IoT Based Architecture for Agricultural Farm Monitoring

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Abstract

In the modern world, monitoring the farm is a big challenge to the farmers. Over the past decades, farmers have faced a lot of difficulties due to many farming related issues. The use of advanced techniques in agricultural sector will help to monitor and safeguard the crops with less man power. In this paper, an architectural model is proposed to improve the automatic monitoring of the farms. This architecture is designed to collect weather related data like temperature, rainfall, humidity etc., through various sensors and the images of the leaves with the Help of drones. The collected data is stored into the cloud environment, performs analysis and reports the actual status of the farm. Also, the proposed architecture will help to predict the intensity and spreading pattern of the diseases which are identified through the analysis of the collected data using advanced prediction techniques.

Keywords: IoT, Smart Monitoring, Drone, Leaf Disease

Introduction

Internet of Things is an advanced automation and analytics system which has applications across various industries through its unique flexibility and ability to be suitable in any environment (e.g. Agriculture). The Internet of Things (IoT) is a collection of intelligently linked devices and systems to leverage the data collected by embedding sensors and actuators in machines and other physical gadgets [1]. For this intelligence and interconnection, IoT devices are supplied with embedded sensors, actuators, processors, and transceivers. IoT is not a standalone technology; rather it is a combination of various technologies that work together in tandem. The term "Internet of Things" (IoT) was first coined by Kevin Ashton, who was a British technologist in 1999, in which the physical world objects can be connected to the Internet through sensors [2].

Internet of Things is a technology for interconnecting objects with access. Using Internet of Things technology, “objects” recognize themselves and obtain intelligent behaviour by making decisions [4]. Also, they can communicate information about themselves to other things. With the internet of things, anything will be able to communicate to the internet at any time from any place to provide any services by any network to anyone. This concept will create a new type of application which includes smart vehicle and the smart home, to provide many services such as notifications, security, energy saving, automation, communication and entertainment [5].

The agricultural industry is totally dependent on innovative ideas and technological advancements to increase yields and profits. There are plenty of compact IoT technologies in Agriculture for finding temperature, humidity, wind speed, soil content, pest infection and rainfall which still exist with many setbacks. As an alternative, in this paper, Drones are used to monitor the farm in a reliable and faster way. This collected data can be used to automate agricultural process and activities, improve quality and quantity, reduce risk and waste, and minimize efforts to manage crops [6, 7]. The need for IoT in agriculture is because of the rise in the need of saving fertilizers and chemical crop protection agents, to control crop state and prevent its loss when stored. It also helps to increase the machinery efficiency, monitor state and locating of farm animals and to track processing line equipment condition.

The challenges of IoT in agriculture are the cost of equipment and the need for wider internet coverage. If these two prerequisites fertilized to the farmers in affordable cost, the farmers in the developing countries will enjoy the benefits of this technology. In this paper, the related works are examined and a novel IoT based architecture for farm monitoring is proposed.

Review of Literature

Daisy *et al*. [8] demonstrated an approach which was useful in crop protection basically in large area farms, and it was based on automated techniques that can identify the diseased leaves by using colour information of leaves. In the first stage, the captured RGB image was converted to grey scale and resized. Finally, the variety of diseases in the leaf and the location of the diseases were also detected using various techniques. This approach was implemented for the early control of disease in early stage and protection from specific diseases.

Malvika *et al*. [9] evaluated the system for diagnosing the disease in the leaf and assisted the farmers for precise judgment. The diseased parts of the leaves were identified by the images captured through drones. As the result of segmentation, Colour HSV features were extracted from the captured images. Artificial neural network (ANN) was used to distinguish between the healthy and diseased samples. The result of ANN classification provided a better accuracy of 80%.

Solahudin *et al*. [10] discussed Gemini virus attack in chilli crop with the help of Bayesian segmentation method. The defected portions of the crop were analysed with the help of images taken from the Earth's surface. The images were captured using the aerial photography through multi-copter. In addition, the Bayesian segmentation method determined the levels of defected crops with a 3-dimensional input colour component such as Red, Blue and Green.

Monzurul *et al*. [11] used image processing and machine learning techniques to determine the cause of plant diseases. The proposed approach classified the diseased images by using image segmentation with support vector machine and 90% of accuracy was earned through this automatic disease detection system.

Lala *et al*. [12] proposed a system for automatic crop irrigation, which monitored various factors like temperature, humidity, wind and water level. Temperature and soil moisture sensor were utilized to measure the factors which were previously mentioned. The received data was transferred to the server by using Global System Monitoring technique. After the prediction was made, the status of the crop was sent as a message to farmers mobiles. The farmers' proposed system was developed with low cost and a new technology.

Sanjeev *et al*. [13] recommended a method using Back Propagation Neural Network (BPNN) classifier to detect plant diseases based on visual symptoms which occur on leaves. The author classified two diseases of pomegranate plant namely Bacterial Blight (BB) and Wilt Complex (WC). Images were captured by digital cameras and were classified as healthy and unhealthy. Furthermore, these images were enhanced and segmented to detect infected portions. BPNN classifier was used to extract colour and texture features to classify the disease, which helped the farmers in effective decision making. The classification accuracy obtained was 97.30%.

Chandan *et al*. [14] developed a system to operate the water motor automatically according to the water requirement. The humidity level was determined through soil moisture sensor and the water motor was turned on/off based on the humidity level. Local Shortest Path (LSP) algorithm was used for controlling the wireless multiple networks between these automatized processes.

Darshna *et al*. [15] proposed a water system for gardens by using sensor microcontroller system. The temperature sensor and soil moisture sensors sent information to the microcontroller which did assessments based on quantity of water required for vegetation. The GSM module was used in order to let the user access the machine through mobile phone.

Newlin *et al*. [16] recommended a solution for detecting and monitoring plant leaf disease automatically by analysing the texture of various types of plants. The diseases were identified at the initial stages. In this research work, though the identification rate was low and the misclassification was avoided based on the symptoms of the diseased plant.

Architecture for Farm Monitoring System

In this section, the IoT architecture for farm monitoring is described. It contains four major phases namely: data collection through IoT devices, data sharing by communication technology, data storing in cloud with internet, processing and data visualization. The phases in the proposed architecture are essential in design of any IoT based application. Figure 1 illustrates the IoT architecture for farm monitoring.

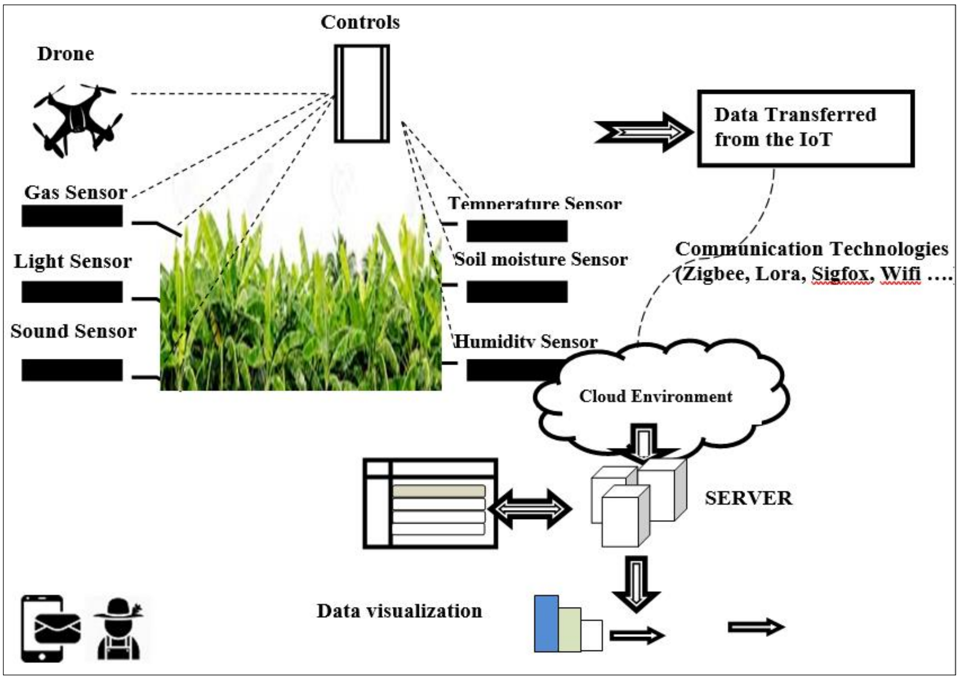

Fig. 1: Architecture for farm monitoring

Data Collection

The IoT devices or things are a collection of embedded systems that communicate with other devices through internet. This is sometimes referred as IoT sensors. In the architecture, various IoT sensors are used such as drone, temperature sensor, humidity sensor, soil moisture sensor, sound sensor and air sensor for smart farming. These sensors monitor and measure the various farm variables like temperature level, humidity, wind speed, soil content, pest infection and rainfall.

Data sharing

In IoT systems, communication technologies play a vital role for a successful deployment. Basically, the communication technology requirements can be classified as standard, spectrum and application layout. The communication standard can be divided into short-range and long-range communication standard. The communication spectrum can be divided into licensed and unlicensed spectrum. The IoT application scenarios can be grouped based on sensors or network, and deployment scenarios. With the help of these communication technologies, the data can be transferred to the cloud successfully.

Data storing in cloud with internet

The IoT devices or things are connected to the internet to gather information about the environment which is done using sensors. The collected data is stored in the cloud environment for analysis. Cloud is a paradigm that enables ubiquitous access to a shared pool of configurable system resources which provides high level service with minimal cost and management scale over the internet. The cloud is used here for storing images, weather data etc., and to monitor the farm. Thus, the stored data is available and accessible always to the physical environment. The sensors are used for collecting data and the collected data are stored in the cloud storage. The IoT cloud is designed to store and pre-process the data and perform analytics like predictions.

Data Processing and visualizing

The last phase in the architecture is processing and visualizing the analysed data. In this phase, the data is analysed in the cloud by using different algorithms to make a decision. The large amounts of data which was collected by various sensors are cleaned and processed. The unwanted data is cleaned using pre-processing techniques and the prediction techniques are used for decision making. Thus, the predicted results will be sent to the farmer through the mobile app. The farmers can easily identify the status of the farm through a suitable interface. It will aid the farmers to monitor the farm and take appropriate decisions and actions. Furthermore, if there is any disease or damage in the farm then a notification and recommendation will be sent to the farmers to take the needful action to eradicate the disease.

Conclusion

The proposed architecture will help the farmers to monitor the farms periodically. Manual work could be reduced by adopting this architecture in monitoring the farm and disease identification. Since, the diseased images are captured using drones in an Ariel view, the entire farm is covered without missing any plant and within a short span of time a vast area can be covered. The latest technologies such as cloud and IoT are used in this architecture. The status of the plant condition like temperature level, humidity level, soil nutrients etc., are observed using various sensors. The proposed model performs only the monitoring process. In future, an integrated architecture for automation of the agricultural process can be proposed.

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