Smartphone and IoT based system for Integrated Farm Monitoring

Manoj A. Patil[1], Amol C. Adamuthe[2], A. J. Umbarkar[3]

[1,2]Asst. Professor, Department of IT, KES's Rajarambapu Institute of Technology, Affiliated to Shivaji University Kolhapur, Maharashtra, India
[1]Research Scholar, VIT Vellore
[3]Asst. Professor, Department of IT, WCE, Sangli, Maharashtra, India
[1]manoj.patil@ritindia.edu
[2]amol.adamuthe@ritindia.edu

Abstract. India has larger agricultural lands but it does not cross the world's standard in plant productivity. There are many reasons for low plant yield. To improve the productivity and technological support system for agriculture is essential. This paper presents an integrated farm monitoring system by using Smartphone application and Internet of Things. Using this system farmers can remotely monitor farm for soil moisture, leaf wetness duration, pH level in the soil, temperature and humidity in the environment. The system quickly analyses the weather and soil conditions in a particular area where the plant is present and gives new insights to manipulate the decision making. The system is deployed and tested in fields of Islmapur, Maharashtra. The proposed tool is cost effective and productive system for farmers.

Keywords: Farm monitoring, IoT, Smartphone, Sensors.

1 Introduction

Agriculture is the major source of Indian Economy. Around 70% of Indians are depending on agriculture and it generates one-third of the revenue. Agriculture shares the largest part of the employees about 52% in India. Also, agriculture stands in the third position in contribution towards GDP (14%). India has huge agricultural lands but it does not cross the world's standards in plant productivity. In India, agriculture product losses are very huge. One of the major reasons for this is lack of knowledge about the weather changes and effects of the same on the plant's health which in turn has a major effect on agricultural productivity.

Farming has been perhaps the most adopted profession through the course of history. It provides people with the food and many other essential materials that one needs in life. Advancement in traditional agriculture field is mandatory for the development of an economic condition of the country. In India, a majority of the farmers still follow the traditional practices of agriculture which result in poor yielding. Agricultural issues making a week for the development of the country. Traditional farming in the Indian context is farming done using traditional equipment's, embedded knowledge and

wisdom gained from the experience over many generations. Mostly passed on by visual and oral instructions. The optimal solution to this problem is technology-based agriculture by reforming the traditional methods of farming. The speed of the work has been accelerated with the arrival of machines. Similarly, with better techniques being applied, plant yield will increase as we use modern techniques instead of using traditional methods. Smart agriculture practices and advanced technology reduces the labour work than traditional agriculture, and quantity of the yield is increased because there is a focus on maximizing production and maintaining a consistent quality. The aim of this proposed system is to make agriculture system smart using Mobile Application, Web Application and IoT technology.

The proposed system has the potential to address the issue such as how to deal with the plants when environment condition changes. The data collected by the IoT sensors which gives an overall status of the plants and based on this data requirements are identified. The IoT solutions based on sensors data will help in improving the plant productivity by the way of monitoring the plant. With this systematic analysis of the sensor data surrounding the plant is possible and the user can see all the details about the plant in a simplified manner so that he can take appropriate decisions about the plant.

This paper is organized as follows: In section 2 presents related work for the agriculture sector. Section 3 is about a proposed integrated system. Finally, section 4 is conclusions.

2 Related work

There are various difficulties to design a fully smart agriculture system for monitoring and plant disease prediction and lots of research is taking place based on IoT. In the existing systems, many researchers and industrialist worked on smart agriculture system.

In [1]-[4], authors developed an advanced system for monitoring the weather conditions at a particular area and allow a user to access the data through the Internet.

In [5]-[7], authors extended research on the design and development of a smart nitrate sensor and soil moisture for monitoring nitrate concentration in surface and groundwater.

In [8]-[11], the authors proposed an algorithm for image classification and segmentation technique which is used for automatically detecting plant leaf diseases.

In [12]-[13], the authors proposed a crop diseases intelligent monitoring system. It uses ZigBee technology to connect the end sensing devices and big data platforms.

In [14], authors proposed a monitoring system identify grape diseases in its early stages by using Hidden Markov Model and provides alerts via SMS to the farmer.

In [15], authors developed a set of an agricultural Internet system with expert guidance and investigated the key sensors in the perception layer, 4G in the transportation layer, application framework for the application layer.

In [16], authors developed an automatic agriculture monitoring system which will monitor the agricultural field and performing live video streaming for monitoring through a raspberry pi camera.

In several agricultural systems, disease warning is done through Leaf wetness duration (LWD) measurements and it is an important variable for the diagnose of plant disease epidemiology [17]. These sensors have the ability to track environmental changes, allowing you to grow healthier crops with a higher yield.

In [18], authors proposed a weather prediction system using a fuzzy logic algorithm for supporting general farming automation.

Table 1 summaries the review of work done in the area of agriculture sector using information technology

Table 1. Summary of literature survey

Purpose	Parameters used	Method used	Ref.
Weather Monitoring	Temperature, humidity, light intensity & CO	IoT based monitoring system using Arduino Uno	[1]
Weather prediction	Soil moisture and Weather Service Provider	Fuzzy logic algorithm	[18]
Irrigation monitoring	Soil moisture & temperature, environmental temperature & humidity and CO2 sensor	Fuzzy logic-based weather condition modeling system	[2]
Soil Monitoring	pH sensor, temperature sensor, and humidity sensor	IoT based soil monitoring system using raspberry pi	[3]
Soil Moisture	Passive Soil Moisture Product (L2_SM_P) and its validation	Preliminary validation of the L2_SM_P soil moisture product	[5]
Soil Nutrients Detection	Nitrogen, phosphorous and potassium	Nutrients are determined by chemical processes	[7]
Water management	Humidity and the temperature of the soil	IoT based on Raspberry PI	[13]
Water management	Temperature, humidity and moisture using sensors	IoT based on Raspberry PI	[16]

Water management	Humidity and the temperature of the soil	IoT based automatic irrigation system using Raspberry Pi	[4]
Water management for chili plants	pH sensor and EC sensors	IoT Technology in automatic water sprinkle and real-time monitoring	[6]
Detection of Plant Leaf Diseases	Leaves like rose, beans leaf, lemon leaf, banana leaf and beans leaf	Classification of disease using feature extraction method	[8]
Leaf diseases ın pepper plants	Plants, leaves and stems	Soft computıng technıques	[9]
Crop disease	Disease incidence & severity	Machine Learning	[10]
Leaf Disease	Humidity, temperature and soil moisture sensing	IoT based on Raspberry PI	[11]
Grapes Diseases	Temperature, humidity, moisture, leaf wetness sensors	Machine Learning and IoT	[14]

These papers presented automation system for smart agriculture and disease prediction by considering specific sensor features and image-based system. However complete farm monitoring system is not available as per requirement of farmers from different regions.

3 Proposed system for Integrated Farm Monitoring

This paper proposes an integrated system for farm monitoring based on smartphone and IoT Technology. The proposed system is designed and developed to integrate data of different sensors to monitor the plant and farm conditions.

The sub-objectives are,

- Enable the farmers to easily visualize data collected from sensors.
- Collect and manage the data received from the sensors by using Mobile App and Web App.

It collects the data from the particular field using various sensors and sends it to the microcontroller through a wifi module. To analyse the collected data, it uses cloud service. The system gives integrated information to the farmer about plant condition based on sensors data. The user can access the sensor data through Android Smartphone and Web App (Website Application) via cloud service. In addition to these parameters, some other parameters like pH of the soil, moisture content in the soil and nitrogen are also played a vital role in plant growth. By collecting and monitoring these data, the farmer can make a better decision so, that the yield of the plant could be increased.
We have used the components like Raspberry Pi, Soil Moisture Sensor, DHT

temperature Sensor, Leaf wetness duration (LWD) Sensor, pH Sensor. The Raspberry Pi, Sensors, Relay Board, Android Phone, Computer, etc. are integrated to monitor the plant effectively. Smartphone connected wireless to the Raspberry Pi (RPI) via the Internet. RPI is a small hand-held computer connected to the sensors. An android app helps to monitor the plant by taking date from various sensors. RPI provides bare metal programming on Linux and contains libraries which can directly communicate with GPIO (General Purpose Input Output) pins by many programming languages like Python and C. It made by ARM (Advanced RISC Machines) processor with a 1GB RAM and provide powerful performance processor. Free tool of Linux based Operating System is available like GNU drivers USB, file system, graphics, and Unix-like Environment. The system helps to manage sensors data, analyse the data, envision the results. This system will be really useful to the farmer, who can take a decision immediately based on sensor data and helps him/her to treat plant or harvest effectively. Figure 1 shows the activity diagram of the proposed system.

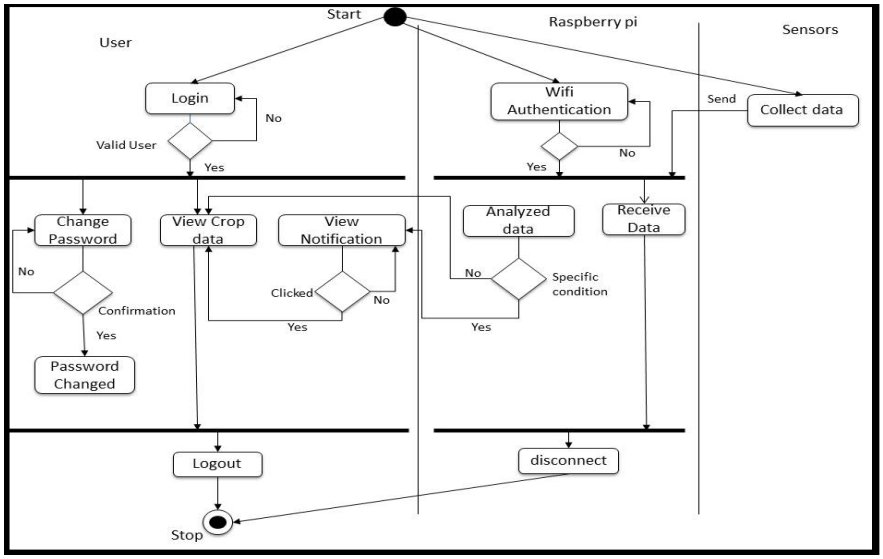

Fig. 1. Proposed system: Activity diagram

Soil Moisture Sensor measures the volumetric water content in the soil. The amount of moisture content in soil is important to know because to provide the optimum nutrients to the growing plant. Measuring a pH of the soil is an important aspect for growing healthy plants because it controls required nutrients available for the plants like nitrogen, phosphorus, and potassium (NPK). The humidity and temperate sensors measure the temperature and moisture in the air.

Smartphone (Android application): This module is used for the user interface to the system through mobile application by login to the system as authenticating the user.

The user should enter correct credentials to get access into the system. If the user enters the correct username and password then he/she will get access to the system and can see all the details about the plant, otherwise, it will show the invalid user.

Website application (Web App): This module is used for the user interface to the system through Web application which is having similar functions like a Smartphone.

Internet of things: Internet of things provides the connectivity between various sensors, Android application, Web App and Embedded system through the internet connection.

To interface with the system, we can use Smartphone android application by clicking on app icon of the smart plant on your smartphone then it will start the app. The authentic user can see all the plant details in the simplified manner shown in fig. 2. We can also access the plant details through the Web App. A user will be able to see the history of data on web application shown in fig.3. We have tested this system in Islampur (MS, India) April 2018 and analysed sensor data to check the performance of the plant. We have been accessed the sensor data through Mobile App and Web APP.

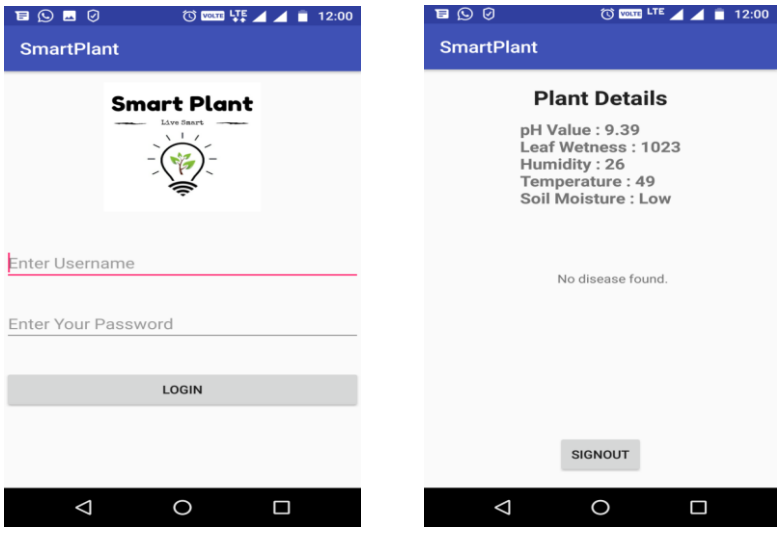

Fig. 2. Smartphone Android Application

The cost of the proposed system is around Rs. 7000, covers 10 guntha area and which is a cost-effective solution. We have integrated fives types of sensors data which are very important to monitor the plant growth whereas existing system considered only three sensors to monitor. We are using android and web application to monitor the farm by the farmers but the existing system used only web application which is not feasible for the farmers to monitor.

We gather most of the information about the environment remotely which is required for healthy plant growth. It helps the farmer to get needful information which is crucial for the smart agriculture.

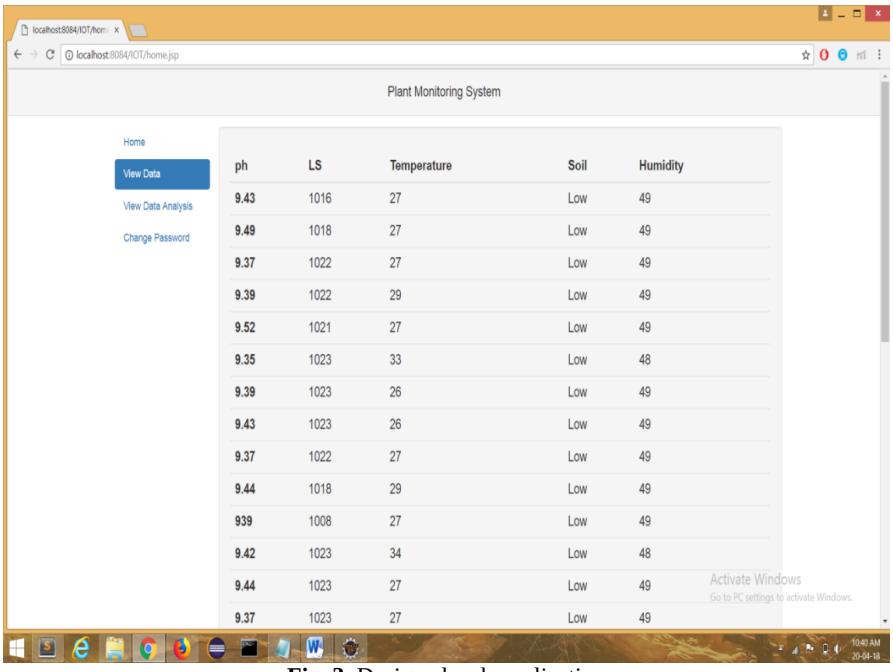

Fig. 3. Designed web application

We have developed simple and user-friendly mobile application and web application to monitor the details of the plant. Monitoring via Smartphone application requires less manpower and people with physical disabilities can be employed for the monitoring of fields. Overall, our proposed system is feasible and has a wide scope in terms of its application.

4 Conclusions

Paper presents a system helpful to farmers for improving the productivity of farms by continuously monitoring the farm conditions. The proposed system continuously collect real-time data from the surrounding environment through sensors. Internet of Things technology is used to monitor the plant condition through sensors data that works of parameters namely soil moisture, leaf wetness duration, pH level, temperature and humidity. Continuously monitoring of environmental conditions send to farmers on mobile application. Proposed system is implemented in Islampur and accepted by many farmers. Future scope of the work is to use machine intelligence for decision support system to farmers for different agricultural problems.

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