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Smart Farm Using Internet Of Things In Agriculture

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Abstract : *The Internet of Things (IOT) is a revolutionary technology that represents the future of computing and communications. Most of the people all over world depend on agriculture. Because of this reason smart IT technologies are needed to migrate from traditional agriculture methods to modern methods. Using modern technologies can control the cost, maintenance and monitoring performance. Precision agriculture sensor monitoring network is used greatly to measure agri-related information like temperature, humidity, water level etc. So with IoT, farmers can remotely monitor their crop and farming equipment and automatic irrigation is done by phones and computers using mobile computing and cloud computing. Recommendation of crop can be done using data mining. Also plant diseases are identified using image processing.*

Keywords: *Automated Irrigation, Crop Suggestion, Image Processing, Internet of things, Networks Smart Farm.*

I. Introduction

The survival of humans primarily depends on food. Therefore, agriculture becomes an important part of human eco-system. Agriculture is the primary source of livelihood for about 58% of India's population. As most of the people all over the world depend on agriculture and the country's economy depends on agriculture, therefore, it is necessary to make development in the field of agriculture. The traditional methods of agriculture requires farmers to repeatedly visit the field, check the soil and choose suitable crops, provide proper amount of water to the crops. All these tasks require a lot of manual and labor work and also require a sound knowledge related to agriculture. If any of the tasks is not carried out properly then it may lead to low yield and may cause loss to farmers.The Internet of Things (IoT) is a megatrend of the upcoming generation technologies that have a impact on this current century where interconnection of smart objects and devices. Therefore, introducing automation in wide range of applications such as smart farms, waste management, health care etc. With the advancement of technology and introduction to IoT, the work of farmers has eased to a great extent as it not only connects things together but also helps things to communicate and exchange information. Using this, farmers can not only remotely monitor their crop but can also take proper actions.

In the proposed system, Iot based on smart farm which can help farmers get good yield and also saves manual time and efforts. The primary focus of the paper is to help farmers with the crop selection according to the soil condition. The soil conditions can be measured using temperature, moisture and humidity sensor, and with the help of data mining crops will be recommended, Data mining is used for all data mapping & processing. It is about finding rules in data. The technology of data mining is narrowly connected to data storage and is intertwined with DB management system. Data mining involves the process of finding large quantity of previously unknown data, and then their use in important business decision making. DB(Database) which if analyzed, provides relevant information to agriculture decision makers. The overall goal of the data mining process is to extract information from a data set to extract previously unknown, interesting patterns such as groups of data records (cluster analysis), unusual records (anomaly detection) and transform it into an understandable structure for further use. The data mining is the process of finding patterns or correlations among lot of fields in large relational databases. Here, K-nearest neighbor technique is used for smart farming decision making[8].

The paper focuses on providing farmers with knowledge of diseases which help farmers for identifying diseases of crop using image processing. Moreover Without improved efficient agricultural water consumption is expected to increase globally by around 20% in few years[8]. Automatic irrigation will be provided by taking sensor data, analyzing the real time data with database, and activating irrigation when sensor value falls below a threshold value.

II. Iot S-Farm Network

The Iot smart farm network or the IoT network for smart farm is one of the vital elements of the IoT in agriculture. It supports access to IoT backbone, facilities the transmission and reception of agricultural data, and the use of automation irrigation. The Sensor carry the information from the field/farm, the fetched data is transmitted using a gateway i.e. physical devices or software program that serves as the connection point between the clouds and controllers, sensors and intelligent devices. All data is moved to the cloud and then the data is integrated with datasets collected which is stored in database where it is protected and then data is analyzed. The analyzed data is reflected to the actuators like pump for irrigation (drip and sprinkle).

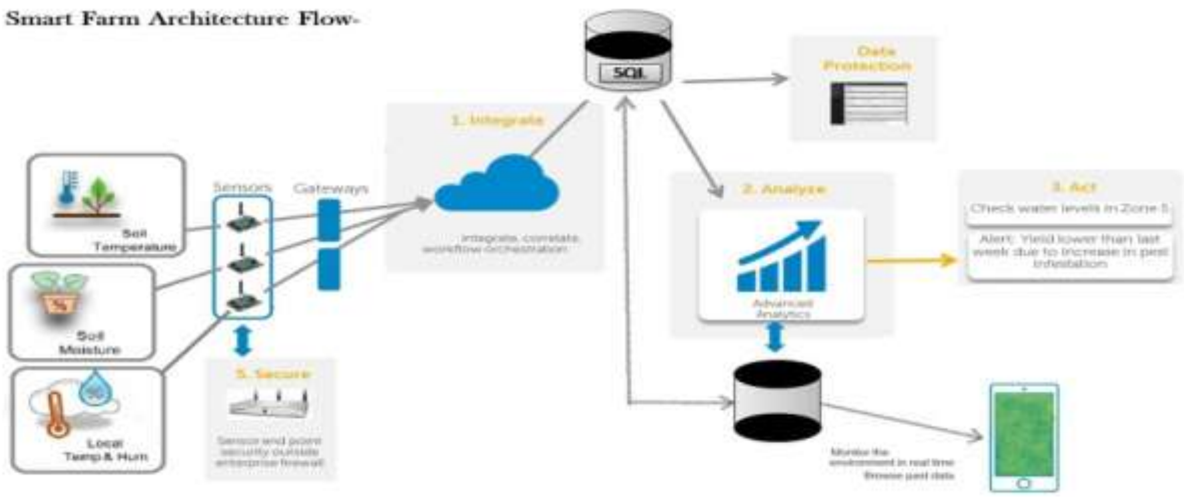

Fig.1. The architecture flow of S-Farm

III. Four Layers of S-farm

The four layes of iot smart farm are Communication, Data mining, Image Processing and automation Irrigation which is done after the data analysis.

Communiation	• Gateway Application Protocol- MQTT,CoAP,
Big Data Mining	• Classification, Clustering • Prediction, Association, Decision Tree
Image Processing	• Database Image • Query Image
Automation Irrigation	• Data Actuator • Drip Irrigation, Sprinkle Irrigation

Fig.2. Four Layers Diagram

3.1) Communication- The communication between sensors and mobile application or computer is done using application protocol, which acts as a gateway. The major gateway used is MQTT. Message Queue Telemetry Transport (MQTT): MQTT is a messaging protocol that was introduced by Andy Stanford-Clark of IBM. MQTT aims at connecting embedded devices and networks with applications and middleware. The connection operation uses a routing mechanism (one-to-one, one-to-many, many-to-many) and enables. MQTT is an optimal connection protocol for the IoT. MQTT utilizes the publish/subscribe pattern to provide transition flexibility and simplicity of implementation as depicted in Fig. 3. Also, MQTT is suitable for resource constrained devices that use unreliable or low bandwidth links. MQTT is built on top of the TCP protocol. It delivers messages through three levels of QoS[15]. The latter was defined specifically for sensor networks and defines a UDP mapping of MQTT and adds broker support for indexing topic names. The specifications provide three elements: connection semantics, routing, and endpoint.

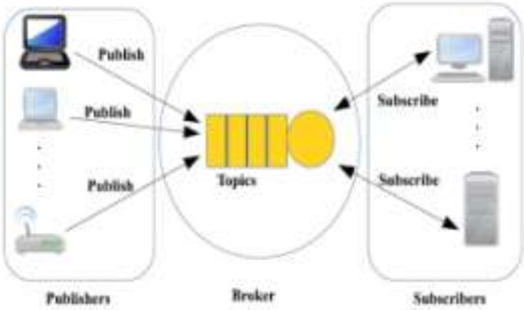

Fig.3. Architecture of MQTT

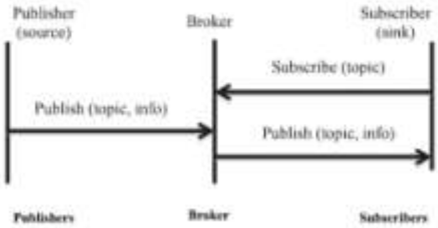

Fig.4. Publish/subscribe process utilized by MQTT

MQTT simply consists of three components, subscriber, publisher, and broker. An interested device would register as a subscriber for specific topics in order for it to be informed by the broker when publishers publish topics of interest. The publisher acts as a generator of interesting data. After that, the publisher transmits the information to the interested entities (subscribers) through the broker. Furthermore, the broker achieves security by checking authorization of the publishers and the subscribers [15]. The MQTT protocol represents an ideal messaging protocol for the IoT and M2M communications and is able to provide routing for small, cheap, low power and low memory devices in vulnerable and low bandwidth networks.

3.2.) IoT and Big Data Mining

Big data analytics is rapidly emerging as a key IoT initiative to improve decision making. One of the most prominent features of IoT is analysis of information about "connected things". Big data analytics in IoT requires processing a large amount of data and storing the data in various and wide storage technologies like cloud etc. The data which is gathered from node/sensors is much of the unstructured data which is gathered directly from web-enabled "things" big data implementations will necessitate performing lightning fast analytics with large queries to allow organizations to gain rapid insights, make quick decisions, and interact with people and other devices.

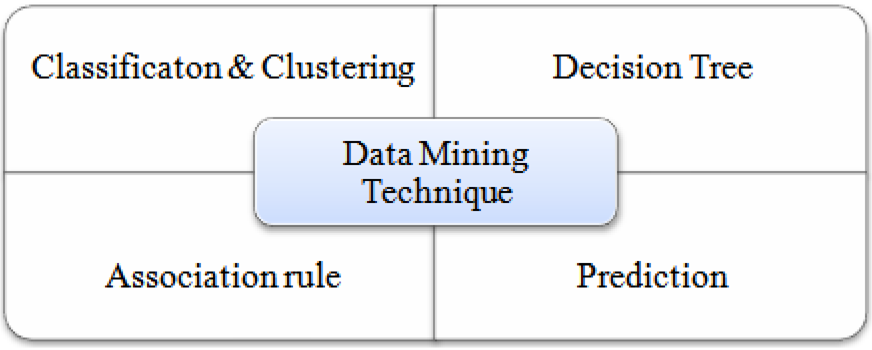

Fig.5. Data Mining Technique

There are different data mining Technique like classification, clustering, association rule mining, and prediction categories, Each category is a data mining function and involves many methods and algorithms to ful_ll information extraction and analysis requirements. For example, Bayesian network, and k-nearest neighbor (KNN) offer classification methods. Similarly, partitioning, hierarchical clustering, and co-occurrence are widespread in clustering [16]. Association rule mining and prediction comprise significant methods. Clustering is another data mining technique used as a bigdata analytics method. Contrary to classification, clustering uses an unsupervised learning approach and creates groups for given objects based on their distinctive meaningful features. The well-known methods used for clustering are hierarchical clustering and partitioning. The hierarchical clustering approach keeps combining small clusters of data objects to form a hierarchical tree and create agglomerative clusters. Divisive clusters are created in the opposite manner by dividing a single cluster that contains all data objects into smaller appropriate clusters [16]. The process of association rule mining involves identifying interesting relationships among different objects, events, or other entities to analyze market trends, consumer buying behavior, and product demand predictions. Association rule mining focuses on identifying and creating rules based on the frequency of occurrences for numeric and nonnumeric data. Data processing is performed in two manners under association rules are Sequential Data Processing and significant data processing.

3.3) Image Processing

Image processing is means processing digital image by means of a digital computer. We can also say that it is a use of computer algorithms, in order to get enhanced image either to extract some useful information. The proposed system contains how to monitor diseases on plants and suggest better solution for healthy yield and productivity. The proposed paper use two databases of images, one for query images and other for training images.

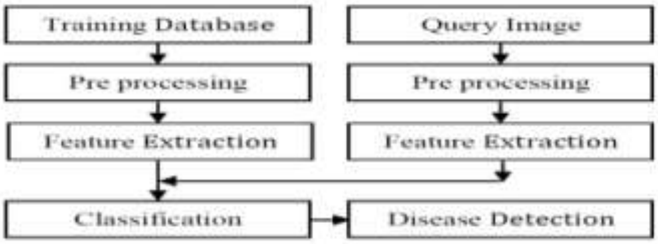

Fig.6. Phases of image processing

The query image which is captured is acquired then it is preprocessed from two different data sets one is the training dataset and other is test dataset. Then image segmentation is done in which image is divided into small segments to recognize object to extract information from image and then feature is extracted and the image is matched with training datasets and query datasets. Matching is done.

3.4) Automation Irrigation

Irrigation depends on certain factors such as Crop name, Crop stage, soil condition. Current day and next day temperature, humidity, etc.

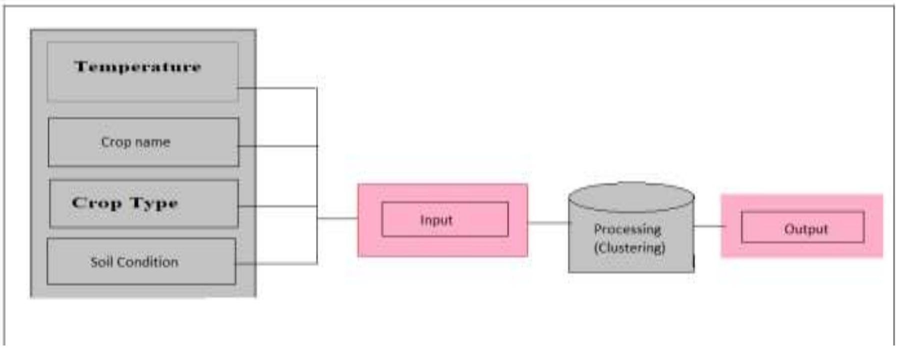

Fig.7.Automation irrigation

In Fig.7 shows the working of smart irrigation system it takes temperature, crop name, crop stage, soil condition as input. All this inputs are preprocessed then give the result as water required per hector. Irrigation is done automatically when the value of moisture of soil is below the threshold value which is in database. The automation is activated and the water is supplied to crop in different type of irrigation like Drip Irrigation and Sprinkle irrigation.

IV. Hardware Description

4.1 Arduino: The arduino board is a freely available open source development microcontroller capable to cope up with a variety of communication protocols that is a must to be usable for any kind of IoT device. This board is cheap and feature rich with availability of a variety of daughter boards that have an amazing stacking feature to the main mother board. The availability of wifi and ethernet shield along with the low power BLE-4 arduino shield makes it suitable for rapid prototyping and programming with ease. The easy to use and abundant example programs in the arduino IDE makes it simple for the user to get started pretty quickly in the process of making IoT device work seamlessly in all kind of environments.

4.2 ESP-8266: The ESP-8266 module [4] little beast is an extremely capable wireless programmable microcontroller board. The ESP8266 WiFi board is a SOC with integrated TCP/IP protocol stack that can give any secondary microcontroller access to your WiFi network. The ESP8266 board is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor and therefore this is more suitable to be used as a sensing node that is capable to sense the data from various wirelessly connected IoT sensor nodes and send data to the central server like

Fig.8. ESP 8266-01 (NodeMCU) wifi IoT module.

4.3 DHT11 Sensor: The DHT11 is a basic, low-cost digital temperature and humidity sensor. It gives out digital value and hence we can give its output directly to data pin instead of ADC. It has a capacitive sensor for measuring humidity. The only real shortcoming of this sensor is that one can only get new data from it only after every 2 seconds.

Fig.9. DHT 11 (Temperature and Humidity) Sensor

4.4 Soil Moisture sensor: Soil moisture sensor measures the water content in soil. It uses the property of the electrical resistance of the soil. The relationship among the measured property and soil moisture is calibrated and it varies depending on environmental factors such as temperature, soil type, or electric conductivity. Here, It is used to sense the moisture in field and transfer it to Arduino microcontroller in order to take controlling action of switching water pump ON/OFF. The sensor used is capacitive soil moisture senor v1.2 which is highly water resistance.

Fig.10.Capacitive Soil Moisture Sensor

4.5 Relay: A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal.

V. Conclusion

A conclusion section The project is a shift from manual agriculture to automatic agriculture. It bridges gap between farmers and good yield production to get maximum profit. This project focuses on field monitoring using IoT devices which provide live soil moisture, humidity and temperature of the field to the farmers. This helps farmers to remotely monitor their crop and equipment by phones and computers. Therefore, an individual can take a prompt action to manage the field based on the data received from field. The automated irrigation implemented is found to be feasible and cost effective for optimizing water resources for agricultural production. The irrigation system can be adjusted to a variety of specific crop needs and requires minimum maintenance. Also over-irrigation and under-irrigation are prevented. The plant diseases is identified by using image processing, which help famers to cultivate healthy crops. Moreover, the crop recommendation helps farmers to grow suitable crops. Hence, the application provides a great help to farmers.

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