Agriculture monitoring and prediction using Internet of Things (IoT)

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***Abstract*—Agriculture has become the most significant growing sector all over the world because of increasing the population. The main challenge in the agriculture industry is to improving farming efficiency and quality without constant physical monitoring to full fill the speedily increasing demand for the food. Apart from the mounting population, the climate circumstance is also a huge challenge in the agricultural industry. The aim of this research paper is to propose a smart farming model based on the Internet of Things using the clustering to deal with the adverse condition .in this model, we use the different types of the sensors like soil moisture, air pressure, rain detection and humidity sensors for a different purpose. The data will collect on the cloud and calculated automatically. The smart agriculture can be adopted from the crop control, collection of useful data, and analysis automatically. The purpose of this paper is how the implement the Internet of Things (IoT) in the monitoring of humidity, soil condition, temperature, and supply water to the field, level of water, climate condition. The IoT based Smart Farming System being planned via this report is integrated with different Sensors and a Wi-Fi module producing live data feed that can be obtained online.**

Keywords— Smart farming, IOT, Clustering, Sensors, Cloud

I. Introduction

Internet of Things has created its application in numerous areas, such as a smart car, connected road, smart city, smart home, smart industry, smart agriculture, connected campus, and building, and other domain also. The main advantage of using IoT is to join together the real world and the virtual world by using the Internet as the intermediate of communication and exchange data and information with each other. IoT is the combination of interrelated computing devices, mechanical machines, digital machines, objects, internet, animals, or people that are provided by unique identification and the capability to move the data over networks without requiring any human-to-human or human-to-Machine or Human-to-Computer interaction.

Smart agriculture is the execution of different technologies & devices like the internet, cloud, and sensors devices. As in today's, the world population is growing every day and it is believed to be around 9.8 billion by 2060.for producing the foods of those billion of peoples we require to pick up the productivity of crops. The world population is growing day by day and the agricultural land is decreasing due to a lot of reasons like industrializations, housing buildings and commercial markets are being buildup on agricultural parkland. To feed these billions of people, we need to increase the productivity of the crop. This is possible to implement the Internet of things (IoT) in the agriculture industry. Smart Farming is also known as precision farming.

Fig. 1. Sensor deployed in field for data capturing

Smart Farming and Traditional Farming are very different from each other in every prospective. Traditional Farming uses the oldest and conventional ways of agriculture and using old machinery for agricultural occupation and producing crop without knowing any reevaluation of demands of the market and weather forcing reports but smart farming use very innovative technologies like smart devices, IoT sensors nodes, Internet and cloud storage for data collection. Farmers chatting community, time to time measurement of different factors like the best environment for the growth of the plantation, how much nutrients, soil quality, water quality, air pressure are required. By using smart technology, farming has become very easy, economical, and cost-effective. Farmers can reduce the employment cost and improve crop yielding by using smart technology, it also provides better crop production.

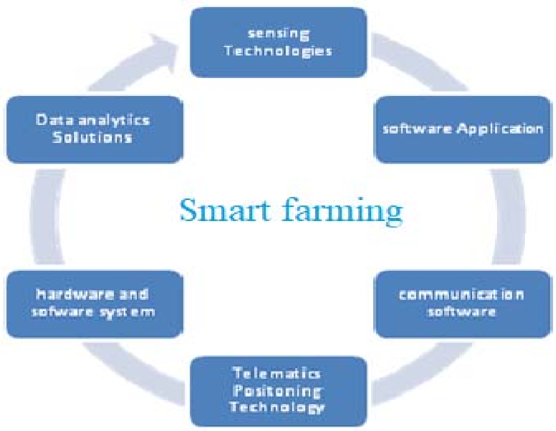

Fig. 2. Basic architecture of IOT based on Hardware /Software

Now a day, the agricultural industry is bent on using IoT technology for smart farming to achieve crop performance in the global market and other factors such as minimal human disruption, time and cost, etc. Advances in technology ensure that sensors collect data from a wide variety of nodes. Networks are also readily available worldwide .and that smart farming can be achieved with full promise. Focusing on improving agriculture in agriculture, smart farming is the best solution to the problems that the agricultural industry currently faces. This may be due to the Internet, smartphones, Sensors devices, and IoT devices.

The smart agricultural market is expected to earn $ 18.55 Billion by 2022, at a CAGR of 13.9%. BI estimates that 76 million IoT devices will be shipped for agricultural use by 2020. In the CAGR of 20%. IoT devices can be very easy to improve production and harvesting in the agricultural industry as these IoT devices can be used to monitor soil acidity, temperature, humidity, air pressure, etc. In addition, smart agriculture will be helpful in monitoring livestock production & health as well. IoT sensors can provide farmers with information about rainfall, crop yields, and insect infections. Soil nutrients are very useful in production and provide specific information that can help to find improved farming methods. The Internet of Things, with its real-time, direct, and integral features, will drive a major change in agricultural procurement management and provide the necessary technology to establish a uniform flow of agricultural goods.

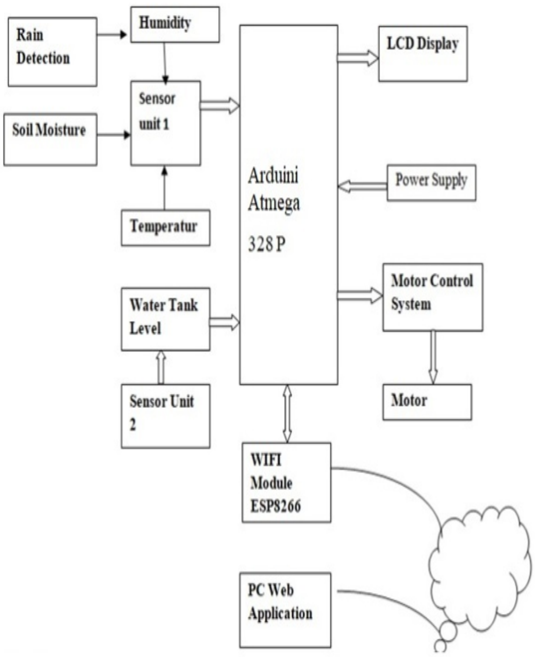

Fig. 3. System Block Diagram

II. PURPOSED MODEL

The main purpose of these models is to expand the centralized monitoring system & organize the agricultural land. This can be managed from any place wirelessly by using the mobile phone. The application users can control the elementary operations of collecting the irrigation data, environmental data, soil moisture, and fertilization data without human intervention .this collected data can be used for the perception of assessing crop performance & calculate crop forecasts and personalized harvest recommendation for any farm using the application.

The sensor network is planned to acquire the information according to the climatic situation of the farmland such as Temperature, Soil Moisture, Humidity, and Light. From the help of this model, we will decide on the operations on the farm field. In a single field, we can have more than crops separated into fields.

The data from all these nodes are collected & forward to cloud storage. Here, we are using the cloud service as a storage database of collected data. Data can be sent to the cloud to store in the cloud database. Farmers can log in to their particular accounts to view their history and the current data of each node.

III. WORKING OF MODEL

Wireless data communication: The data is collect from the various sensors node and forwarded to the server through wireless transmission (WIFI module).

Sensor data attainment: The sensors are boundary with Adriano Uno board such as DHT11, temperature sensors, Rain detection sensor, humidity and Soil moisture is used.

Data analysis & Decision making: The data analysis is the process of analyzing the data collected from different sensors from the agriculture field. The water motor will be automatically switched ON if the soil moisture falls below the threshold and vice- versa. The farmer can even operate the Motor by using the mobile using mobile Apps

Automated irrigation system: In the automated irrigation system once the control established from the mobile application or web application. The data processing is used to pass access form web application to the electrical switches during the Arduino microcontroller.

Mobile Application: Mobile Apps will be developed in android OS. The mobile phone application is provides help for monitoring and controlling the agriculture filed from any place

Web application: - The web application will be designed to observe the ground and crops from everywhere using an internet connection. The webpage can be communicated using the processing IDE.

IV. DEVICES USED

A. Soil Moisture Sensor

Soil moisture sensor senses the moisture content of the soil. The output of this soil moisture sensor has both analog & digital signals. When the soil is dried up the current will not move by it .So that the output is called to be highest.

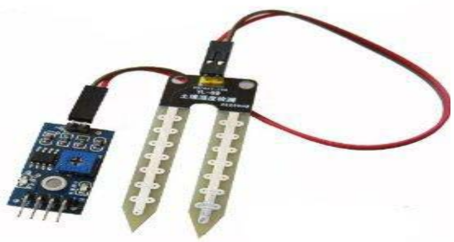

Fig. 4. **Soil moisture sensor**

B. Temperature Sensor

The LM35 sensor is used to measure the temperature purpose because of its output voltage is linear among the Celsius scaling of temperature. It has a large operating rang. The highest output is 5V.The output will raise 10 mV for every 1 degree go up in temperature.

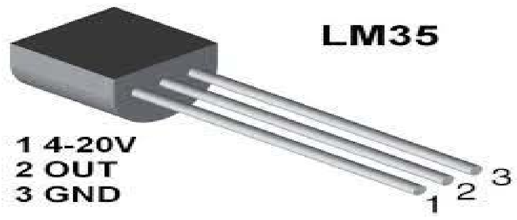

Fig. 5. Temperature Sensor

C. Humidity Sensor

They are small in size, power consummation is low up-to-20 meter indicator transmission make it the greatest option for different applications, This DHT11 Humidity sensor have the features humidity sensor difficult through calibrated digital signal output.

D. Rain Detection Sensor

Rain sensor module is a rain detection tool. This sensor can be used as a switch when a raindrop falls on a rainy day and measures the intensity of rainfall. Rain board and control board separate for additional use, LED power indicator and flexible sensitivity with potentiometer. Analog output is used to detect rainfall.

Fig. 6. Rain Detection Sensor

E. Communication Module

The ESP8266 board is a lovely, cheap Wi-Fi mode suitable for enhancing Wi-Fi performance using the UART serial connection. Features include 802.11 b / g / n protocols, Wi-Fi Direct (P2P) soft-AP, Integrated TCP / IP Protocol Stack.

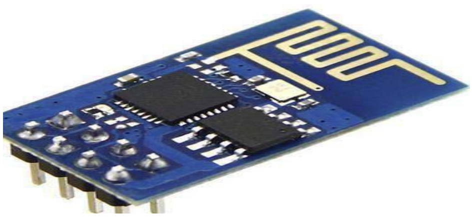

Fig. 7. Wi-Fi Module

V. EXPERIMENTAL RESULT

The evaluation of Rabi & autumn (Kharif) crops is accepted with data like humidity, temperature, and rainfall. We can analyze and predict the finest crop for the field based on the collected data which is collected from various sensors node. The collected data from various sensors node are as follows which is established with the values obtain throughout the experiment in Tables 1, 2 & 3. Figure. 10, 11 & 12 deals with the Rainfall trends, temperature trends, and Soil moisture trends throughout Kharif and Rabi seasons respectively. The table 1, 2 & 3 shows the average temperature data, rainfall trends, and average surface soil moisture trends respectively for different seasons over past years starting from the year 2017. For these table data values, the graphs are plotted, which can be used for prediction over the coming years.

TABLE I. DATA OF TEMPERATURE TRENDS DURING RABI AND KHARIF SEASON

Year	Kharif Session (°C)	Rabi Session (°C)
2017	27.1	22.5
2018	26.5	21.5
2019	27.9	23.1
2020	25.3	21.7

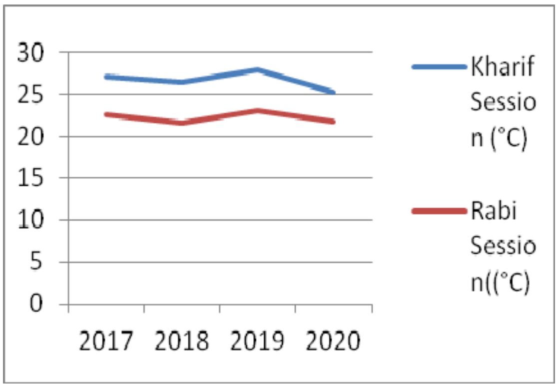

Fig. 8. Temperature trends all through Rabi and Kharif seasons

TABLE II. SURFACE SOIL MOISTURE TRENDS DATA THROUGHOUT KHARIF AND RABI SEASON

Year	Kharif Season (mm)	Rabi Season (mm)
2017	8.4	10.4
2018	8.5	10.6
2019	9.8	10.3
2020	7.9	11.2

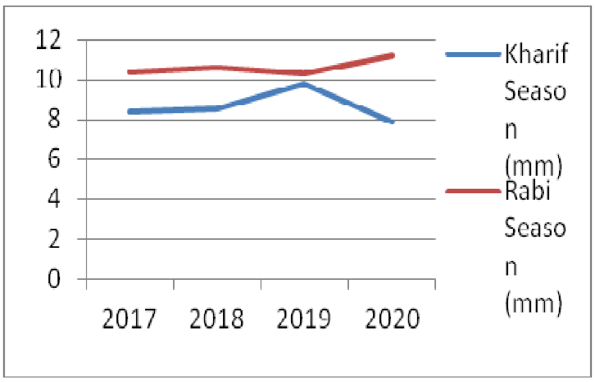

Fig. 9. Surface soil moisture trends throughout Rabi and Kharif seasons

TABLE III. RAINFALL TRENDS DATA THROUGHOUT RABI AND KHARIF SEASONS

Year	Kharif Season (mm)	Rabi Season (mm)
2017	775	108
2018	640	190
2019	849	85
2020	585	174

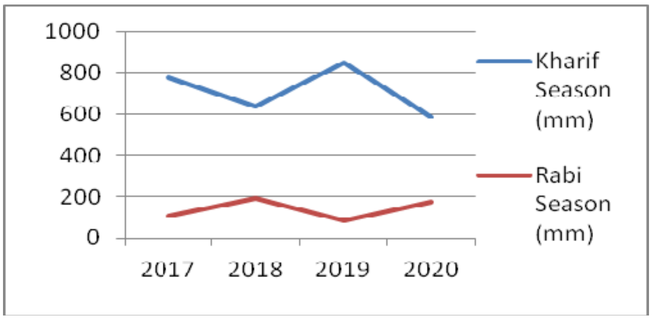

Fig. 10. Rainfall trends throughout Rabi and Kharif seasons.

VI. CONCLUSION

The IOT-enabled agricultural system has helped us to achieve modern scientific solutions. This paper has helped fill the gap between quality, production, and quantity. Data entered by collecting and importing data from multiple real-time use or cloud storage sensors in the database to ensure quick action. With seamless end-to-end performance and advanced business process, the manufacturer speeds up the process and reaches supermarkets in a timely manner and makes the proposed system fully operational.

It also reduced human efforts, simplifies the techniques of farming, and it is also helpful to gain smart farming. Along with these features, smart farming can help to develop the market for farmers with a single touch and minimum hard work.

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