = dht.autoObjRead();
if (monitor == ON) **then**
if (motion == True) **then**
Notification ON and send via WiFi
else
Notification OFF
else
Notification OFF

Water Irrigation Unit

A well-designed irrigation system serves as a blueprint for implementing a modern farming strategy. Irrigation of water is critical to the total farming process. Proper irrigation aids in the cultivation of proper growth, mitigating the negative effects of limited rainfall. This proposed work is based on the DHT22 temperature with humidity and soil moisture sensors. The DHT22 is a low-cost humidity meter that measures humidity levels from 0 to 100 percent with a 3 to 5 percent accuracy rate. It contains a temperature range of -35°C to 80°C and an accuracy level of (+/)

0. 5°C. Soil moisture sensors determine the total amount of water in the soil. Both sensors are wired directly to the NodeMCU board. When the soil water level is lower than 25% and the rate of the temperature is upper than or equal to 35°C, the Node MCU monitors those data and displays sensor data on the smartphone. When a user sends a short signal to the relay module to activate the water valve, the DC water valve opens & irrigates the land as needed.

Algorithm 3: Algorithm for Computing and Action for Turning ON/OFF the Pump
Input: Read the humidity through DHT22. **Output:** ON/OFF the water pump 1: smois = dht.computeSoilMois(); 2: **if** (percentage(smois) <= 25) **then** 3: Relay Module: ON Position 4: **if** (percentage(smois) > 25) **then** 5: Relay Module: NC Position

Power Supply Unit

The sun, as a great source of power, offers a remarkable characteristic. Sun can give coherent and extremely renewable energy to all humans on the planet. Solar photovoltaic (PV) modules convert solar power into electric power. We employ solar panels as the power source for the entire system to make this proposed system echo-friendly and cost-effective. The solar panel is linked directly to the relay module. The total system has no exterior parts, which reduces human labor and maintenance expenses. **Fig. 8**depicts the physical voltage measurements of a 12V dry cell and (b) a solar panel, while **Fig. 9** depicts a comparison between them.

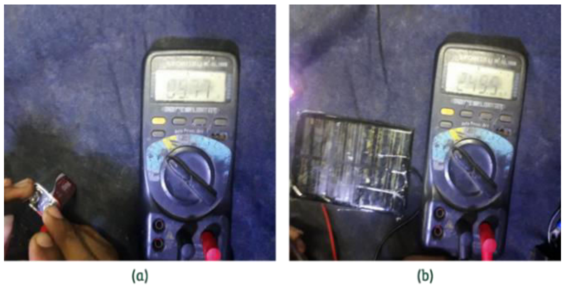


Fig. 8: (a) Voltage measurements of a 12V dry cell, and (b) Voltage measurements of a solar panel.

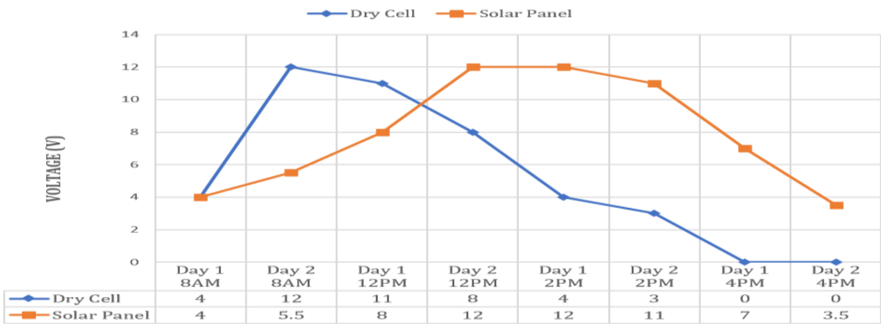


Fig. 9: Comparison between 12V dry cell and solar panel.

Section 2: Automated LDR-based Lighting System

Plants require light sources for energy and life. Phototropism occurs when plant growth hormones begin to accumulate in the plant's stem, leading the plant to face the light. Section 2 of the proposed system is divided into many components, which are described below. As a standard guide, most plants need illumination for 10 to 14 hours every day. However, numerous factors impact how much light is required because the sun does not give the same quantity of brightness throughout the year. As a result, managing the lighting for an intelligent IoT-based intelligent farming system comprises an important regulation for the entire system. It is always noticed that darkness is also required for plant photosynthesis. **Table 1** shows how the light varies depending on any type of plant.

Table 1: Lights for various types of plants.

Types of Plants	Brightness in Lumen
Low Light Plants	500-2500 lumen
Medium Light Plants	2500-10000 lumen
Bright Light Plants	10000-20000 lumen
Very Bright Light Plants	20000-50000 lumen

Lighting Unit

We have concentrated on plants that need above than 12 hours of illumination for healthy development. Farmers in the modern world aim to cultivate a variety of crops or plants where light is always needed the major of the time. Some plants, such as dragon fruit, orchids, and Cactaceae, require just a small amount of darkness to blossom, and the rest of the time, constant illumination is necessary. To provide 24-hour illumination, we developed a new system that combines an LDR (Light Dependent Resistor) sensor with some additional user-friendly aspects. Section 2's working technique is described in Algorithm 4.

Algorithm 4: Algorithm for Section 2 (Automated LDR-based Lighting System)
Input: Measure the brightness through LDR.
Output: ON/OFF the light.
1: **if** (LDR == Low Brightness) **then**
2: Light == 0 // If Enough Daylight
3: **else**
4: Light == 1 // If area is Dark

Experimental Setup for Implementation

This section describes how to put this proposed system's design process into action. This suggested system's setup is separated into two sections: Section 1 and Section 2. A Blynk software has been created to let users view.

Device Setup of Section 1

Fritzing software has been used to create Section I, which is divided into numerous segments. **Fig. 10** depicts the Section I device configuration (Automated Sensor-Based Smart and modern Farming).

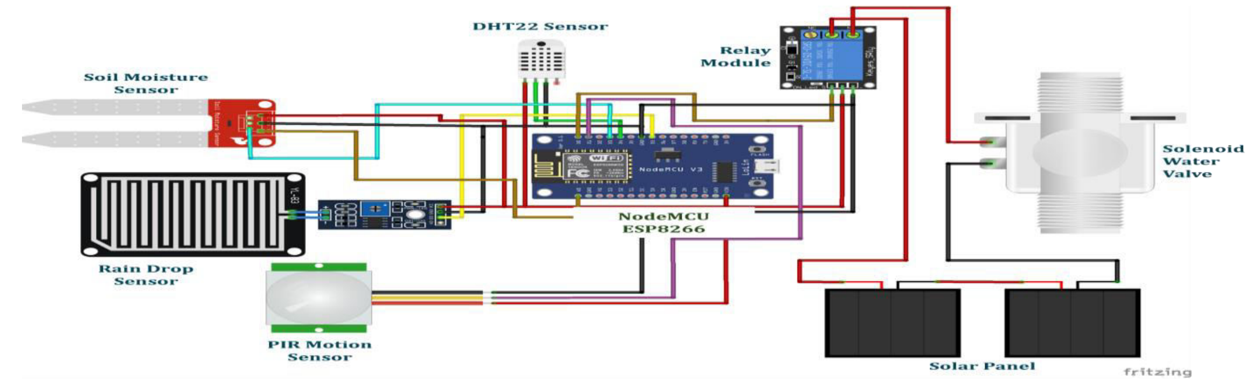


Fig. 10: Device configuration of Section I.

Device Setup of Section 2

Design of Section 2 has been created with the big support of the Proteus software, which is divided into numerous sections. A Section 2 device configuration is seen in **Fig.11**. (Automated LDR-based Lighting System).

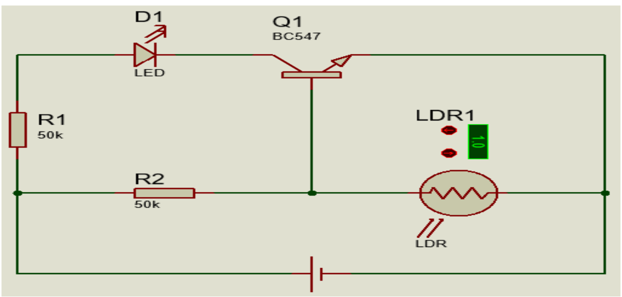


Fig. 11: Device configuration of Section 2.

Blynk Software Development

Blynk is an IoT platform that facilitates the creation of updated IoT devices. It can read, store, and display sensor data as well as remotely operate devices. It also functions as a control panel for seeing and manipulating devices and it is available for both Android and iOS. The program has a fairly functional UI and a variety of widgets for various uses. It operates on its currency, known as energy. Blynk always contains two parts: the Blynk Server and the Blynk Library. Through its server, Blynk Server provides a safe, responsive, and centralized cloud service that facilitates communication between devices. Blynk Server is also open source; it also allows users to create their servers.

RESULTS:

In **Fig.12**, this work attempt to depict the entire system in green. A simulated agricultural setting, complete with sensor and auto lighting systems has been created. The solar panel worked as the system's power source. Furthermore, this work utilizes NodeMCU as a microcontroller, which is likewise installed. This microcontroller is directly linked to each sensor. The system determines whether the pump should be turned ON or OFF by analysing the real data. However, when the sunshine is coming, the LED light is turned OFF, and when there is darkness, the LED light is ON.

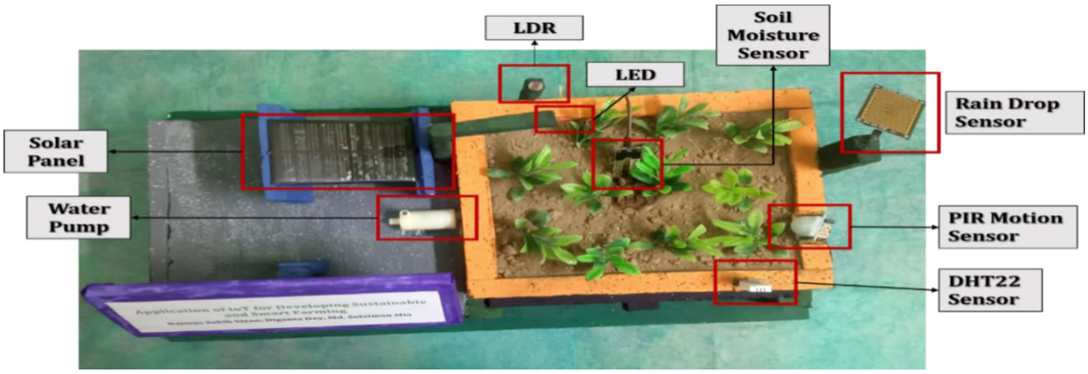


Fig.12: Implementation of proposed system.

Fig. 13 illustrates a graphical representation of the temperature changes in the different time zone of a day. It signifies that the temperature is low in the morning. Furthermore, the temperature is nearly at its peak in the evening. **Fig. 14** attempts to depict graphically how the humidity changes at different times of the day. It denotes that the humidity is low in the morning. However, it is gradually expanding. Furthermore, the temperature is close to high in the evening period, and the humidity is also at its peak.

Fig. 15(a) depicts the sensor's detected data. The water pump may control by turning it ON and OFF depending on the soil-moisture value. When the value of the soil moisture rises, it will display a notification, which is seen in **Fig. 15(b)**. Similarly, if an external item is detected, it will trigger a notice in this Blynk Software via the PIR Motion Sensor, as seen in **Fig. 15(c)**.

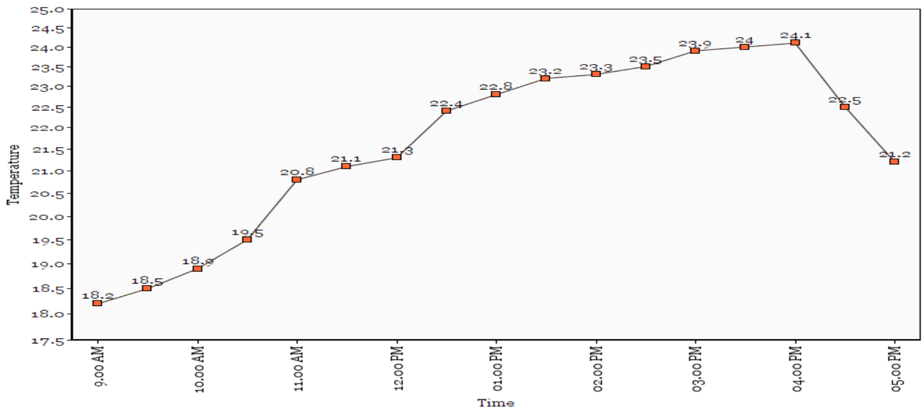


Fig. 13: Temperature reading from DHT22.

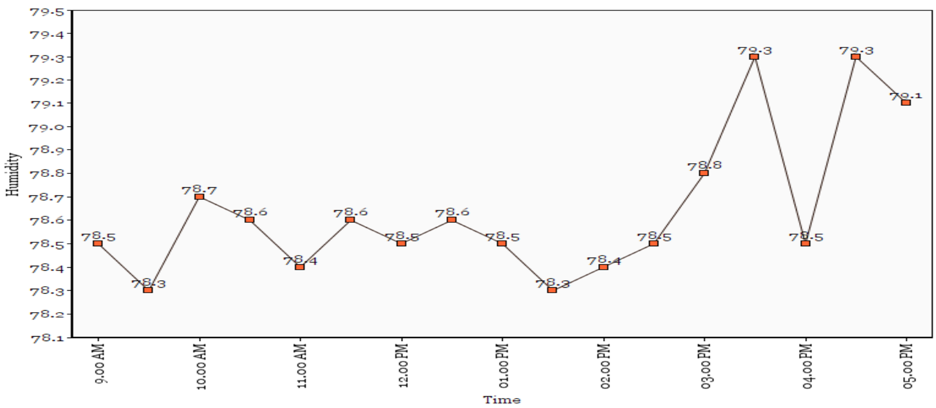


Fig. 14: Humidity reading from DHT22.

Fig. 15: (a) Blynk software interface, (b) Notification when soil is dry, and (c) Notification when external object detect.

Table 2: Comparison between proposed systems with other existing works.

Sensor Parameter	Micro controller	Wireless Protocol	Mobile/Web Application	Existing Work
DHT22 Sensor Soil Moisture Sensor Raindrop Sensor PIR Motion Sensor LDR	NodeMCU ESP8266	WiFi	Yes	Proposed System
DHT22 Sensor Raindrop Sensor Solar Panel	ESP8266	WiFi	No	Anupama *et al.* (2020)
DHT22 Sensor Raindrop Sensor Solar Radiation	Raspberry Pi	LoRa, 4G	Yes	Santos *et al.* (2019)
Temperature Sensor, Humidity Sensor, Soil Moisture Sensor	Arduino Uno	WiFi	MQTT Dashboard	Fizza *et al.* (2022)
Temperature Sensor Humidity Sensor Soil Moisture Sensor Visual Sensor pH Sensor CO2 Sensor Soil NPK Sensor	Arduino Uno	WiFi	No	Podder *et al.* (2021)
pH Sensor Soil Moisture Sensor Water Level Sensor	Arduino Uno	WiFi	Yes	Almalki *et al.* (2021)
Soil Moisture Sensor LDR Sensor Temperature Sensor	Raspberry Pi 3 b+	4G HAT	Yes	Rohith *et al.* (2021)
DHT22 Sensor	ESP8266	WiFi	No	Tripathy *et al.* (2021)
Temperature Sensor, Humidity Sensor, Soil Moisture Sensor	ESP8266	WiFi	Yes	Atmaja *et al.*(2021)
DHT11 Sensor Photoresistor Soil Hygrometer	Arduino Uno	WiFi	No	Izzuddin *et al.* (2021)
Temperature Sensor Humidity Sensor, Soil Moisture Sensor	Arduino Uno	WiFi	No	Ariffin *et al.* (2020)
Air Temperature Sensor	Arduino Uno	LoRa	No	Yaseen *et al.* (2020)

Soil Temperature Sensor Air Humidity, Soil Humidity Sensor Brightness				
Temperature Sensor Humidity Sensor	Arduino Uno	WiFi	No	Sarma *et al.* (2020)

Comparison with Similar Approaches

This section compares the system to other systems that are already in existence. **Table 2** shows the comparative analysis based on different parameters. These comparison tables display that the suggested system outperforms the existing models.

CONCLUSION:

This work attempted to integrate an innovative technology known as the IoT Technology into this suggested system, with several fundamental elements of modern farming (IoT). This research work has developed some new methods while avoiding the influence of animals and other exterior objects on their farms. A farmer executes this technology to monitor rain conditions by employing a rain detection sensor. The authors are also concerned with certain key concerns such as preventing future food crises, watering the land, improving the plant's growth value, reducing manpower, employing new ways of soil mixing, auto-regulating by mobile app, conserving electricity, and providing 24-hour illumin ation. The proposed system's major goal is to make farming more intelligent, eco-friendly, and user-friendly in a systematic manner. The authors hope that, shortly, this suggested approach will follow the way for all other individuals throughout the world to make agricultural practices more accessible and efficient.

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CONFLICTS OF INTEREST:

All authors declare that they have no conflicts of interest to disclose.

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