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Crop Recommendation and Automated Irrigation System

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Abstract*: The system provides a crop suggestion system which suggests the farmer the most profitable crop they can grow with the available resources, weather condition and market demand. This will be achieved with the help of data provided by the government and other sources. Smart farming also known as precision farming is the implementation of IoT in agriculture with the help of IoT devices, cloud internet and further analysis of data collected for precision farming. Through this system a farmer will be notified time to time about the condition of soil through analysing various parameters in soil like humidity, pH and temperature of the surrounding. With the help of humidity sensor and soil moisture sensor the condition of soil will be monitored and based on the condition, irrigation will be supplied automatically. This will reduce the wastage of water in irrigation and the crops will get precise amount of water supply. We will be using drip irrigation which is an efficient way of irrigation for orchard crops, vegetables, cash crops, flowers, spices, oil seed, forest crops. Integrating the efficient irrigation technique and automating it for precise irrigation will help to maintain the crop health with efficient use of resources. Adding to the irrigation system we also analysed the past crop production, state wise data for predicting the production and profitability of individual crop and suggest them to the farmer so that it will be profitable to farmers.

Keywords: Integrating, IoT devices.

I. INTRODUCTION

The agriculture is the basic and most important need of human being to stay alive and farming is one of the most difficult tasks to do for human beings, the amount of labor work needed and providing the resources like water, manure and pesticides at right amount and at right time, one has to be very knowledgeable about crops and soil. There are many factors like weather condition, condition of water which is supplied, condition of soil which is what minerals the soil have and what they must provide through manure, the irrigation system they use is one of the most important factors because there are some efficient ways of irrigation system for different category of crops.

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The irrigation should be precise too so that water will not be wasted which is a major problem in India, many villages are facing water scarcity and drought conditions. So, there is a major need for a systematic irrigation system which will reduce the wastage of water and easy to use by the farmers. Previously many research and projects have been done on the smart agriculture, in some places, the monitoring of the field through IoT devices have been going on and the monitoring is done in proper supervision of an agricultural specialist. This monitoring is done periodically to know the health of the crop based on supplied resources in a controlled manner. The irrigation system used is also monitored and water is provided in a controlled manner so that the nutrients don't wash away with water and soil doesn't face waterlogging, also there should not be dry soil conditions. But the irrigation technique is not that efficient, the modern irrigation techniques like drip irrigation and sprinkler system should be used along with the integration of IoT. Through previous researches we can find out the parameters required for a particular crop, for example, the data has been collected for almost every large production crops which include how much moisture content should be needed in soil in daily basis for the crop, how much nutrients the soil should contain and what weather conditions it requires. All the farming techniques require a precise and controlled way to provide resources to the field, our objective is to make a system which can be used in different types of farming techniques by just making some small changes in the system. Focused on the traditional farming technique the system will provide a precise irrigation system with the help of IoT devices which will improve the soil condition and also reduce the wastage of water. The system will also provide a real-time monitoring system which will be helpful for the farmers to know remotely about their field and can control the system remotely. It will also be automated for irrigation so that manual work or continuous supervision is not needed.

II. LITERATURE SURVEY

[1]Anjal Dokhande, Chetna Bomble, Rakshanda Patil in their paper proposes a smart irrigation system based onMicrocontroller ATMEGA328P on the Arduino UNO platform for an automated irrigation system that monitors and maintains the required amount of moisture content in the soil. The setup uses a moisture sensor to take the moisture content readings from the soil and gives the output to Arduino in form of analog signal. This paper tells about the soil composition that is generally used in the field. Soil is comprised of different types of particles and minerals in different composition giving different classification of soil that constitute different water holding capacity.

Clay	Silt	Sand	Gravel
0-0.002 mm	0.002-0.075m m	0.075-4.75m m	4.75-80m m

Fig 1: Holding capacity of soil

Based on this we also understood the water-holding property of the soil as the water begins to fill the void between theparticles. It is classified on three levels based on the water level between the particles.This is helpful as each crop has different water requirement. This also helps in setting the sensor values through which irrigation will be automated.

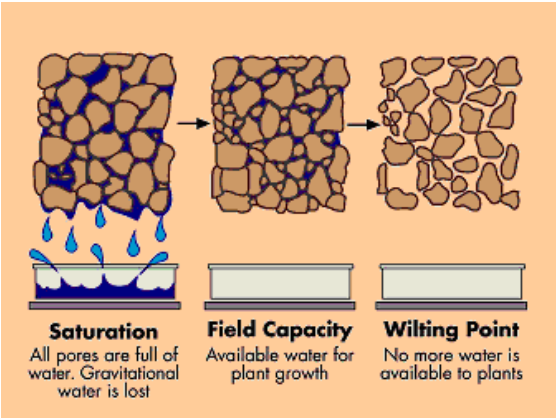

Fig 2: Different conditions of soil

[2]ZENG HU, LONGQIN XUin their paper proposes the use of Wireless Sensor Networks (WSNs) for getting the required data from the farm field from the used sensors and send the required data to the server using wireless module. The Wireless Sensor Networks usually works in the non-licensed spectrum also the resource elements for collecting data are spread in a big farm field. In orderto install extra nodes (sensor nodes) and increase the lifespanof the Wireless Sensor Networks in fields, relay-assisted, relevant multiple access is implementedonto the uplink transmission stage of the direct transmission from the nodes (sensor nodes)for sinking the nodes which acts as the main node to collect data. Relevant multiple access (NOMA) Can transmit multiple symbols on the same resource elements simultaneously by breakingthem intothe power domain and separatingthem by the different power levels of different symbols required by each resource element.

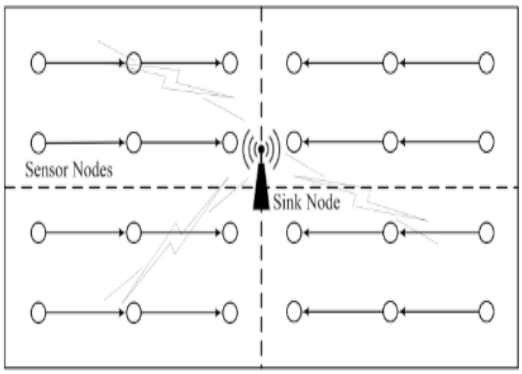

Fig 3: WSN in a farm field

Sensor nodes are deployed at the required places to collect data from sensors and the data is transmitted to the sink node which acts as a base station to collect all data and upload it o cloud servers or sending it to the user application.

[3] Jinyu Chen and Ao Yang used the Internet of Things to monitor the farm and collect the data for intelligent farming. The data they collected is used to visualize the data and analyze and cluster analysis to find the key technologies in the development of intelligent and precision farming, which will effectively increase the production of agriculture.

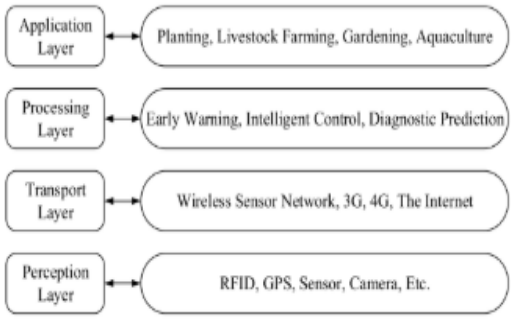

Fig 4: Smart farming

With the help of Internet of Things devices and sensors, they achieved the functions such as sensing, identification, monitoring, and feedback of the IoT based agriculture. These methods helped them to analyze the health of the crop in real-time with the controlling of parameters and resources needed in the farming process. With the help of their data, we can see how the GDP of the country is directly proportional to the crop produced. Their data focuses more on the agricultural practices near Jinsha river Basin, how it affects the per capita GDP and overall GDP, how much farming can be done on the Jinsha River Basin and how it will affect the country.

[4] Muhammad Ayaz and MohammadAmmad-Uddin in their paper they developed a system through which the whole parameters and situation of the field can be analyzed. We can say they made the agricultural field talk to us so that it can produce effectively. They focused on using almost all possible ways to get the condition of the field like water and nutrition monitoring, disease and bugs monitoring, soil monitoring, crop health monitoring, and environment monitoring. This monitoring system was possible with help of some sensors like leaf sensor for measuring chlorophyll content by analyzing the color of leaf, stem sensor for measuring the radius of stem through which we can analyze the health of stems, temperature sensor, and humidity sensor is used to provide precise water supply based on the environment's temperature and moisture content in soil, this is the most efficient way of irrigation. They also included fruit sensors for monitoring the health and size of fruit. This system will provide many services for farmers like irrigation, pesticides, fungicides, herbicides, fertilization, soil preparation, yield condition, and yield storage.

[5] NurzamanAhmed and Debashis De made an IoT-based control devicefor the technological developmentand rural agriculture.Different control system components and modificationsare addressedand evaluatedin all areasincluding testbed evaluations.IoT's MAC and routing solution has achieved better efficiencyin storage, latency, and throughput.

[6] Neha K. Nawandar and Vishal R. Satputein their research paper focuses on the controlling of water level in the soil by controlling the water supplied to the farm. They used Arduino UNO along with Raspberry Pi for retrieving the values through sensors and sending the data to the server for analyzing the change in parameters through graphs provided in ThingSpeak open-source Internet of Things application. The data will be continuously sent to the farmers mobile through which they can monitor and switch on and switch off the water supply to the farm through a mobile application provided. This paper also focuses on the difference between blockchain models and IoT system models in agriculture, a major difference between these two models is blockchain is more secure compared to IoT based systems. IoT based system faces a big challenge for security.

[7] Jaiganesh.S and Gunaseelan.Kin their paper documented about farming which is implanted with advantages such as GPS, sensors that enablethe information to be dissectedand alsotrade information betweenthem.Agriculture cloud and IT benefit provides farmers with unique expertise in the managementof yield development, assessment, manure, disease detail strategy for cure. Through the survey on smart agriculture, we have an understanding of the possible systems that can be implemented to tackle the problem and we are clear that what objectives have been completely achieved, what has been partially achieved, and what is yet to be achieved. can conclude that a system can be made which will help in precision agriculture and also can be used in different types of farming techniques by making small changes in the system. The need to improve the traditional farming is very high and also possible because of new emerging technologies. The data gathered from the field of any crop production is very useful if it is analyzed in the right way and can reveal many solutions to the existing problems and also help the current system to improve continuously over time. The system also has to be automated so that it requires minimal human involvement which will force human to focus on more important issues. This will reduce the labor work and wastage of resources needed for the crop to grow. The effective use of IoT sensors with a robust system can help in making farming smart.

[8]Kavianand G, Nivas V M, Kiruthika R and Lalitha S in their paper proposed a Smart Drip Irrigation system based on the ARM 9 processor, which is used to control and monitor the irrigation system. This paper initially compared different types of irrigation systems that exist today and understood the efficiency of each of the methods in crop growth and other factors.Drip irrigation method came out to be the best technique for irrigation by controlling the water content in the soil and also preserving water wherever required.After selecting the most efficient technique, a system was proposed that for automatic irrigation using drip irrigation using ARM9 processor AT91SAM9G45, which enables remote monitoring of the moisture parameters and a system for automatic switch on/off of system valves.

[9] Ibrahim Mat, Mohamed Rawidean Mohd Kassim, Ahmad Nizar Harun, Ismail Mat Yusoff in their paper mentioned about the importance of IoT based smart farming and its effects in the GDP of the country. Their system is able to track all types of data like temperature, humidity, CO2 level, amount of fertilizer used, amount of water used and other resources needed for farming. These things helped them to monitor the farm closely and keep the farming method transparent from the harmful things.

[10] Rahul Dagar, Subhranil Som, Sunil Kumar Khatri in their paper talked about the poly house in which the farm is protected by the steel structure and polythene from the outside harmful environment. This helped them to control the environment inside the poly house depending upon the crop need. The irrigation system and use of fertilizers is in controlled way which allow them to properly utilize the resources and be cost effective at the same time.

III. PROPOSED WORK

A system can be made which will help farmers in irrigation based on the soil moisture to maintain its health properly and also save water which is most important thing along with soil for farming. The system will use microcontrollers like Arduino UNO and Raspberry pi and sensors like soil moisture sensor and humidity sensor which will help in monitoring the soil and help controlling the drip irrigation which is a very efficient irrigation technique.The microcontroller Arduino UNO and Raspberry pi are best for controlling the low voltage sensors and devices like servo motor, GPRS module and temperature and moisture sensor. Through Arduino the data from sensors can be sent to cloud like ThingSpeak for data visualization and further use of data in other platforms. Arduino can also be programmed to switch on and off the servo motor based on the readings through sensors for accurate automated irrigation of crops. GPRS module is used to send a text message to a particular phone number or send data across internet. The data sent to ThingSpeak server from Arduino is sent through GPRS module which has a SIM slot.The system will be able to suggest crops based on the soil conditions, weather conditions of the area, predicted weather for this season and the demand of the crop in market based on the previous market price of the crops which will increase the profits for the farmers. The technical details of each device used is given as follows:

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (Atmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (Atmega328P)
EEPROM	1 KB (Atmega328P)
Clock Speed	16 MHz
LED_BUILTIN	13

Table 1: Technical details of Arduino UNO

Power	3-5V
Max Current	2.5mA
Humidity	0-100%, 2-5% accuracy
Temperature	40 to 80°C, ±0.5°C accuracy

Table 2: Technical details of Humidity sensor DHT22

Input Voltage	3.3 – 5V
Output Voltage	0 – 4.2V
Input Current	35mA
Output Signal	Both Analog and Digital

Table 3: Technical details of Humidity Sensor

PCB size	50mm X 30.5mm X 1.6mm
Voltage Input	3.4V ~ 4.4V
Interface	UART
Indicator	NET, STATUS
Button	POWER

Table 4: Technical details of GPRS Module (SIM808)

IV. IMPLEMENTATION

The system consists of one microcontroller board, two sensors, one servo motor, a GPRS module, an android app, cloud service, and power source for the Arduino UNO. The microcontroller we used is Arduino UNO, which is enough for small IoT projects, as we increase the parameters through more sensors, we can use Raspberry Pi as microcontroller. The coding in Arduino is quite easy as it is based on C/C++, and the coding can be done in Arduino IDE. The sensors we used are Humidity sensor DHT22 and Soil moisture sensor FC-28, the humidity sensor will give humidity in environment and soil moisture sensor will give the amount of moisture in soil which will help the system to know when to start irrigation. We used a GPRS module, SIM808 module which provides us with GSM, GPRS and GPS functions. It will constantly update the data in cloud storage and give the real time value of soil moisture and humidity in field in mobile app. Through the mobile app one can monitor and control the irrigation system of their field. The GPRS module
will also send text message if the moisture content in soil is low or too high, so that farmer will be warned earlier. The cloud storage we used is ThingSpeak which is an open-source Internet of Things Application and API for storing and retrievingdata from devicesusing the HTTP and MQTT protocol across the Internet or via aLocal Area Network. We are also using servo motor for switching on and off the drip irrigation system, it will be controlled by the Arduino.

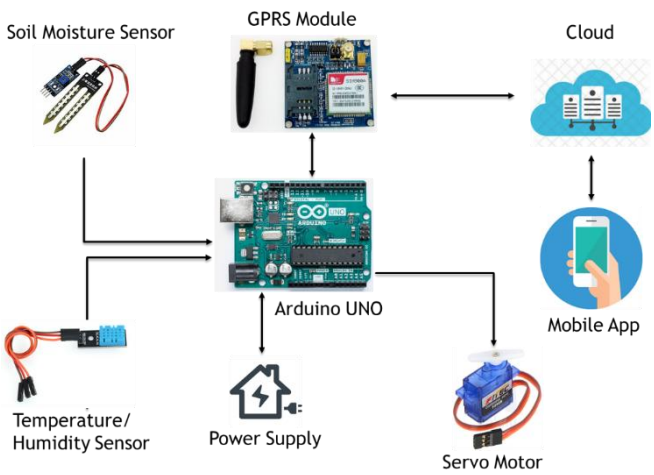

Fig 5: System architecture

For the storing and retrieving of data from IoT devices like sensors installed in soil through Arduino we used ThingsSpeak which is an open-source application and API of Internet of Things (IoT) for storing and retrieving the data from IoT devices using the MQTT and HTTP protocol through the Internet or via a LAN. ThingSpeak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates. We need to create a channel to get the API keys to get the read and write keys throught which we can send data to server and retrieve data from server. We can see the channel stats in private view and get the API keys under API Keys section. We can also visualise the data in ThingSpeak of past values through charts and graphs. For croop suggestion we use different types of data like state wise rainfall, crop details like weather condition needed, soil type and other requirements of crop, temperature and weather of the area and soil type in the area. Through Linear regression algorithm we will predict the profitability of the crop based on previous data and through Random forest

V. RESULTS DISCUSSION

The system is able to irrigate the field properly on the given values for humidity and moisture in soil which was set from the start based on the type of crop. The system also stored and was able to retrieve the data sent by the microcontroller through GPS module, which helped in visualizing the condition of soil.

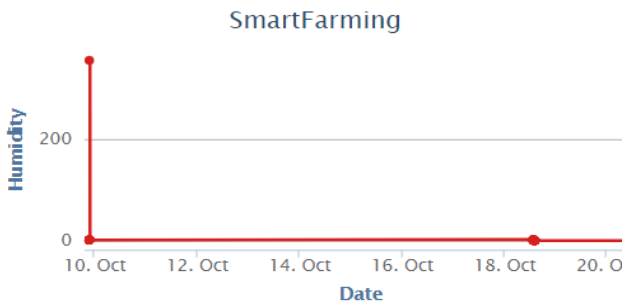

Fig 6: Humidity sensor readings

As we can see through the graphs, when the value needed was set as 0 for humidity, the system maintained the soil's humidity nearly as 0. Also, the moisture needed at the time of putting the seed in soil should be less and gradually it should increase as it starts to grow. More factors can be added in the system for sensing the turbidity of the water and checking the availability of right minerals present in the soil. These will help for a better view of health of the soil.

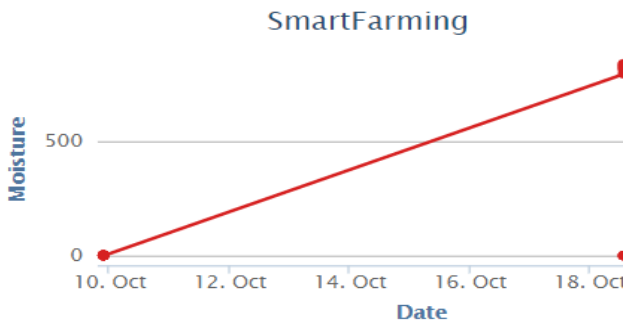

Fig 7: Moisture sensor readings

With the help of Linear regression and Random Forest algorithm we were able to analyze the data for crop prediction based on the previous year's weather, soil type, rainfall, type of crop and temperature conditions of the area. Because of this suggestion system the farmers will be able to know which crop will allow them to profit more from the resources available and market trend. The farmers mostly grow crops by seeing neighbor farms or which they are growing from past years, this can affect their crops and profit because soil quality, climate and market demand changes after some years. Farmers are also unknown to new type of crops which can be grown on their farm, about which our crop suggestion system will suggest them so that they can gain knowledge about those and grow the same.

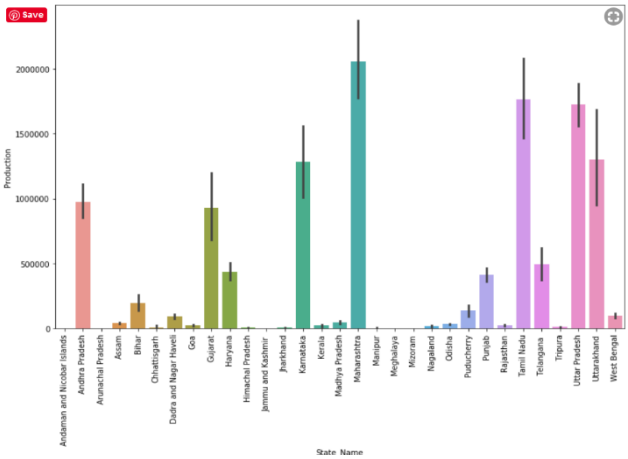

Fig 8: State wise crop production in a year

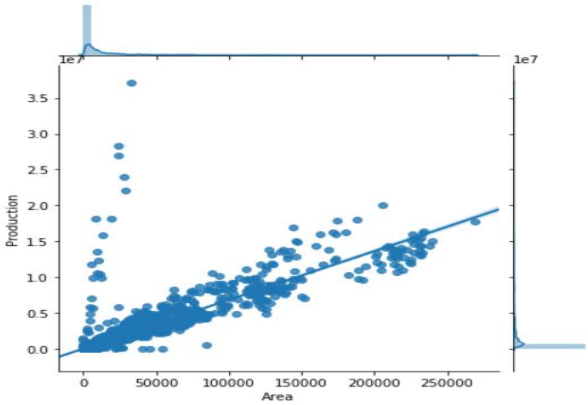

Fig 9: Area vs Production of a particular crop

VI. CONCLUSION

Through these systems the farming can be revolutionised for the better use of resources which are needed by the crop. The automatic irrigation system can be very useful for the areas with shortage of water, it will reduce water logging and provide constant water all over the field. The data retrieved by the sensors can also be used with health of the crop to analyse how much humidity and moisture content is needed for a particular crop. The crop suggestion part of the system can be modified to add more data types like market price of the crop and demand in market which will further help the farmers to profit from their farming.

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Aman Rakesh is currently pursuing B.Tech degree in the Computer Science Engineering from the S.R.M. Institute of Science and Technology, Chennai, India and is currently in the 8th Semester of Graduation. His area of interest is Artificial Intelligence, Internet of Things and Data Analytics. He is trying to find ways to implement AI and IoT in the livelihood of normal people so as to make their life better with the use of these technologies. With this understanding, he tried to make this research on farming based on soil conditions, temperature, and production of crops, which will provide sufficient information to farmers to choose a suitable crop that can be most profitable for them. This is his first research paper publication with an earnest attempt to help people and utilize this technology in the best way possible. This small research will be helpful in the understanding of the used technologies in this field and might help in developing an even better method in the future. Currently, Aman is working as an Intern in Coviam Technologies in the Data Analytics Team.

Dr. C.N.S Vinoth Kumar received his B.E. degree in the discipline of Information Technology from Annamalai University, India, M.E Degree in the discipline of Computer Science Engineering from Annamalai University, India, Ph.D. degree in the discipline of Computer Science and engineering from Annamalai University.His area of interest is Wireless Sensor Networks, Cryptography & Network Security, Artificial Intelligence, and Graphics. He is the lifelong member of computer society of India and International associations of engineers. Currently he is working as Assistant professor, Department of CSE in SRM Institute of Science and technology, Chennai, Tamilnadu, India.