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Greeniot: A Smart IoT Gateway for Connected Farming

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***Abstract*— This paper elaborates the use of Cloud computing and IoT for farmers. This brings the farm-land to the farmer's doorstep. Greeniot is a comprehensive Internet of Things solution to help farmers for execution of agricultural operations in smarter and efficient ways. The high-precision sensors are used to provide proper data for assessing soil quality, detect diseases in plants, predict ambient conditions, sunlight, humidity, moisture, and pH required for production and data driven farming for better crop production and smart use of farming resources. The devices are mapped to the local server and the data is sent to the server. The server can retain the data for some time and then transfers it to the cloud-based platform, which then provides predictive analytics for specific plant and crop models. Using this technique farmers can get all the analytics, insights, and personalized recommendations in layman's language on a mobile app.**

Keywords—MQTT protocol, sensors, LoRa communication

I. INTRODUCTION

In today's world, the population is rapidly growing, it is predicted to reach 9.6 billion by 2050, hence one of the world's problem is to generate more yield by 2050, cultivate more and more crops as per the need of the increasing population in the world. Along with this day by day, the requirement of additional farm-able land, and water is increasing. Solution to these difficulties faced by today's farmers is the need of a device or Equipment which can speed up production and reduce loss of time and crops which gets wasted and damaged due to weather conditions which can be solved by an IoT Device. This device will be helping farmers to control and monitor crops. In this paper Smart IoT solution for farmers is proposed that brings the farms-land to the farmer doorstep.

Different methods of IoT based farming is incorporated [1,2]by adding different measurement of parameters. Various smart farming methods are implemented using IoT [3,4,5]. Instead of going for a fixed type of system this proposes a system which is able to fulfill all types of agricultural needs of the farmer. Greeniot allows farmers to easily connect any sensor for monitoring parameters & access it from anywhere, and set up rules to control devices. This device measures soil parameters (temperature, moisture, conductivity, pH level, moisture absorbance rate); environmental parameters (temperature, humidity, atmospheric pressure, light intensity, CO2 level, and weather data from external stations), sends images from the camera module connected to the device and geographic parameters in real-time by deploying multiple sensor nodes. The high-precision sensors provide data for assessing soil quality, detect diseases in plants, predict ambient conditions sunlight, humidity, moisture, and pH required for production and data driven farming for better crop production and smart use of farming resources.

In this paper connections from sensors to the cloud is done using real time data as an extra helping hand. The system is having a virtual fencing system forming matrix of connected fencing poles for detecting sensor data required for processing and the lidar for detection of animal presence for alerting the farmer and triggering automation pre-programmed action like the sound generation and the herbal repellent on fencing so that animals not able to cross the boundary of farm. All the data collected from the sensors are stored in the data lake of the cloud and analyzed by the farmers for better understanding of crop conditions.

II. BLOCK DIAGRAM OF GREENIOT

Two hardware modules are designed one for handling I/O operation and sending sensor data to cloud. I/O unit collects environment data like temperature, Humidity, soil moisture and air speed from sensors. This data is sent to cloud using MQTT relay driver unit. Second hardware module is camera unit which is face/presence detection system. Camera unit helps in detection of unwanted entry of animals also used to monitor farm and plant growth using image detection feature.

Fig.1 gives block diagram of system. This consists of two Units i.e., Main Unit and Camera unit. Main unit is divided into seven sub units. Details of these seven subunits are given below.

Sensor interface Unit: This unit is an input to ESP32 microcontroller which performs the logical operation on the sensor data collected from DHT22, soil moisture and air speed sensor. This data is forwarded to cloud or local server using WI-FI, Bluetooth, LORA.

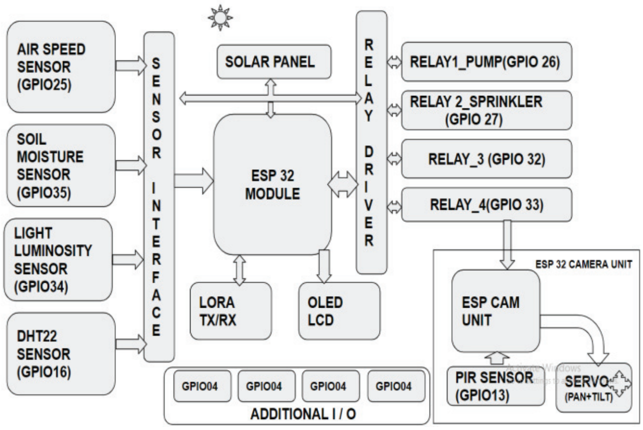

Fig.1: Block diagram of Greeniot

Relay Driver and Actuator unit: This unit performs relay control operation which receives signal from ESP32 which drives the relay via relay driver circuit. Relays are controlled by user commands given from IOT dashboard. This unit allows machines like motor, pump and camera units to get activated. Relay driver unit provides protection to MCU and sensors from AC/DC current fluctuation.

Solar panel/power generation unit: This unit provides power to sensors. MCU units and other components to operate which generally requires 5V/12V.

Additional I/O & LCD: This unit is a special feature of greeniot. It is used for additional I/O connections required to connect special sensors or additional relay interface. This works on I2C protocol which provides the ability to extend the system.

LoRa communication: This unit helps in getting connected with other smart IoT sensors located across fields in the range of 2-20km which can be extended to 50km in rural areas. LoRa is working in transmitter(TX) mode when WIFI is not available else it goes to receiver(RX) mode which allows to form a communication with other smart devices.

Microcontroller Unit: ESP32 is a heart of greeniot which performs operation on the basis of instructions given. It works on 3.3V and 5 V with smart sleep mode having inbuilt WIFI and Bluetooth module with dual core processor. It receives input from sensor interface and shares data to cloud similarly it takes command from user dashboard and performs operation by driving relay to activate output actuators motors to work.

Camera unit: This unit allows farmers to view farm field and helps in monitoring farms with detection of animals. This unit is having PIR (passive infrared sensor) and servo helps in detection and rotation of camera module to monitor fields.

System starts with checking internet connectivity. If the connectivity is not available then system is changed to transmitter mode. Lora is used to transfer data to local station else sensor data is transferred to cloud server via MQTT protocol. Camera unit gets turned on by command from the user received by ESP32 by activating relay and camera module. Similarly other relays can also be activated by user dashboard.

III. RESULT

Main unit is used to monitor sensor readings and actuator control unit. It consists of ESP-32 microcontroller, Relay module, Additional GPIO which is used to activate Relay LED, DHT22 sensor, soil moisture and power converter circuit for converting 12V to 5V. This power converter is implemented using 7805 voltage regulator and filter circuit. Relay and switches are controlled via command from IoT dashboard. This is received by MCU which then activates GPIO. ESP32 detects sensor reading. These sensor reading are given to IoT dashboard via MQTT broker at backend and cayenne cloud service to create UI. ESP32 forwards data packets to the IoT platform every 4 seconds. IoT dashboard has features like triggers and event scheduling which alerts users via SMS alerts, Email Alerts. Event scheduling is used to perform tasks at specific times like activating pump relay at a particular time everyday without missing any day and stops only after detection of rainfall.

A. Sensor testing using Arduino IDE:

Fig.2 gives Sensor output reading on Arduino IDE.

It shows the Arduino IDE serial monitor readings from sensors like Temperature, Humidity, soil moisture and air speed in every 4 seconds with baud rate of 125000 bits per seconds. Arduino IDE connects software with ESP 32 serial print which is used to print readings on serial monitor. ESP 32 is connected at port 3.

```
15:43:35.929 -> Humidity: 30.00 %       Temperature: 32.00 *C
15:43:35.929 -> air speed: 78     soilMoistureValue: 101
15:43:35.929 -> ***************************************0
15:43:40.981 -> Humidity: 29.00 %       Temperature: 33.00 *C
15:43:40.981 -> air speed: 75     soilMoistureValue: 101
15:43:40.981 -> ***************************************0
15:43:45.982 -> Humidity: 29.00 %       Temperature: 33.00 *C
15:43:46.012 -> air speed: 73     soilMoistureValue: 101
15:43:46.012 -> ***************************************0
15:43:51.058 -> Humidity: 30.00 %       Temperature: 32.00 *C
15:43:51.058 -> air speed: 69     soilMoistureValue: 101
15:43:51.058 -> ***************************************0
15:43:56.070 -> Humidity: 30.00 %       Temperature: 32.00 *C
15:43:56.070 -> air speed: 60     soilMoistureValue: 101
15:43:56.070 -> ***************************************0
15:44:01.503 -> Humidity: 30.00 %       Temperature: 32.00 *C
15:44:01.503 -> air speed: 73     soilMoistureValue: 101
15:44:01.503 -> ***************************************0
```

Fig.2: Sensor testing using Arduino IDE

B. IoT dashboard web view:

Fig. 3 shows us the actual view of the IoT Dashboard which gives us a visual view of sensor readings, graphs and buttons to control actuators. This is made using Cayenne Platform which allows free use for academic purpose and easy to used platform with features like SMS/Email alerts, Event scheduling, Triggers, Monitoring and control of Data.

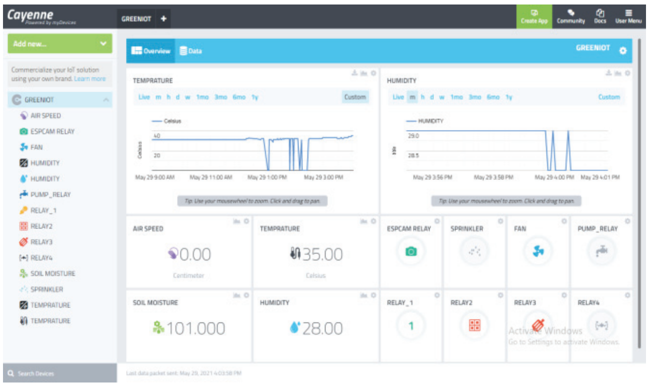

Fig.3: IoT dashboard view

C. IoT Mobile Dashboard View:

Fig 4 shows us Mobile UI of IoT dashboard which can be directly accessed via Unique link only allowing selective user. It has features like IoT Web Dashboard but mostly this is used to monitor and control with fixed features designed by Admin.

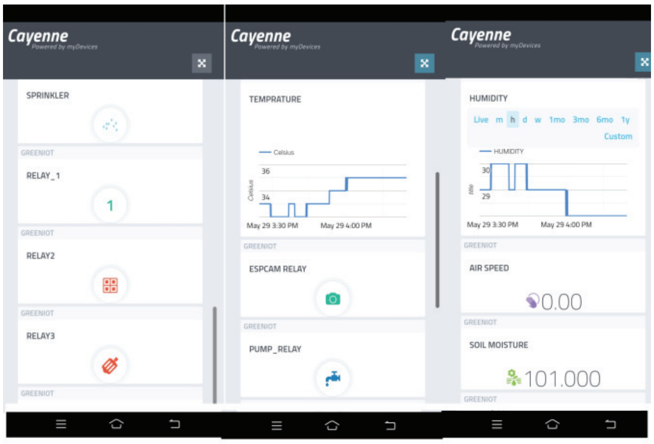

Fig.4: IoT mobile dashboard

D. Sensor Reading Graph Over Cloud

Fig.5, Fig.6, Fig.7 shows an output Graph of sensor with respect to time which helps in understanding conditions of farms and understanding the environment changes like prediction of Rainfall by visualizing temperature drop, humidity drop and air speed. Similarly, it predicts sudden changes in farms at particular time slots.

Fig.5: Air speed sensor graph

Fig.6: Temperature sensor graph

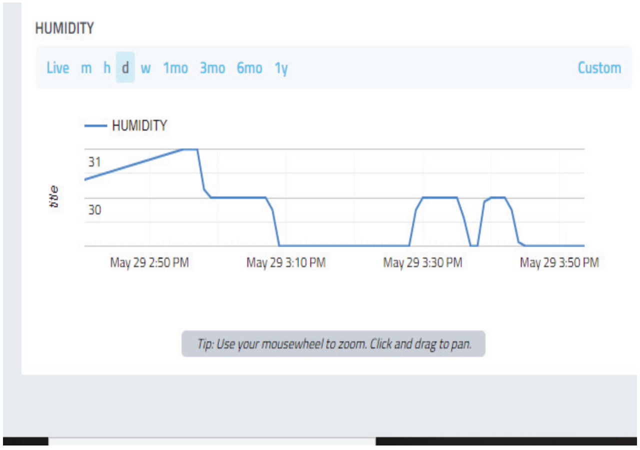

Fig.7. Humidity sensor graph

It Allows to better understand the farm and application area where it can be analyzed to perform certain task which leads to data driven farming for better and effective precision-based farming.

E. Alerts and Trigger:

Fig.8 shows the Alert and Trigger settings page of IoT Dashboard which allows setting triggers whenever a certain condition reaches to set points it performs action. It alerts via SMS and Email.

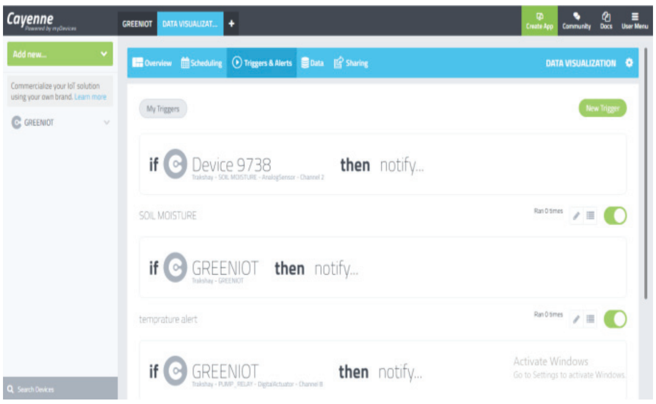

Fig.8: the Alert and Trigger settings page of IoT Dashboard

IV. CONCLUSION

With the advancement in 5G and internet connectivity it is possible to monitor using various smart sensors. Greeniot is used for Agricultural applications. Farmers can gain better control over the process of raising livestock and growing crops, making it more predictable and efficient to track and control the farm condition from any part of the world which helps in better connectivity.

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