An Approach for Agricultural Field Monitoring and Control Using IoT

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Abstract - *Modernization of the farming process is one of the crucial steps for a country like India, which has to import tremendous amount of grains and agro products from other countries to meet the demand of 1.2 billion populations. Various architectural and technological improvements have been suggested in the past and have been widely adopted over the years to improve the productivity of the agricultural field. One of the major challenges of the agriculture is the proper monitoring of the soil health, the environment, and adjusting the irrigation as well as the plant clear according to this observation. Traditionally, Indian farmers have adopted manual observation based technique which has resulted in either excessive use of pesticides or under use of watering or many issues which results in less efficient and less productive crops. In this work we propose a novel IoT based solution for agriculture field monitoring and irrigation control. The system connects physical sensing devices with the cloud and connects the irrigation control mechanism with the cloud. This keeps an immense analysis and problem solving capability to the overall architecture. Results have shown that we can mitigate data in real time with exceedingly low latency and based on that we can take the decisions.*

Key Words: IoT, Sensor Network.

1. INTRODUCTION

Internet of things (IoT), basically is a cloud of interconnected physical devices, which can communicate with each other over the Internet. We propose a Novel IoT sensor network for monitoring the environmental parameter in an agriculture field. Mitigating this data to the cloud through a secured IoT hub (Thingspeak), and then run and predictive analysis and the machine learning on the gathered data (mat lab deployed at Thingspeak).The proposed system overcome the limitations of traditional GPRS based system through protocols like MQTT, secured HTTP, which not only ensured that the data is safe and secured, but the entire communication is over an authorized secured socket layer which gives immense security to the data. The proposed system also have bandwidth compatible and cross level compatible, therefore the client level solution can be run either on the mobile, PC or on the tablet. The remote monitoring solution that we offer can be monitored in real time through any remote devices including mobiles or tablets. This provides the flexible for the data visualization, data understanding, and the predictive analysis also given the scope for the farmers to prepare for the advanced data which might appear in the future. The proposed system is 4G compatible, it is not limited by the bandwidth and high latency, which is experienced for the GPRS based system. At the same time the MQTT protocol itself free, the overall operating cost for controlling mechanism is null in comparison with GSM based system, where each SMS's has a cost which is determined by the tariff of the service provider.

The rest of the paper is organized as follows. Section II presents the related work. Section III gives out details of the proposed scheme. The implementation and results are discussed in section IV, then finally concludes the paper and outlines future works in section V.

2. RELATED WORK

"Monitoring Precision agriculture monitoring system based on wireless sensor networks," Zhenyu Liao; Sheng Dai; Chong Shen, Wireless sensor network (WSN) is a new technology that can provide processed real-time field data from sensors physically distributed in the field. Based on investigation and applications in precision agriculture, a wireless agricultural and environmental sensing system for crop monitoring is presented in the paper. The setup of smart crop monitoring System is based on TinyOS while system test is implemented using real-time agricultural data and historical data. The results indicate that the application scenarios are correct and reasonable, which enables users precisely acquire information from environment.

"Optimal design of solar powered fuzzy control irrigation system for cultivation of green vegetable plants in Rural India," Singh, S.N.; Jha, R.; Nandwana, M.K., presents solution for an irrigation controller for cultivation of vegetable plants based on the fuzzy-logic methodology. Water is an essential element for growth of the plants, the amount of water given to the plants depends on its size, moisture control of soil, which is affected by temperature of environment, evaporation due to wind velocity and water budget. This presents a control strategy to feed water to plants in a controlled and optimal way. The study pertains to develop a solar powered pump controller, using fuzzy logic control strategy to feed water for cultivation of these plants.

" Quantifying Water Savings with Greenhouse Farming", Kelsey A. Czyzyk, Shayne T. Bement, William F. Dawson and

KhanjanMehta, Greenhouses can help farmers reduce spoilage and increase yields, and therefore improve their livelihoods. As compared to open air farming, greenhouse farming requires less water due to reduced evapotranspiration. The test methodology involves a simplified pan evaporation measurement used with the Penman-Monteith and Hargreaves equations. Data including air temperature, relative humidity, wind speed, and water loss inside and outside them greenhouse, were collected from similar greenhouses in Kenya and Cameroon. Results indicate that the water savings within greenhouses are around 50-90%. This significant reduction in water consumption allows for agricultural intensification as well as horticultural production in arid and semi-arid regions that make up over 80% of the land in several African countries.

”Design of Wireless Sensor Network-Based Greenhouse Environment Monitoring and Automatic Control System”, Yongxian Song, Juanli Ma, Xianjin Zhang and Yuan Feng,” wireless sensor network (WSN) is presented, which adopts Atmega128L chip and CC2530 that is a low power RF chip from TI to design the sink node and sensor nodes in the WSN. The monitoring and management center can control the temperature and humidity of the greenhouse, measure the carbon dioxide content, and collect the information about intensity of illumination, and so on. The system can solve the problem of complex cabling with the advantages of low power consumption, low cost, good robustness, extended flexible and high reliability. An effective tool is provided for monitoring and analysis decision-making of the greenhouse environment.

”Smart Farm Using Wireless Sensor Network for Data Acquisition and Power Control Distribution”, Francisco B. Culibrina, Elmer P. Dadios, involves a Smart Farming which makes a tremendous contribution for food sustainability for 21st century. Using wireless sensor network in farming from; independent power source distribution, monitoring valves and switches operation, and remote area control will efficiently produce excellent quality farm products in all season. In order to control farm power distribution and irrigation system, this proposes a communication methodology of the wireless sensor network for collecting environment data and sending control command to turn on/off irrigation system and manipulate power distribution. The simulation results shows that the proposed system developed is accurate robust and reliable.

” Smart Farming System Using Sensors for Agricultural Task Automation”, Chetan Dwarkani M, Ganesh Ram R, Jagannathan S, R. Priyatharshini proposed a novel methodology for smart farming by linking a smart sensing system and smart irrigator system through wireless communication technology. The system focuses on the measurement of physical parameters such as soil moisture content, nutrient content, and pH of the soil that plays a vital role in farming activities. Based on the essential physical and chemical parameters of the soil measured, the required quantity of green manure, compost, and water is splashed on the crops using a smart irrigator, which is mounted on a movable overhead crane system. The detailed modeling and control strategies of a smart irrigator and smart farming system are demonstrated here.

3. MODULES

The modules which are used in the design can be summarized into following modules.

- **Physical parameter monitoring**: We have used light sensor(LDR),temperature sensor(seed studio temperature sensor),rainfall sensor(resistor based potentiometer),and soil moisture sens, and we have added the sensor with the analog ports of Aurdino compatible extension board with Intel Edison device. These analog ports are of 10bit precisions; therefore we get A/D values for the sensors within the range of 0, 1, 2, and 3.
- **Data display:** The observed data is displayed on a color LCD for local observations of the parameters.
- **Data integration to the cloud:** We use thingspeak IoT gateway to mitigate this data using http sockets, encoded with API keys being offered by the thingspeak. Once the data is mitigated into thingspeak it can be observed in real time from anywhere in the world.
- **Alert generation:** We have defined threshold for temperature as 40’c, light intensity as more than 70’c, and soil moisture as less than “0”, as in an unsuitable conditions for the plants, in case such a condition when observed the farmer is notified through a matt channel.

We can also adopt a close loop controlling of the pump based on the parameter but we have offered the farmers choice for accessing the irrigation system based on his experience and observation of the values.

- **Irrigation Control:** We have used a 230 volt pump through a relay and we have added it with the data port of Intel Edison board. The irrigation system is connected with the farmers using MQTT protocol which is a high queue guaranteed, low latency communication protocol for Iota farmer can generate particular commands for switching on and turning off of the irrigation system. Once the respective command is asynchronously obtained by Intel Edison it triggers the relay on and off based on the command. We have added an advanced cloud based data mining technique based on MATLAB by means of which we can not only observe the value of the environment but we can also predict their future values. Therefore farmers can be prepared with the future conditions, this is been done with the mat lab analysis where the code is deployed directly on the cloud.

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4. IMPLEMENTATION AND RESULT ANAYSIS

User can analyze the output at the thingspeak, which will give the graphical notations of all the values. Thingspeak is an open source Internet of Things (IoT) application and API to store and retrieve data from things using the HTTP protocol over the Internet or via a Local Area Network. We can see the graphs of temperature value, light value, soil moisture value and the rainfall value.

Fig -1 Experimental setup

A Real time data visualization can be analyzed in the thingspeak, which is an IOT hub. The following figure shows the real time data visualization.

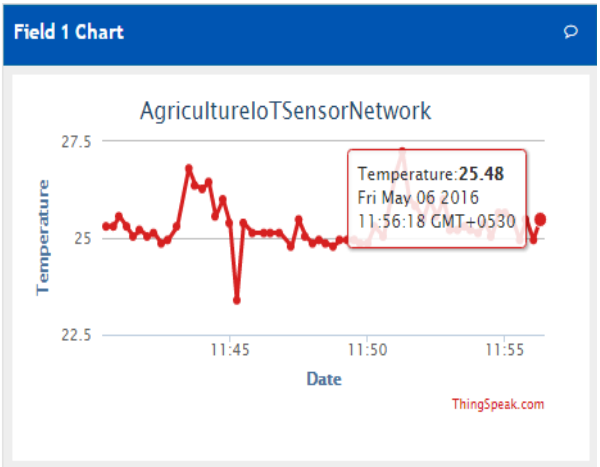

Chart -1: Analysis of Temperature value

The graph in the above figure suggests that the temperature value is analyzed in the thingspeak IoT hub. The graph is plotted with temperature value v/s date.

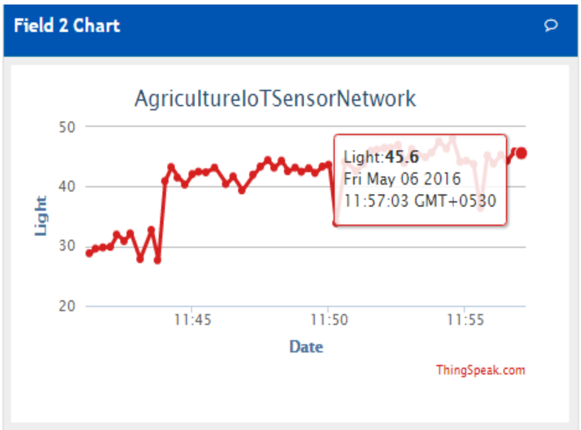

Chart -1: Analysis of Light value

The above graph shows that light value is changed with change in the sensor.

The below figure shows the graph of moisture value. The value is being analyzed by taking vaious reading of the soil value.

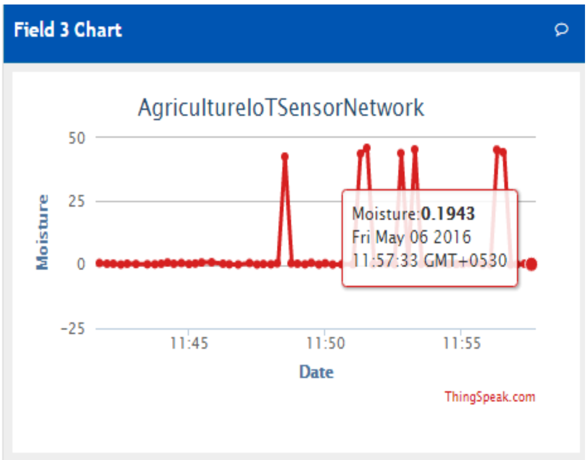

Chart -1: Analysis of Moisture value

The below figure shows that the rainfall value is analyzed in the thingspeak, by dissipating its value into the cloud.

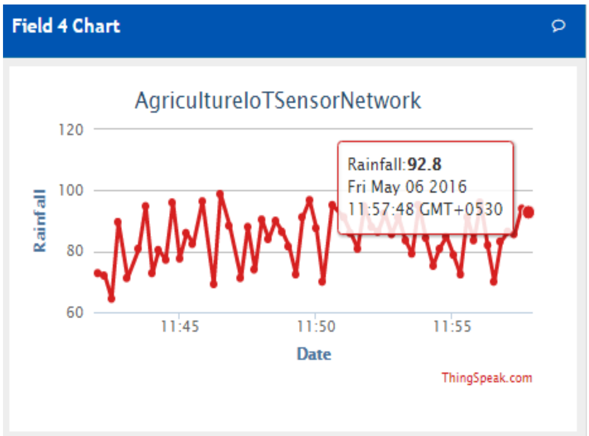

Chart -1: Analysis of Rainfall value

5. CONCLUSIONS

Improvement of the crop productivity is a major challenge in the countries like India, the technological improvement is a mandatory work to improve the crop productivity to support and sustain the need for ever green population of our country. In the past several sensor driven network have been proposed to successfully monitor the large agriculture field. However most of the technology does not offer on the data mining technique and predictive analysis, which limits the data usage o accurate state of the field and crop. We propose a novel technology by means of which gathered data from physical sensing devices is mitigated in the cloud, where a machine learning technique could in real time produce not only the alerts corresponding to the current state of the environment and the crop but at the same time can offer predictive analysis of the future state of environment as well as crops template format .

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