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Involuntary Nutrients Dispense System for Soil Deficiency using IOT

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Abstract : The Internet of Things (IoT) is transforming the agriculture industry and enabling farmers to contend with the enormous challenges they face. However farmers use antiquated techniques which lead to overuse or under usage of fertilizer. The aim of the project is to reduce the usage of fertilizer in the field and also to reduce the work of the farmer. If more amount of fertilizer is used, it will affect the human health and also affect the nature of the soil. The soil pH solution is very important because the soil solution carries macronutrients such as Nitrogen (N), Potassium (K) and Phosphorous (P) that plants need in specific amounts to grow, thrive and fight off diseases. If the soil pH level is more than 5.5, it raises the nitrogen content in it. When soil pH is between 6.0 and 7.0 then phosphorous is also available to the plants. Plants cannot utilize N, P, K and other nutrients, if soil solution is too acidic. In acidic soils, plants are more likely to take up toxic metals and some plants eventually die of toxicity (poisoning). Here the pH sensor is used to remotely monitor the nutrients level in the soil for better crop production. The pH sensor detect the pH value in the soil and send the data to the Raspberry Pi which will get displayed in the LCD display. Based on the pH value the NPK values are obtained. Here the IoT is used to enable the farmers to easily visualize the data and take actions on insights and recommendations.
Keywords : pH sensor, Internet of Things, Raspberry Pi, LCD display, Liquid Level Sensor.

Introduction

The continuous cultivation of plants with inefficient management of fertilizer inputs has resulted in effect on the consumer malnutrition, environmental concerns and decrease in yields-qualitative and quantitative.The system provides balanced nutrition level to the plant by monitoring and modifying pH level of fertilizers with respect to soil parameters. Soil is a major source of nutrients needed by plants for growth. Plants require seventeen essential elements for growth. If any one of these elements is missing, a plant will not grow, even if all the other elements are present in their required amounts. Soil nutrients are classified into two types they are, macronutrients and micronutrients. The macronutrients which plays the major role for plant cultivation are nitrogen (N), phosphorous (P) and potassium (K). Soil pH is an indication of the acidity or alkalinity of soil and is measured in pH units. The pH scale goes from 0 to 14 with pH 7 as the neutral point. From pH 7 to 0, the soil is increasingly more acidic and from pH 7 to 14, the soil is increasingly more basic or alkaline. The availability of macronutrients are highly pH dependent. The aim of the project is to develop a web surveillance system using a RASPBERRY PI port, which basically is an equivalent replacement to small sized CPU of a computer.

Raspberry Pi is a credit-card-sized single-board computer. It does not include a built-in hard disk or solid-state drive, but uses an SD card for booting and long-term storage. In modern agriculture domain, monitoring the plants parameters play an important role in diagnosing and giving appropriate nutrients. In the existing system plants are monitored using bedside monitoring station with wired sensors, which makes the plants to be periodically monitored by the keepers. The farmer can get the information about the field from anywhere with the help of IoT. The Internet of Things (IoT) is the network of physical objects – devices, vehicles, buildings and other items embedded with electronics, software, sensors, and network connectivity-that enables these objects to collect and exchange data. Internet of Things allows objects to be sensed and/or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit. If a person is travelling the output can be checked with the help of any smart device.

Problem Formulation

The main disadvantage of microcontroller is speed. They also have complex architecture. Therefore, understanding their functionality is quite difficult. The microcontroller accepts only c language. Microcontroller is mainly used for the repetition of the process since they cannot be reprogrammed.A fiber optic sensor is used for the detection of salinity and liquid level. In terms of liquid level monitoring, the selection of sensitivity and the detection range can be easily achieved by moving the positions of sensor probe. The sensing principle of the proposed system is similar to that of an automatic refractometer. The maindisadvantage of fiber optic sensor is its installation cost.

The system reduce the effect of high concentration of salt and minimize the pH problems in the soil by spreading fertilizers in the controlled manner and also improve the productivity. The result of solution's pH measurement gives the information about availability of nutrients in solution and EC readings are indicative of amounts of fertilizers being injected into the fertigation system. This system may help in the efficient use of fertilizer and also helps to improve soil structure and environment. So this indigenously developed low cost auto fertilizer control system ensures better returns to human's health and environment. But this system requires manpower to be present in the field and monitor.

Related Works

BaljitKaur andDilip Kumar proposed a system for balancing the nutrition level by managing pH and electrical conductivity level of fertilizer solution according to soil pH and electrical conductivity. The delivery of fertilizers in the field was through irrigation water. The system will automatically monitor EC and pH level of fertigation[1] solution with respect to the parameters of soil. The paper may help in the efficient use of fertilizer and also helps to improve soil structure and environment.

Zhang Feng discussed the design of wireless sensor[5] network and Internet technology of farmland automatic irrigation control method. The paper references some enterprise's actual production processes, to the traceability system based on Web water-saving irrigation processing scheme.

According to the author the final analysis of the network in the Internet was based on the agricultural plants of farmland water-saving irrigation system integrated approach. Thepaper shows that system through the embedded control technology, complete intelligent irrigation can improve the agricultural irrigation water use efficiency and automate the irrigation system.

Hang-Zhou Yang, Xue-GuangQiao,Kok-Sing Lim and Wu-Yi Chong reported about a fiber optic[7] sensing technology for the detection of salinity and liquid level of a given solution. The paper was based on the principle of the displacement measurement in a large measuring range by generating a variety of outputs for various sensing objectives. In the described paper the sensor was investigated analytically and experimentally.

Taslim Reza S.M, QaderNewaz and Jamal Uddin.proposed a system for automatic irrigation system for using solar power[9]. As the proposed model was automatically controlled it will help the farmers to properly irrigate their fields. The system was secured with password for the restricted number of users. The sufficient amount of power was provided by the solar power to drive the system. To overcome the necessity of electricity and ease the irrigation system for our farmers, the proposed model can be a suitable alternative.

Nutrient Dispense System

In the system the macronutrients are measured with the help of pH sensor. The analog input from the pH sensor is converted into digital input and send to the controller called Raspberry Pi. Nutrient dispense system block diagram is shown in the Figure.1. From the pH value the NPK content in the soil can be obtained. Then it is compared with the already stored threshold value and if the obtained value is less than the threshold value then the relay circuit for corresponding nutrient is switched ON.

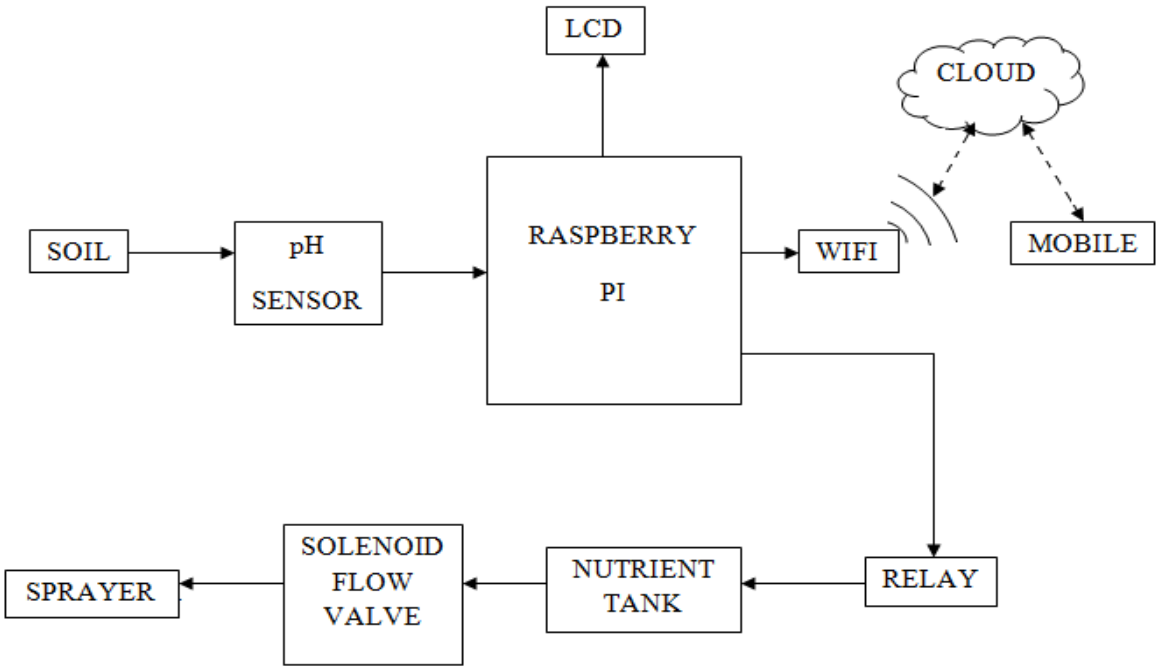

Figure.1.Block Diagram of Nutrient Dispense System

The pump connected to the relay is switched ON by 12V power supply. At the same time the current values of the nutrients are displayed on the LCD display. Finally the digital input value is sent to the farmer using Internet of Things and this can be viewed by the farmer through computer or smart phone. Two 15V transformer will be used in the nutrient dispense process. The main purpose of transformer is 230V power supply is converted into two set of 15V power source with 500mA current.Specification of the transformer are voltage 2*15V, current 1*500mA, rated power 15A. Transformer output power source are connected to bridge rectifier. Bridge rectifier is used to convert ac into dc. During this process some noises occurs and that can be removed with help of capacitor.

pH sensor is used to measure the pH value of the soil. pH sensor output signal is analog signal that will be passed to MCP 3028. It converts the analog signal into digital signal. Digital signals are passed to the raspberry pi. Raspberry pi only accept the digital signals. From the input value the NPK values can be obtained. NPK threshold value is already programmed in the raspberry pi kit.NPK values are compared to threshold value, if the NPK values are less than the threshold value relay will be switched ON and message will be displayed on the LCD display.

In pH sensor the combined electrode is combination of glass electrode and reference electrode in single entity. The module power of pH sensor is 5V. The pH measuring range is 0-14.

Relay, a switching device will be placed between the controller and the nutrient tank. The relay will get switched when it gets input from the controller. It gets small current as input from the Raspberry Pi and controls the nutrient tank. Here 5V SPDT relay is used. It is a high quality Single Pole Double Throw shield relays. It is used in high voltage or high current device. This relay's coil is rated up to 12V, with a minimum switching voltage of 5V. The fertilizers needed to increase nitrogen, phosphorus and potassium content in the soil are mixed with water and then stored in the nutrient tank. Liquid level sensor(UM0022) will detect the level of

liquid contained in the nutrient tank and send the information to the controller. It is a kind of liquid level proximity sensor, which use high frequency ultrasonic technology and self triggering continuous measurement. It has high accuracy and good directivity.

Solenoid flow value is an electro mechanical actuated value to control the flow of liquid from the nutrient tank to the sprayer. A centrifugal pump will be placed after the nutrient tank to move liquids through the piping system. The fluid enters the pump impeller along or near to the rotating axis and is accelerated by the impeller, flowing radially outward into a diffuser or volute chamber, from where it exits into the downstream piping system. Centrifugal pumps are used for large discharge through smaller heads.

Result and Discussion

Thus the proposed system, continuously monitors the pH level in the soil. The threshold value for the three nutrients is already stored in the controller. The analog value from the pH sensor is first converted into digital value and sent to the Raspberry Pi. Then the input value is compared to the threshold values.

Figure.2. pH Value from the Sensor

If the input value is not between the threshold values or lies between the threshold value then the input value is displayed on the LCD module as shown in the Figure.2. The obtained value is not the actual pH value. The pH value is measured by dividing the obtained value by 14.By the same time the corresponding nutrient's relay is switched ON.

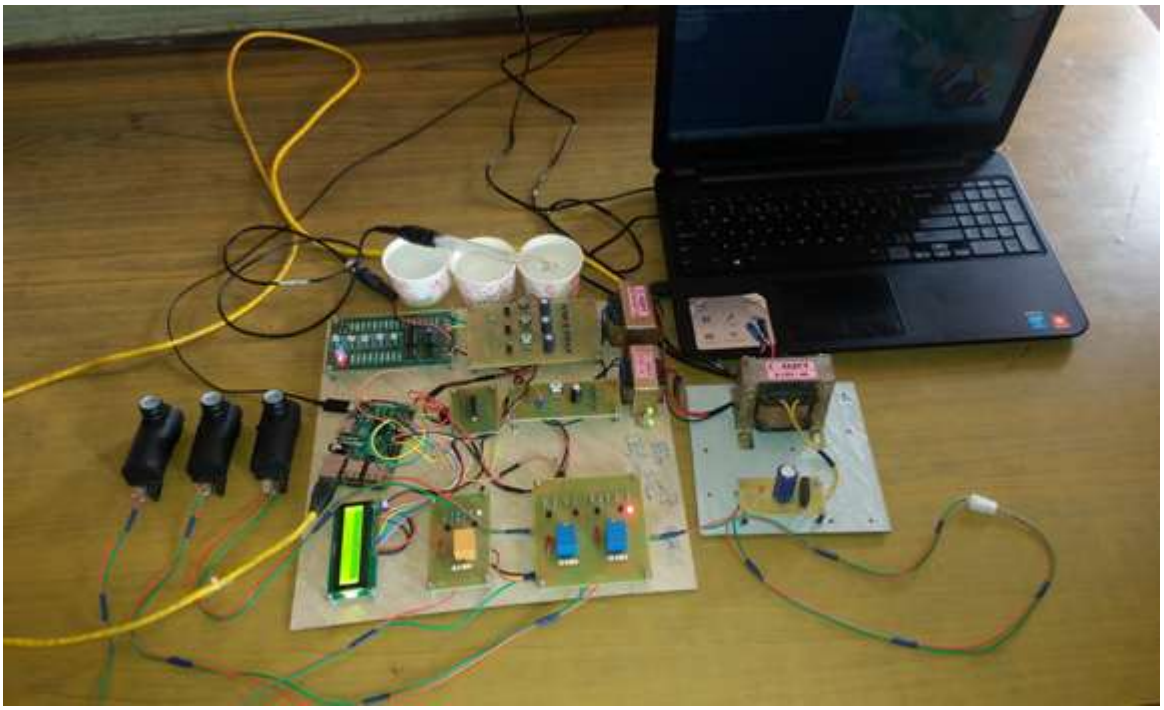

Figure.3.Experimental Setup of Nutrient Dispense System

The entire setup of the nutrient dispense system is shown in the Figure.3. The pH value of the soil has been measured and displayed on the application. If the pH range is in between 3 to 5, then nitrogen content is unavailable in the soil.

If the range is between 5.5 to 7, then phosphorous content is unavailable in the soil. If the pH range is between 8.4 to 9.1, then potassium content is unavailable in the soil.

Table.1. Experimental pH values from the sensor

S.No.	Obtained NPK-pH Value	pH Value	Soil Nature	Nutrient	Relay 1 Status	Relay 2 Status	Relay 3 Status
1.	53	3.7	Acidic	Nitrogen	ON	OFF	OFF
2.	83	5.9	Acidic	Phosphorous	OFF	ON	OFF
3.	128	9.1	Basic	Potassium	OFF	OFF	ON
4.	98	7	Neutral	Phosphorous	OFF	ON	OFF
5.	63	4.5	Acidic	Nitrogen	ON	OFF	OFF
6.	122	8.7	Basic	Potassium	OFF	OFF	ON

Based on the pH value the nutrient deficiency is analyzed and corresponding relay will be switched ON as shown in the Table.1. NPK content varies for each plant. So the threshold values of the nutrients are set based on the plant cultivating. The pH value of the soil has been measured and displayed on the application as shown in the Figure.4. Depending on the pH value, the levels of nitrogen, phosphorous and potassium in the soil can be obtained and the nutrient which is unavailable to the plant is also displayed. Based on that respective relay can be controlled by human, away from the field.

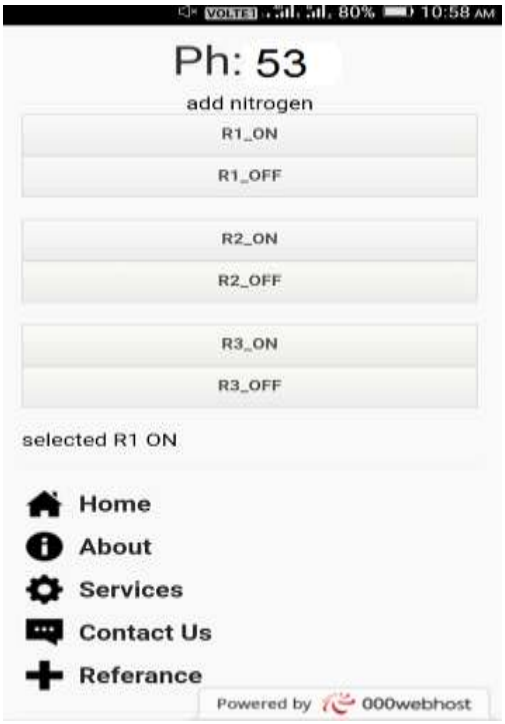

Figure.4.Screen Shot of Mobile Application

Depending on the pH value, the levels of nitrogen, phosphorous and potassium in the soil can be obtained and displayed to the farmer with the help of mobile application as shown in the Figure.4. The obtained value is compared to the threshold value and if the obtained value is less than the threshold value then the respective fertilizer will be sprayed in the field by the approval of the farmer.

Conclusion

By continuously monitoring the NPK content in soil it is easy to preserve the soil health from land pollution and water pollution. This is implemented by using Internet of Things. The data obtained from sensor are stored in the cloud storage and the data along with a message is sent to the user through mobile phone. This may reduce the presence of manpower in the agricultural field. There are variety of crops. For certain crops, a person must monitor the crop for frequent number of times in order to manage their water content, nutrition level, etc,. If any of the nutrient content is less in the soil structure, then it is balanced by injecting the specified solution for increasing that nutrient content through irrigation system. Here an efficient irrigation system is used and all these process are controlled by Raspberry Pi.

The nutrient dispense system can easily reduce the amount of pesticides used in the soil structure and can also prevent the soil from various problems such as soil pollution, water pollution, etc,.

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