Design and Implementation of IoT-Based Smart Precision Agriculture Farming

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Abstract- The study aims to produce an IoT-based system for precision agriculture farming capable of accurately investigating and monitoring the farming fields. It is from any distant area and evaluates the fundamental conditions like equipment guidance, yield monitoring, remote sensing, and in-field electronic sensors of the ground. It is an exceptional farm management tool that presents and examines information from various sources in a solitary, simple-to-utilize application. Farmers can't utilize an enormous volume of crude information accessible from sensors, controllers, monitors, and other systems from numerous areas. This paper integrates data into a single, farmer-friendly platform. It is an automated solar-powered system that prevents the over and under-usage of water, and fertilizers. It eliminates the dependency on assumptions and minimizes human interventions. By executing the most recent sensing and IoT advancements in horticulture practices, each part of the traditional cultivating technique can be fundamentally changed. At present, a consistent combination of remote sensors and the IoT in smart farming can raise agribusiness to levels that were already incomprehensible. By following the acts of smart horticulture, IoT can assist with working on the arrangements of numerous customary cultivating issues, like drought response, yield enhancement, land appropriateness, water system, and vermin control. Significant occasions in which advanced technologies are helping at different stages to improve overall efficiency.

Index Terms- Internet of Things (IoT), Smart agriculture, Advance agriculture practices, Precision agriculture, Renewable Energy, Urban farming, site-specific farming.

I. Introduction

The proposed idea aims at various scientific applications which could be assembled in the agricultural field for better precision with better efficiency utilizing less - assumption. An innovative and eco-friendly farming solution to reduce costs & wastage; and improve yield/hectare. It is an exceptional farm management tool that presents and examines information from various sources in a solitary, simple-to-utilize application. Farmers can't utilize an enormous volume of crude information accessible from sensors, controllers, monitors, and other systems from numerous areas, we are integrating data into a single, farmer-friendly platform. It includes a strategy for checking the rural fields from any far-off area and evaluating the fundamental conditions like equipment guidance, yield monitoring, remote sensing, and in-field electronic sensors of the field. More significantly, it transforms crude information into important data, helping growers and their trusted consultants in uttering sound, science-based choices in near real-time Precision agriculture is being infiltrated by the Internet of Things (IoT), which is expanding into all industries [1]. It offers a way to gain a deeper understanding of the situation in farms and fields, a way to increase automation even in more complicated, process-related farming, like irrigation, and data to gather a comprehensive understanding of the entire food production value chain that can aid stakeholders in their strategic decision-making. The decoupling of data collection from utilization and the use of the widely available worldwide Internet as a fundamental data transfer method are the two core components of the Internet of Things (IoT) [2]. This opens fresh opportunities for more targeted applications, resulting in more accurate and justifiable judgments that will benefit farmers and the food industry.

II. THEORETICAL BACKGROUND

Agriculture is the method of nourishing and raising animals, food, and other necessities of life. Agriculture plays a huge part in the economy of Pakistan. It is the backbone of our system [3]. The agricultural sector constitutes around 26% of the total Gross Domestic Product (GDP) of Pakistan. This sector supplies the country with furnished food and raw material. Furthermore, it provides job opportunities to people living in rural areas. Around 43% of Pakistan's total population earns their living from the Agricultural field. The export of Agricultural goods and commodities is a great source of earning foreign exchange. According to the latest report, Pakistan's population is increasing drastically at a dire rate of 2.4 percent per annum [4]. Due to this upheaval, the demand for agricultural products is greatly increasing. Agriculture is the most important sector; is not given enough attention it should receive. It has been suffering issues of expenses of fertilizers, medicines, and shortage of water as well. On top of that, the expense of fertilizers and medicines required for crops is another alarming problem. If these problems are not attended to, they would destroy Pakistan's agriculture. As we know that agriculture sector has a 21% share of GDP, and it has 41% employed labour. The sector that runs the country preferably be given the attention that it deserves [5].

A. RENEWABLE ENERGY IN PAKISTAN

Pakistan sets the goal of achieving 5-6% of its total on-grid power supply from renewable sources by the year 2030. Out of the total installed capacity, which is 26GW, renewable energy holds a share of 4.2%. Pakistan is God-gifted having a great potential for renewable resources, but only a few wind or solar projects and some large hydroelectric projects have made use of this potential. Alternate/Renewable energy contributes to 1136 MW of currently installed capacity of PV, biomass, and wind-based projects [6]. Earlier Government of Pakistan declared different policies and enabling incentives such as upfront tariffs, tax benefits, net metering, refinancing facility, and other micro-financing policies for promoting corporate section investment in the alternate energy (AE) sector [7]. Considering the market development, technological growth, cost limitations, and new monetary mechanisms, the GOP decided to release the market and launch more competition with the private players for providing electricity from renewable energy resources (that is wind/solar) with the finest tariff rates [8]. Correspondingly, the GOP has instigated tenders to entitle competitive bidding for renewable energy projects.

B. PRECISION AGRICULTURE FARMING

Precision agriculture can be characterized into two general classes, in particular 'soft' and 'hard' PA. 'Soft' PA essentially relies upon a visual perception of yield and soil and the management choice is dependent on experience and instinct. Whereas 'hard' PA uses all cutting-edge innovations like GPS, RS, VRT, and so forth depending on measurable examination of logical information [9].

III) METHODOLOGY & DETAILS OF DESIGN

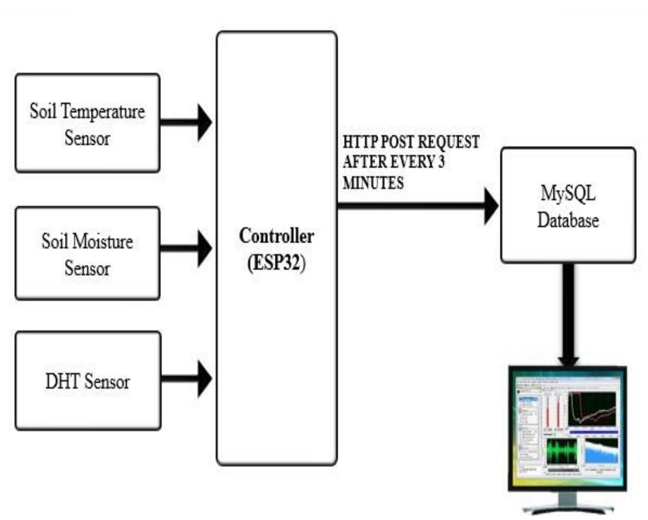

Figure 1: Block diagram

1) TESTING OF SOLAR PANEL

a) Determining the Short Circuit Current and Open Circuit Voltage of our solar panel:

Table 1: Open and short circuit current

Parameter	Measured Value
Short Circuit Current (A)	0.45A
Open Circuit Voltage (V)	20.7V

b) Observing the effect of shading on the short circuit current of the panel:

Table 2: predicted vs measured current

Cover Amount (Shade)	Predicted Current (Amps)	Measure Current (Amps)
No shade	0.45A	0.43A
25% covered	0.27A	0.28A
50% covered	0.225A	0.25A
Totally covered	0.01A	0.03A

As the shading across the panel results in the degradation of the panel's efficiency. It is observed that 25% of shading on panel results in a 41.4% reduction in maximum power and 40.7% in ISC.

c) Graph Of Current vs Angle:

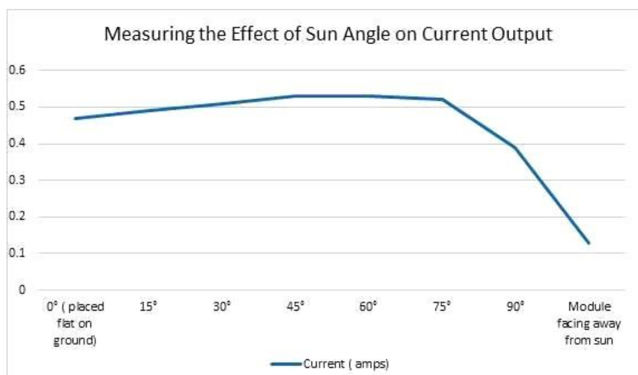

Figure 2. Graph between current Vs angles

The graph is showing that currently varies according to the solar angle. The panel gives a maximum output when the sun's rays are perpendicular to the panel.

2) TESTING OF BATTERY

a) Battery Charging Time:

The time taken by the battery to charge completely is calculated as; Battery Capacity (Ah) / Charging Current (A) Charging current of the battery should be approximately 10% of the Battery Capacity (Ah) rating.

So, for a 50Ah battery capacity the charging current would be:

$$I = 50Ah \times (10/100) = 5A$$

Considering the losses that will occur during charging, the charging current would be between the range 5A-7A Suppose we take battery charging current=6A Hence,

Charging time of battery = 50Ah / 6A

= 8.33 hours

The above calculation is for an ideal case. In practice, it has been observed that an estimated 40% of losses occur while charging the battery.

then,

50 x (40/100) = 20 (50Ah x 40% losses)

Therefore,

Battery capacity = 50Ah + losses = 50 + 20 = 70Ah Now the actual charging time of battery will be:

T = 70Ah / 6A =11.66 hours ≈ 12 hrs.

Thus, a 50Ah battery would take 12 hours to fully charge when a charging current of 6A is provided.

b) Battery Discharge Time: The discharge time of the battery = Battery capacity x Battery Voltage / Applied load

= 50 Ah x 12V / 93 watts (0.125hp = 93 watts)

= 6.45

hours, Therefore,

The battery will provide backup for approximately 6 hours.

3) INTERFACING OF SENSORS

In our project, we are using three sensors to determine the most important soil and environmental parameters that affects farming. The sensors used are DHT11, DS18B20, and Soil Moisture Sensor V1.2.

DHT 11 sensor is used to measure the humidity level by measuring the water content present in the atmosphere [10].

DS18B20 sensor measures the temperature level of the soil. Soil Moisture Sensor measures the moisture of the water content present in the soil.

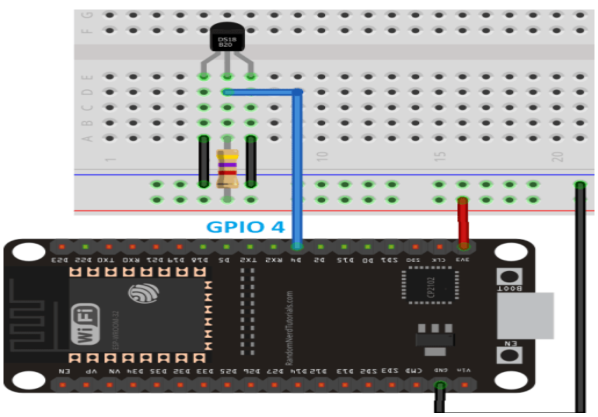

Figure 3: Temperature sensor

4) DATA TRANSMISSION

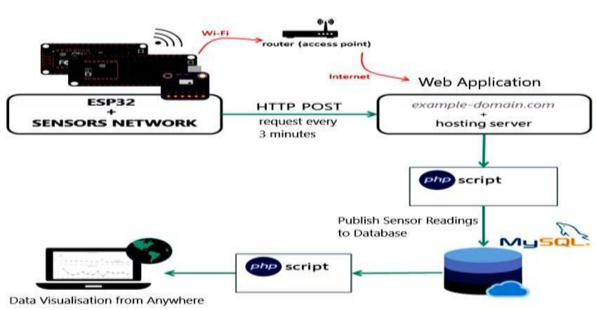

Figure 4: ESP Network

5) DATA LOGGING

Data Logging is an essential part of any real-time device. In our system, we have used MySQL Database to store the real-time readings of the sensors used in the system. To log data into MySQL Database, we have used PHP to communicate the microcontroller (ESP32) with the database [11].

6) UI/UX DESIGNING

Figure 5: GUI

Figure 6: GUI_2

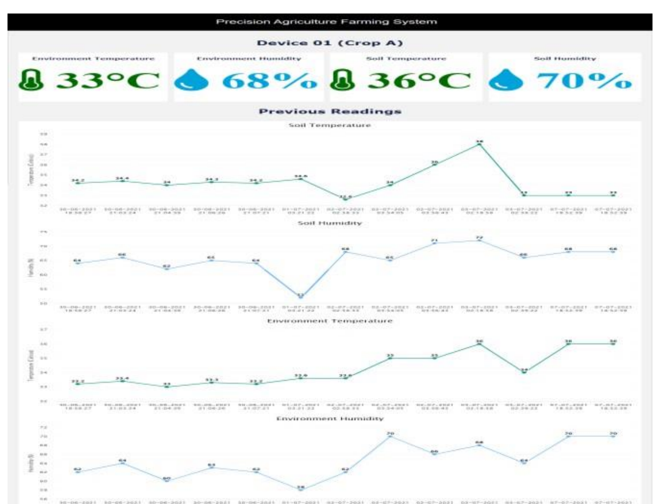

Figure 7: Sensors data Graph 1

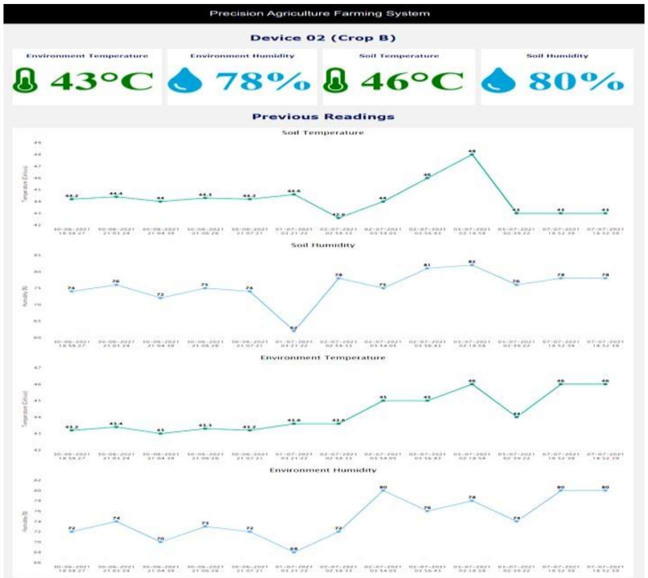

Figure 8:Sensors data graph 2

IV) RESULTS

Solar-powered IoT-based precision farming system has been successfully designed and tested. All the requirements were enforced to achieve an accurate farming system. The moisture content of two different crops has been detected by the soil moisture sensor. If the moisture level is found to be below than threshold value i.e., we have set 80% for the system, an alert will be sent to the dashboard which will inform the user that the soil is dry, and water is needed by the crops. The outcome is that we have effectively handled the issues that were doled out to us. Albeit the undertaking is straightforward, yet dangers are a lot greater. As water shortage is one of the major problems of the city and most of the areas don't have even a fixed time for the arrival of water. sometimes it has been observed that motors are kept running for a longer period so by making an Automated system using sensors we have deducted this problem as the sensor would give the proper information about the water which is needed for the watering of crops at a specific time. The microcontroller controls the water conservation by using a moisture sensor which shows the moisture level at a specific time, so the water is given to the crops a/c to that value required by them. This project will save time as well as money and water with less human labor.

V) CONCLUSION

In our venture, solar powered precision agriculture farming system is proposed, this model is designed for low cost, and increased reliability and to provide an alternative source for electric power generation and monitoring of the farming system which would help farmers to use water, chemicals, fertilizers, etc. efficiently for productivity. The solar powered system provides an alternative way to encounter the electricity demands for farming. This system is designed to assure an adequate water supply and to avoid over/under irrigation. The system is driven by enough solar power. Solar-powered precision agriculture farming system is mainly employed in those areas where there is a low-efficiency rate of crops. The proposed system is convenient to implement and provides environment-friendly solutions. The designed system would be favorable for farmers when its implemented and it's helpful to the government with energy from the solar panels by providing one of the solutions for major problems i.e., energy crisis. The sensor indicates when soil requires water and when not. This system also reduces the wastage of water along with less human intervention by optimizing water usage. As the system is self-starting so it requires minimal and less maintenance also the system uses solar energy, which is renewable and having a great deal for usage in electricity generation. The system illustrates the feasibility and usage of solar PV applications. The investment cost is high though but if the system is implemented on large scale, the overall benefits would be long-term and economical in long run.

VI) FUTURE WORK

A. *Addition Of Rain Gun Sensor:*

By adding a rain gun sensor, we can prevent the fields from flooding in case of heavy rains. This would help in saving water as well as protect the fields from being over-flooded.

B. *Object Detection Using IR Sensor:*

Another sensor that can be added to work on the productivity of the framework is an IR sensor that would alert the farmer in case of detention of any object in the irrigation field. Siren hooters can be used to alarm the farmers about the detection.

C. *Control:*

The system can be made more efficient by the introduction of remote control. With all the inputs of the sensors is being uploaded to the cloud and the whole system can also be controlled using a mobile application.

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