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Solar Powered Soil and WeatherMonitoring System Using Iot

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Abstract: ***The proposed project is designed to monitor the environmental conditions such as Temperature, Humidity, Soil Moisture, Rain level and Light Intensity in order to monitor the conditions of agricultural farm land. Through this design the farmers can receive the informationin remote mode. The farmers can use this information as a reference to improve the agricultural productivity. When correct information is collected every day, the farmers can predict the problems and can take necessary precautions.***

Keywords: Arduino Uno, DHT11 Sensor, Soil Moisture Sensor, Rain Drop Sensor, Light Intensity Sensor, LCD Display, GSM Module.

I. Introduction

A soil and weather monitoring system using IoT is a modern approach to monitor the agricultural land that leverages the power of the internet and sensor technologyto provide farmers with real-time data about theconditions of their agricultural land. With this system, farmers can monitor the parameters such as temperature,humidity, soil moisture, rain level and light intensity. Byanalyzing this data, farmers can make informed decisionsabout when to irrigate and help farmers to increase crop yields and reduce water consumption.The proposed design can be used in agricultural farmland as well as in horticulture. Overall, the solar- powered soil and weather monitoring system using IoT uses sensors to collect data on soil and weather conditions, which is then processed by a microcontrollerand sent to a cloud platform for storage and analysis. Thesystem can provide real-time data and help farmers to improve the sustainability of their farming practices. The term "Internet of Things" refers to the connection of objects, equipment, vehicles, and other electronic devicesto a network for the purpose of data exchange (IoT). The Internet of Things (IoT) is increasingly being utilized to connect objects and collect data. As a result, the Internetof Things' use in agriculture is crucial. The idea behind the project is to create a smart agriculture system that is connected to the internet of things. The technology is combined with an irrigation system to deal with soil and weather monitoring. The temperature and humidity in the surrounding region, as well as the moisture level of the soil, are monitored using the Temperature and Humidity Sensor (DHT22) and soil moisture sensor. The data will be available on both a smartphone and keypad phone in the form of short message service (SMS) [1]. A smart- sensors-based solar-powered system is developed for monitoring and controlling the tube well that ensures proper water provision to crops. The developed system properly checks weather and environmental conditions temperature, humidity, etc., soil conditions wet or dry, and crop conditions to monitor and regulate water flow accordingly to minimize water consumption [2].

The system uses sensors to monitor and adjust environmental parameters such as temperature, relative humidity, barometric pressure, and rain level, and then sends the information to a web page, where it is plotted. Data from the deployed system can be accessed through the internet by using a smartphone [3]. Varun et al proposed a Weather Monitoring System using the IoT to monitor temperature and humidity level, Barometric pressure, light intensity, air quality and rainfall. The required hardware includes Raspberry Pi, Arduino Mega, Temperature andHumidity sensor (DHT11). Light intensity sensor, Airquality sensor (MQ-135) and raindrop sensor. All the above sensors are used to measure the given parameters. Arduino IDE and Node-red software is used for programming and connecting hardware devices and online services. All sensors and hardwarecomponents are connected and built with Raspberry pi and Arduino. The Arduino board is programmed with necessary code through Arduino IDE. The output of the Arduino is stored in the local database using the influx database [4]. Kumari et al [5] proposed a Real- Time Cloud based Weather Monitoring system. This is a loT-based framework to gather the constant climate boundaries and store the information to the cloud stage. The gathered information is shown through the website page. The information is of extraordinary benefit where weather conditions are required. The climate boundary incorporates temperature, stickiness, dew point, light power, pneumatic stress, precipitation, and smoke rate. The Node MCU is used to move the detected information to the Thing speak cloud stage. Low-cost loT- ba s ed weather monitoring system for smart community paper proposes a real-time weather monitoring systemdesigned for a smart home that displays weather parameters such as the intensity of rainfall, temperature, wind speed and light intensity obtained from the sensors to the cloud [6]. Anita et al proposed an internet of things (IOT) based smart irrigation system to identify the dampness in the soil and to control the watering of the crops automatically. The primary motivation behind is to keep up soil dampnesslevel so that there is no damage to the harvests. Soil dampness sensors are fundamentally utilized for estimating the gauge volumetric water content. Microcontroller is used for getting the information from the water system sensors and after that passes the information on the web utilizing General packet radio services (GPRS) module [7]. Fhaizal et al proposed monitoring system is equipped with a Temperature and Humidity sensor (DHT11), Light-dependent resister (LDR), and soil moisture sensor to monitor temperature, humidity, and other parameters. The internet of things (IoT) is implemented in this systemto send all the information from sensors to the Cloud and display it through the Thing Speak website. The mobile application will read all the data from the Thing Speak website to display and send a push notification to the farmers instantly if the crop soil conditions are out of the acceptable range. Based on the observation, the serial monitors and the Thing Speak website will be updated with new data for every 20 seconds. Solar PV-based battery is proposed as the main power supply of the system, hence possible to be installed in remote areas [8]. Abhishek et al proposed a design which will interface Temperature and Humidity senor (DHT11), Rain Sensor (FC37) with Node MCU ESP8266-12E Wi-Fi Module. The design will measure humidity, temperature, Barometric pressure, and rainfall and upload the data to a web server. Once the code is uploaded you can find the IP address of Node MCU in the serial monitor. With the same IP, you can go to any web browser and display the data in a beautiful widget format. The project can be used in remote areas where the data is to be monitored [9]. Raja Prakash et al proposed a design, the system projected is a complicated answer for watching the atmospheric condition at a selected place and create the data visible anyplace within the world. This design has a tendency to investigate whether streaming knowledge like temperature, humidity. Here the design has a tendency to use Thing Speak tool for implementing Whereas the knowledge is collected through Internet of things (IOT) sensors [10].

II. PROPOSED METHODOLOGY

The proposed design allows the farmers to check weather and soil parameters in remote mode. The proposed design uses DHT11 sensor to measure temperature and humidity, soil moisture sensors to measure soil moisture content at different places in the field, rain drop sensor to measure rain level and LDR sensor to measure light intensity. The proposed design is achieved by using technology of internet of things and cloud. The sensing data from sensors sent to ATmega328P microcontroller for processing the data collected by the system should be made available in real-time through an IoT communication platform, allowing users to access the data from anywhere and at any time. The sensing data is monitored in cloud platformas well as in user phone through SMS. The proposed design can be used in agriculture, horticulture, Argo farmor any other field where soil and weather monitoring arecritical.

The proposed methodology for a solar-powered soil and weather monitoring system using IoT can be broken down into the following steps:

Sensor selection: The first step is to select the appropriate sensors to measure soil moisture, temperature, humidity, soil moisture, rain drop and light intensity sensor. The sensors should be compatible with IoT communication protocols and have low power consumption to optimize solar energy usage.

Hardware design: The hardware design involves the selection of microcontrollers, power management circuits, and communication modules. The microcontroller should be able to read data from the sensors and transmit it wirelessly using an IoT communication protocol. Power management circuits should ensure efficient use of solar energy to power the system, and communication modules should be compatible with the selected IoT protocol.

Solar panel sizing: The size of the solar panel depends on the power consumption of the system and the location where it will be deployed. It is essential to calculate the energy consumption of the system to ensure that the solar panel provides enough power to keep the system running continuously.

Cloud-based server setup: A cloud-based server is required to store, process, and visualize the data transmitted by the system. The server should be configured with the selected IoT protocol to receive and process data in real-time.

Data analysis and visualization: The data collected by the system should be analyzed and visualized to provide insights into soil and weather conditions. The visualization should be user-friendly and accessible from anywhere using a web or mobile application.

Deployment: Once the system is designed and tested, it can be deployed in the field. The deployment process involves installing the system in the desired location, configuring the IoT communication protocol, and connecting it to the cloud-based server.

Maintenance: Finally, the system should be regularly maintained to ensure optimal performance. This includes checking the solar panel and battery health, ensuring that the communication modules are functioning correctly, and updating the software as required.

In summary, the methodology for a solar-powered soil and weather monitoring system using IoT involves selecting sensors, designing hardware, sizing solar panels, setting up a cloud-based server, analyzing and visualizing data, deploying the system, and maintaining it regularly.

III. Block Diagram

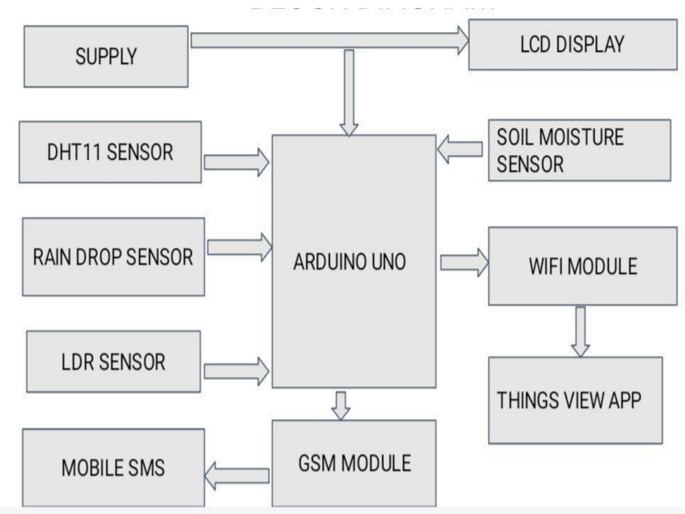

Fig.1 Block Diagram

In the above Fig.1 Sensors are placed to detect the parameters of Temperature, Humidity, Soil Moisture, Rain Level and Light Intensity in a field of various soil. Solar panels are used to generate electrical energy from sunlight. They are typically installed on the top of the system and are responsible for generating the required energy for the system to operate. The microcontroller is the primary controller of the system. It is responsible for controlling the various sensors, collecting data from them, and sending the data to the cloud using IoT communication protocols. Temperature, Humidity, Soil Moisture, Rain Level and Light Intensity sensors, these sensors are responsible for collecting data about the soil and weather conditions. The IoT gateway acts as a bridge between the sensors and the cloud. It receives the data from the sensors and sends it to the cloud using wireless communication protocols. The cloud server is responsible for storing the data collected by the system. It also provides access to the data to the end user through a web-based interface. The user interface provides a graphical representation of the data collected by the system. It allows users to view the data in form of graph.

Arduino Uno

ARDUINO UNO is an open-source microcontroller board based on the microchip ATmega328P microcontroller. The board is equipped with sets of digital and analog input/output pins. The board has 14 digital I/O pins ,6 analog I/O pins and is programmable with the Arduino IDE (Integrated Development Environment) via USB cable.

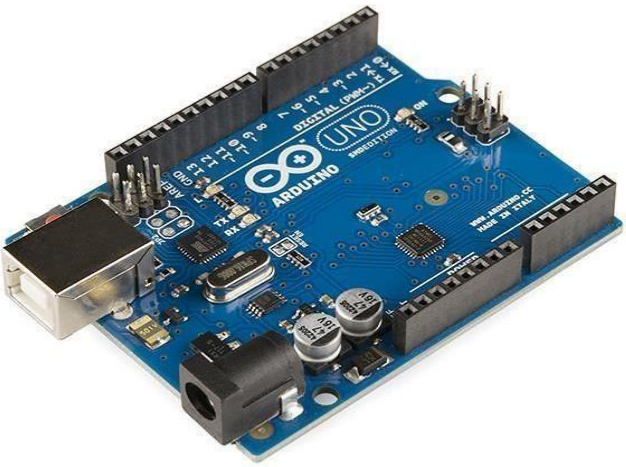

Fig.2 Arduino Uno

DHT11 Sensor

DHT11 sensor is used to measure the temperature and humidity of the environment. It measures the surrounding air and split out a digital signal on the data pin.

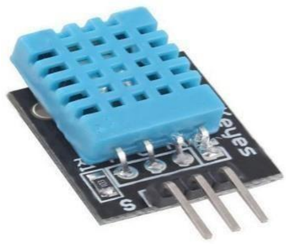

Fig.3 DHT11 Sensor

Soil Moisture Sensor

A device which is used to sense the moisture level in the sand is called soil moisture sensor. This sensor reminds the user to water their plants and also monitors the moisture content of soil.

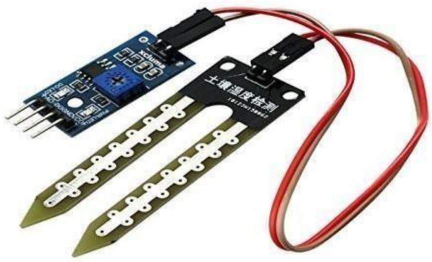

Fig.4 Soil Moisture Sensor

RAIN DROP SENSOR

Rain drop sensor is used for sensing the rain. It consists of two modules, a rain board that detects the rain and a control module, which compares the analog value, and converts it to a digital value.

Fig.5 Rain Drop Sensor

Light Intensity Sensor

Light Dependent Resistor is responsible for collecting data about the intensity of light at your surroundings. The LDR is essentially a resistor that is sensitive to light, when higher intensity light falls on photosensitive surface its resistance drops and when less light is received its resistance increases.

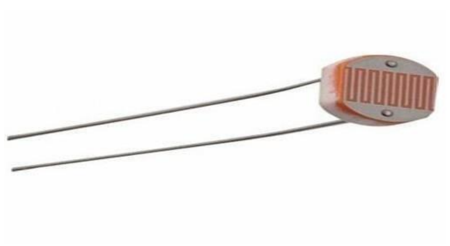

Fig.6 Light Intensity Sensor

WI-FI Module

The ESP8266 is a WI-FI microchip, with a full TCP/IP stack a microcontroller capability. This small module allows microcontroller to connect to a WI-FI network and make simple TCP/IP connections.

GSM Module

GSM (Global System for Mobile Communication) module is used to send data in the form of SMS.

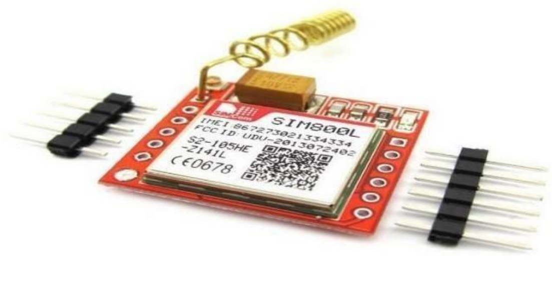

Fig.7 GSM Module

IV. Result And Discussion

Solar powered soil and weather monitoring system using iot is a systemthat utilizes the various sensors, communication networks, microcontroller to monitor the field parameters such as temperature, humidity, soil moisture, rain level and light intensity. Sensors are connected to microcontroller that collect data and send data to cloud platform through wi-fi and SMS sent to farmer phone through GSM (global system for mobile communication).

The result of a solar-powered soil and weather monitoring system using IoT can be evaluated based on the accuracy and reliability of the data collected, the efficiency of the solar energy usage, and the overall system performance.

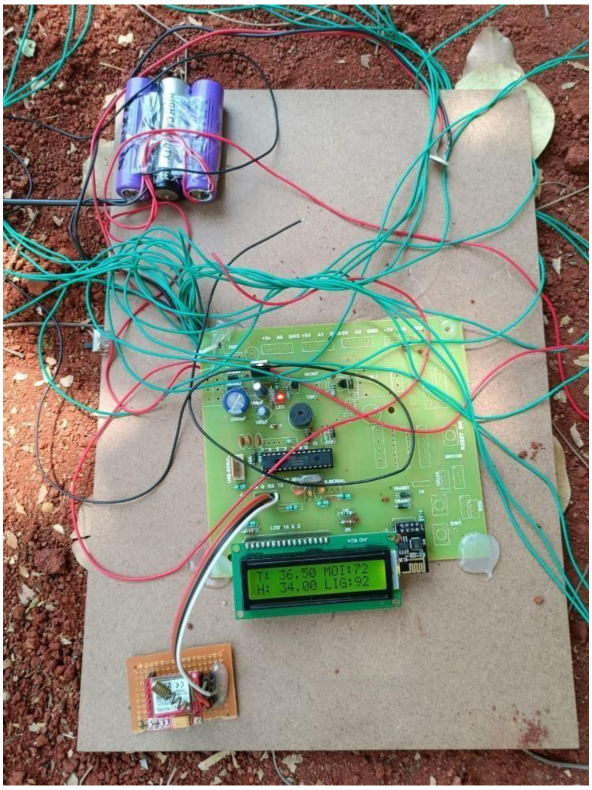

Fig.8 Module tested in Soil

The system can provide real-time data on soil moisture, temperature, humidity, soil moisture, rain level and light intensity allowing farmers and researchers to make informed decisions about agricultural practices. The data can be analyzed and visualized to identify patterns and trends in soil and weather conditions, enabling farmers to optimize irrigation, fertilization, and other agricultural practices.

The use of solar power ensures that the system operates continuously in remote locations. The IoT communication protocol enables the wireless transmission of data, reducing the need for physical intervention and enabling remote access to data from anywhere. The cloud-based server can store and process large amounts of data, making it accessible and easy to analyze.

However, there are some potential challenges with the system. For example, the accuracy and reliability of the data collected may be affected by environmental factors such as extreme temperatures, humidity, andrain level. Additionally, the cost of the hardware and cloud-based server may be a limiting factor for some use.

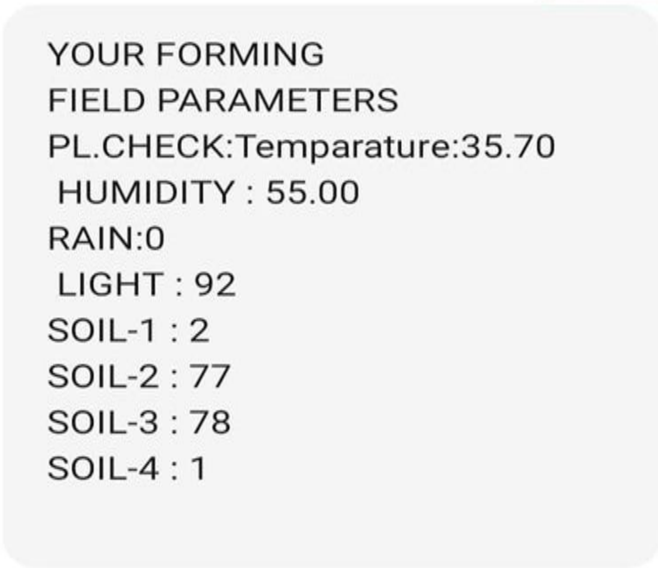

Fig.9 SMS through GSM at 1:00pm on mar27,2023 in Vijayawada.

Solar powered soil and weather monitoring system using iot is a system that utilizes the various sensors, communication networks, microcontroller to monitor the field parameters such as temperature, humidity, soil moisture, rain level and light intensity. Sensors are connected to microcontroller that collect data and send data to cloud platform through wi-fi and SMS sent to farmer phone through GSM (global system for mobile communication).

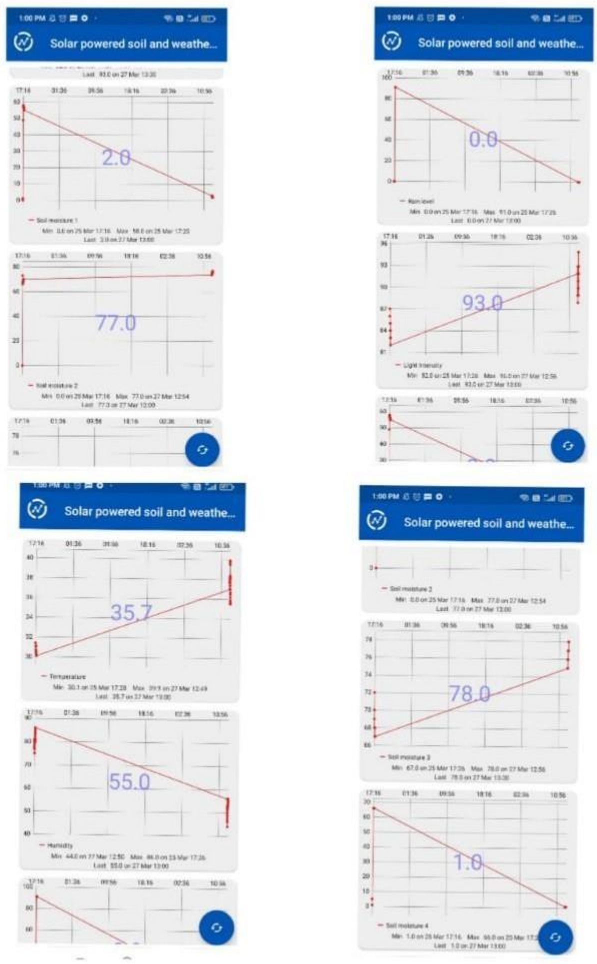

Fig.10 Graphical representation of readings at 1:00pm on mar 27, 2023 in Vijayawada.

From the above Fig Graphical representation of readings i.e., Temperature, Humidity, Soil moisture-1, Soil moisture-2, Soil moisture-3, Soil moisture-4, Rain level and light intensity. The time taken to send SMS (short message service) to users' phone is less than a minute.

Table 1: parameters obtained from designed hardware

Parameters	Test-1		Test-2		Test-3	
	Values obtained through SMS	Values obtained through thingview app	Values obtained through SMS	Values obtained through thingview app	Values obtained through SMS	Values obtained through thingview app
Temperature	36.80(°C)	37.7(°C)	35.70(°C)	35.7(°C)	30.10(°C)	30.1(°C)
Humidity	54%	53.0%	55%	55%	83%	85%
Soil moisture-1	3%	3%	2%	2%	55%	55%
Soil moisture-2	74%	74%	77%	77%	70%	70%
Soil moisture-3	75%	75%	78%	78%	67%	68%
Soil moisture-4	1%	1%	1%	1%	66%	66%
Rain level	0(mm)	0(mm)	0(mm)	0(mm)	91(mm)	91(mm)
Light Intensity	92(lx)	92(lx)	92(lx)	93(lx)	82(lx)	82(lx)

First test was conducted on March 27th 2023 at 12:46pm in Vijayawada.
Second test was conducted on March27th 2023 at1:00pm in Vijayawada.
Third test was conducted on March 25th 2023 at 5:30pm in Vijayawada.

Table-2: Difference and Error calculation for Temperature

parameters	Values obtained from google	Values obtained in thing view app	Values obtained through SMS	Difference		Error	
Temperature (Test-1)	34(°C)	37.7(°C)	36.80(°C)	3.7	2.8	9.8%	7.6%
Temperature (Test-2)	34(°C)	35.70(°C)	35.7(°C)	1.7	1.7	4.76%	4.76%
Temperature (Test-3)	33(°C)	30.1(°C)	30.10(°C)	2.9	2.9	8.7%	8.7%

The values of Temperature from the designed hardware are compared with the standard values (obtained from google). The error percentage is calculated and tabulated as shown in table 2.

Table 3: Difference and Error calculation for Humidity

parameters	Values obtained from google	Values obtained in thing view app	Values obtained through SMS	Difference		Error	
Humidity (Test-1)	54%	53%	54%	1	1	1.88%	1.85%
Humidity (Test-2)	54%	44%	45%	10	1	18.5%	16.6%
Humidity (Test-3)	55%	85%	83%	30	28	33%	33.7%

The values of Humidity from the designed hardware are compared with the standard values (obtained from google). The error percentage is calculated and tabulated as shown in table 2.

V. Conclsion

In conclusion, a solar-powered soil and weather monitoring system using IoT is a promising technology that has the potential to revolutionize the agriculture sector. The system can monitor temperature, humidity, soil moisture, rain level, and light intensity weather conditions in real-time and provide farmers with the necessary data.

Moreover, the use of solar power in the system reduces energy costs and ensures sustainability by reducing carbon emissions. The integration of IoT technology also allows for remote monitoring and control of the system, enabling farmers to receive updates on their crops' condition from anywhere and make timely decisions.

As for the future scope, the solar-powered soil and weather monitoring system using IoT is expected to evolve continuously with technological advancements. The system can be further enhanced by incorporating machine learning algorithms that can analyze the data collected and provide predictions for future crop yields, disease outbreaks, and weather conditions.

Furthermore, the system can be integrated with other smart agricultural technologies, such as precision farming, crop management systems, and drone-based monitoring, to create a comprehensive and efficient agriculture management system.

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