Low-Cost Green Power Predictive Farming Using IOT and Cloud Computing

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Abstract—**Internet of Things (IoT) is the development of new technology that helps us to solve many complex real-time applications with low cost of power and minimum resource involved with very low price and powerful performance of single task and multi-task. One of them is the solution applied to Predictive Agriculture (PA) it has the capability of gathering ongoing information on various parameters identified with farming. This paper presents a low-cost power flexible and reliable predictive farming system using IOT with the cloud computing platform. Wireless Sensor Network (WSN) gives ease, low vitality utilization, simple to execute arrangement in spots of trouble some access for the usage of wired systems. Here we collect real-time information using different sensor nodes (NodeMCU) and sent them into a master node (Raspberry Pi) , and then sends the data into the cloud for processing and takes required actions. Predictive farming is an approach to advance assets and improve development through the gathering of important data and deploying wireless sensor networks systems. This will result in getting a more predictive decision which will result in high economic growth of the country, in turn, helps the farmer to yield good results with decision towards watering, type of the fertilizers to be used, kind of environment to be well within the place.**

keywords— IOT, cloud storage, Predictive Agriculture.

I. INTRODUCTION

IOT is the technology which defines wireless sensor network (WSN) systems with different arrangement, the information can be exchanged through wireless communication and secure channels that help us to maintain the consistency in getting real-time data through rounding sensors from agriculture fields to the cloud computing platform without losing data while transmitting data from sensor node to another. Farming is the most significant pillars for the well-being society, it represents the very first essential component for the economy of numerous nations. Precision farming technology is considered as the most advanced method to raise production as well as the quality of the crops[1]. In today's world, the most significant part of predictive agriculture is to improve the production and maintain the value of important crops such as food crops, cash plantation and horticulture crops in order to make better communities in the world. In advance predictive farming, using greenhouse we can apply an autonomous environment to achieve our predictive target based on data-driven to meet the requirement and drive an economy. The principle preferred standpoint of the nursery is to give adaptable condition which can be easily controlled and accomplish the predictive production based on environmental constraints which are relevant to the type of crop with respect to the need of environmental parameters required to maximize the yield of crops [2][3]. Predictive farming offers the instruments to help upgrade assets for development through the consistent checking of exact imperatives such as water level. The idea of IoT is can be used in many different applications such as predictive farming [4,5], environmental monitoring and many others. Nowadays IOT is considered as the most important technology due to the ability to connect for world-wide objects using wireless sensor network to communicate wirelessly to achieve a goal [6,7]. In this paper, we present mainly two parts to implementing the wireless sensor network as in figure.1.

The first part includes all IOT hardware devices such as a sensor. The sensor is the device which is designed to perform a specific task that is to generate real-time data, the data can be used to control certain activity related to the task of the system. The second part includes IOT software such as cloud computing platform (NodeRed and Cayenne), this software capable of storing real-time information on the cloud, access real-time generated data to analyze, process and takes an action based on predefined parameters related agriculture to achieve the intended expectation. IOT with wireless sensors network is very helpful in fields of predictive agriculture for improving the productivity depending on real-time data analytics and optimize the resources with a more efficient manner to maximize the yield of crops with minimal effort and less power utilization. To implement wireless sensors network first we placed the required sensors (nodes) in the field of agriculture to generate the related real-time data, all information will be sent to a master node from master node to the IOT cloud computing platform(cayenne) where data will be store, access, analyse, process and display output on to the farmer's websites and message to smartphone.

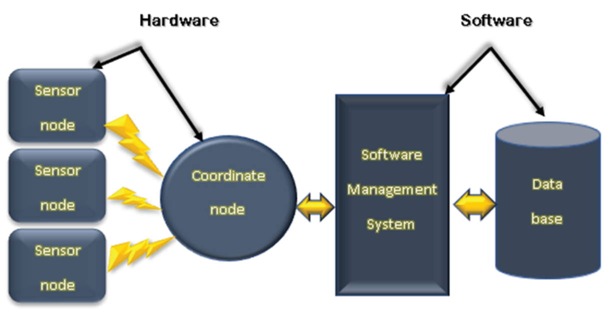

Fig.1. View of a WSN system

II. LITERATURE SURVEY

Using Arduino board [8] microcontroller to support wireless sensor networks for achieving real-time applications is pretty suitable for a single task application, Arduino can support wireless sensor network using an external device or interface for Wi-Fi support to communicate wirelessly with related connected sensors .one of the Wi-Fi interfaces that enable Arduino board to connect wireless sensors network is XBEE which has two parts. one for sending the data and others for receiving the data. Arduino broad has no in-built Wi-Fi module and it is suitable for connecting sensors and controlling them with simple programming not a complex task with the support of different programming languages. In case of a single task, it is good to use to manage related system but the problem comes when the system gets extend into multiple task need to be done at once (receiving the data from multiple sensors and send them into the cloud) [9,10].

III. PROPOSED SYSTEM

Implementation of wireless sensors network (WSN) in this paper contains three types of points, a master point which goes about as a portal between neighborhood and cloud computing platforms. The remaining two nodes represented as local nodes which are directly connected to the actual sensors placed in the corners of agriculture fields. The nodeMCU (microcontroller) acts as multiple local nodes having inbuilt Wi-Fi module capable of communicating with WSN remotely with the support of Wi-Fi connection, nodeMCUs will collect real-time data generated by multiple sensors placed in the fields of agriculture**.** Sensors are communicating with each other to collect real-time data related to given agriculture parameters. Different types of sensors are used including (DHT22, GPS, soil moisture, light sensors, and many others). first sensors generate the related data into the nodMCU (microcontroller), nodeMCU is represented subnode which is directly connected to the relevant sensors and placed in different corners of agriculture fields to collect real-time generated data by sensors, collected data from different sensors to nodeMCU will be sent to the master node. the master node is Raspberry Pi (microprocessor). Raspberry Pi is powerful enough to receive real-time data coming from different nodeMCUs at the same time after data has been received to master node the Raspberry Pi pushes the data into IOT cloud computing platform (Cayenne). the Cayenne stores the data which are coming from Raspberry Pi, process them and send the output or result to the farmer website and message to smartphone whenever we need.

A. Node 1

The NodeMCU (ESP8266) in figure.3 is a low-cost Wi-Fi module microcontroller. ESP8266 is allowed us to connect with Arduino IDE or any IOT integrated development environment to program and control any tasks, as it supports inbuilt Wi-Fi, we always we placed ESP8266 at the corner of agriculture to generate the required data. It is placed at the sensing unit to collect the real-time generated by the related sensor. It is used to connect the pressure sensor to maintain the status of pressure and provide the relevant details about the pressure. It is also connected to a UV light sensor which is capable of capturing the real-time data related to radiation (light intensity).

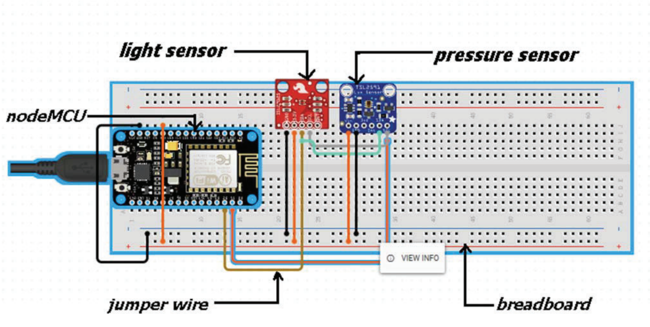

Fig 2. nodeMCU connected to UV and pressure sensors

B. Node 2

NodeMCU connected to soil moisture sensor (Fig.3) to find out the amount of water being reside in the agriculture fields. Soil moisture is used for measuring and controlling the specific amount of water that needs to provide and one can manage the irrigation process remotely by restricting the amount of water needed.

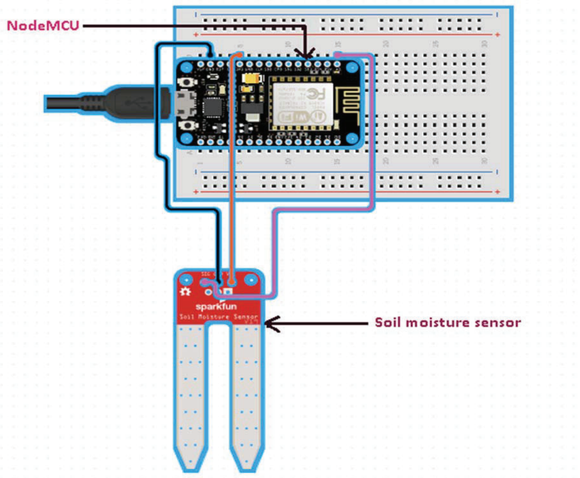

Fig 3. NodeMCU connected to soil moisture

C. Node 3

From Figure.4**,** Raspberry Pi is ease, Visa estimated PC that connects to PC screens or TV and utilization a standard console, keyboard, and mouse. Raspberry Pi microprocessor is capable of holding the real-time data coming from different nodes (nodeMCUs) at the same time. The power of Raspberry Pi is computing complex task and also supports programming languages in networking on Linux operating system. Here raspberry pi represents as the gateway between local nodes and cloud. It receives all the data coming from the local node (NodeMCU) and send them to the cloud to process and take action based on the requirement.

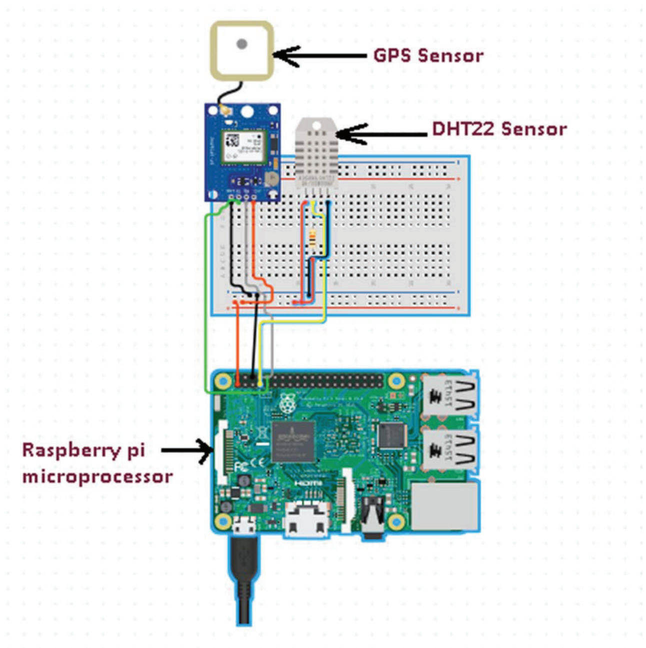

Fig 4. Raspberry Pi connected with DHT22 and GPS sensor

IV. SYSTEM ARCHITECTURE

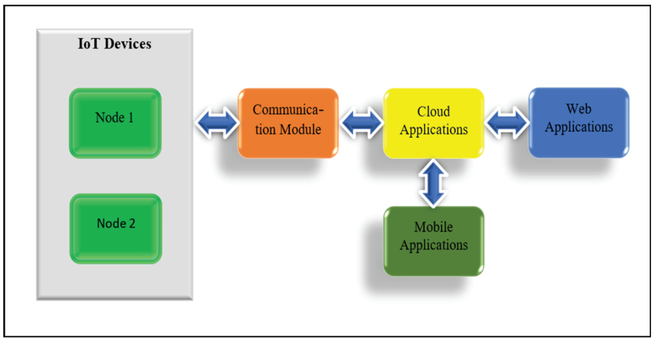

Fig 5. Block diagram of the proposed method

The proposed method consists of five parts

- IOT devices.
- Communication modules.
- Cloud Apps.
- Web application.
- Mobile application.

From figure.5, IoT devices represent all the hardware resources which are to be included in the implementation of the system. These IOT devices can help us to generate real-time data like sensors which are powerful to generate real-time information. Microcontrollers are a small device which can take input instructions, process the data and give the output under certain criteria. Communication modules are the technology which is responsible for providing and establishing communication channels like local area network and Wi-Fi. Cloud apps are services of cloud computing platform provided with a variety of services like storage and processing units for performing analysis and take some actions when required. Web app and mobile app are costumer side application through which we can interact with.

V. RESULT

In figures [6,7] represented simple implantation using three components (NodeMUC, DHT22 and GPS sensor). Here NodeMUC acts as the center unit which is able to collect real-time data generated by sensors later on these collected data will be used by master node (Raspberry Pi) to push real-time generated data into the cloud.

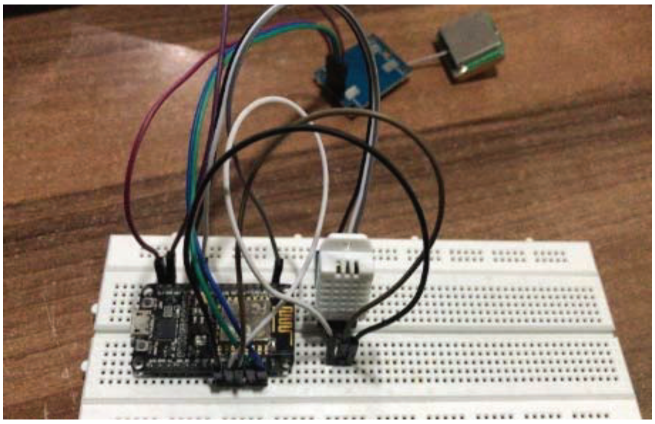

Fig 6. View of DHT22 and GPS implementation

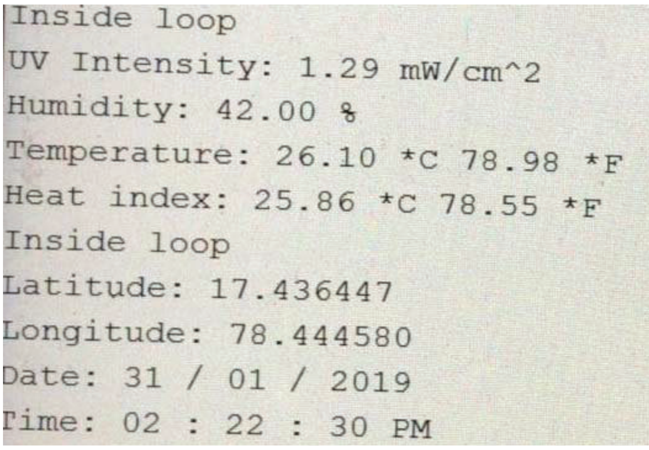

Fig 7. The output of DHT22 and GPS implementation

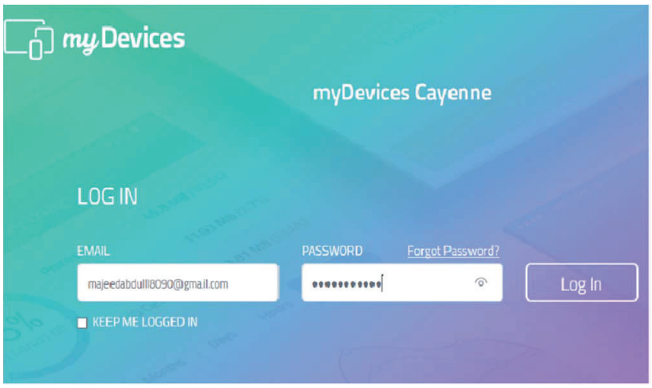

Fig 8. Login page of Cayenne platform

Figures [9,10] are represented all channel or different sensors connected to the graphical interface of cayenne cloud platform. This graphical interface is used to visualize the data in ease and more understandable format of stored data on the cloud, and figure [11] is represented ongoing data being rendered from sensors node directly to the cayenne app.

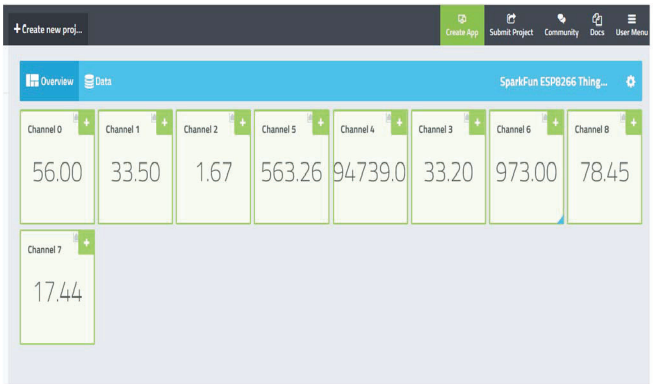

Fig 9. Cayenne dashboard

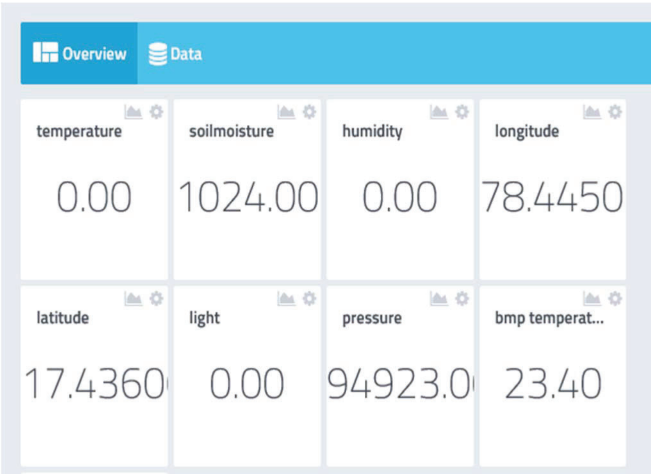

Fig 10. Different Sensors connected to Cayenne dashboard

Live m h d w 1mo Custom Query

Timestamp	Device...	Channel	Sensor Name	Sensor ID	Data T...	Unit	Values
2019-02-22 12:24:12	Generic ES...	7	Channel 7	885783d0-366e-11e9-a2...			1024
2019-02-22 12:24:12	Generic ES...	6	Channel 6	87764b90-366e-11e9-9c...			525.881
2019-02-22 12:24:12	Generic ES...	8	Channel 8	8b4e55a0-366e-11e9-81...			17.436
2019-02-22 12:24:12	Generic ES...	9	Channel 9	89e046b0-366e-11e9-b8...			78.445
2019-02-22 12:24:11	Generic ES...	5	Channel 5	86b08a90-366e-11e9-80...			95165.00
2019-02-22 12:24:11	Generic ES...	4	Channel 4	829f6f20-366e-11e9-a2...			26.200
2019-02-22 12:24:11	Generic ES...	0	Channel 0	80f0d4c0-366e-11e9-81...			18.100
2019-02-22 12:24:11	Generic ES...	2	Channel 2	849831e0-366e-11e9-8c...			30.740
2019-02-22 12:24:11	Generic ES...	3	Channel 3	857b17d0-366e-11e9-a0...			0.833
2019-02-22 12:24:11	Generic ES...	1	Channel 1	81d0ad70-366e-11e9-9c...			-0.700
2019-02-22 12:24:09	Generic ES...	8	Channel 8	8b4e55a0-366e-11e9-81...			17.436
2019-02-22 12:24:09	Generic ES...	7	Channel 7	885783d0-366e-11e9-a2...			1024
2019-02-22 12:24:09	Generic ES...	9	Channel 9	89e046b0-366e-11e9-b8...			78.445

Fig 11. Real-time data stored on the cloud

Figure [12,13] are represented data graph for the temperature sensor and UV sensor which are connected Cayenne dashboard.

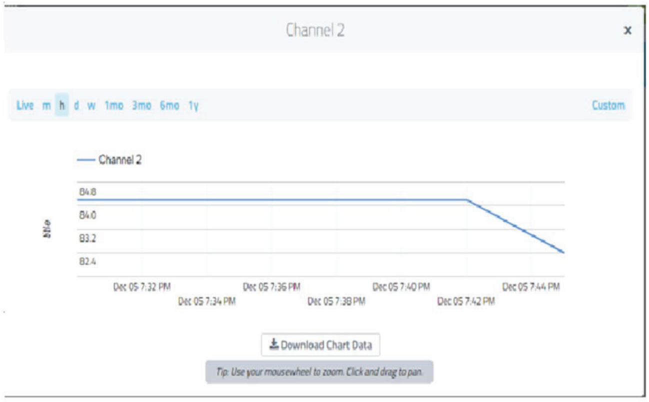

Fig 12: Temperature sensor Graph.

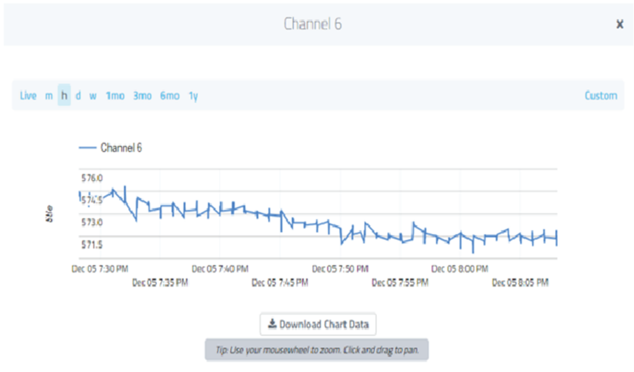

Fig 13. UV sensor Graph.

VI. CONCLUSION

In this paper, we developed information-based agriculture software supported by wireless sensors network (WSN) using greenhouse management that can help the farmers to optimize the resources and maximize the production. Greenhouse farming offers a good environment where we can deploy the wireless sensors network system and monitor precisely depending on all parameters specified to help in making the best decision support. The system capability is to gather continuous information from agriculture fields, analyze data and takes required actions to help farmers raise their production by providing better result through the website and send a message to the smartphone. Attributes of sensors, for example, moderate vitality wastage of power, great correspondence and self-sorted out combinedly will predict the water level and send the data to us whenever we need.

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