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Conceptual Design and Implementation of Simulated Version of Context Aware Agricultural Land Monitoring System

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Abstract -It is very tedious and difficult for Farmers to monitor and track every event happening in the farming land. In order to overcome the difficulties facing by Farmers and hence to improve the comfort level of Farmer it has become inevitable to go for technology assisted context aware precision agriculture. In order to realize the context aware precision agriculture the various technologies like WIFI, Bluetooth, Sensors, GPS, GPRS, Mobile Computing, Cloud Computing, Distributed Computing has to be integrated along with Artificial Intelligence techniques. The context aware computing technology can be used to provide farming land context based services to farmer. The research work presented in this paper proposes a conceptual design and implementation of simulation version of context aware agricultural land monitoring system. The proposed system sends a mobile and web based notifications related to normal and abnormal status that prevails in the farming land.

Keywords: Context -aware, Sensors, Intruder, temperature, moisture levels, crops, irrigation, Simulated farming Land.

I. Introduction

Farmers feel fatigue and tired while doing their day today farming activities. It is difficult for a farmer to track every movement of his workers who are handling various types of crop and vegetation in a large area of agricultural land. The everyday analysis of environmental conditions like temperature, moisture, soil condition etc., becomes hectic & cumbersome for the farm owner. Large number of crops is harvested by the farmer which becomes difficult for him to analyze the infected crop which may cause huge damage to the agricultural land. Due to lack of context aware service providing technology it is not easy for a labor/owner to collect the crop condition qualitatively and quantitatively all the time. In addition the different tasks like prediction of rainfall, judging which soil and climate is best suited for which crop or vegetation becomes.

The solution for the above mentioned problems is to go for technology assisted context aware precision agriculture. For realization the farming land has to be embedded with variety of sensors for temperature measuring, moisture (water) level estimating, detecting disease infection, crop collecting time notifying sensor, intruder detecting time sensor, etc. A set of devices which can collect sensor data, generate context information and send the useful information to Farmer through email or sms or mobile notification has to be mounted in the field.

As an initiation of research work on context aware techniques for precision agriculture in this paper we have presented a conceptual design of simulated version of agricultural monitoring system .The agricultural land is simulated as a grid of wireless sensors surrounding each plant. The simulated sensors will generate the simulated values of various aspects of agriculture like moisture level, water quantity, soil quality, fertilizer required, insects infected, intruders attacked, humidity value, temperature value, etc., for the service recommendation engine of the monitoring system. The service recommender or decision making engine after processing the sensor values creates the context and sends to the mobile app or web app as notifications and messages.

II. Literature Survey

From the last 5 to 10 years the most of the researchers [1-15] are showing significant interest for doing research in the domain of technology assisted precision agriculture. The technologies like wireless sensor networks, cloud computing and mobile computing is being used for different purpose like monitoring the water level, measuring the soil moisture level, detecting the crop infected by the disease, detecting the presence of intruder, etc.. The following section discusses some of the research work going on in the domain of precision agriculture.

Iqbal Singh, MeenakshiBansal [1], have presented an approach for monitoring water level in the farm area for Precision Agriculture using Wireless Sensor Networks(WSNs). The proposed approach demonstrates the functioning of the network, soil, weather which concentrates on the data quality. It uses an automatic algorithm to ensure maintenance especially, water monitoring over large areas. Most soil moisture sensors are designed to estimate soil volumetric water content based on the dielectric constant (soil bulk permittivity) of the soil.

FaithpraiseFina, Philip Birch, Rupert Young [2], have presented an approach for automatic plant pest detection and recognition using k-means clustering algorithm and correspondence filters. A decision support system based fuzzy logic controller is also used for this purpose. The proposed work evaluates a software solution for automatic detection and classification of plant leaf diseases. Image processing technique is employed for the following purpose: 1) To detect diseased leaf, stem, fruit and roots 2) To enumerate affected area by disease 3) To find shape of affected area of plant 4)To determine color of affected part of plant5) To determine size & shape of fruits and plant 6) Summarizes the different weather conditions in which the plants get affected by pests and diseases.

In the Community web portal S.Aravindram, U.Dinesh and M.Hariharan **[3]**, have presented an approach for detection of intruder and protection of cultivation lands using image processing technique called Electronic Fencing. The proposed technique aims at efficiently detecting the intruders like animals, unknown persons who are making an attempt to spoil the agricultural crops & also to provide the contextual information to owner of the land so that he can take necessary action on them.

Gary Woodill [4], have presented an approach based on mobile cloud computing (MCC) called mAgriculture, which acts as an application for benefiting the business of farming. MCC as a development and extension of mobile computing (MC) and cloud computing (CC) has inherited the high mobility and scalability. It analyses the features and infrastructure of mobile cloud computing. The proposed approach also explains the need for mobile computing for the purpose of agriculture, the brief definition on what all features of the agriculture could be monitored like animal tracking and identification, monitoring water levels etc. Experiments were carried out at lab scale to sense the temperature, humidity, water level, pH level and fire detection. Based on the information received by the user through GSM, an action of control can be taken from any place.

Li Han, Salomaa Jyri, Jian Ma [5], elaborated the use of context aware mobile computing. Terrestrial sensor systems have been used to provide more detailed information about local soil, vegetation and water conditions. It also explains mobile cloud architecture, off-loading decision affecting entities, application models classification, the latest mobile cloud application models, their critical analysis and future research directions.

KristofVermeulen [6], presented a novel diagnostic algorithm as an alternative method to automatically monitor the leaf temperature of a glasshouse tomato crop based on the Eco physiological interactions between a leaf and its surrounding microclimate. It is intended to be implemented as a software tool in glasshouse climate control systems, a critical overview of all relevant equations found in literature was first given.

III. Design of the Proposed System

A simulated system for agricultural land monitoring is proposed in the research work presented in this paper. The system makes use of simulated sensors, simulated intruder detector, simulated fencing, and simulated actuators for studying the monitoring system. The architecture of the proposed system is illustrated in Figure 1 below.

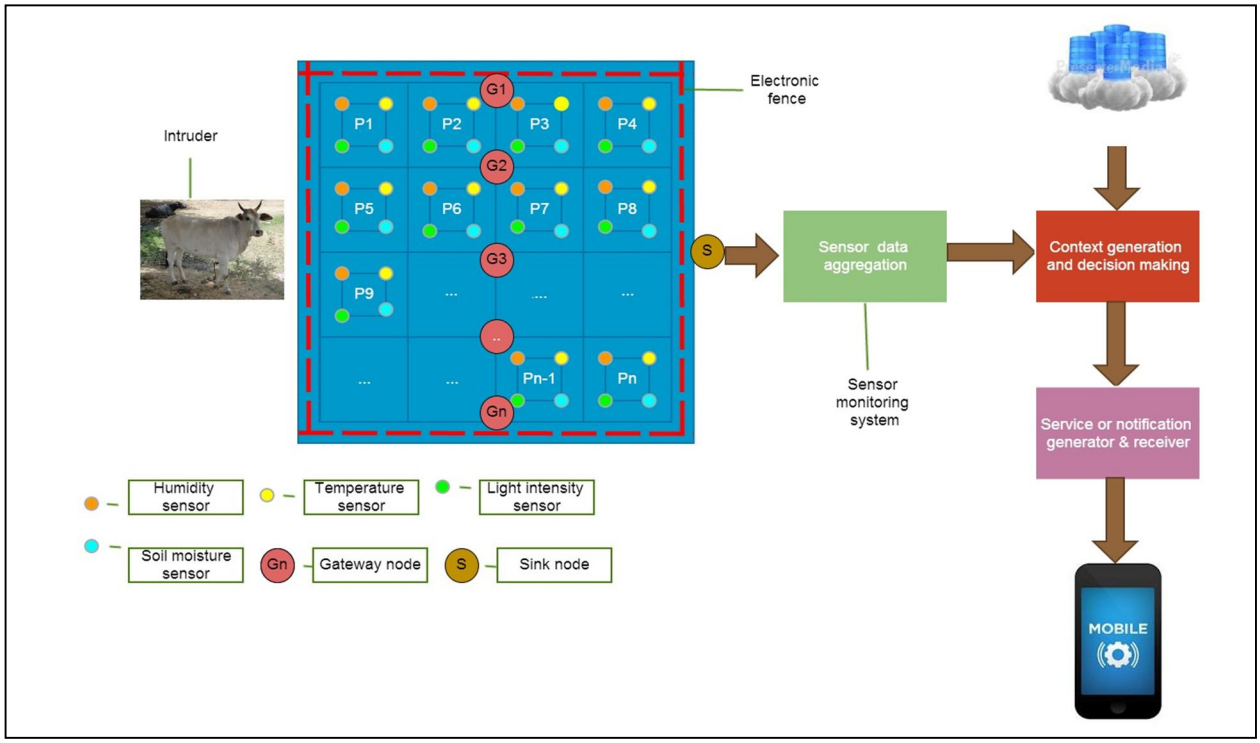

Figure 1: Architectural Diagram**.**

It consists of following components which are used to provide agriculture related services to farmer using Wireless Sensor Networks (WSNs).

1. *Agricultural Land* which is filled with the components like Plants (P1, ------Pn), Sensors and Gateway Nodes (G1,G2,--Gn).

2)*Electronic Fence component:* It helps in detecting the intruder who is trying to attack the farm by generating alert message.

3) *Sensor component:* It is a set of sensors which is used to sense and capture information like soil moisture level, temperature, humidity and health condition of plants.

4) *Sensor data aggregation component/ Sensor monitoring system:*It helps in integrating all the data collected from different sensors

5) *Context generation & decision making component:*It helps in generating the contextual information by taking the simulated sensor values from the cloud database & also to take appropriate decision regarding the context

6) *Service or notification generator & receiver component:* It helps in sending the notification about the events that are taking place in the farm. For example it may send the alert message to the farmer when the intruder attacks the agricultural land.

As illustrated in the architecture farm is monitored by the network of various sensors. The various information collected by sensors is sent to Monitoring System through Gateway nodes. Monitoring System sends the information collected to store in a database on cloud. Cloud sends various notifications to farmers using GSM or any internet facilities. Farmer can get the latest information on time that is happening in the farm by accessing the database from cloud.

3.1 Various Tasks Performed by the proposed simulated Agricultural Monitoring System:

The proposed agricultural monitoring system performs the various tasks like intruder detection, water level sensing and disease detection. The techniques or algorithms used for the various monitoring tasks are as described below:

Task1: Monitoring the status of Moisture Level: The system regularly monitors the moisture level of the soil. And when the moisture level falls behind the threshold value, the system sends the notification to farmer **and** water supplier. The procedure with steps used by the system is as given below :

S1: For each Plant
{ Measure: *The _Current _Moisture Level and Threshold_Moisture_Level*
While (*Moisture _Level <= Threshold*)
{ 1. Establish _Water_ Connection between Plant and Water supply;
2. Supply the Water Until the Saturation Level is Reached.
}
}
S2: End

Task2: Disease Detection and sending the status to Famer Technique: The system regularly monitors the health conditions of the plant and if it detects any abnormal conditions it sends notification to Famer.The stepwise procedure adapted by the system is as given below :

S1: Scan the image of the leaf
S2 : While (*Scan the Image)*
{ if (*Scanned Image == Diseased Image*)

{ **1.** Sent the Infected details to Monitoring System
2. Monitoring System Sends the Information to Farmer
}
}

Task3: Intruder Detection: The system regularly monitors the possibility of attack from the intruder with the help of simulated electronic fencing**.** If the system detects any intruder it plays ALERT _BELL with high volume to get rid of intruder and also sends notification to Famer.

S1: Initialize the Intruder detecting Sensor
S2: While (*Intruder_Detection_Sensor_ON*)
{ if (*Intrusion==True*) SEND ALERT to Control Center
While(*Intrusion ==True&&Intruder_Presence == True*)
{ 1.Switch_ONN ALERT _BELL;
2.Send Notification to Farmer;
}
}

IV. Implementation of the Proposed Simulation based Context Aware Agricultural Land Monitoring System

A simulator was developed in JAVA programming language using event based Components like Forms, Buttons, Radio Buttons, Panels, Text Box, etc. The images of Tomato plant were inserted into the rectangular Buttons to represent the plant growing area. The sensors are simulated using the Radio Buttons. The simulated agricultural monitoring system was designed as shown in the Figure 2. The simulated land is divided in to multiple grids, each grid representing one tomato plant and set of sensors monitoring the different attribute of plant properties.
The active and inactive status of the monitoring system was simulated by changing the color of fence (rectangular boundary) from green to red. During the active status the simulator was designed such that whenever the mouse is moved across the plant grid, it would open the properties pages pop up menu which will display plant properties like plant id, humidity, temperature, stem color, fruit color etc as illustrated in the figure3 .

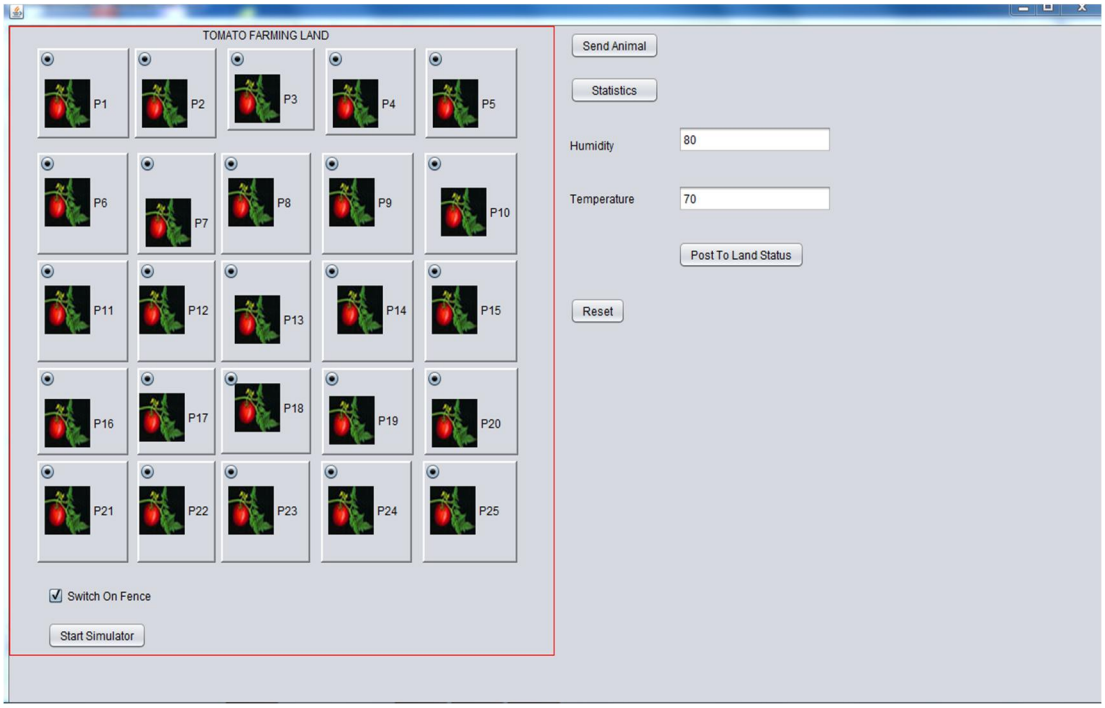

Figure 2: Snapshot of a Farm Land monitored by Monitoring System.

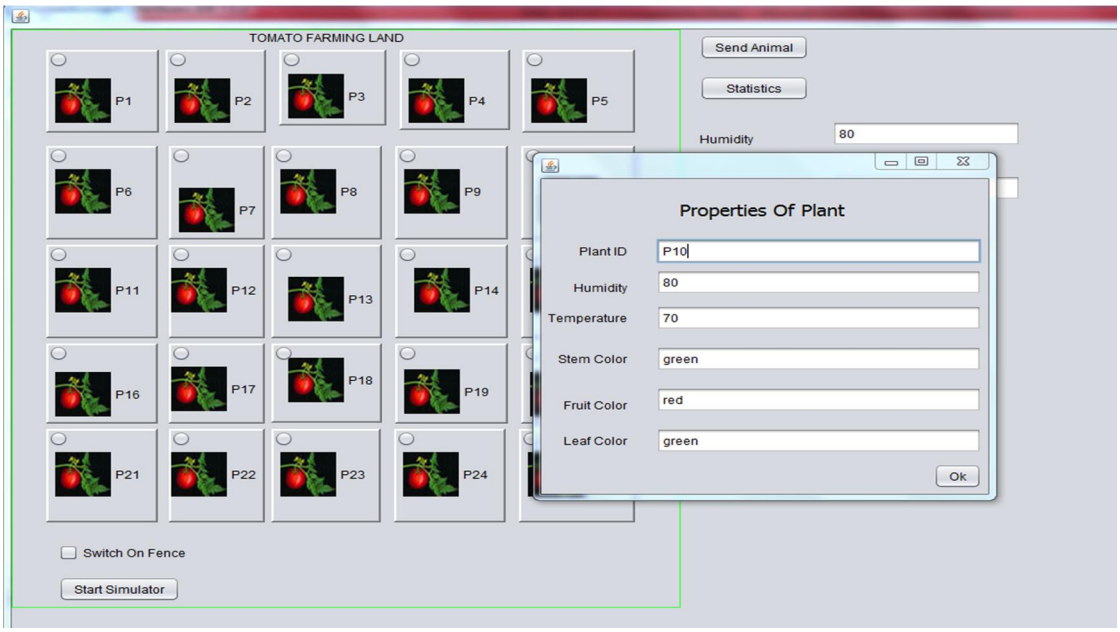

Figure 3: Snapshot that shows Properties of Tomato Plant.

Figure4 illustrates the status of the simulator whenever the disease is detected in tomato plant P14. As illustrated whenever the plant disease is detected the simulator displays the detailed information like disease, name of the disease, date and at what time the particular plant is affected by a disease. In addition the same message will be sent to the famer in the form of mobile notifications.

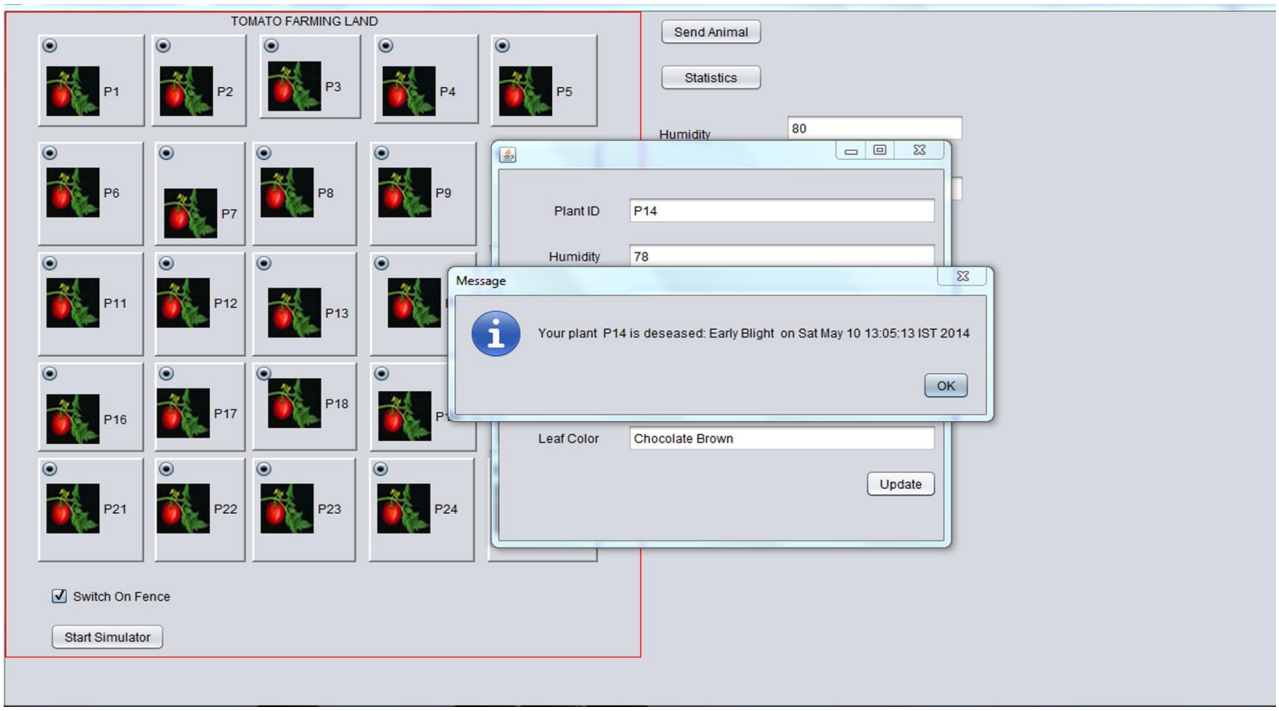

Figure 4: Snapshot of an identified disease.

Figure 5 illustrates the status of the simulated system when the intruder like cow is detected.When the cow crosses the electronic fence, which is turned on, the system rings alarm in the farm and intimates farmer about the entrance of an intruder.

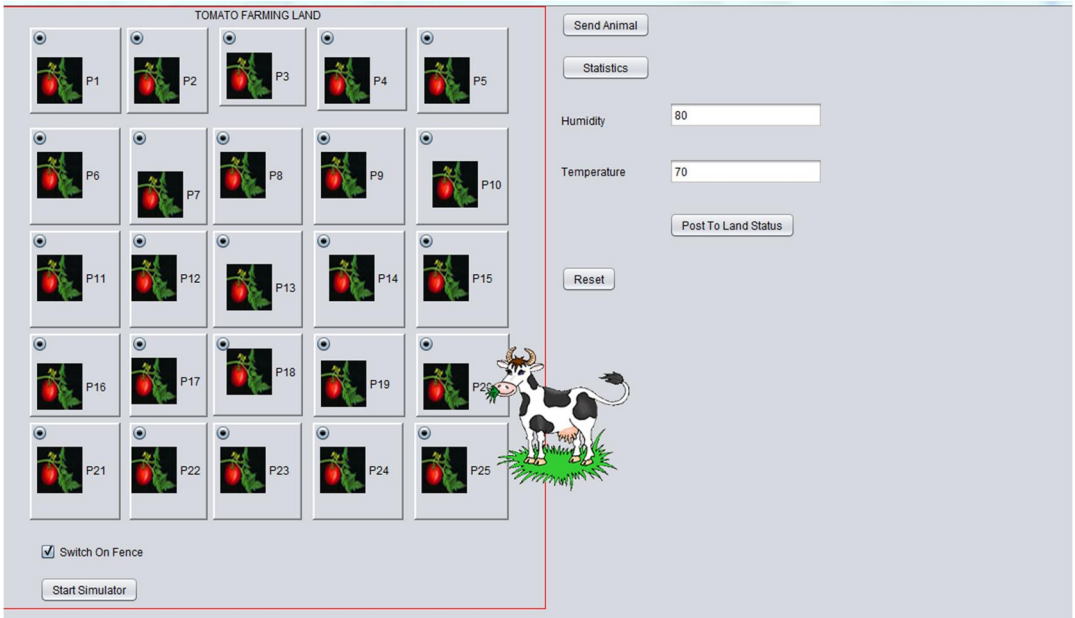

Figure 5: Snapshot of an Intruder entering the land.

The figure 6 shows the snapshot of the notification sent by the simulated system as viewed by the registered Farmer in his mobile application.

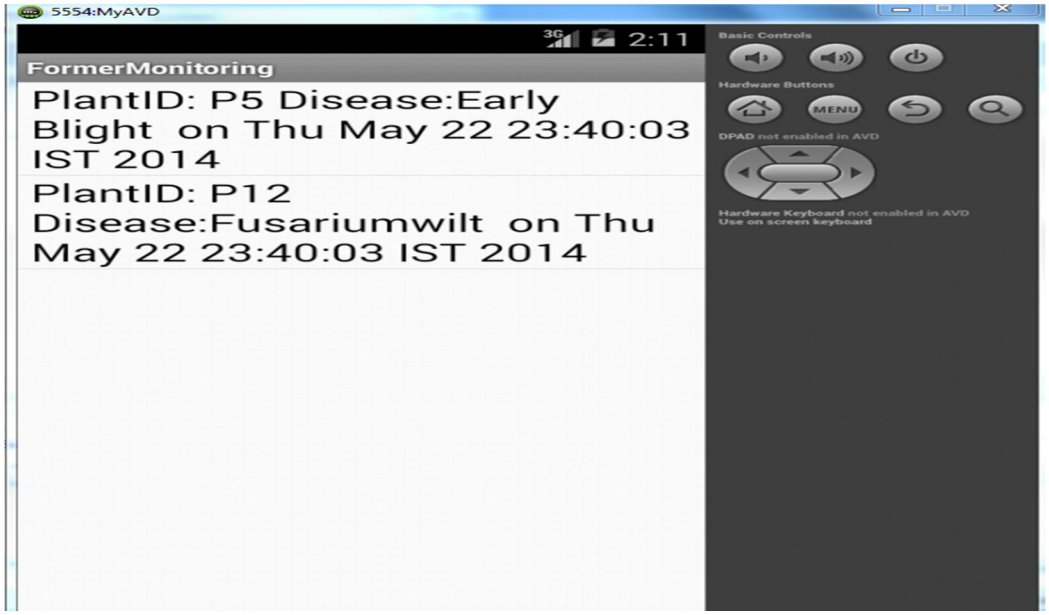

Figure 6: Snapshot of the plant disease notification sent by simulated system

V.Conclusion

The research work presented in this paper proposed a conceptual architectural design of the simulated agricultural monitoring system for tomato plants. The simulated system was used to monitor the different plant growing parameters like humidity, moisture level, plant health conditions and also to detect intruder. The simulated system continuously monitors the crop land and if any abnormal conditions are noticed or detected it will send the information to the farmer in the form of mobile notifications. This application is mainly intended to provide valuable service to famers to get the latest update about their farm such as soil moisture level, temperature,disease status of the plants and the presence of intruder.The proposed approach is also useful for researchers and students for the purpose of understanding & improving the precision agriculture. As a future work the real time implementation of the agricultural monitoring system will be designed using various technologies like WIFI, Bluetooth, Sensors, GPS, GPRS, Mobile Computing and Cloud Computing along with Artificial Intelligence Techniques.

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