Advanced Agriculture Field Monitoring and Controlling System

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Abstract - *The growing population renders agriculture an important sector in the world. Boosting crop production and quality any manual supervision to efficiently satisfy the requirements rising food provision symbolizes the major challenge for agriculture. Climate change is also a major problem in the farming industry, apart from the increasing population. The aim of this project is to propose an Autonomous Smart farm food focused on IoT method to cope with unfavorable situations. The intelligent agriculture, to precision field analysis, efficient data collection and intelligent cultivation innovation, can be enacted. This is a smart agricultural field management device that tracks the moisture, light intensity and temperature of the fields and automatically controls the actuators to maintain the favorable condition for the crops. Without human intervention, action based on these standards is essential after rendering perceived information. Temperature, soil moisture and light intensity are measured here, and for new data evaluation in cloud database, these perceived properties are kept. Using the web application user can track the status of the field and can able to control directly from the web application.*

***Key Words*: Internet of Things, Autonomous Cultivation, Cloud, Web Application, Agriculture.**

1. INTRODUCTION

Today, customized the executive's structures region unit the quality for cutting edge nursery, with continued with adjustment as the development powers. Climate status can kept with the help of these customized administration structures, any place the system will be worked therefore. The guideline segments of any administration system territory unit estimation controller, data getting ready, data verifying, data introduction and recording. In nature control structure, each parameter ought to be safeguarded perpetually inside an unequivocal reach. The agrarian region, uniquely making land, the use of the planet the executive's development keeps on being stressed, essentially because of its significant expense. Thus, a bearable improvement of common attentive and the board system for heightened nursery age is inevitable. In this proposal, we've arranged a system that may assemble the information known with nursery air and yield standing and the executives the nursery subsequently seeable of the accumulated information to anticipate. With densely perceptive atmosphere, this investigation gives the clarification for establishing connection among sensors banners and hint appraisal, separating the improvement, headway of profit and the normal factors that they will reveal.

To robotize the cultivating tasks, a few ecological parameters those have sway on cultivating, are required to find at various areas. The significant ecological parameters incorporate temperature, light intensity, dampness, and level of water. Various kinds of sensors sent across the field to screen ecological variables identified with cultivating and appended with processor. As indicated by natural situation, chip controls various cultivating hardware (pump, fan and so on.) without human mediation. Aside from these detected information can put away in cloud. Processor joined with Wi-Fi chip transfer those detected values to the cloud. Various remote condition checking framework utilizes GSM based and additionally GPRS innovation. Yet, they have a few impediments including significant expense of system framing, low access rate and so on. The whole paper has designed as follows, Section 2 emphasizes the work related to intelligent farming. Section 3 explains the proposed architecture of the IoT-controlled smart agricultural network. Section 4 outlines the research setup and results for the process proposed to be introduced. Section 5 emphasizes the Statistical projection from the real time data. The article is eventually concluded in section 6.

2. RELATED WORK

Md Ashifuddin Mondal proposed a system which monitor the field conditions, which includes temperature and soil moisture that detects by the sensors and upload the sensor data to the thingspeak cloud for monitoring purpose in [4].

M. A. Abdurrahman suggested a price-effective item for the cultivation of the alarm water in [5]. The system was composed of minimal effort sensors and clear hardware to monitor the water progression accordingly. Additionally the stickiness and heat level are measured and showing in screen. This system gives plants water as shown by the degree of dirt dampness and pre-requisite for yielding water.

P. A. Bhosale proposed a microcontroller-based water system scheduler based on indigenous minimal effort time, which includes various sensors to differentiate between humidity, temperature and wind in [6]. Based on these characteristics, system infers appropriate actuators (transfer valves, solenoid valves, and motor). The captured information is passed on via GSM module to the client in SMS style and inserted into a sd card.

J.Balendonck implemented a water scarcity program that involves a communication of in-field water system controllers and clay sensors in the board structure in [7]. Water system controllers are linked via remote link to the rancher's PC. When water supply is limited, water quality is low, or when filtering is prevented the system can used. They utilized choice emotionally supportive network (DSS) that causes ranchers to upgrade water system and manure the board based on chosen crop, water accessibility and harvest advancement. The decision support system can work on local area PC or remote database, and if appropriate, the client may talk to DSS to change the procedures of the water system.

F. TongKe has suggested genius IoT-reliant agribusiness and distributed computing. Farming data cloud is designed with various assets to achieve dynamic asset and burden change conveyance in [8]. Enormous knowledge measurement obtained via RFID, remote communication is taken care of in the data cloud of agribusiness.

Ji-Chun Zhao invented the horticultural production control system and invention in IoT. The developer proposed a web- and remote correspondence-dependent remote test system. A data that the executive structure also intends to store the details. The knowledge gathered can be used for offices for agrarian research [10].

Different from the research implemented in [5, 6], our proposed model now merely provides smart, brilliant cultivation that robotizes the cultivation tasks while, in addition, recording rural field temperature, light intensity and humidity estimates of the cloud condition through correspondence innovation for further investigation. Furthermore, the use was absent in [8] but this paper integrates the subtleties of the execution of our suggested model. Present in Table 1 is a similar analysis of our suggested structure with other relevant process alluded to here.

Table-1: Relative study with the related work

Authors	**Parameters**	**Microcontroller**	**Autonomous System**	**Statistical Projection**	**Cloud Storage**	**Web Application**
Utpal Pati	Temperature, Soil moisture, Light	Esp-32	Yes	Yes	Yes	Yes
Md Ashifuddin Mondal, Zeenat Rehena [4]	Temperature, Soil Moisture	Arduino Uno	No	No	Yes	No
Abdurrahman, G.M. Gebru [5]	Soil Moisture	PIC16F887	No	No	No	No
P.A. Bhosale [6]	Soil humidity, Temp, Wind Speed, Radiation and sunshine	PIC Microcont-roller	No	No	No	No
J. Balendonck. [7]	Temperature, Soil moisture	Irrigation Controller	No	No	No	No

3. IMPLEMENTATION DETAILS

Our primary aim is to create an IoT- intelligent autonomous cultivation to monitor and control electrical equipment such as pumps, poly house flaps etc, without any person interference depending on environmental situation such as soil humidity, light intensity and heat. These variables will be reserved for future data processing in the cloud and monitor through web application. Farming is done for a better managed atmosphere inside the poly houses. The conceptual framework, as seen in Figure-1, consists of different stages. It is parted into five modules: the stage of sensors, middleware, networking stage, cloud server and web application stage.

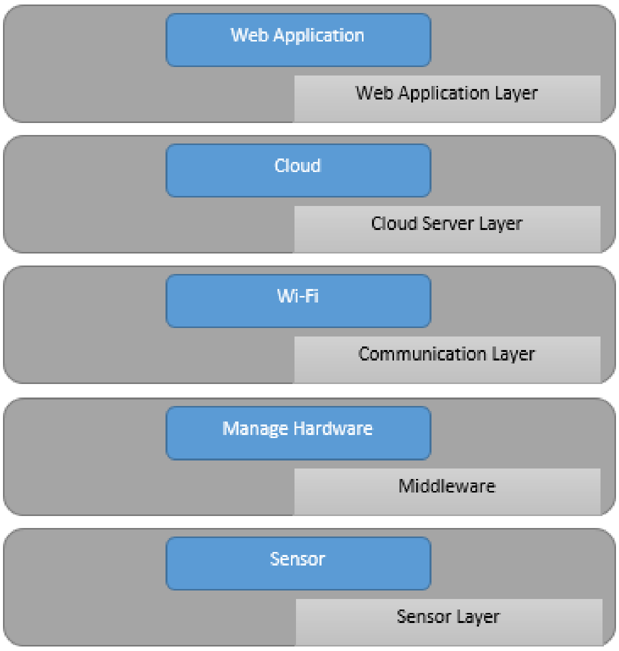


Fig-1: Various parts of the system

3.1 Sensor Layer

It is our system's first stage. This is responsible for detecting the different environmental criteria and tracking them. Various types of sensors are scattered over the agricultural area for detecting or capturing the parameters. Different variety of sensor have been used for this research: clay humidity sensor for tracking levels of water, light sensor for tracking the light intensity and heat sensor for observation within polyculture houses the temperature point. Sensors are connected to a microcontroller based on Esp-32. The microcontroller with sensors developed the first IoT devices used in agriculture.

3.2 Middleware

It is our system's second layer. In order to automatically control the agricultural cycle, the middleware is necessary. The microcontroller must be planned. Based on the threshold value of the various tracking field parameters, the sensed value is inserted in the microcontroller. This layer tracks closely both the temperature, soil humidity levels and light intensity, which influence crop yield directly and take decisions.

If the clay humidity level is significantly smaller than the limited criteria, the microcontroller shifts to a pumping unit in the field for watering the soil. The soil moisture level threshold parameters differ for different soil types [11]. In Table 1, Table 1 according to [11] is given the suggested soil moisture content levels for various soil types at which irrigation occurs. The system suggested requires a level of 17% of soil moisture. When the humidity levels exceed the threshold, the pump is turned off automatically, avoiding excessive energy use.

When the temperature point reaches the threshold, the microcontroller switch on the poly house fan. The suggested framework assumes a ceiling of 36 ° C. Changes in temperature contribute to decreased lifetime of the plants and affect the balance between plants and pests. This also boost the respiration of the crops and slowing down production of fertilizers.

If the light intensity is very low then the esp-32 switch on the light that has connected to the esp through the relay for better crop production and switch off when there is a sufficient amount of light available.

Table-2: Humidity level in various types of soil for cultivation

Soil Type	Moisture Content
i) Clay	29%
ii) Loam	26%
iii)Sandy Loam	17%
iv)Silt Loam	19%
v) Loamy Sand	15%
vi)Silty Clay Loam	27%
vii)Sandy Clay	24%
viii)Clay Loam	28%
ix)Silty Clay	33%
x) Sand	06%

3.3 Communication Layer

Our system communicates wirelessly with the router through the Wi-Fi chip, as it benefits from Bluetooth. With a short-term link from the router, Bluetooth enables short range connectivity over Wi-Fi. Thanks to massive cabling, Ethernet connections are stopped. Here the microcontroller is fitted with field-deployed sensors and opens a gateway to the cloud for sensed soil temperature, light intensity and humidity. The gateway uses protocol based on an IP. Processor or chip sends the HTTP request to the cloud in order to write considered data to the correct server.

3.4 Cloud Server Layer

Cloud service providers offer with an on-demand accessibility of computer system resources, particularly data storage and processing capabilities, without the active direct user control. The word typically describes data centers for many users of the Internet. Big clouds, which are popular today, also have central server functions that spread over several locations. An edge server may be allocated if the user connection is relatively close. In our system each sensors information is being sent to the cloud server to remotely store all data. The esp-32 fetch those data from the cloud server to automatically control the actuators by itself by its intelligent system. All the sensor data and what is the status of the actuators when they have turned on or off or currently working is continuously uploading in cloud server. The web application fetch all the information from the cloud as per user request.

3.5 Web Application Layer

In this system we have introduced a web application for monitoring data that is collected from the cloud server. Controlling the actuators using web application user interface. Web application contain with different graphs that continuously showing the real time data. Web interface also included the buttons to control the actuators directly by the user.

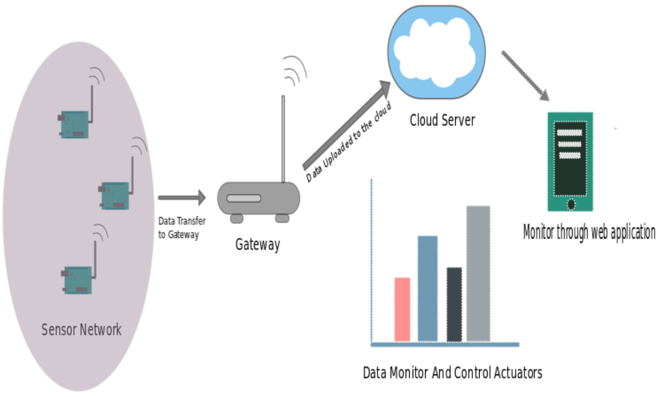


Fig-2: System architecture

4. EXPERIMENT AND RESULT

Various hardware is used to understand the planned system. As a microcontroller, Esp-32 board is used, and various sensors are connected to it. Dht-22 was used for heat sensing applications and Adafruit Stemma was used as a monitor for clay humidity. Steeper engine fans are attached by a 6 pin relay to Esp-32 board for high voltage control equipment.

Dht-22 is a heat detecting device, communicate to the Digital pin of Esp-32. The collected data from dht-22 is transfer to the Esp's middleware.

Adafruit Stemma is a humidity sensor attached with analog to digital converter pins of the Esp-32, have two samples to transmit current in soils and read the resistance to soil moisture. The determined data are loaded into the middleware in the Esp.

LDR has used to calculate the light intensity in the area which was attached with the Adc pins of the esp32. When there is a more light it will give analog value range from 1000-2024 and in low light it will give value range from 50-500.

In the module of Esp-32, the collected data are transfer to the middleware and middleware controls all actuators (Controlling Pump, Fan, light) based on those values. Arduino IDE is used for modeling middleware.

In addition to automatically monitoring and control actuators, Esp-32 sends the variables calculated to the cloud server. Esp-32 board interacts wirelessly with cloud via a router to store environmental parameters. This model uses Wi-Fi-based connectivity. The Wi-Fi module of Esp-32 is included. The Esp-32 module connects to a common gateway system with a Cloud connection.

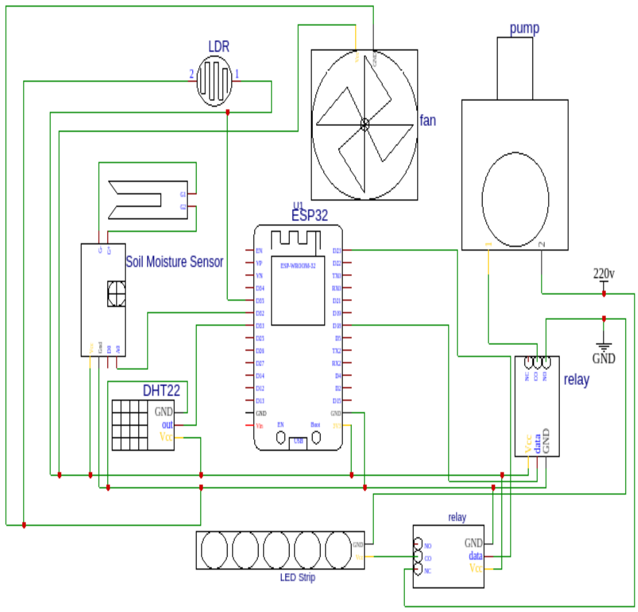


Fig-3: Setup

The proposed method extracted temperature, moisture and light intensity from the testing area on the basis of the experimental setup. The cloud server deploys these sensed values in every 9 seconds as it takes 9 seconds of updating time. Figure 4 reflects a time graph dependent on temperature and figure 5 reflects a time graph dependent on ground moisture.

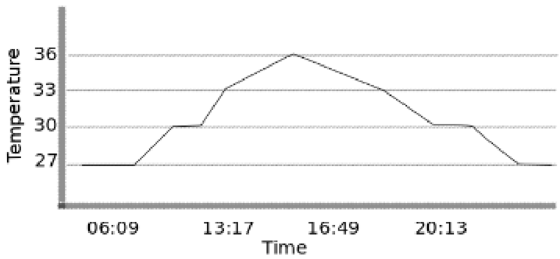


Fig-4: Temperature Vs Time Graph

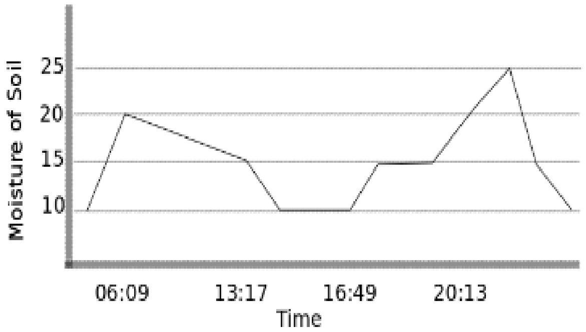
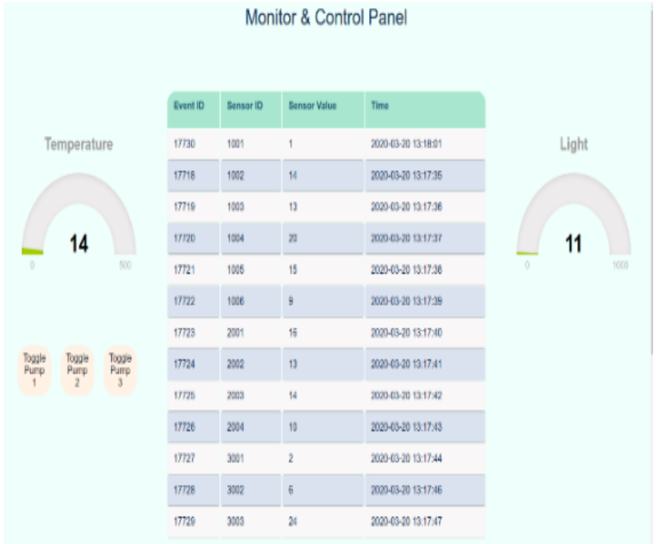


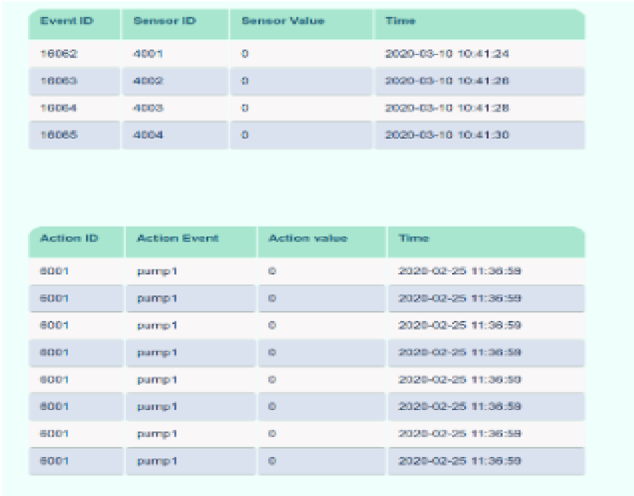
Fig-5: Moisture level Vs Time graph



Event ID	Sensor ID	Sensor Value	Time
17730	1001	1	2020-03-20 13:18:01
17718	1002	14	2020-03-20 13:17:35
17719	1003	13	2020-03-20 13:17:36
17720	1004	20	2020-03-20 13:17:37
17721	1005	15	2020-03-20 13:17:38
17722	1006	9	2020-03-20 13:17:39
17723	2001	16	2020-03-20 13:17:40
17724	2002	13	2020-03-20 13:17:41
17725	2003	14	2020-03-20 13:17:42
17726	2004	10	2020-03-20 13:17:43
17727	3001	2	2020-03-20 13:17:44
17728	3002	6	2020-03-20 13:17:46
17729	3003	24	2020-03-20 13:17:47

Fig-6: Web Application Dashboard

Figure 6 shows the web application dashboard for the user to direct monitor and control the appliances by using mobile or desktop or laptop. The web application contain with different tables, graphs and gauge for better visualization and easy to understand. The tables contain the different sensor value with their sensor id and time. Figure 7 shows actuators status in timely manner.



Event ID	Sensor ID	Sensor Value	Time
16062	4001	0	2020-03-10 10:41:24
16063	4002	0	2020-03-10 10:41:26
16064	4003	0	2020-03-10 10:41:28
16065	4004	0	2020-03-10 10:41:30

Action ID	Action Event	Action value	Time
6001	pump1	0	2020-02-25 11:36:59
6001	pump1	0	2020-02-25 11:36:59
6001	pump1	0	2020-02-25 11:36:59
6001	pump1	0	2020-02-25 11:36:59
6001	pump1	0	2020-02-25 11:36:59
6001	pump1	0	2020-02-25 11:36:59
6001	pump1	0	2020-02-25 11:36:59
6001	pump1	0	2020-02-25 11:36:59

Fig-7: Actuators status and sensor data table

5. PROJECTION

An estimate is a value that is derived from data obtained from a survey of units of that population for a country. Estimation is a method that changes the survey data systematically to find an approximate data for the population.

A projection illustrates whatever the possible changes will be in a population if the predictions about future developments actually occur. Those conclusions are also based on previously existing patterns of transition. For example: data gathered on the total number of retail chain stores over three years indicate an rise from 8 first year stores to 12 second year stores to 18 third year stores. It could perhaps be expected that there will be 27 stores after the fourth year if the chain continues to grow with the same trend of growing by half (50 per cent) per year. A projection does not predict or forecast what would happen, it shows what will happen if the assumptions that underlie the prediction actually occur.

The sensor data uploaded in cloud server and using web application we get the projection of data.

Temperature(degree)	Time
22	6:10
24	8:45
25	10:20
28	11:45
33	12:59
35	14:17
34	16:22
32	18:30
29	19:45
26	21:45
26	22:37

Fig-8: Real-time data

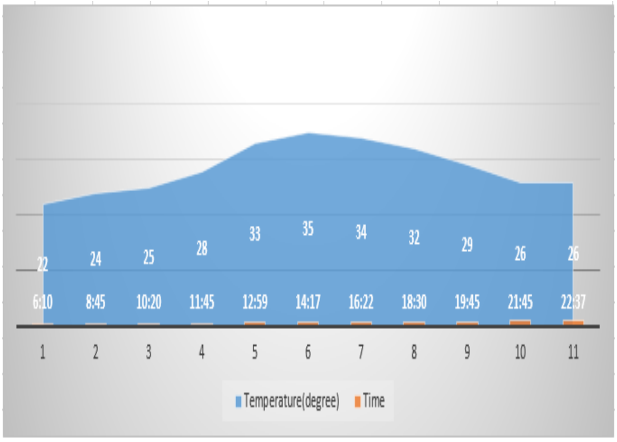


Fig-9: Real-time data graph taken for projection

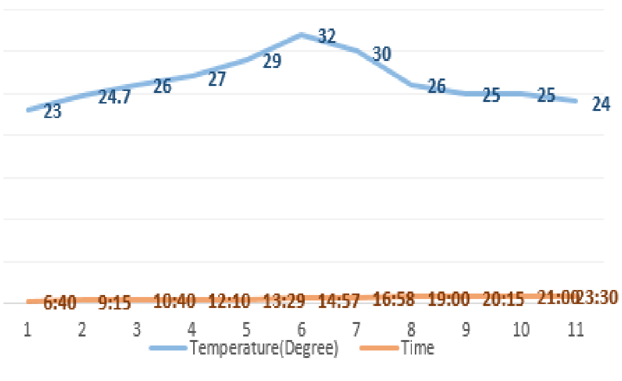


Fig-10: Temperature with time projection graph

Projection helps to tackle the environment condition accurately.

6. CONCLUSION

On the basis of above device parameters, various data of soil moisture and temperature levels and light intensity have been determined and the Esp-32 board regulates high voltage farming equipment without human interference on the basis of predefined clay moisture, light intensity and heat threshold values. This program ensures continuous field surveillance and initiates necessary activities, as needed, in the absence of people in the field of agriculture. It decreases to some degree the human labor and expense of agriculture. The max value of clay humidity, light intensity and heat must be altered and implemented by manually modifying the middleware to incorporate the proposed method in the particular type of soil texture condition referred to in Table-2 or remotely using the web application.

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