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Smart Soil Analyzer with Irrigation using IoT

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***Abstract*— The project at task enumerates control and read operations within a single IOT applet, the real time moisture content and weather forecasting ensures the sprinkler/water pump system is activated only when necessary. Further, the ability to conduct fertility test to find deficiency of requisite content like nitrogen, phosphorus and potassium and provides a final log of deficient nutrients which alerts the farmer on the exact fertilizer required, this function is also complemented by an image processing unit which monitors the health of the plant. This ensures there are no human perception errors on the exact routine of manure distributions which is often not considered in the latest Agro-tech solutions.**

***Keywords*— NPK, IoT, Irrigation, Blynk, Agro-tech, Image processing.**

I. INTRODUCTION

Agriculture is one of the basic sources of livelihood of people It is an important aspect in developing a country. Traditional means of agriculture have become obsolete and to be able meet current demands a shift has to be made towards technology driven methods. In theory a lot of data is generated during the different stages of agriculture. Analysis of these data can give critical information on different characteristics of the crop. Data for parameters such as nutrient content, moisture levels, plant health, weather and atmospheric conditions play a vital role in agriculture.
The ability to collect data for the above parameters, coupled with IOT and cloud computing provide a potent method for an agricultural monitoring system. Nutrient and moisture content of the soil play a vital role in the growth of the plant. A basic monitoring system must be able to perform these functions. Soil testing refers to the chemical analysis of soils and is well recognized as a scientific means for quick characterization of the fertility status of soils and predicting the nutrient requirement of crops, existent solutions depend on laboratory methods to conduct testing. Soil testing has been received as a unique tool for rational fertilizer use. Generally referred 4:2:1 NPK used as a desired ratio does not substitute the need and importance of actually working out the nutrient deficiency in the soil and adding the required nutrient through fertilizers and manures to meet the crop needs. Traditional methods of soil analysis are not a real time method and will lead to delays.

II. RELATED WORKS

Authors in [1] demonstrates a method to measure NPK in soil using a light source. The optical transducer uses an optical detector such as photodiode and three light sources to determine the nutrient concentration. The process is based on beer-lamberts law of absorbance. A study on [2] indicates a soil analysis based on photon absorption characteristics of NPK. When IR light falls on the soil, the scattered light intensity is measured using a photo diode. It is seen that soil with higher NPK concentration have different peak characteristics at different wavelengths. Author in [3] gives idea of an IOT based agricultural system. A combination of internet and wireless remote monitoring system is expressed and a set of methods for monitoring is given. A study on [4] gives an idea of a precise irrigation system that monitors soil moisture, estimating water requirements and driving a drip irrigation system. The system is based on using wireless sensor nodes. These nodes relay the collected data to a base terminal. Authors in [5] talk about an approach which combines the major emerging technologies such as IOT with to build an efficient method to handle data generated during agricultural process. The approach uses IOT with cloud computing to generate relevant information from the collected data.

III. PROJECT ARCHITECTURE

Fig 1. Shows the basic architecture of the project, the micro-controller unit acts as the primary processor and handles all the operations of the robot. The Internet of Things architecture is developed by using a Wi-Fi module or with the help of GSM module depending on the availability of technology in the area the project is deployed. The NPK sensor uses 3 LED light to determine the amount of absorption of light; this is used to determine the concentrations of Nitrogen, Phosphorus and Potassium in the soil. The microcontroller processes this data and pushes it into the cloud. Similarly, the microcontroller gets data from the moisture sensor, processes this data and pushes it into the cloud.

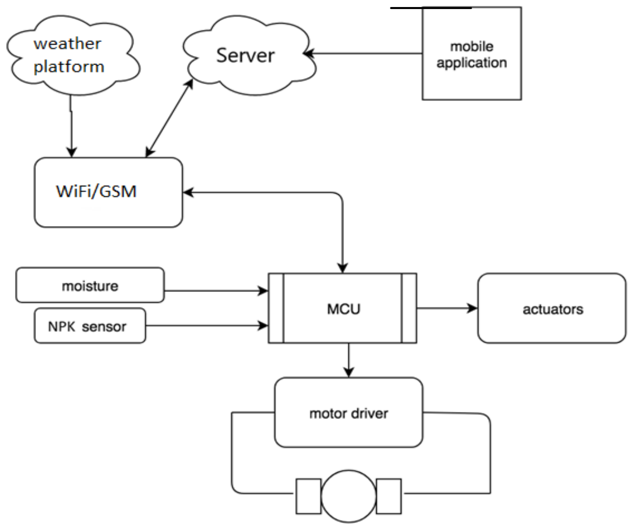

Fig. 1 Architectural block diagram

The user is provided with a dash board which represents the data in a user readable format and will also suggest necessary actions. The user through the app can disperse required nutrition or irrigate the field. The micro controller unit will also decide by how much is the field to be irrigated based on the moisture sensors data and through data received through weather platform. The microcontroller has provisions for both autonomous control or through user assistance; the microcontroller can operate and perform all tasks without user interference. The application provides options to set the mode of operation and allows customization of parameters.

IV. METHODOLOGY

Nutrients in the soil are estimated in real-time using optical transducer and lights of distinct wavelength. It works on the principle of beer-lamberts law of absorbance. Initially a sample of soil is scooped into a container that is blacked out on the inside. At the bottom of the container is a reflective medium, the soil is placed above it in a uniform layer. The optical setup consists of three light emitting diodes, the wavelength of the LEDs corresponds to the absorbance range of each of the nutrient under test. The optical setup is placed directly above the soil sample inside the container. A light dependent resistor then measures the amount of light that is being reflected back from the sensor. The distance of the optical setup from the soil sample plays a major role in the readings obtained. An optimum distance of about 2cm is selected. A series of thresholds is then found by using the setup against a set of samples whose NPK concentrations are known. These thresholds can then be used to predict the nutrient content of the soil. A moisture sensor which is essentially two conductors separated by distance is then pricked into the soil the readings obtained is proportional to the water level.

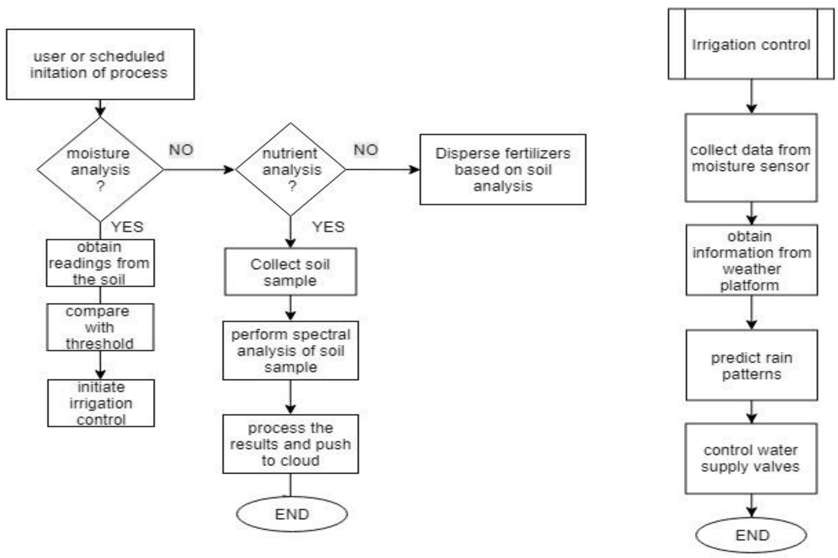

Fig 2. Flow chart of the process

A health monitoring system is implemented with the help of image processing. An image of a leaf is processed to detect the type of disease. The procedure used is explained in the flowchart in Fig 3.

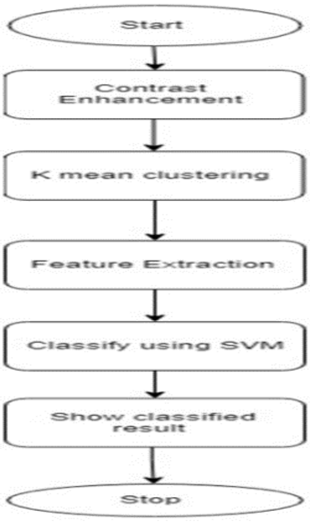

Fig 3. A plant health monitoring system using image processing

The obtained image is enhanced by using contrast stretching. The RGB model is then converted to CIELAB format. The feature extraction is done using K mean clustering. This process segments the image based on local means and extracts the disease effected region from the leaf image. The segmented area can then be used to monitor the severity of the disease. The next task is to find the type of disease, this is done with the help of Support Vector Machine classifier. Initially a gray-level co-occurrence matrix is generated. The matrix holds values on the spatial relation between pixels. From this matrix, statistical data such as variance, correlation, and homogeneity are calculated and is used as features of the test image. Similarly, the features from a training image are extracted. A Training image is one where the disease has been identified and the extracted features can be used for future reference. The sets of features are then given to an SVM classifier, which classifies the disease.

V. EXPERIMENTAL RESULTS

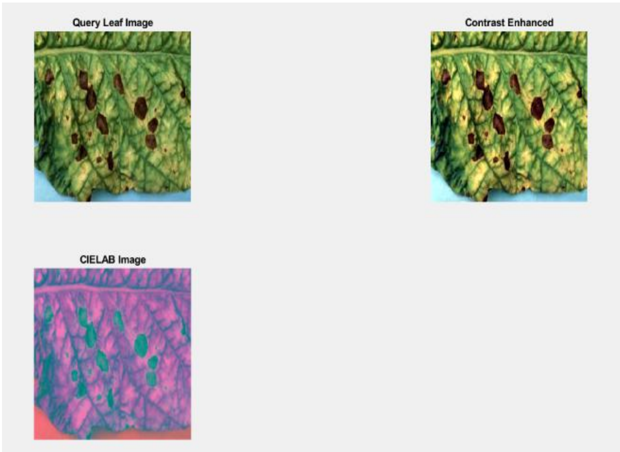

Fig. 4. Intermediate images obtained in processing of leaf consists of Query leaf image, Contrast Enhanced image and CIELAB Image.

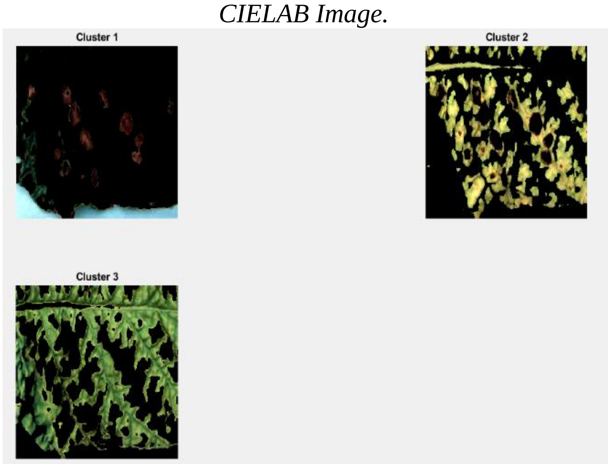

Fig. 5. K mean cluster images.

Fig 4. and Fig 5. gives the results obtained from the health monitoring process. Images in Fig 4. Shows the intermediate images obtained after each step in the image processing. The first image shows a normal image of the leaf. Since the quality of the image cannot be guaranteed, the image has to pre-processed. The second image is the enhanced version produced after contrast stretching. The third image is obtained after conversion of the enhanced image from RGB to CIELAB format. The third image is then segmented using K mean clustering and the results are mapped to the second image. This gives the three cluster images as shown in Fig 5. The clustered images are then given to the SVM classifier for disease detection and classification. It can be seen that in Fig 5. The image labeled cluster 1 contains the disease indicators and the SVM classification on this image results in the disease detection.

The Table I shows the voltage readings obtained by the optical transducer. The values are obtained by performing the analysis for different samples of soil, whose general nutrient concentration is known.

TABLE I. LDR Reading of soil samples.

Nutrients	LDR readings in voltages		
	Low concentration	Normal concentration	High concentration
Nitrogen	1.35-1.42	1.45-1.53	1.55-1.64
Potassium	1.22-1.41	1.46-1.58	1.61-1.73
Phosphorous	1.28-1.39	1.49-1.63	1.65-1.78

The output from the moisture is analog in nature and is inversely proportional to the water level in the soil. A higher water content would provide better conductivity between the two electrodes, and hence the resistance decreases. This means that the output voltage would reduce with increase in the moisture content of the soil the graph in Fig 8.3 shows the variation of voltage with moisture level.

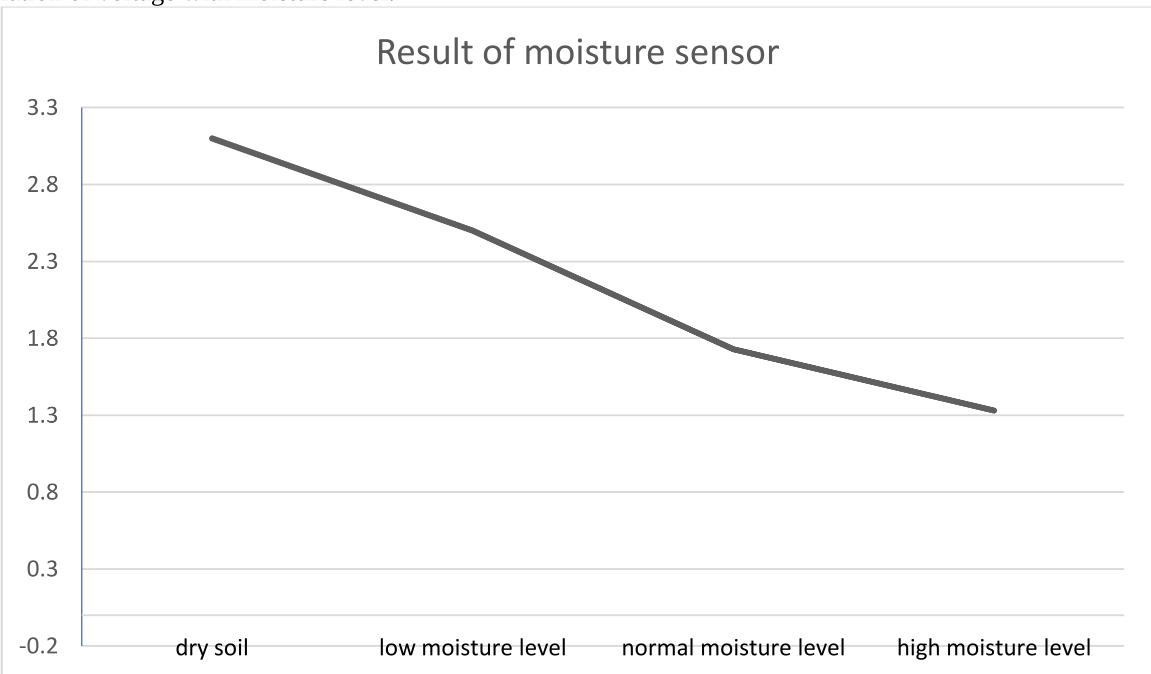

Fig 6: Result of moisture sensor.

The Fig 6 shows the range of voltage values that was obtained for samples of soils belonging to the categories mentioned in the Table II.

TABLE II: Result of moisture sensor.

Moisture level	**Voltage reading**
Dry Soil	3.18-2.75 V
Low	2.48-2.03 V
Normal	1.73-1.44 V
High	1.35-0.96 V

VI. CONCLUSION

In Automated farming practice we intend to reduce human errors by monitoring the soil quality using sensor via smartphones and webserver. Here three LED light source of different wavelength is used to determine the amount nutrient content (NPK) in soil. Based on the analysis, nutrient rich fertilizer is supplied in liquid form through sprinkler.

Automated irrigation system makes farming more efficient, user friendly and saves time. Moreover, wastage of water is reduced and simplifies the water management system. In addition, image processing performed on the leaf monitors and detects disease, based on result further action can be carried out.

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