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Design and Implementation of IoT based Agriculture Data Monitoring System using Sensors

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***Abstract*—Agricultural output is negatively affected by the presence of plant diseases. The likelihood of food spoilage rises in the absence of prompt diagnosis of plant diseases. An essential part of supervising and deciding on agricultural output is inhibiting plant diseases, which are the basis for successful plant disease prevention and management. A major problem in agriculture in recent years has been the discovery of plant diseases.**

There may be more favorable circumstances for the spread of aircraft illnesses because of climate change. Keeping an eye on the weather is crucial. Reducing the frequency of anti-disease treatments at optimal times is a common outcome of using meteorological indication control techniques. So, in a perfect world, it protects the crop better with less pesticide and labor expenditure, and it also lessens crop losses due to mechanical and phytotoxic conditions. Using sensors and the Internet of Things (IoT), we want to build an electronic system that keeps tabs on a wide range of environmental factors that could stunt plant development or even induce plant illnesses.

***Index Terms*- Atmospheric conditions, Plant diseases, Sensors, IoT.**

I. Introduction

The use of cutting-edge information technology in precision farming has the potential to revolutionise the management of commercial agricultural fields on a grand scale, allowing for more output at reduced costs. A lot of the factors in precision farming are controlled by specific gadgets, and the machines themselves are fully computerised. Thorough ground-level atmospheric monitoring and lightning-fast data transmission to controller are essential to this type of highly automated agricultural practices. Making decisions and controlling agricultural equipment also need processing capacity to be available at the central server (database). Automated electronic equipment can manage irrigation to a significant extent using such real-time information. Our technology may be utilised in agriculture by means of sensors that detect soil moisture content, temperature, humidity, and light intensity. A wire links these sensors together. The sensors that are utilised are both economical and durable.

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The most fundamental cause of plant diseases is the variability of climatic conditions. From a plant disease prevention standpoint, it is best to keep an eye on and record the current weather conditions. Therefore, we are trying to develop a system which will examine the fluctuation in moisture level, temperature, Humidity and lux for one day, one week, and one month or even for one season. One may readily deduce the current, weekly, and monthly water and pesticide needs of plants from the data supplied by the system. Data collected from a variety of sensors allows one to configure the system to do things like spray insecticides, water at specific times, etc. We can cut labour costs by implementing this technology, which only requires one worker. This discovery has the potential to be used on a wide scale, which might result in additional savings in personnel.

II. Literature Survey

In their proposed system, Agni Biswas and Sarthak Prakash [1] want to track the soil's moisture, pH, humidity, and temperature, and then control the on/off operation of a pipe valve based on these readings. The data Indication system comprises of Atmega328 coupled to Bluetooth module which is used to deliver signals to android or windows smart phones and timings of irrigation is displayed on android screen when connected by Bluetooth [1].

In light of what we've learnt from this research [1], we believe that the food crisis in India has been averted and that food production has been steadily increasing thanks to quick technology breakthroughs and prompt policy initiatives. Connecting a smart sensing system with a smart irrigation system using wireless communication technology is defined by Chetan Dwarkani et al. [2] as advanced farming. Their technology takes into account physical factors like soil moisture, nutrient concentration, and pH. When crucial soil parameters are detected, an intelligent irrigation system is used to sprinkle the crops with the appropriate amount of water, compost, and green manure [2]. A adequate amount of water was sprinkled by the irrigator system, as described in this work, depending on the content of moisture sensors.

For the purpose of determining soil nutrients, namely NPK, Akshay Sankpal and Krishna K. Warhade [3] examined sensing technologies in addition to other portable methods such as electrochemical, mechanical, optical, etc. Mainly optical approaches were researched for the measurement of soil nutrients with the employment of optical LED's and VIR-NIR technologies [3]. After reviewing the literature on soil nutrient determination methods, the authors of this research concluded that the optical approach is the most effective and uses the least amount of electricity.

Using a photodiode, light-emitting diode (LED), microcontroller, and analog-to-digital converter (ADC), Tamal Adhikary et al. [4] created a sensor device that could detect soil macronutrients such as phosphorus (P), ammonium nitrogen (NH4-N), and nitrate nitrogen (NO3-N). A GPRS modem and sensor unit have been combined to enable remote data gathering to a server. The author contrasts the sensor results with those from chemical lab tests [4].

A soil testing system was created by D. Rupa et al. [5] using an embedded system. This system determines the amount of fertiliser needed for a specific crop by sensing environmental factors and the amount of nutrients in the soil. If any abnormal conditions are detected, a message is sent to the farmer through GSM. The block diagram for Soil Testing utilising Embedded System is illustrated in Figure 1 [5].

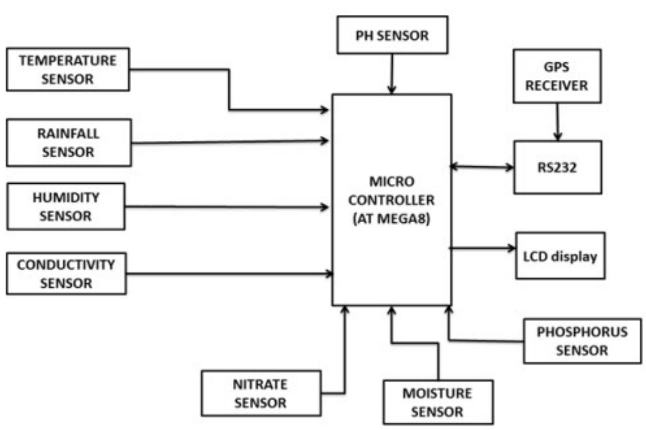

Figure 1: Block Diagram of Soil Testing using Embedded System [5]

An MCU (STM32L152RE) system was introduced by Abdullah Na et al. [6]. MCU initializes the peripherals to be utilised to control and manage the different sensing values and communication blocks of the devices. The node microcontroller unit (MCU) examines the device's connectivity and gets individual sensor readings. If so, it sends information to a mobile device; otherwise, it collects a fresh sample. Bluetooth was integrated into the system to allow data transmission to a nearby mobile phone. Figure 2 shows the firmware flow diagram that explains how it works. [6].

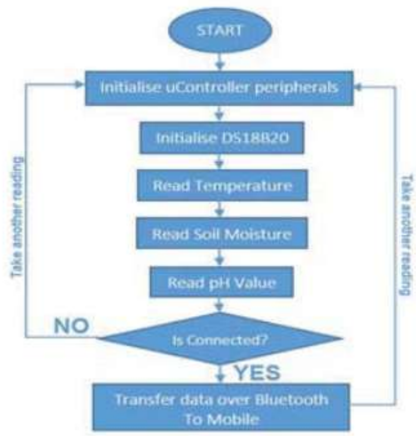

Figure 2: Firmware Flowchart [6]

An Internet of Things (IoT) based system for measuring soil moisture, temperature, and pH is introduced in this journal article. We have constructed and verified designs for pH, temperature, and moisture sensors. [6].
R.Sindhuja and B.Krithiga [7] created a sensitive, reliable and automated electrochemical sensor system for monitoring the nutrients in soil using Arduino UNO Microcontroller. For quick detection in the field, an electrochemical sensor coupled with an Arduino can react to specific ions in a matter of minutes. The two-stage electrochemical flow-through sensor system FIA is the foundation upon which the electrode system operates. method for identifying soil nutrients.
Laxmi C. Gavade and Mr. A.D. Bhoi [8] reviewed different techniques of detection of N, P and K contents, humidity of the soil by using different sensors and also monitor the temperature and sunlight in the farmland. For this article, the authors compared several sensors for sensing
different soil characteristics. Chemical analysis, or the precise quantification of A] Conductivity Measurement Technique, B] Electrochemical Method, and C] Optical Method are the three ways that NPK is carried out. Reading this research [8] helped us understand that, in general, these methods are comparable, and that the detection of soil macronutrients would always include a chemical laboratory.
In order to forecast which crops will thrive in a given soil type in real time, Dharesh Vadalia et al. [9] used a pH meter to calculate the average proportion of the three fundamental soil nutrients: nitrogen, phosphorus, and potassium. Arduino UNO R3 was used to construct the system. The crop prediction system and soil quality analyser are depicted in Figure 3 as a block diagram [9].

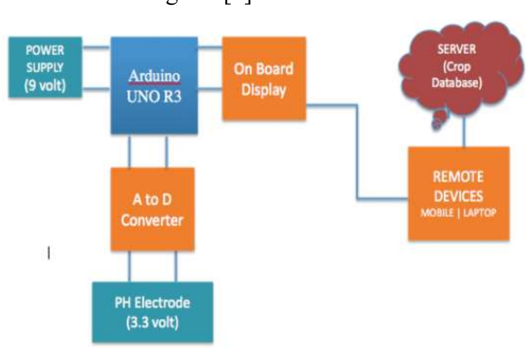

Figure 3: Block diagram of Soil Quality Analyzer and Crop Prediction System [9]

A fibre optic-based colour sensor for determining N, P, and K levels in soil samples was developed by Deepa V. Ramane et al. [10]. For that colorimetric measurement of aqueous solution of soil has been used. The color detector depends on the idea of absorption of color by solution. The levels of N, P, and K can be determined as high, medium, low, or none at all with its guidance. We built sensor probes alongside accurate signal acquisition circuits to identify the soil deficiency. These cutoff points determine whether components are lacking.

III. Hardware Description

A. ESP8266

ESP8266 is a complete, standalone Wi-Fi networking solution that can host software applications. The device can be utilised as a request processor and booted immediately from an external disc if it has flash memory. Onboard cache helps to boost system performance and minimise memory needs. Wireless Internet connectivity is also limited to certain interfaces, such as the SPI/SDIO or CPU AHB bridge, which can be easily integrated into microcontroller designs with the help of Wi-Fi adapters. With its large storage capacity and fast processing speed, the ESP8266 is ideal for low-power startup and operation applications that make use of sensors and other specialised devices connected to its general-purpose I/O (GPIO) interface. This is seen in Figure 4, which displays the ESP8266.

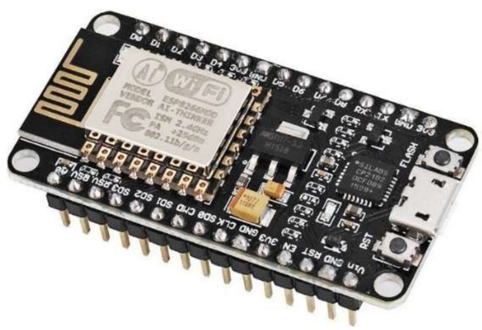

Figure 4: ESP8266

B. Soil Moisture Sensor

The soil moisture sensor finds out how much water is in the soil, often known as its humidity. The output module might be high when the soil is experiencing a water scarcity; otherwise, it is limited. The device keeps tabs on soil moisture and alerts users when it's time to water plants. Soil irrigation, planting, and agriculture are only a few of the many uses for it. Present in Figure 5 is the Moisture Sensor.

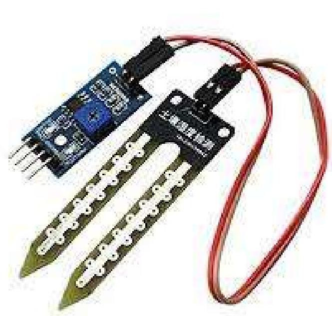

Figure 5: Moisture Sensor

C. Air Temperature & Humidity Sensor DHT11

Humidity and temperature gauge The temperature and humidity may be measured with the help of a DHT11 sensor. It takes readings from the surrounding air using a thermistor and capacitive humidity sensor. With a signal transmission range of up to 20 meters and minimal power consumption, this sensor is both affordable and efficient. The DHT 11 sensor is shown in Figure 6.

- Voltage required for power supply: +5V
- Temperature: inaccuracy of ± 2 °C from 0 to 50 °C
- RH: 20-90% with a margin of error of ±5%

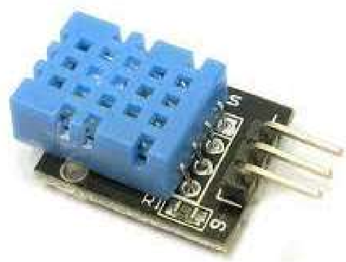

Figure 6. DHT 11 Sensor

IV. Software Description

ThingSpeak

The developers of ThingSpeak claim that their open-source application and API, ThingSpeak, allows users to gather and save data from items connected to the Internet or a local area network (LAN) over the HTTP protocol. A lot of people use ThingSpeak for social networks that allow users to post status updates, apps that collect data from sensors, and apps that monitor where you are. IO Bridge first introduced ThingSpeak in 2010 as a solution to bolster Internet of Things applications. The mathematical computer software Matlab, developed by Math Works, is integrated into ThingSpeak. Without having to buy a Matlab license from Math Works, it enables ThingSpeak users to analyse and visualise downloaded data using Matlab. Mathematical works are closely related to ThingSpeak. Actually, you may register for a Math Works account on the ThingSpeak site, and all of the ThingSpeak files are uploaded to Math Works Matlab data centre. User agreements and application guidelines form the basis of our Terms of Service and Privacy Policy. Thanks to ThingSpeak, we can see a visual correlation between time and a number of environmental variables.

V. System Working

Controllers and wireless modules monitor the main atmospheric conditions, which include light, humidity, temperature, and moisture. The system software may receive all of this data wirelessly once it has been created by a variety of sensors. A simplified system diagram is shown in Figure 7.

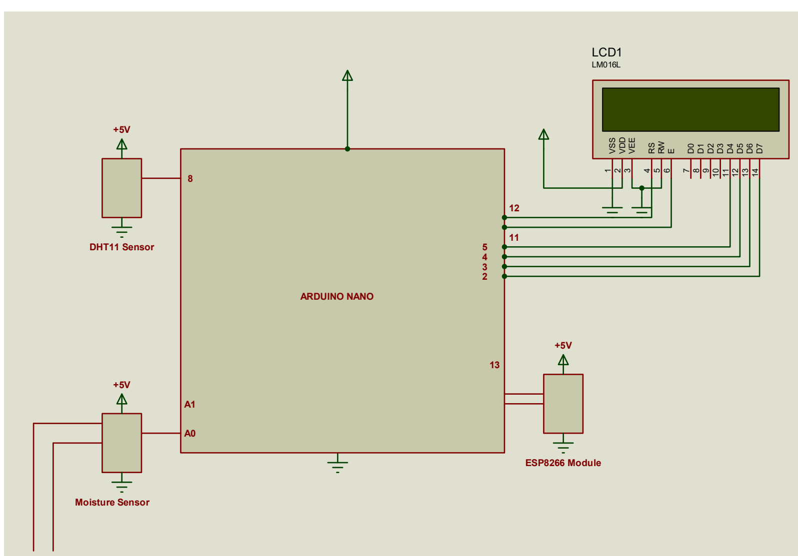

Figure 7: Circuit Diagram

Figure 8: Actually, implemented Circuit

An automated method for detecting atmospheric conditions is shown in Figure 8. Various sensors—including those for temperature, humidity, and moisture—coupled to the Arduino microcontroller. All sorts of soil and environmental parameters can be picked up by these sensors. The LCD that indicates the system's humidity, temperature, and moisture readings is shown in Figure 9.

Figure 9: LCD Readings on System

VI. Result

We have used every imaginable kind of sensor to compile our data in this system. We will save the collected data at the IoT. The ThingSpeak server can retrieve data. Fig. 10 shows a screen capture of the downloaded data.

	A	B	C	D	E	F	G	H	I	J
1	created_at	entry_id	Temp	Humidity	Lux	Moisture 1	Moisture 2	Moisture 3	Moisture 4	Moisture 5
2	2022-10-20T11:22:19+05:30	16373	29	87	90	49	50	58	18	18
3	2022-10-20T11:22:36+05:30	16374	29	87	90	45	47	54	18	18
4	2022-10-20T11:22:53+05:30	16375	29	87	89	44	45	53	16	16
5	2022-10-20T11:23:10+05:30	16376	29	87	89	41	44	51	18	18
6	2022-10-20T11:23:27+05:30	16377	29	87	89	43	44	50	19	18
7	2022-10-20T11:23:44+05:30	16378	29	87	89	43	44	50	16	16
8	2022-10-20T11:24:01+05:30	16379	28	86	89	43	43	50	16	15
9	2022-10-20T11:24:18+05:30	16380	29	87	90	42	43	49	16	16
10	2022-10-20T11:24:35+05:30	16381	29	87	90	42	43	49	16	15
11	2022-10-20T11:24:52+05:30	16382	29	86	93	41	42	48	18	18

Figure 10: Screenshot of data stored

In later versions of ThingSpeak, you may also see how time interacts graphically with other environmental variables including light, humidity, temperature, and wetness. Figure 11 displays the different ThingSpeak maps. The first graph, the Field 1 Chart, is a graphical representation of the relationship between the date and temperature. The Field 2 Chart is the second graph, and it depicts the relationship between humidity and date graphically. The third graph, the Field 3 Chart, is a graphical representation of the relationship between date and light, or lux. The fourth graph, Field 4 Chart, is a graphical representation of the relationship between date and moisture.

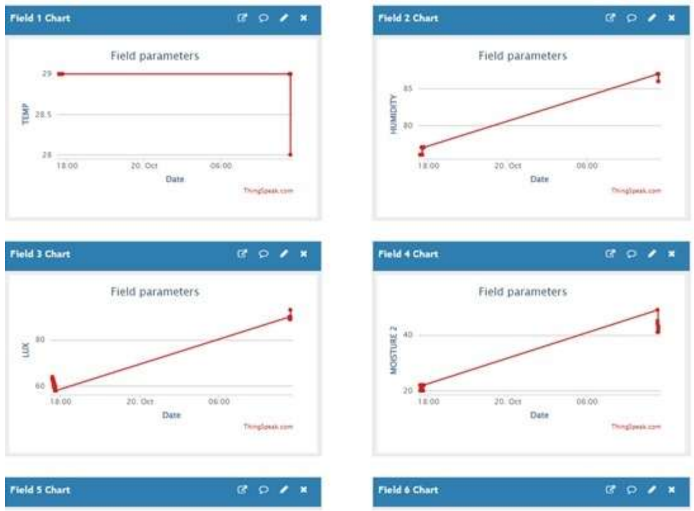

Figure 11: ThingSpeak Results

The data was gathered over the course of many days for testing purposes. The following values for the date 10.10.2022 include statistics on humidity, light, temperature, and moisture. Fig. 12 shows a screen capture of the retrieved data. From the screenshot, we can see that 30 readings were collected inside on the same day.

	A	B	C	D	E	F	G	H	I	J
1	created_at	entry_id	Temp	Humidity	Lux	Moisture 1	Moisture 2	Moisture 3	Moisture 4	Moisture 5
2	2022-10-10T15:05:11+05:30	15779	28	95	84	36	47	47	18	18
3	2022-10-10T15:05:28+05:30	15780	28	95	84	35	44	44	18	18
4	2022-10-10T15:05:45+05:30	15781	28	95	83	34	42	42	18	18
5	2022-10-10T15:06:02+05:30	15782	28	95	83	34	41	42	18	18
6	2022-10-10T15:06:19+05:30	15783	28	95	84	33	41	41	15	15
7	2022-10-10T15:06:36+05:30	15784	28	95	83	33	40	41	15	15
8	2022-10-10T15:06:53+05:30	15785	28	95	83	33	40	41	15	15
9	2022-10-10T15:07:10+05:30	15786	28	95	83	33	40	40	15	15
10	2022-10-10T15:07:27+05:30	15787	28	95	83	33	40	40	16	15
11	2022-10-10T15:07:44+05:30	15788	28	95	83	33	39	40	15	15
12	2022-10-10T15:08:01+05:30	15789	28	95	83	33	39	40	18	18
13	2022-10-10T15:08:18+05:30	15790	28	95	83	33	39	40	15	15
14	2022-10-10T15:08:35+05:30	15791	28	95	83	33	39	40	15	15
15	2022-10-10T15:08:52+05:30	15792	28	95	83	33	39	40	15	15
16	2022-10-10T15:09:09+05:30	15793	28	95	83	33	39	40	15	15
17	2022-10-10T15:09:26+05:30	15794	28	95	83	33	38	40	18	18
18	2022-10-10T15:09:43+05:30	15795	28	95	83	33	38	40	18	18
19	2022-10-10T15:10:00+05:30	15796	28	95	83	33	38	40	15	15
20	2022-10-10T15:10:17+05:30	15797	28	95	83	33	38	40	15	15
21	2022-10-10T15:10:34+05:30	15798	28	95	83	33	38	40	15	15
22	2022-10-10T15:10:51+05:30	15799	28	95	83	33	38	39	15	15
23	2022-10-10T15:11:08+05:30	15800	29	95	83	32	38	40	15	15
24	2022-10-10T15:11:25+05:30	15801	28	95	83	33	38	40	15	15
25	2022-10-10T15:11:42+05:30	15802	28	95	83	33	38	39	15	15
26	2022-10-10T15:11:59+05:30	15803	28	95	83	32	38	39	15	15
27	2022-10-10T15:12:21+05:30	15804	28	95	83	33	38	40	15	15
28	2022-10-10T15:12:38+05:30	15805	28	95	82	33	38	39	18	18
29	2022-10-10T15:12:55+05:30	15806	28	95	82	33	38	39	18	18
30	2022-10-10T15:13:12+05:30	15807	28	95	82	33	37	39	18	18
31	2022-10-10T15:13:30+05:30	15808	28	95	82	33	38	39	15	15

Figure 12: Screenshot of data stored

Additionally, we may quickly retrieve readings by having graphs of the different parameters on an Excel file. Figure 13 is a graphical representation of the readings stated in Figure 12.

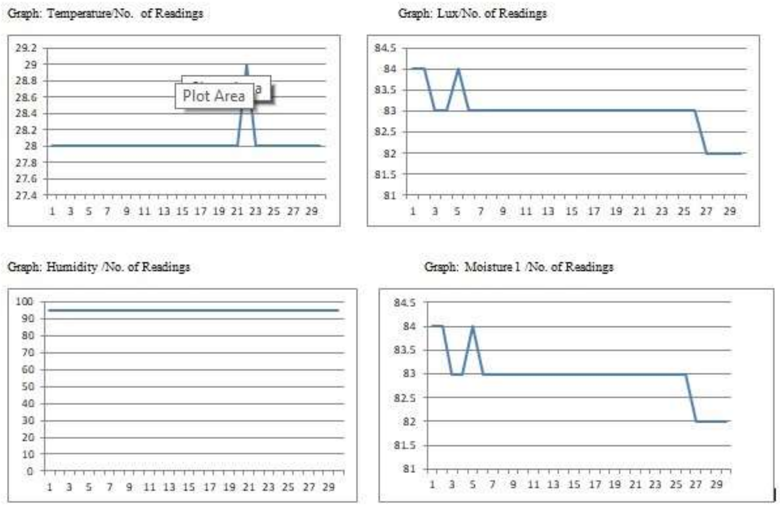

Figure 13: various graphs of readings.

VII. CONCLUSION

However, plant diseases are a major obstacle to agriculture and overcoming this is still an open problem. A few infected crops can spread the disease to all crops in the field, further affecting the sale of agricultural products. There is interest in research in areas such as plant diseases.

The main purpose of this smart machine is to make it innovative, easy to use, time-saving and more efficient system than existing machines using IoT. The quadruple measurement system includes soil moisture, temperature, air humidity and lux value in order to provide accurate results. When the weather conditions change, plant diseases can occur. Therefore, our body helps to detect changes in weather conditions and this helps us to detect the occurrence of plant diseases. Thanks to the server update, farmers can get information about the condition of their land.

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