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Iot Based Quality Estimation of Chemical Fertilizers

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Abstract: ***With the growing era in every field, agriculture is the main field where dramatic changes have taken place. The early farming used to take away a lot of time and hard work of the farmers with no guarantee that the yield would be as expected. The use of chemical fertilizers was proved to be a boon to the farmers and their crops. With the help of chemical fertilizers, the yield was much stronger and abundant than it used to be while the usage of organic fertilizers. The chemical fertilizers consist of all the required nutrients by both the soil and the crops which help in a much more profitable yield. But over use of these chemical fertilizers can cause devastation of the crops and can even result into soil deficiency, hence making the soil inappropriate with any other yield. Hence, knowing the quality of the soil is very much required for its appropriate usage. This paper proposes an idea of building an IoT device that would estimate the quality of the chemical fertilizers before it's by knowing its pH levels and the chemical components present in it.***
Keywords: Agriculture, IoT, soil nutrients, pH levels

I. INTRODUCTION

Most part of India is rural based. Hence People in rural areas have agriculture as their main occupation. It is the main sector where most of the economy is raised. Earlier days, pure organic fertilizers such as animal excreta, human excreta, vegetable matters etc were used to grow healthy crops in abundant. With the organic fertilizers, the release of nutrients to plants is much slower and hence the crops take more time to grow. So to grow the crops in a shorter period of time, farmers now have started using chemical fertilizers. Using chemical fertilizers, the plant gets continuous flow of nutrients which helps the crops grow in a much shorter period of time. Chemical fertilizers also help the plants to hold on to the nutrients and water easily hence making the crops strong. The three main macronutrients that are present in the fertilizers and are important to the crops are Nitrogen (N), Phosphorus (P), and Potassium (K). Other essential secondary macronutrients present in the fertilizers are calcium (Ca), magnesium (Mg), and sulfur(S). Some of the other micronutrients are copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), zinc (Zn), boron (B). Other significant chemicals present in the fertilizers are silicon (Si), cobalt (Co),and vanadium (V). Hence, Chemical fertilizers have become a boon to the agricultural industry.

Over the last few years the production of the harvest has been drastically changing. This has happened due to the usage and implementation of chemical fertilizers and pesticides in the crop fields. Optimization of production of crop has become really necessary and this can be done using fertilizers that are matching to the crop needs. Different crops need different kind of fertilizers due to the variations in soil types and it's nutrients level for the efficient growth such as nitrogen (N), phosphate (P2O5), and potassium (K2O). The appropriate mixture of all these nutrients without any of it's over usage gives an exact N-P2O5K2O ratio.

There are numerous ways to calculate the nutrients present in the fertilizers. The very first thing is to check the requirement of nutrients that is needed by the crops. For this, you first need to check the nutrient contents in the soil in which the crops has to be grown. Soil tests have to be done to check the P2O5 and K2O levels in the soil which is very much required by the plants. This soil tests are majorly done in private and public soil test laboratories. The concentrations of N-P2O5-K2O is shown in 3 numbers.The chemical components in any kind of chemical fertilizer rate can be calculated manually. In order to calculate a fertilizer application rate, you will need the N-P2O5-K2O content of the material from the package label, your target rate (normally from a soil test), the total area you will be applying to, and the density of the material if aliquid fertilizer is to be used.

This paper proposes an idea of how sensors can be used to estimate the quality of chemical fertilizers being used today in the soil for the growth of different kinds of crops.

II. PROBLEM STATEMENT

In India 2/4th of population depends on Agriculture. It plays a major role in the growth of Indian economy. Farmers put in a lot of hard work and dedication in growing the crops. With the growing era, the use of chemical fertilizers has increased widely. With the use of certain essential chemicals required for the crops, the harvest would be much more stronger and faster than normally

expected. When compared to organic fertilizers, the chemical fertilizers helps in faster distribution of the nutrients that are very much required for the crop's growth. Along with the abundant use of chemical fertilizers in the crops, it is very much necessary to check the quality of the chemicals that are being used in the crops. If the chemical fertilizers can be useful for crop's growth, excessive use of the same on the crops can destroy the whole reaping, further resulting in soil depletion and making the soil infertile for any further harvest. There are certain manual calculation methods that can calculate the amount of chemicals present in any chemical fertilizers. But this makes the whole method tedious.

To overcome this problem, this paper focuses on building a device that will check the exact quality of fertilizer by detecting the appropriate pH value, quantity and appropriate components that are required in the fertilizers for the strong, abundant and fast growth of the soil.

III.DESIGN METHODOLOGY

A. Existing System

One of the devices present detects the NPK nutrients present in the soil using Fiber Optic Sensor. A solution is made of the soil based on the coefficient of the soil and then is tested under different light colors. The light that gets reflected is received by another optic fiber which converts this light reflection into electrical signals. With the help of the threshold values present in the database, the NPK values can be determined.

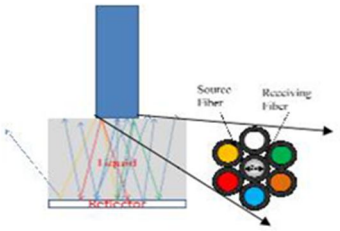

Fig 1 Working principle of optic based NPK sensors

Another existing system is a device that identifies the soil nutrients present using Arduino. In this proposed system, there is an electrochemical sensor that uses the principle of absorption of the ions from the solution of the sampled soil. The sensor and the arduino microcontroller circuit is used together to detect the deficient nutrient in the soil.

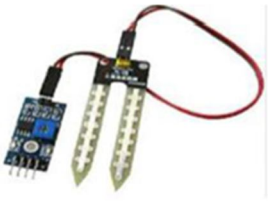

Fig 2 Electrochemical sensors

Another device that exists is IR-3000 Moisture Sensor which is used to maintain exact moisture levels in the fertilizers. It continuously monitors and controls the moisture levels in the fertilizers either manually.

Fig 3: IR-30000 MoistTech

Another existing system is the Yara N-Sensor. It is a variable rate nitrogen sensor which is used to measure the crop's nitrogen requirement to adjust the amount of fertilizer to be put into the soil accordingly.

Fig 4: Yara N-sensors

One of the other proposed systems is used to predict the suitable crops that can be grown in a particular farm by testing the NPK values of the soil present using sensor network. There are NPK sensors that collect the values of the components and updates the data. Based on it, the algorithm would predict the crop to be grown using the historical data.

Algorithm 1 Crop prediction

INPUT: Nutrients
OUTPUT: Predicting crops.

```
while 1 do
    NPK ← Record nutrients from the sensor(NPK sensor)
    ◁ NPK sensor is used to record the NPK values into
the database.
    Bayes ← Posteriori(NPK)
        ◁ Find the probability of each nutrients from the
database.
Predict ← predict(Posteriori(recroded,GroundTruth))
    ◁ Based on posterior probability the matched group of
crops are suggested to the user.
```

Fig 5 Algorithm of crop prediction

One more existing proposed model aims at developing a smart system that would provide an ideal environment for the crops. The sensors sense the soil moisture and the humidity levels, and this information is sent via zigbee network to a remote computer. The remote computer will be capable of controlling the motor and humidity fan located on site.

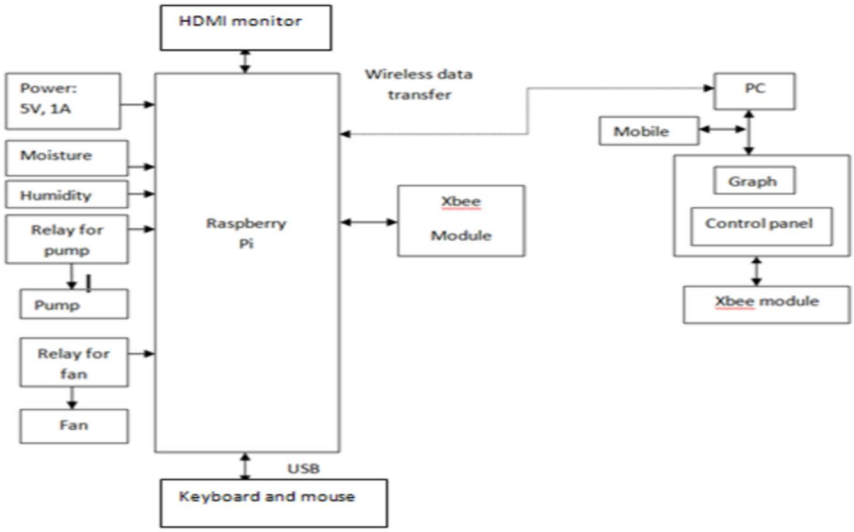

Fig 6: Block diagram of the smart system

Another existing system is a Multidisciplinary Model for Smart Agriculture using Internet-of-Things (IoT), Sensors, Cloud-Computing, Mobile-Computing & Big-Data Analysis. It is a multidisciplinary model based on all the above mentioned technologies where all the agents related to the agriculture and farmers will have to register in their Agro CloudMobileApp. the cloud would store details of the agents, their agencies and farmers along with details of the properties of the soil of their farmland and also the current environmental conditions. The stored properties of the soil and environment is sensed and sent to their cloud using IoT. Later analysis of the fertilizer requirement, crop sequence analysis, market requirements, total harvest along with current stock is all analyzed using Big data analysis.\ The following points summarizes the various limitations in the existing systems:

1) *Optic Fiber Sensors:* The detection of NPK nutrients using optic fiber sensors and Electrochemical sensors only concentrates on knowing the quality of the soil in which the crops have to be grown and not the quality of the fertilizers.
2) *IR-3000 sensor:* The IR-3000 sensor only detects the moisture levels in the fertilizers and not the complete quality of the fertilizers being used.
3) *Yara N-Sensors:* The Yara N-Sensors checks the rate of nitrogen present in the crops and accordingly spreads over the fertilizers into the crops. But it does not detect the quality of the fertilizers being put into the crops.
4) *Nitrogen Fertilizer Measuring Instrument:* This system aims towards measuring nitrogen level content required by the corn plants only and does not aim at knowing the quality of the nitrogen fertilizer that is being used.
5) *The network and NPK sensors:* The network and NPK sensors is used to predict as to which kind of crops can be grown into the particular soil but does not check the quality of fertilizers that would be used to grow the crops.
6) *The Smart System:* The smart system enhances the crop growth by controlling and monitoring the soil environment. It does not concentrate on the fertilizers that would be used into the soil for crop growth.
7) *Multidisciplinary Model for Smart Agriculture:* The multidisciplinary model is a mobile application that gives the overall analysis of the fertilizers requirement, crop production, stock production etc, for a smart agricultural production. But it does not concentrate on knowing the quality of the fertilizer being used. All the proposed or existing systems only concentrates on knowing the quality of the soil or predicting the correct crops to be grown on the land. Knowing the quality of the fertilizers that is being utilized in the soil for the crops is important. If not checked, it can spoil all the crops grown or can even lower the quality of the soil.

IV. PROPOSED SYSTEM

The proposed system is aimed at checking the quality of the chemical fertilizers that is being used into the soil for the strong and fast growth of the crops.

This can be done by checking the pH values and the of the required components present in the chemical fertilizers. It would also check the various chemicals that would be present in the fertilizers that are actually essential for the crops. This system aims at building a device having IoT based pH sensors that would check the pH value of the chemicals in the fertilizers from its aqueous solution and also a chemical sensor that would check each and every component present in the fertilizer that is required by both the soil and the crops for the abundant growth of crops. The pH value results shown by the IoT sensors, are then compared with the stored datasets of average of actual pH values of the components that should be present in a good quality fertilizer hence approximately determining whether the chemical fertilizers that is being used into the soil is of a good quality or no.

Later, the chemical sensor present in the device would determine all the nutrients or chemicals that are present in the fertilizers. The given results are then checked with the stored dataset. If the fertilizers have approximately all the nutrients that is needed for a good harvest, it can be said that the fertilizer that is being used is of a good quality.

The microcontroller of the device will have the datasets present which would later be used to compare the detected values with the existing values.

The microcontroller will have the pH values of all the essential components of the chemical fertilizers along with the total average value of all the component's pH.

The pH value detected from the aqueous solution of the fertilizer by the pH sensors is later compared with the average value calculated using the existing datasets and hence approximately estimates the quality of the soil.

Similarly the weight sensors would be used to calculate the quantity and the nutrients present in the fertilizer's samples and the detected values is compared with the existing datasets and the quality is determined.

The below flow diagram shows an overview of how the proposed device would work.

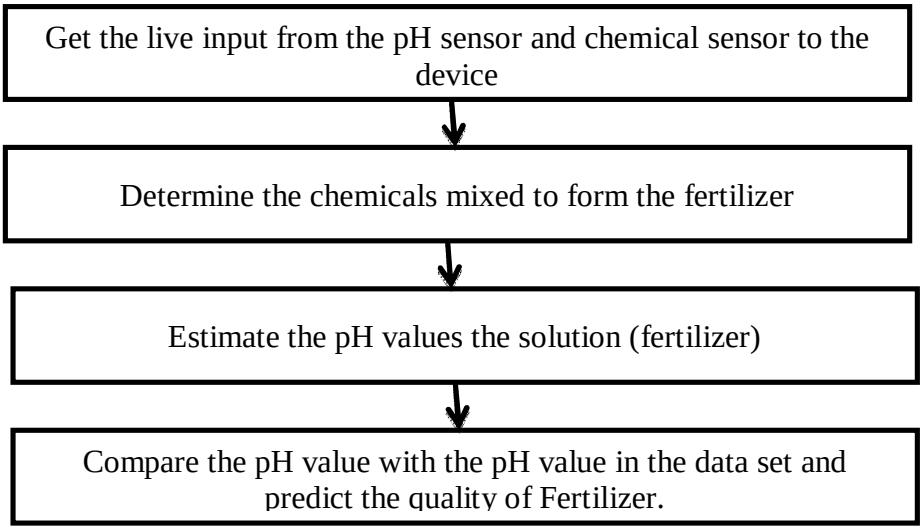

Figure4.: Flowdiagram of the working of the device

V. CONCLUSIONS

Here, it is being concentrated to develop a IoT based device havingthe pH sensors along with chemical sensors which estimates the pH value in the aqueous solution of the fertilizer sample and also the chemical components in a chemical fertilizers respectively, which will ultimately give us a result of how good the fertilizer is for the yield of the crops, without damaging the soil.

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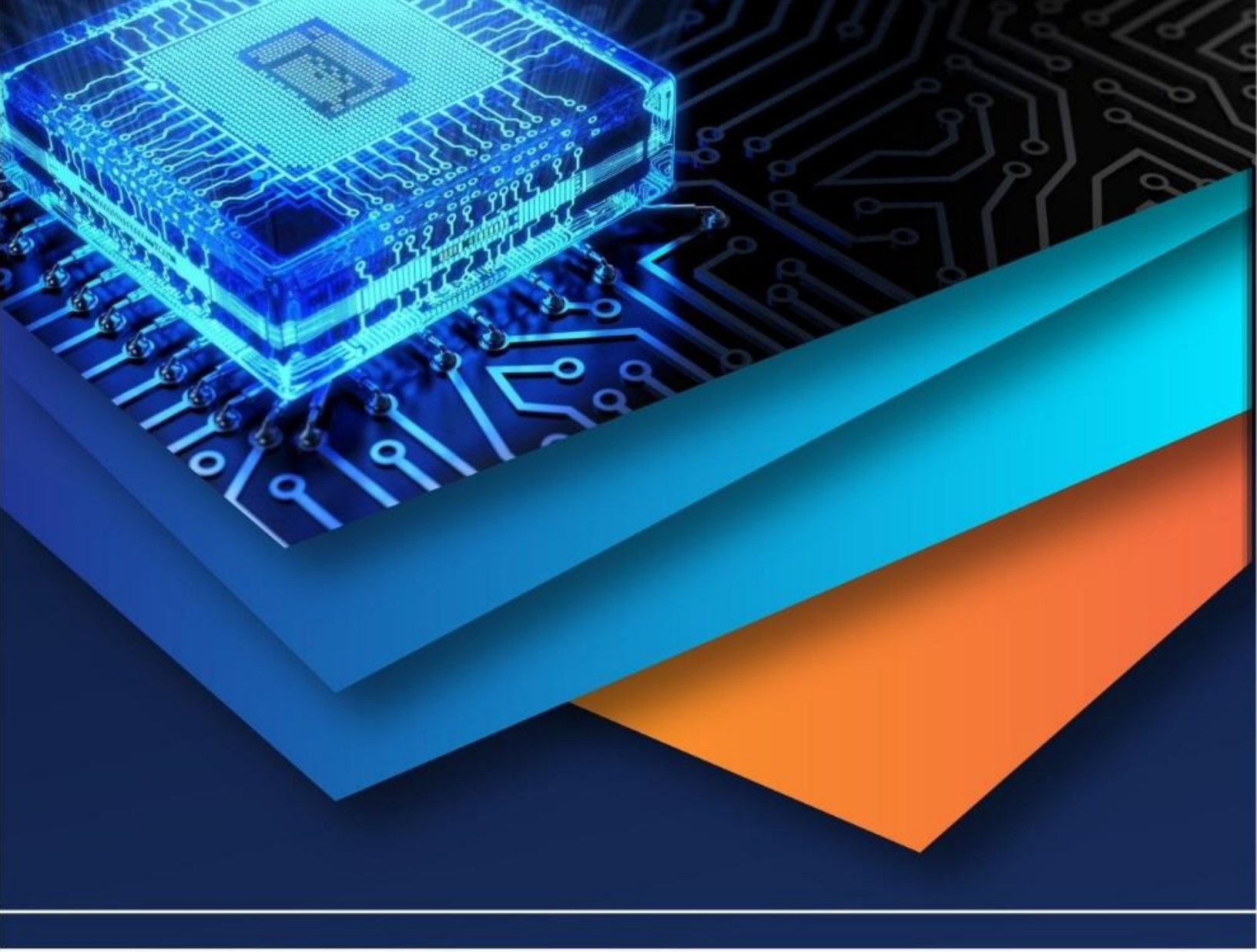

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