Real-Time Atmospheric & Disease Notification System in E-Agriculture

Afshan Almas^{*1}

¹Institute of CS & IT, The Women University Multan, Pakistan

*Corresponding Author: afshan.6024@wum.edu.pk

Abstract

Realtime Atmospheric Measurements & Disease Notification in E Agriculture is designed for the in time notification purpose to the user and also identify disease attack on leaf. System is based on sensors which provides the real time reading of soil and temperature to the microcontroller and then sent to the user's android mobile phone in form of notification and then image is captured using digital camera and save in database. Captured image is processed in MATLAB using the best image processing algorithm to identify about the disease type and alert the user about the disease attack on leaf. So results shows that the proposed technique is effective for the betterment in field of agriculture.

Keyword: Atmospheric Measurements, Disease Notification, Temperature.

Introduction

Agriculture is playing a vital role for giving profit to economy of any country and providing large scale employment. It has been one of the most important industries in human history since it provides humans with absolutely indispensable resources such as food, fiber and energy. Pakistan is an agricultural country so it is very important to improve the quality and productivity of the agriculture based products; which can be achieved by proper irrigation, according to the nature of the crop and outside temperature, and in time noticing and curing the crop diseases. So the interest is growing to introduce the modern technological trends in the field of agriculture. The ubiquitous and pervasive nature of the upcoming devices in every field provide a lot of facilitation to the stakeholders, similarly, there use in agriculture introduce a new concept of E-Agriculture.

It is seen as an emerging field focusing on the enhancement of agricultural and rural development through improved information and communication processes. The use of proper methods for notification about the crops plays an important role for the agriculture. The system consist of low cost sensors such that a poor farmer can also afford it. System offers an easy, low cost and reliable Notification System assist about the condition of soil by measuring the soil parameters by using different sensors for the better quality of the crops the disease attack on the leaves of the crops is identified by using best image processing

algorithm. All the identified parameters are sent on mobile to the user/stakeholder in form of notification on mobile using communication module. Arduino microcontroller with GSM module can convey the message over the remote locality and also can transfer the data directly to the user's mobile without the need of any other PC. It reduces the complexity of the entire system. By this system, the system will be more reliable, very less maintenance and it attains more speed when compared to the previous system. Precisely the system can provide accurate results and increase the productivity in the agriculture.

Problem Statement

Improve the yield productivity (P) by notifying and scheduling the stakeholders for making in time proper decision regarding the irrigation, temperature and disease attack in result (R) better productivity can be obtained, such that

$$P^{I,T,D} \rightarrow R$$

where I is moisture level of soil, T is temperature and D is set of diseases such as follows
 $D = \{d_1, d_2, \dots, d_n\}$, d_i is specific disease on leaf images obtained.

Objectives and Scope Of Research

Main objective of the research is to design a system that can notify the user in real time by measuring the environmental parameters as follows:

- i. Sensors based notification system to measure the soil parameters for the notification purpose to the farmer.
- ii. Analysis of system overall. Such that detect the diseases attacks on the crops by using image processing techniques.
- iii. Farmer can implement the system to maintain the agriculture field overall.

Related Work

In recent years, advancement in information technology and telecommunication has played a significant role in the field of agriculture. This chapter provides a background literature. In this chapter there is review on different types of system used for improvements in the field of agriculture by using different types of technologies involved. Chapter is divided into two sections first section is about role of IOT in the field of agriculture and other is about the Disease identification on plants using image processing

IOT in E- Agriculture

Lala Bhaskar et al. [1] presented the Automatic crops irrigation system for the improvements in agriculture field at present labor saving and water saving are major issues this system keeps notifying the farmer by using GSM technique data can be transferred at distant places notifications on mobile phones as well as on LCD. Input parameters are taken by sensors such as humidity, temperature and fed into Here we have kept the motor running time of the Drip storage lower than running time of Main storage, and keeping same all parameters like moisture, humidity, temperature etc. Microcontroller collects the all inputs from the sensors and after the mathematical calculation it represents the actual value in predefined unit.

This is a low budget system with an essential social application which can be further enhanced using technology. This system also conserves water and provides the accuracy in system. But this paper has deficiency about communication with system if farmer wants to know the status of crops at field such as crops quality and water level at various locations. But limitation of this system is it does not provide flexibility of communication with users.

Ms. A. Sivasankari, Mrs. S. Gandhimathi [2] proposed real-deployment of application of wifi based WSN based crop monitoring which is designed and implemented to realize modern precision agriculture which allow the farmers to collect data from inaccessible locations. This system investigates and explains in depth the use of Wi-Fi WSN802G modules and its abilities. The current system performs well for transferring and logging of values from the various sensor nodes using standard commercial products and works in conjunction with equipment already in use. It allows for relatively easy connection to nodes and communication, farmers had to rely on satellite and aircraft imagery or other map based systems to accurately target their growing areas. Heterogeneous distributed network of hierarchical agricultural sensors. Drawback of this system is it do not facilitate the real time updating of system and if there is any failure in wireless networks then whole system will be down.

Yogesh G. G., Devendra S. C. [3] presented a monitoring system for agriculture using different types of sensors which measures the environmental parameters and then periodically send this to center node after every thirty minutes. At center node Arduino Mega 2560 is used which [provides the more accurate and clear condition about the fields. Finally information is sent at the user interface on android mobile phone based on Short message service using Global system for mobile. As well as user can also send request if wants to know about the condition of fields.

Lutful Karim, et. al [4] suggested Sensors based M2M agriculture monitoring system consist of bottom layer containing hierarchal sensors network Upper layer consists of five modules: acquisition module, network management module, alarm/network status display module and business module M2M communication networks by integrating sensors in agricultural field with other wireless devices such as PDA, smart phones (i.e., MTC devices that people use in their everyday life) Data collected from sensors are transmitted to central server through different wireless devices and network (e.g., Wi-Fi, GPRS). Besides, the framework focus on designing an energy efficient and reliable zone-based topology and routing protocol for agricultural sensor network where multiple base stations (BS) or gateway node can be placed outside of the network area so that sensors can communicate with the nearest Base Station to reduce energy consumptions. Efficient shortest path establishment to achieve energy efficiency, providing fault tolerance to achieve reliability of the framework should also be considered.

Disease Detection

Santosh R.,et al. [20] provided a survey on crops disease detection and prevention by using the mobile phone. Some farmers are unable to predict the diseases at their crops at early stages which may cause to the loss, to overcome this problem the authors have developed a expert system in form of android app by using the research in image processing by

identification through leaf disease detection, soil condition, weather report. This system provides complete soil information online but do not notify the users about the current information about the fields.

Sachin D. K., A. B. Patil [21] presented a diseases detection by using the image processing techniques because its not possible to monitor the diseases manually also requires experts for the processing time. This is focused to present various techniques for segmentation and features extraction. So for that purpose different classification, segmentation, artificial neural networks, Support vector machine algorithms are used for the identification purpose. By using these all techniques and processed results are generated in MATLAB hence we got the required results to overcome the problem of disease.

N.SatyaPriya et al. [22] presented an automated knowledge based system for detecting disease on lemon leaf at early stage, for this farmer do not need to check manually about the disease of leaves. The man force is reduced because an efficient system captures the image of leave and compares it with the trained database known as classifier using the SVM classifier to find the defected parts of leaf. Image preprocessing is applied for enhancement in which a colored image is converted into gray scale image using MATLAB. Then image segmentation is applied to perform partitioning of image into constituent regions. Image classification is applied using cany edge detection algorithm after complete process the system notify the user in form of alarm by speaking the name of disease.

Proposed Technique

A generic technique is proposed to remain the users aware about their agriculture field by notifying the condition about soil moisture, air temperature and diseases attack on the yield. The implementation layout of the proposed technique is graphically represented in figure 3.1. An acquisition stick is designed on which the required hardware modules for sensing, different values in real time atmosphere like temperature and soil moisture level, and capturing the images of leaves are placed. The sensed values are shown on liquid crystal display (LCD) screen attached on stick and the decision making for sending the data to the server in case of crossing threshold values are made in a microcontroller, where the server perform some operation on the acquired data and accordingly send the notification to the respective users.

Figure 1: Components of System

The activation performed by the proposed technique at each step are described at the following sub-sections.

Data Acquisition

A data acquisition stick is designed which contains the sensors and a camera for capturing the images of the leaves. The soil moisture sensor is used to measure the water content in soil, similarly the temperature sensor measure the air temperature, whereas, the images of leaves are captured and after 6 hours. These information are passed to the database server, by using microcontroller and GSM module, and process is performed regarding the disease attack is performed and notification is send to the users. The architecture and working of each associated component is explained in the following subsections.

Soil Moisture Sensor

Soil moisture is measured as percent of water in soil. Such that a predefined threshold is for measuring the soil moisture of specific field. The soil probes consist of two thin copper wires each of 5cm length which can be immersed into the soil under test. In this research experiment system uses FC-28 soil moisture sensor with Arduino. Sensor having the four pins (A0 pin from where reading is being stored,D0,GND,VCC). The soil between the probes acts as a variable resistance whose value depends upon moisture content in soil. Sensor measures the value based on threshold values. Sensor prints the output value as dry if it is greater than 1000 and wet if less than it.

Air Temperature Sensor

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. The temperature sensor LM35 is used to measure the temperature around the field. In case of events like fire in the field, this sensor will detect and respond to very high temperature according to predefined value of threshold. The system's response is to send an SMS alert to the user.

Web Camera

For disease detection on the leaves, camera is used to capture the images of crops or fields in real time after certain time period. System used 25 mega-pixel cameras to capture the images of field during different time slots invoked by microcontroller. This camera captures the images of leaves, connects it with the web server and notifies the user about the affected area on leaf. For experiment of proposed system mobile camera is used for taking images and store in database for future processing.

LCD Display

The name LCD initially referred to Liquid Crystal Display. System uses 16*2'' LCD display. A 16*2'' LCD means it can display result in 2 lines and displays 16 characters per line. In this LCD each character is displayed in 5x7 pixel matrix. But for the experiment purpose only android mobile screen while using the App for soil moisture sensor for showing the sensor values.

GSM

To alert the user at distant places for specific details about the fields a notification is sent including all parameters including basic details. For the notification system GSM is playing a vital role in the system to notify the users in unique feature such as in form of SMS (Short Message Service). The Global System for Mobile communications (GSM) is the most popular standard for mobile phones in the world. The GSM platform is a hugely successful wireless technology and an unprecedented story of global achievement and cooperation. Most GSM systems operate in the 900 MHz and 1.8 GHz frequency bands.[20] System send different messages in different scenarios with data and time showing different parameters such as moisture, temperature and disease is present or not in Y/N form with the name of disease and other details of image. But for experiment purpose P105 Bluetooth module is used for sensing the values on Android mobile phone App build for soil moisture.

Figure 2: Data Acquisition stick

Data Pre-Processing

All the measured values are sent onto the server using the GSM module for preprocessing which transforms the raw data into useful and understandable form. Because the gathered data from the devices in real world may be incomplete, inconsistent, false values or duplicated, therefore preprocessing is done to clean the missing or garbage values from data and to resolve inconsistencies. Such as the measured parameters of soil those have to be sent to the user should be in predefined threshold values. To handle the noisy data acquired from sensors in numeric format Correlation analysis is performed for data cleaning.

For handling the noisy data of captured images following steps are performed

- a) Image Segmentation is performed by converting RGB image into HIS and then boundary and spot detection is applied to detect the infected part of the image.
- b) After segmentation image clustering is performed for this a best clustering algorithm is chooses which divide every image into 'n' number of clusters.
- c) At the end these holding algorithm is applied which creates binary images into gray level image and according to threshold separates the image into clusters as infected leaf gets change by color which shows the disease.

Figure 3: Disease Identification Process

Data Analysis

To discover the useful data from acquired data inspection, transformation and modeling is performed on the data. Data suggestion and conclusion is made on the pre-processed data. At this step analysis is performed by getting raw data from the sensors in form of parameters of soil and images of leaves then performing the analysis by breaking the data into pieces to get the useful information. And captured images are enhanced in contrast and segmentation and classification is performed, for this reason a best image processing algorithm is used such that every image is divided into 3 clusters hence shown as $n*3$. To get the useful information from the gathered data, system performs analysis on data such that preprocessed values are

fed into the microcontroller to analyze the parameters such as soil moisture, temperature and captured images on fields. System analyze the measured values with the predefined values in the system such as water level of soil and temperature in air, it then matches values are either beyond threshold value or not. Preprocessed images are also analyzed by breaking a image into three clusters of images by using Fuzzy C-Means clustering by using the membership values whereas Fuzzy C-Means is soft clustering method in field of image processing which is helpful in segmenting most complex leaf images where most of the regions are overlapping. The cost function of FCM is given as:

$$J_{FCM} = \sum_{i=1}^N \sum_{j=1}^C u_{ij}^m d_{ij} \quad \text{Eq.(1)}$$

Where $m \in (1, \infty)$ is the degree of fuzzy coefficient. The membership values are initialized randomly. Clusters centroids are C are computed by following formula

$$c_j = \frac{\sum_{i=1}^N u_{ij}^m x_i}{\sum_{i=1}^N u_{ij}^m} \quad \text{Eq.(2)}$$

After computing the centroids new membership values computed again againun till there is no more change in clusters of image. Infected image is given as input image then it is broken into three segments on the basis of membership values, by choosing the ROI(Region of Interest) if we choose $k=3$ then it classify the image into a category of disease.

Decision

Decision is conclusion or resolution approach after the strong consideration. Decision making is the process of making choice after successful analysis of data. Decision is made for the betterment of agriculture system such that the status of soil and disease on the leaves is made in the microcontroller when sensors measures the low moisture level it send signal to the microcontroller, the sensed value is matched with the pre-defined threshold values. As well as the decision about whether the leave of fields have disease or not, the captured image is compared with other image in the data set and decides that to which category it belongs. Decision is made on comparison with the all other images in database

Storage

System stores the output parameters for future use such as the measured parameters i.e. soil moisture, temperature and images of leaves are stored at the central database server with date, time, coordinates and paths of stored images in separate file will be stored. System stores the

all real-time readings of sensors with all details and also shows the calculation time of process and affected area of image. System stores the accuracy calculated at every iteration of process.

Notification

In agriculture industry awareness about the technology is necessary to keep the people up to date about the current status of the fields, because its time consuming and difficult to gather the parameters of soil and other factors manually. To overcome this problem a notification system is designed to notify/alarm the user about the real time condition of field. For this purpose Global System for Mobile Communication (GSM) is selected for notification system on android mobile phone as well as on the LCD panel. Which can reduce the time and effort requirements for the continuous monitoring of the environmental conditions. An app is developed using C# which receives the readings from sensor and save as notification then sends to the user on their registered mobile number. User can get notification about the soil moisture detection and disease detection on images of leaves. For the experiment notification is sent on android mobile connected via Bluetooth module.

Experimental Results

Many researchers have presented different systems for the improvements and growth in the field of agriculture, both for improving the quality and quantity. As discussed earlier for the notification system sensors based, microcontroller, wireless networks, Raspberry Pi, Arduino are involved. Some systems notify the farmers on screen but what if the farmer is out of the range of fields, so there is methodology of sensors based notification system designed for the field of agriculture. This System measures the parameters from the soil and keeps notifying the user about the condition of soil i.e. moisture or water level in soil for this ArduinoGenuino software for Arduino Mega Keys module after the processing the soil moisture level is measures by sensor and sent to the android mobile phone of user. Other part of project based on notification about the diseases on leaves. For disease identification the proposed algorithm is applied on leaf images, tested image is segmented into 3 clusters containing the region of interest. The centroids of clusters are initialized by Fuzzy C Means (FCM). The proposed algorithm is implemented in MATLAB (R2013a) and performance of algorithm is measured by measuring Segmentation Gain

Experiment is conducted for the first module of the system based on IOT, for experiment three container of soil are taken and sensors injected in mud tested at different moisture level i.e. dry, low wet and full wet soil. Readings of sensors are recorded as follows in Table:

Moisture Level	Measurements of Sensor (between 1-1200)
Dry	891-1160
Sprinkle water	170-190
Low wet	170-226
Full wet	90-130

For experiment images are tested one by one and at the end accuracy is measured in form of segmentation gain for each type of disease as follows:

$$\text{Segmentation Gain} = \frac{\text{Number of images correct Segmentation}}{\text{Total Number of Test Images}} * 100 \quad \text{Eq.(2)}$$

Disease	Segmentation Gain
D1	70 %
D2	72.7 %
D3	70 %

(a) Raw image with disease

(b) Enhanced Contrast

(c) Segmented into Three Clusters

(d) No of Clusters i.e. k=3

(e) Disease Identification

Figure 4.3. Disease Identification in MATLAB

Algorithm for Segmentation on images

FCM(Fuzzy C-means) clustering algorithm is proposed here because it returns the best accuracy. Algorithm segment the image on the basis of membership value computed at each iteration and clustering is performed on basis of K clusters basis on Region of interest because fuzzy C Means cluster the image into more than one clusters. FCM is a type of soft clustering that allows data items to be a part of more than one cluster but with a different degree which is known as membership value. It is helpful in segmenting complex infected images of leaf that belongs to one or more clusters.

Conclusion and Future Work

A new system for the field of agriculture is proposed. The system notifies the user about the status of soil by getting measurements from sensors attached with arduino. System provides reading at different environmental conditions and meanwhile captures the image of specific field. After the proper measurement about the condition of soil the new method for irrigation can be proposed in future work. The proposed algorithm for detection of disease on leaf images provides high segmentation accuracy. The captured images in mobile are compiled by using FCM algorithm in image processing. Then system notify the user about is there is any disease attack on leaf. After the proper identification of disease the treatment for each category of disease can be proposed in future work for further improvements in this field as well as with high accuracy in the field of agriculture in future work.

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