IoT based Agri Soil Maintenance through Micro-Nutrients and Protection of Crops from Excess Water

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Abstract: The productivity of the crop depends on the soil, fertilizers, and water. The fertilizers provide micronutrients for vegetable farming like nitrogen, zinc, and others. To meet the increasing demand for food, crops should be able to withstand the adverse effects produced by the environment and unpredictable sources. The structure of smart agriculture is similar to networks, which are designed in 3 layers. Sensor layer to get information about various parameters, products, and operating environment. Transport layer to communicate the obtained information in between the various devices and as well as to and from a remote server. Application layer to analyse, visualize and predict the data for further actions to be implemented. In the proposed system, it uses multilinear regression to predict the water levels and micro-nutrients that are excess for the crop cultivation because farmers need analog data, not digital data. So that they can take necessary precautionary steps to protect the field from getting damaged.

Keywords: Internet of Things, Layered Architecture, ThingSpeak, E-Farming

1. Introduction:

To supply food for a growing population in countries like India, researchers have started providing solutions by Embedding the Internet of Things with deep learning techniques, which is a state as “Smart IoT”. With this advancement, E-farming has taken a new paradigm, where all the sensors needed for farming are connected to the remote server either using remote protocols or wireless technologies in the distributed environment. This smartness helps the farmers to monitor these fields even they are far away from the fields. The data from different sensors exist in different formats so in a cloud environment all these are converted into a single and understandable format so that the designed framework can work on it. IoT supports a third-party tool know as “ThingSpeak”, which works with Matlab Simulator, to provide the visualization and analysis on the data shared. It is one of the best tools which can provide more sophisticated, and reliable data after collecting from multiple sources.

2. Related Work:

In [1] A. Archana et al explored irrigation management studies for finding the saline solids in soil. To improve the crop yield facility it uses two strategies, one is bioremediation, in which different species of plants can be cultivated and the change of plant growths can be changed from time to time. But the plants which have good property to absorb the salinity should be planted before seeding the plants. The second strategy identifies the products that limit the amount of salinity so that measures can be adopted to increase/decrease based on the requirement of soil. It uses a cyclic and sequential reuse mechanism. The model has developed a mobile application which takes care of soil nutrients based on the nano materials and optical sensors to find the deficient values among the soil particles those results in less agricultural production.
In [2] Md. Hafizur Rahman et al studied the impact of domestic sewage on soil composition for soil efficiency. In this study, the system majorly focused on phosphorous, zinc, nitrogen, and potassium elements. The model has clearly studied the controlled release on nano fertilizers and their impact on the agricultural soil lands. The research has proved that the utilization of sewage has significantly improved the harvest of crops. Continuous monitoring of toxic substances is focused majorly on this paper. The impact of the toxic sf rate greatly impacts the productivity rate of the agriculture soil. The quality of sewage is analysed by assessing the irrigation water. The PH value measures the content of acidity in the heavy materials. It is observed that the contents of nutrients are more in sewage content. The disposal of these elements will contaminate the groundwater and air.

In [3] Meena et al proposed a model supply organic and inorganic fertilizers to the crops and the effects of their supplements. In the long run, crops get damaged due to the utilization of various fertilizers on the crop to increase the productivity rate. This module works on the DTPA extractor to identify the utilized micronutrients by the soil. Zinc and copper can adversely affect the crop for long time utilization. Due to organic matter, the harvest of the crops increases. It also combines the substances of micro and macronutrients very perfectly. The excessive utilization of phosphorus in the soil can reduce the content of zinc due to chemical reactions. If less phosphorus is supplied, it can harm the carbon hydrates and organic materials. The water content is also damaged due to phosphorus and zinc. The data analysis is performed with the statistical measurement with SPSS tool famous for visualization also.

In [4] Hongal et al designed a framework for monitoring smart agriculture for increasing crop production through CC3200 chip technology. This technology act as an interface to work with multimedia images rather than video capturing. This integrated system has a major component known as “NodeMCU”, for operating temperature and humidity sensors using WIFI module and HDC module to track the soil moisture continuously. It also contains the network processor component which communicates with the server and gets the physical address of the devices it is communicating with.

3. Proposed Methodology:

Internet of things technology has brought to every field of common man’s life by making everything smart and intelligent. IoT is a shared network of objects where the objects interact through the internet. One of the important applications of IoT is smart agriculture. The Demand for agricultural products is constantly increasing, so to meet these increasing needs society needs a smart IoT implementation in agriculture. Nowadays farmers are struggling with many problems in agriculture i.e., overflow of water, damage to crops because of climatic changes, and lack of micronutrients in the soil. The development of intelligent smart farming through IoT-based devices is day by day turning the future of agriculture production by not only enhancing it but also making it cost-effective and reducing wastage of water, fertilizers and increases crop yield. The proposed system monitors crop fields using sensors for soil moisture, humidity, temperature, and PH values of the soil. These components are represented in figure 1.

| Soil Moisture Sensor | Soil PH value Sensor | Humidity Sensor |
|----------------------|---------------------|----------------|

Figure 1: Different Types of Sensors
The system connects a drone to the proposed model for continuous monitoring of the entire crop area. Using these parameters, the model has automated the irrigation system i.e. if the threshold values are less than the required amounts, then immediately it is notified. Monitoring the environmental factors is not a complete solution to increase the yield of crops. Hence, automation must be implemented in agriculture using IoT-based automatic tractors, alarms, sensors, agricultural robots to overcome this problem.

Smart and good agriculture depend on the various factors which are illustrated below:

a. To prevent bad elements from air attacking the crop, the system arranges and operates humidity and temperature sensors by reading their value regularly. The general definition for humidity is the presence of water vapor to a maximum amount in the air. In general, the maximum threshold it can accept is “75%”. Deviation of the humid values less than the threshold may increase bacterial elements which may result in crop failure. The real values obtained from sensors are stored in the cloud with the help of wireless sensor networks and are notified to the farmers.

b. Soil maintenance is the key factor in agriculture, manual maintenance of which is highly impossible and increases the cost of production. The system needs some mechanism to automate this process otherwise it suffers from either an underwater problem or excess water problem and this, in turn, damages the entire crop. The water content in the soil is determined by the moisture level sensor and the temperature of the soil is notified to the farmers so that when the farmers feel it is the optimum value, they can plant the seeds for further cultivation. The other important element that is related to the soil is the “type of crop” to be cultivated. All types of soils are not good for all types of farming. So based on the composition of the soil the system needs to decide the type of crop to be grown.

c. Water monitoring is not only needed for their level amount to be served for the crops they should also be monitored to identify their elements compositions along with their PH value. To get good and quality products from crops, they should be supplied with good nutrients soil. In traditional mechanisms, fertilizers for crops are inorganic compound elements. With time, the various nutrients of the crop get acquainted with these elements so to work with these elements smart, the PH value of the soil is obtained to compute the structure of the soil, bacterial components, and presence of toxic substances. The PH value between 5.5 to 7 is acceptable for good crops.

d. The system needs to implement a machine learning algorithm that can decide on the environmental conditions based on the historical data stored in the cloud platform. So any drastic changes will not affect the crop by early prediction of disaster. Simultaneously, the need to monitor the irrigation system, nutrient elements, and the temperature in between the crops and the ground surface by providing a solution that can handle the climatic conditions by taking help from the LCR meter. The system should work on the gases and carbon hydrates for successful crop production.

All the four conditions which are mentioned above are maintained by the various sensors and decisions on these are monitored by the machine learning algorithm known as “Multi Linear Regression”, because the crop production does not depend on a single factor it depends on various factors. Some are measurable and some are not measurable. These measurable values handling by the system are illustrated in figure 2.
The proposed system is attached to the drone to capture the real time video frames of the entire agricultural field and get the parameters like water level, PH value of soil moisture, humidity, and other parameters. These values are passed as the test dataset to multilinear regression model then the model predicts the attributes which are dangerous to the crops and immediately notifies to the farmer through mobile app.

4. Experimental Results: The drone is the major element for capturing crop images timely because the manual checking of the entire crop is not possible. So, the drone architecture to control the crop is shown in figure 3.
The figure 3 explains the hardware components connection of the drone, which is treated as “circuit diagram”. The flight controller model takes care of the drone in terms of the direction while travelling in the air. ESC’s controls the speed of the motor with the help of brushless motors.

The water level is monitored and shown as a graph in the ThingSpeak, a third-party application for a better understanding of the concept to the user and farmers. The graph in figure 4 represents the level of water on a particular day at different intervals of time. At evening 5 P.M. on a particular date, the water level is suddenly dropped so the app immediately notifies this to the farmer.

Similarly, the humidity level sensor can also be pictured using ThingSpeak Application as shown in figure 5. The humidity levels at different timings of a day are recorded for prediction and stored for future training process.

Figure 4: Water Level Sensor Results

Figure 5: Humidity Level Sensor Results
Conclusion:

A Smart agriculture system should handle four components effectively in which the first and major component is data acquisition from different sensors; this can be performed either by implementing using Bluetooth protocols or WLAN technology. In this module, since the data is collected from drones and sensors, the system implemented both techniques. The second step is to handle the cleaning of data with standard or mean values in case of any missing values from the sensors because of its dis connectivity from the field simultaneously it should be notified to the server so that it can be immediately replaced without getting delay. The third component is data visualization, which plays its key role in terms of identifying the statistical measurements, tracking the crop continuously, and acting as various monitoring systems. The fourth component is a machine-learning algorithm to decide on crop production. Using these components achieves more than a 90% success rate.

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