Sensor Data Validation

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ABSTRACT

Agriculture is the primary occupation in our country for ages. In India about 70% of population depends upon farming and one third of the nation’s capital comes from farming. But now due to migration of people from rural to urban there is hindrance in agriculture. To overcome this problem we go for smart agriculture techniques using IOT. The Internet of things (IOT) is remodeling the agriculture enabling the farmers with the wide range of techniques such as precision and sustainable agriculture to face challenges in the field. IOT interconnects human to thing, thing to thing and human to human. IOT enables the objects to be sensed and controlled remotely across existing network model. The paper comprises of sensors that sense the field parameters such as temperature, humidity, moisture and fertility in the farm. The sensed values are validated and later sent to the WI-FI module and from WI-FI module the validated data are sent to the farmer’s mobile or laptop using cloud. The farmers are also notified by SMS if the field needs a care.

An algorithm is developed with threshold values of temperature, humidity, moisture and fertility that are programmed into a node MCU to control water quantity. Farmer can automate the motor from anywhere in the world.

Keywords: IOT, Arduino, node MCU, Ubidots, WI-FI module, sensors

I. INTRODUCTION

As the world is trending into new technologies and implementations it is a necessary goal to trend up in agriculture also. Many researches are done in the field of agriculture. Most projects signify the use of wireless sensor network collect data from different sensors deployed at various nodes and send it through the wireless protocol. The collected data provide the information about the various environmental factors. Monitoring the environmental factors is not the complete solution to increase the yield of crops. There are number of other factors that decrease the productivity to a greater extent. Hence automation must be implemented in agriculture to overcome these problems. So, in order to provide solution to all such problems, it is necessary to develop an integrated system which will take care of all factors affecting the productivity in every stage. But complete automation in agriculture is not achieved due to various issues. Though it is implemented in the research level it is not given to the farmers as a product to get benefitted from the resources. Hence this paper deals about developing smart agriculture using IoT and given to the farmers. In this paper, IOT technology helps in collecting information about conditions like temperature, humidity, moisture and control motor using microcontroller. IOT leverages farmers to get connected to his farm from anywhere and anytime. Agricultural crop monitoring and control can be done using Arduino Uno. Wireless sensor networks are used for monitoring the farm conditions and micro controllers are used to control and automate the farm processes. This paper is useful for farmers in maintenance and controlling of crop production.

Fig.1 AUTOMATION IN AGRICULTURE

II. LITERATURE SURVEY

Liu Dan, Joseph Haule, Kisangiri Michael and Wang Weihong, Cao Shuntian carried out experiments on intelligent agriculture greenhouse monitoring system based on ZigBee technology.
The system performs data acquisition, processing, transmission and reception functions. The aim of their experiments is to realize greenhouse environment system, where the use of system efficiency to manage the environment area and reduce the money and farming cost and also save energy. IoT technology here is based on the B-S structure and ccc2530 used like processing chip to work for wireless sensor node and coordinator. The gateway has Linux operating system and cortex A8 processor act as core. Overall the design realizes remote intelligent monitoring and control of greenhouse and also replaces the traditional wired technology to wireless, also reduces manpower cost.

Nelson Sales experimented with interconnection of smart objects embedded with sensors that enabled them to interact with the environment and among themselves, forming a Wireless Sensor Network (WSN). These network nodes perform acquisition, collection and analysis of data, such as temperature and soil moisture. This type of data can be applied to automate the irrigation process in agriculture for decreasing the water consumption, which would result in monetary and environmental benefits. Authors proposed to use cloud computing which has the high storage and processing capabilities, the rapid elasticity and pay-per-use characteristics makes an attractive solution to the provided might help researchers to highlight issues in the agriculture domain.

Elias Yaacoub, K.SathishKannan, G.Thilagavathi proposed the deployment of a wireless sensor network to monitor and analyze air quality in Doha. Data stored on the server is subjected to intelligent processing and analysis in order to present it in different formats for different categories of end users. This experiment brings out a user-friendly computation of an air quality index to disseminate the data to the general public and also the data presentation for environmental experts using dedicated software tools, for example- the R software system and its Open-air package. Depending on the target end-user the stored data can be accessed and displayed in different formats.

R. Balamurali , NarutSoontranon, PanwadeeTangpattanakul, PanuSrestasathierm, PreesanRakwat, Chen XianYi, Jin Zhi Gang, Yang Xiong have discussed precision agriculture for real-time monitoring of environmental conditions of a farm like temperature, humidity, soil PH etc. The values of monitored parameters are communicated to the remote server in order to take appropriate action, instead an actuator or an automated system can also be used to take appropriate action based on the measured California based trace genomics provided soil analysis services to farmers. Lead investor illumina helped to develop the system which uses machine parameters over a period of time. This paper analyzes the various routing protocols like AOMDV, AODV DSR and Integrated MAC and Routing protocol (IMR) for precision agriculture using WSN. This analysis draws conclusions that Integrated MAC and Routing Algorithm is best suitable for multi-hop routing for precision agriculture using Wireless Sensor Network (WSN) in terms of Network life time. The network lifetime is considered as the time at which the first node in the WSN dies. The work may be enhanced to analyze other network parameters like throughput and end-end delay.

Development of Knowledge Sharing System for Agriculture Application, proposes a methodology where the data related to the agricultural field can be shared using the Knowledge sharing system. The main theme of the research is to design a methodology to share the data and it also involves inheriting of agricultural data. The methodology involves data collection by two methods. First one is the automatic environmental data collection by a sensor, and second method is the experienced data collection by a farmer. Optimal design of solar powered fuzzy control irrigation system for cultivation of green vegetable plants in Rural India, proposes methodology called fuzzy-logic that acts as a solution for irrigation control in order to cultivate the vegetable plants. Smart Farming System Using Sensors for Agricultural Task Automation, proposes a unique methodology that links smart sensing system and smart irrigator system which is collectively known as smart farming process.

ChandankumarSaHu et.al implemented the system in which RASPBERRY-Pi is used for control the irrigation system and connects with internet to send data to the registered mobile number. Automatic message sending is developed using python programming in raspberry-pi. By using the automatic irrigation system it optimizes the usage of water by reducing wastage and reduces the human intervention for farmers. It saves energy also as it automatic controlling the system. Automation in irrigation system makes farmer work much easier. Sensor based automated irrigation system provides promising solution to farmers where presence of farmer in field is not compulsory.

Berlin-based agricultural tech startup PEAThas developed a deep learning application called Plantix that reportedly identifies potential defects and nutrient deficiencies in soil. Analysis is conducted by software algorithms which correlate particular foliage patterns with certain soil defects, plant pests and disease. Learning to provide clients with the sense of their soil’s strengths and weakness.
Sky squirrel technologies inc. is one of the companies which brought drone technology to vineyards. The company aims to help users to improve their crop yield and to reduce cost. Users preprogrammed the drone’s route and once deployed the device will leverage computer vision to record images which will be used for analysis.

III. METHODOLOGY

A. WIRELESS SENSOR TECHNOLOGY

Smart agriculture also known as precision agriculture allows farmers to maximize yields using minimal resources such as water, fertilizer and seeds. By deploying sensors and mapping fields farmers can begin to understand their crops at a microscale, conserve resources and reduce impact in the environment. Advances in sensor technology has also proven beneficial to the agricultural industry through its application for infield soil analysis.

Temperature is the most often measured environmental quantity. Temperature sensing can be done either through direct contact with the heating source or remotely without direct contact with the source using radiated energy instead. There are a wide variety of temperature sensors, LM35 temperature sensor is calibrated directly in celsius (centigrade). It is rated for full -55°C to +150°C range. It is suitable for remote applications. It is of low cost due to wafer level trimming. It operates from 4 to 5V. The sensor has low self heating.

Humidity is defined as the amount of water present in the surrounding air. This water content in the air is a key factor in the wellness of mankind. Humidity sensors are very important devices that help in measuring the environmental humidity. Technically the device used to measure the humidity of the atmosphere is called hygrometer. Humidity sensors or hygrometer can be classified based on the type of humidity it is used for measuring i.e Absolute humidity sensors or relative humidity sensors.

B. SYSTEM ARCHITECTURE

The architectural design to monitor the crops is shown in Fig.3. In this implementation model we used Arduino UNO board, Sensors and ESP8266 Wi-Fi module as an embedded device for sensing and storing the data in to cloud. Arduino UNO board consist of 12 analog input pins (A0-A11), 54 digital output pins (D0-D53), inbuilt ADC. Wi-Fi module connects the embedded device to internet. The Wi-Fi connection has to be established to transfer sensors data to end user and also send it to the cloud storage for future usage. If the threshold limit is crossed the corresponding controlling action will be taken. All the sensor devices are connected to internet through Wi-Fi module. After successful completion of sensing, the data will be processed and stored in database for future reference. After completing the analysis on data the threshold values will be set for controlling purpose.

C. PROCESS FLOW

The data flow diagram to display the monitoring parameters is shown in Fig.4. In this data flow
diagram initially the sensors and Wi-Fi module are connected to the microcontroller i.e. node MCU. The sensor data are processed using the microcontroller and embedded C in Arduino ide. The commands are sent to ESP8266 Wi-Fi module. The Wi-Fi module is checked whether it is functioning properly or not. If Yes the Wi-Fi network is connected or else the commands are received once again. All the sensor data which is being monitored is sent to cloud. The values are plotted on the graph and the monitoring parameters are displayed on Ubidots. The various sensors used are temperature, humidity and moisture sensor. Even a threshold value can be set and the motor switches on automatically as the threshold level is met. A continuous output voltage power source is provided to the microcontroller.

Sensor data validation is an important process executed during the data acquisition and data processing modules. This process consists of the validation of the external conditions of the data and the validity of the data for specific purpose, in order to obtain accurate and reliable results. The sequence of this validation may be applied not only in data acquisition but also in data processing since increase, as these increase the degree of confidence of the systems, with the confidence in the output being of great importance. One of the causes for the presence of incorrect values during the data acquisition process may be existence of environmental noise. Even when the data is correctly collected, the data may still be incorrect because of noise. Therefore, very often the data captured or processed has to be cleaned, treated, or imputed to obtain better and reliable results. Following the existence of missing values at random instants of time, the causes may be the mechanical problems or power failures of sensors. At this case, data correction methods should be applied, including data imputation and data cleaning.

D. COMPUTATIONAL ANALYSIS OF SENSOR PARAMETER

Here we include some basic analytic methods to calculate the Sensors parameters like Temperature and Humidity. LM35 Temperature sensor gives output voltage 10 mv for 1°C. this sensor output is connected to any analog pin of Arduino Uno. Uno converts analog voltage into digital using on chip ADC.

\[
\text{ADC reading}=\text{analog Read}(A1) \quad (1)
\]

\[
\text{Voltage}=\text{ADC reading}^{*}5/(1023) \quad (2)
\]

\[
\text{Temperature}=\text{Voltage}^{*}100; \quad (3)
\]

\[
\text{Relative Humidity} = \left(\frac{\text{density of water vapor}}{\text{density of water vapor at saturation}}\right) \times 100\%. \quad (4)
\]

E. SENSOR DATA VALIDATION

Output: status for sensed data (x)
For \(i=0\) to \(n\) do \(i=i+1\)

ALGORITHM:
Heuristic rule:
\(\delta_1\) -minimum threshold
\(\delta_2\) -maximum threshold
\(n\) -Total number of sensed values
Input: array of sensed data (x)
If \((x[i] \geq \delta_1 \text{ and } x[i] \leq \delta_2)\)
Then status \([i]\) → good
Else
Status [i] ←Not good
End if

F. IOT CLOUD

Ubidots offers a platform for developers that enable them to easily capture sensor data and turn it into useful information. Ubidots platform is used to send data to the cloud from any Internet-enabled device. We can then configure actions and alerts based on our real-time data and unlock the value of our data through visual tools. Ubidots offers a REST API that allows you to read and write data to the resources available: data sources, variables, values, events and insights. The API supports both HTTP and HTTPS and an API Key is required. The variables are created and unique variable ids are assigned to it. The values are plotted in a graph with the date and time in X axis and the values in the y-axis. All the values are displayed to the user with the corresponding date and time and hence the values can be viewed at any time by the user. The threshold values can be set on the Ubidots platform an email or sms or call can be sent to the user when the threshold levels are met. Hence Ubidots is an Inter of Things platform which helps in monitoring all the parameters and displays the values to the user. A threshold values are also set to take corrective actions. The API key which is generated in Ubidots should be added in the Arduino code to connect to the cloud. An APIkey is the “Master Key”: a unique and immutable key that is used only to generate our account’s tokens. A token is a temporary and revocable key which is to be used in our API request. It gets created ones an account is created in Ubidots. Tokens created in our account profile will never expire.

IV. EXPERIMENTAL ANALYSIS

The values of temperature, humidity and moisture parameters are shown in fig.6, fig 7 and fig 8 respectively. A variable id is created for every parameter. A graph is plotted with all the values. The x axis consists of the date and time; the y axis consists of the values. The value is being analyzed by taking various reading of the temperature, humidity and moisture. The graph gives a clear view of the changes in the values with respect to date and time. As soon as the value reaches the threshold value the Wi-Fi module will send a sms to the user. If the moisture value is 0 the motor has to be switched on. When the moisture value reaches 1, the moisture content in the field is good and the motor has to be switched off.

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Fig.6 TEMPERATURE VALUES

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Fig.7 HUMIDITY VALUES

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<td>0.00</td>
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Fig.8 MOISTURE VALUES
In Fig.9, the values are plotted in the graph and the analysis of the parametric values can be done. The green line indicates the humidity graph. The blue line represents the temperature graph and orange line represents the moisture graph.

In Fig.10, a device called agriculture is created and three variables temperature, humidity and moisture is created. The current value of the farm is displayed on the screen.

V. COMPARATIVE PERFORMANCE OF EACH PARAMETER

In Fig 9, the crop yield of each year has been monitored and we find out that with the adoption of new technologies and crop monitoring systems the crop yield has increased from 20% in 2000 to 89% in 2018.

In Fig 10, the number of labors has been monitored and we find out that with the adoption of new technologies and crop monitoring systems the number of labors has been decreased from 60% in 2000 to 15% in 2018.

In Fig 11, the cost has been monitored and we find out that with the adoption of new technologies and crop monitoring systems the cost has been increased from 10% in 2000 to 90% in 2018.

In Fig 12, the accuracy has been monitored and we find out that with the adoption of new technologies and crop monitoring systems the accuracy has been increased from 20% in 2000 to 98% in 2018.
In Fig 12, all the parameters have been monitored and we find out that with the adoption of new technologies and crop monitoring systems the crop yield has increased from 20% in 2000 to 89% in 2018, the number of labors has been decreased from 60% in 2000 to 15% in 2018, the cost has been increased from 10% in 2000 to 90% in 2018, the accuracy has been increased from 20% in 2000 to 98% in 2018.

V. CONCLUSION

Agriculture are gradually being replaced and enhanced by more sophisticated and accurate digital and electronic device. A high percentage of agriculture revenue is lost to power loss, incorrect methods of practicing. This is reduced by the use of smart sensors. The proposal is to perform the agriculture in smart and more efficient way. In addition, this method advocates for the use of the Internet of Things. Internet of Things has enabled the agriculture crop monitoring easy and efficient to enhance the productivity of the crop and hence profits for the farmer. Sensors of different types are used to collect the information of crop conditions and environmental changes and this information is transmitted through network to the farmer/devices that initiates corrective actions. Farmers are connected and aware of the conditions of the agricultural field at anytime and anywhere in the world.

VI FUTURE ENHANCEMENT

By further enhancement of this project farmers can bring large areas of land under cultivation. Only the exact amount of fungicide and pesticide can be used. The system can further be improved by incorporating new self-learning techniques which could deployed in the cloud to understand the behavior of the sensing data and can take autonomous decisions. The other problem farmers are facing is the crop destruction by the wild animals. So the future work include the design of the system that may monitor the farm by installing sensors at the boundary of farm and camera module which may take a snapshot once the sensor detects the entrance and transmit the real time pictures by integrating it with other information.

VII. REFERENCES


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