IOT Based Soil pH Level Maintaing System

Vaishak P Preshanth[a], Ms. Yashika Saini[f], YogeshVerma[b], Vishwajeet Parida[c], Vinayak Sharma[d], Dr. Manish Kumar[e]

[a,b,c,d]B.Tech Scholar, Department of Computer Science & Engineering, AIET, Jaipur, India
[e,f]Assistant Professor, Department of Information Technology, AIET, Jaipur, India

***Abstract*: Fertilizer use that isn't planned results in worse crop quality. When one nutrient is in excess, it can make it difficult for the plant to absorb the others .To address this issue, soil quality is assessed using a pH sensor, which reveals the percentage of macronutrients present in the soil, and soil moisture is maintained at a specific level. Furthermore, the value is dependent on the type of crop being considered. The pH and moisture levels in the soil will be established according to the needs of the crop to be grown on the soil in question .Take this particular crop, which requires a pH of 6.0 to 6.8 and moisture of 4-7mm/hr, controlling these two parameters is likely to increase crop production. For this, a microcontroller-based embedded sample system is being developed, which will allow fertilizers sprinkling in regions where all these macronutrients are weak, proving it to be a valuable and farmer-friendly automated fertilization unit. The proposed design is one-seventh the cost of current systems, making it accessible for farmers while also reducing manual work. Sprinklers cover discrete zones in the field, automating fertilization and saving farmers in rural areas time and effort .This unique approach also has a quick response time since it allows for real-time, in-situ soil nutrient analysis, which helps to maintain the optimum soil pH level for a specific crop while reducing potential environmental damage. As a result, the proposed technology opens up new possibilities for its application in agriculture and other fields.**

Keywords: pH sensor, in-situ, macronutrients, automated, soil testing, system for agriculture.

I. INTRODUCTION

For around 58 percent of India's population, agriculture is their primary source of income. The country went from being food insecure to being self-sufficient. In the year 2020-21, food grain production will reach 303.34 million tonnes . Because of its potential for growth, the agriculture industry is vital to India's economy . It was made possible by the 'Green Revolution' initiative. However, many parts of society were negatively affected by this "revolution," such as consumer health due to excessive use of pesticides and synthetic nitrogen fertilizers, intensive use of natural resources such as water, and repeated crop cycles depleting soil nutrients. Because of the use of these alkaline compounds, the pH of the soil has risen. All of this occurred as a result of farmers employing more natural resources and manmade remedies than they require. Precision farming can assist in making the best decision possible based on data analysis. pH control is defined as "the use of modern information technology to provide, process, and analyze multi-source data with high spatial and temporal resolution for decision-making and operations in pH management." The pH Control System is necessary for growing healthy plants and crops by controlling the pH level in the soil. The pH level of the soil will be measured using a pH sensor in this system. It will assist us in determining whether the soil has a deficiency and whether the pH level has fallen or increased from the (if pH increased it means its changed to basic or if decreased then it becomes acidic) usual pH level. Our system will simply use the database to determine the difference in the normal pH ideal for plants, and then manage the appropriate amount of chemical or fertilizers to the soil until it regains its neutral and healthy environment for the plants. Depending on the crop, the optimal pH range for plant growth varies. While certain crops flourish in the pH range of 6.0 to 7.0, others thrive in slightly acidic conditions. The soil factors that govern the need for and response to lime vary by location. It is vital to have a good understanding of the soil and the crop in order to manage soil pH for best crop performance. Soils become acidic when basic components found in soil colloids, such as calcium, magnesium, sodium, and potassium, are replaced by hydrogen ions.
Soils created in areas with a lot of annual rainfall are more acidic than soils formed in arid areas. This is why, we need to keep on check on for the soil pH and the moisture as we grow any crop with time-to-time interval. There for we propose our microcontroller embedded device to track these occurring differences and pin it down back to normal or to fulfill crops demands for growing and glooming a healthy and chemical free natural fruit.

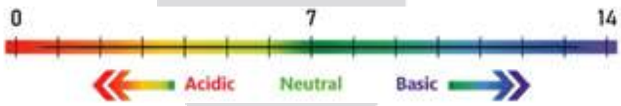

Fig. 1: Flowchart of Main Program

II. COMPONENT USED IN SYSTEM/SYSTEM DESCRIPTION

A. Hardware

1. *Arduino:* The microcontroller is an embedded computer chip that controls most of the electronic gadgets and appliances that people use daily, right from mobile phones, washing machines to anti-lock brakes in cars. The microcontroller was introduced in the electronics industry with the purpose of making our tasks easy that come with even a remote connection with automation in any way.

2. *pH Sensor:* This pH Sensor is a scientific instrument used to indicate whether a solution is acidic or alkaline in nature. [3]A pH sensor is one of the most essential tools that's typically used for water or soil pH measurements. This type of sensor is able to measure the amount of alkalinity and acidity in water and other solutions. When used correctly, pH sensors are able to ensure the safety and quality of a product and the processes that occur within a wastewater or manufacturing plant.[3]

3. *Esp8266:* The ESP8266 Wi-Fi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor.

4. *LCD Display*: The LCD (Liquid Crystal Display) is a type of display that uses the liquid crystals for its operation. Here, we will accept the serial input from the computer and upload the sketch to the Arduino. The characters will be displayed on the LCD.

B. Software

1. *Arduino UNO:* The Integrated Development Environment (IDE) is a simple and easy to learn software for writing Arduino codes.It can be easily connected to a variety of modules like fire sensors, obstacle sensors, presence detectors, GPS modules, GSM Modules, or anything with which you wish to give wings to your dream project.

2. *THINKSPEAK:* ThingSpeak is an IOT analytics platform service that allows you to aggregate, visualize, and analyze live data streams in the cloud.

III. WORKING

The work that was carried out can be classified into three different sections.

A. Hardware Connections

The Arduino and Display, as well as a pH sensor for flow control, are essential components of this suggested automated fertilization approach and pH monitoring system.[4] A pH meter is a voltmeter that measures the electric potential in the solution to be tested for acidity, compares it to a known potential, and utilizes the difference to calculate the pH difference. The microprocessor, which gets a pH value from the pH Sensor, is powered. The percentage of macronutrients in the soil is determined by its pH value. It is tested on a regular basis, and the pH of the soil is determined based on the voltage-to-pH relationship. In the microcontroller's database, a pH threshold value is saved.[4]

Table II implies that a perfect NPK content of soil has a pH value of '7,' hence a threshold value of '7' is used for comparison. The resulting pH is then compared to the threshold pH to determine the difference value .The programmed commands fertilizer to be spread on the fields if the pH value is greater than the threshold. Now, if the stored ideal threshold pH value is larger than the tested pH value, the controller calculates the exact amount of fertilizer required and controls the flow of the fertilizer by simultaneously opening and closing the ph Sensor. The ph Sensor is triggered when the Arduino senses a pH shift. The amount of fertilizer solution to be pH censored and sprinkled is controlled by the ph Sensor. Arduino tracks the pH sensor switching behavior over time at regular intervals in order to adjust the amount of fertilizer solution sprinkled in response to pH changes. [5] A pH circuitry is also built to ensure that the system runs smoothly. The Arduino-controlled pH delivers a high-accuracy pH reading to give the precise solution, which is subsequently dispersed in a circle. The pH sensing unit is placed in the ground to determine the soil's NPK nutritional level.[5] This information is given to the Controller, who will use it to calculate the amount of fertilizer that should be applied to restore the soil's required NPK level. Between the fertilizer unit and the ph Sensor is where the pH sensor is situated. The necessary amount of fertilizer will be pH censored out of the unit and delivered to the valve, where it will be sprinkled on the fields. These fertilizers assist the crop in meeting precise NPK requirements, resulting in higher yield nutritional content and a longer shelf life for the crop. Every minute variation in macronutrient concentration is determined by the change in pH value. [6] A pH sensor's operation is quite similar to that of a battery. The measuring electrode creates a potential directly related to the hydrogen ion concentration on the positive terminal, while the reference electrode offers a stable potential against which the measuring electrode potential can be measured on the negative terminal. The unit can detect minor changes in macronutrient concentration in less time, with an accuracy of roughly 0.02 ph. [6] For more information on the pH sensor utilized in the system. Table 1 gives the technical specification of the pH sensor. It shows the pH Range, pH Resolution, pH Accuracy. Table 1 also shows the Temperature Range which is important to concentration. Because temperature play a very vital role in the growth of plants. Because the pH value varies with temperature, a temperature sensor is included in the pH measuring loop to compensate for this variation.

TABLE I. Technical Specifications of pH Sensor

Characteristics	**Value**
pH Range	0 to 14 pH
pH Resolution	0.01 pH
pH Accuracy	0.02 pH
Temperature Range	-5.0 to 60.0 deg. Celsius
Response Time	<=1 minute

Table shows the relationship between soil pH and macronutrient concentration. The macronutrient content of the soil becomes unbalanced as a result of over fertilization. Acidic media can have a negative impact on plant growth because it inhibits microorganisms that create symbiotic connections with plants.

The main working process can be visualized with the help of flow diagrams. As we can see in the fig. 2. we giving the DC (Direct current) to the Arduino. The Arduino microcontroller unit get started and takes the input form the pH Sensor unit. The pH sensor is analogue type which is easily integrable to the Arduino. Arduino also have some predefined data-sets. On the basis of dataset calculations take places in the Arduino. If pH in range, then it doesn't process any calculation. If the pH is out of range which is not good for plant. And our proposed model solving this main problem.Because pH maintaining is crucial. So, it is essential that we put required precision solution to maintaining the pH range.

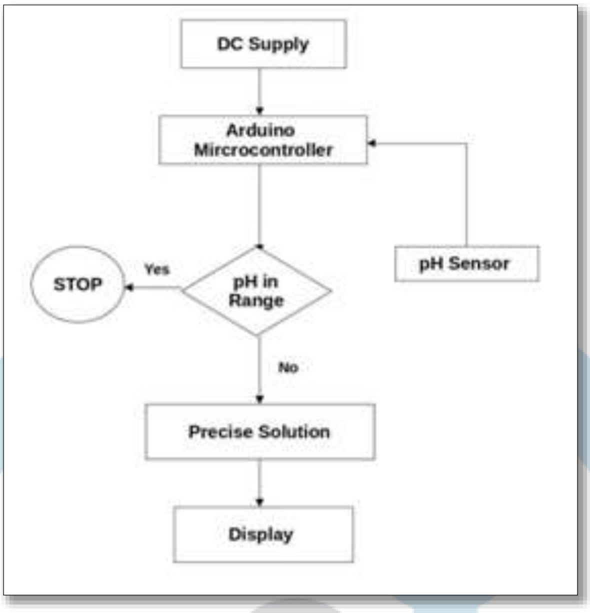

Fig.2: Flowchart of Main Program

The precision solution is calculated on the basis of some standard formulas. Which coded in the Arduino. According to the coded predefined calculation method this system processed the pH range for the given soil type, geographic condition and crop type. After analyzing the whole data and done with the calculation the precision solution is displayed. This output can be interfaced with the help of smartphone or the provided display with the device.

The fig. 3. gives more precision visual description of internal working process of Arduino.

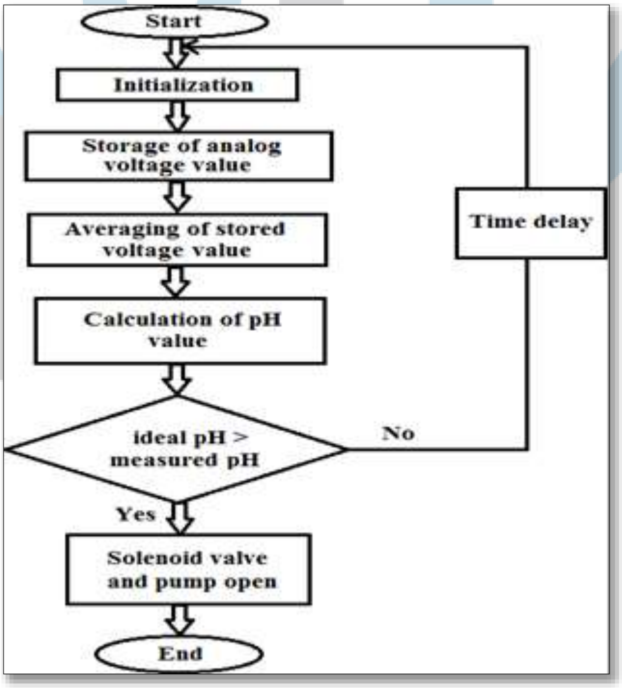

Fig. 3: Flowchart of Main Program

A Driving Circuit and a Switching Circuit are also included in the system. The pH sensor generates a voltage in millivolts as a result of ionic reactions, which is too small to be read by Arduino. As a result, the voltage is amplified by a driver circuit with an instrumentation amplifier so that the controller can read it.

B. pH Calculation

The concentration of the hydronium ion in moles per liter is required to calculate the pH of an aqueous solution (molarity). After that, the pH is computed using the formula:

$$pH= -log[H30+] \quad (1)$$

The pH of a solution is the measurement of hydrogen ion concentration in that solution. According to "Equation (1)", each unit reduction in pH results in a tenfold rise in acidity. We can deduct from Fig. 5 that the pH and voltage relationship is linear. As a result, we utilize the line equation to compute pH from the analogue voltage value, as shown in "(2)",

$$y= mx+c \quad (2)$$

The Arduino Uno's pins are first defined in the algorithm. The procedure starts with the sample rates being initialized and intervals being calculated, as illustrated in Fig. 4. It also specifies precise storage places for the sampled data, such as arrays, as well as a storage length. The sampling of analogue information from the analogue pH sensor, with a running average taken for higher accuracy, is the following stage.

C. sSoftware Integration

The Arduino Uno's pins are first defined in the algorithm. The procedure starts with the sample rates being initialized and intervals being calculated. It also specifies precise storage places for the sampled data, such as arrays, as well as a storage length. The sampling of analogue information from the analogue pH sensor, with a running average taken for higher accuracy. Arduino conveniently monitor the sensor values measured by pH sensor. Variable Synchronization enables communication across devices with minimal coding by allowing you to sync variables between devices. Scheduler programmed jobs to turn on and off for a set period of time (seconds, minutes, hours). Support for any voice assistant integration to make this device voice operated. Dashboard Sharing enables you to share your data with individuals which can be easily viewed in the smartphone by user. It gives an interactive approach between user and device.

IV. CONCLUSION

Design of the low-cost pH and moisture level maintaining system is presented in this paper. This system can be used in farming for effective and control growth of the plants. On detailed investigation of the proposed method, it has been found that, the soil pH could be monitored and with the aid of the pH-macronutrient relationship, the deficient amount of the macronutrient can be provided to the soil effectively. Several environmental issues are curbed due to the idealization of the pH values of the soil samples. There is a check on consumption of chemical fertilizers that are to be used and hence over-fertilization is reduced, which leads to precision agriculture. Furthermore, considering the data for fast growing crops under critical conditions, it has been observed that the time scale to reach the level of moisture and pH in the soil to minimum acceptable level from their optimum level is very large. Hence, the project proves to be beneficial to the farmers as it is cost-effective, reliable, automated and farmer-friendly that leads to a better yield of crops with better nutritious content.

REFERENCES

[1] Aaryan Oberoi;Sagar Basavaraju;S Lekshmi," Effective Implementation of Automated Fertilization Unit using Analog pH Sensor and Arduino" 2017 IEEE International Conference on Computational Intelligenceand Computing Research (ICCIC)

[2] T.He et al. Vigilnet: An integrated sensor network system for energy-efficient surveillance. ACM Transactions on Sensor Networks (TOSN), 2(1):1-38, 2006.

[3] Vijo T Varghese , Kalyan Sasidhar , Rekha P, "A Status Quo Of WSN Systems for Agriculture" in 2015 International Conference on Advances in Computing, Communications and Informatics (ICACCI).

[4] Kristoffer O. Flores, lsidro M. Butaslac, Jon Enric M. Gonzales, Samuel Matthew G. Dumlao, Rosula S.J. Reyes, "Precision Agriculture Monitoring System using Wireless Sensor Network and Raspberry Pi Local Server", Region 10 Conference (TENCON), 2016 IEEE

[5] Marcelo R. Romero, Alexis Wolfel, Cecilia I. Alvarez Igarzabal, "Smart valve: Polymer actuator to moisture soil control," Sens. Actuator B234, pp. 53–62, 2016

[6] P. V. Kasambe, K.S. Bhole and D. V. Bhoir, "Design and Simulation of High SNR Varying Thickness Embedded Strain Sensing Polymer Microcantilever for Biosensing Applications", ASME 2018 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, pp. V004T08A004- V004T08A010, August 2018.