IoT Based Intelligent Agriculture Field Monitoring System

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Abstract Agriculture is becoming an important growing sector throughout the world due to increasing population. Major challenge in agriculture sector is to improve farm productivity and quality of farming without continuous manual monitoring to meet the rapidly growing demand for food. Apart from increasing population, the climate change is also a big concern in agricultural sector. The purpose of this research work is to propose a smart farming method based on Internet of Things (IoT) to deal with the adverse situations. The smart farming can be adopted which offer high precision crop control, collection of useful data and automated farming technique. This work presents an intelligent agriculture field monitoring system which monitors soil humidity and temperature. After processing the sensed data it takes necessary action based on these values without human intervention. Here temperature and moisture of the soil are measured and these sensed values are stored in ThingSpeak [11] cloud for future data analysis.

KeywordsInternet of Things, Smart Farming, Agriculture, ThingSpeak cloud.

I. INTRODUCTION

According to Beechams report entitled Towards Smart Farming: Agriculture Embracing the IoT Vision predicts that food production must have to increase by 70 percent in the year 2050 in order to meet our estimated world population of

9.6 billion people [9]. Hence, it is very important to boost up the agricultural productivity to ensure high yield and farm profitability. The major challenge in quality farming is unpredictable weather and environmental conditions such as rainfall, temperature, soil moisture etc. Moreover, humidity is one of the major environmental parameter in farming as it affects the turgor pressure of plants, which is an indicator of the amount of water in plant cells. When the amount of humidity in air is low, transpiration takes place very quickly in plants. Further, due to high rate of transpiration, plants wilt rapidly as too much water is pulled out from plant cells. On the contrary, when amount of moisture in air as well as temperature is high, the rate of transpiration is reduced which in turn restricts evaporative cooling. In order to monitor these environmental conditions and action have been taken accordingly, continuous manual effort was required which is quite impractical and not possible all the times.

In this respect, IoT plays a significant role in implementing the concept of smart farming to automate the farming operations.

IoT is new computing and communication paradigm in which the objects of everyday life have equipped with sensor, microcontroller and transceiver to sense the surrounding environmental parameters. In addition, communication of the sensed data with one another or user, becoming an integral part of Internet system. In IoT, every objects used in our daily life with unique identifier is connected with each other so that they can send data over the network without human intervention [1, 2]. IoT is growing day by day as many more objects are going to be connected throughout the world. IoT can be used in many different domains such as precision agriculture [1, 2], Smart grid [3], environmental monitoring

[4] etc. IoT technology is gaining popularity in agricultural field for its highly scalable, interoperable and pervasive nature.

To automate the farming operations, several environmental parameters those have impact on farming, are required to track down at different locations. The important environmental parameters include temperature, moisture, and water level. Different types of sensors are deployed over the field to monitor those environmental parameters related to farming and attached with microcontroller. According to environmental condition, microcontroller controls different actuators or farming equipment (Pump, Fan etc.) without human intervention. Apart from that these sensed data can be stored in the cloud. Microcontroller attached with wifi module sends those sensed parameters to the cloud. Most wireless environment monitoring system uses GSM based and or CDMA/GPRS technology. But they have several disadvantages including high cost of network forming, low access rate etc. To be the part of internet, the objects have unique identifier. Internet Protocol version 6 (IPv6), Internet Protocol version 4 (IPv4) is generally used as a unique identifier of the objects.

The rest of the paper is organized as follows. Section II highlights related work on smart farming. Section III describes the proposed system design for IoT based smart farming. Section IV presents the experimental setup for implementing the proposed system and results. Finally, Section V concludes the paper.

II. RELATED WORK

In [5], M. A. Abdurrahman, et. al. proposed a costefficient product for farming where water is scare. The system made up with lowcost sensors and simple circuitry to automatically controls the flow of water. The humidity and temperature level are also sensed and displays in LCD. This system provides water for plants according to the soil moisture level and crop water requirement.

P. A. Bhosale and V. V. Dixit have proposed in [6] an indigenous low cost time depended microcontroller based irrigation scheduler which consists with various sensors for detecting moisture, temperature and wind. This system derives appropriate actuators (relay, solenoid valves, motor) depending on these values. The captured data are conveyed to the user in form of SMS through GSM module and stored into a memory card.

In [7], J. Balendonck, et. al. presented a deficit irrigation management system consists of a network of infield irrigation controllers and soil sensors. Irrigation controllers are connected to farmers computer through wireless link. The system can be used when there is a limited water supply, poor water quality or when leaching is prohibited. They used decision support system (DSS) that helps farmers to optimize irrigation and fertilizer management on the basis of selected crop, water availability and crop development. The DSS may run either in local computer or remote server and user can consult with DSS if needed for changing the irrigation strategies.

In [8], F. TongKe proposed smart agriculture based on IoT and cloud computing. Agriculture information cloud is constructed with different resources to achieve dynamic distribution of resource and load balancing. Large amount of data obtained through RFID, wireless communication are handled in agriculture information cloud.

JiChun Zhao et al. studied the control network and IoT technology for agricultural production. The author proposed remote monitoring system based on internet and wireless communication. An information management system is also designed to store the data. The collected data can be used for agricultural research facilities [10].

Unlike the work presented in [5, 6], the our proposed model in this paper not only provide cost effective smart farming which automate the farming operations but also it recorded the agricultural field temperature and moisture values to the cloud environment through communication technology for further analysis. Further, in [8] the implementation was missing, but this paper includes the implementation details of our proposed model. Table 1 shows a comparative study of our proposed system with other related works which are mentioned here.

III. PROPOSED SYSTEM DESIGN

Our main objective of this work is to design an IoT based smart farming to control high voltage electrical devices like pump, flap of playhouses etc. without human intervention depending on environmental parameters like soil moisture and temperature. These parameters are stored in cloud for future data analysis. Farming is done within playhouses for better controlled environment. The proposed system is consisting of different layer as represented in Fig. 1. It is divided into four modules: Sensor layer, Middleware, Communication Layer and Cloud & Application Layer.

A. Sensor Layer

This is the first layer of our proposed system. It is responsible for capturing and monitoring different environmental parameters. For sensing or collecting the parameters different kinds of sensors are deployed over the agriculture field. For this research work, two types of sensor have used: soil moisture sensor to monitor soil humidity level and temperature sensor to observe.