Fertigation - Nutrient Dispensary Management Using Internet on Things, A Novel Approach

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Abstract : Use of technology in agriculture sector is increasing day by day. The Internet of things is emerging technology that incorporates many technologies from different areas. The Internet of things is transforming the agriculture industry. Fertigation or fertilization is supplying fertilizers to produce the quality crops with higher yields. This is done manually. Iot technology can be effectively useful for fertigation. In this paper, five different papers', abstracts are given. .In the paper, different methods, implementations or algorithm for fertigation system using Iot are described. In these designs, Iot is used to easily visualize the data and take actions.

Keywords- *Iot, fertigation, soil PH sensor, relay, Wi-Fi module, ZigBee module, Wireless Sensor Network, Cloud.*4

Introduction:

Agriculture plays a vital role in the development of agricultural country. In India, about 70 % of the population depends upon farming.One third of the nation's capital comes from farming. Issues concerning the agriculture have always been hindering the development of the country. India is dependent on agriculture for people's livelihood. Agriculture is both, a source of income and food security for multitude of poor income and endangered sections of society. To overcome the problems in agriculture sector, we must opt smart agriculture. For that there is need of modernizing the current traditional methods. There is a major need for reformation of agriculture research. It will help farmer resulting a sustainable growth in the domain.

There are lot of drawbacks of supplying fertilizers manually. As farmers use antiquated techniques, it leads to underuse or overuse of fertilizers. If more amount of fertilizer is used, it will affect the human health as well as nature of soil. The underuse will not meet plant's needs sufficiently.

Controlling of fertigation operation is done through any remote smart device or computer connected to internet. Soil PH is measured using PH sensor or electrical conductivity sensor or fibre optic sensor. Other sensors used are moisture sensor and temperature sensor. Sensors along with needed actuators are interfaced with microcontroller like Rasberry Pi or Arduino. Analog PH values data is converted to digital using analog to digital converter. Network like Wi-Fi or ZigBee modules or hotspot are interfaced with microcontroller for communication between system devices. The relay Microcontroller performs corrective actions according to the results of sensors and intimates the corresponding relay. The relay in turn triggers the motor and fertilizer is supplied appropriately to the plants. These system designs are remotely operatable.

This paper aims at studying different papers having design for smart fertigation.

1. Involuntary Nutrients Dispense System for Soil Deficiency using IOT [1]

This paper describes the system the macro nutrients are measured with the help of pH sensor. The system aim is to develop a web surveillance system using a RASBERRY PI port. It is a single board computer having credit card size. It uses a SD card for booting and long term storage. 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.. 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.

The obtained value is not actual PH value. The PH value is calculated by dividing the obtained value by 14. Here, the PH sensor is made up of electrode with a glass electrode & a reference electrode. The PH measuring range is 0-14. From the digital input, NPK values are obtained. It is compared with threshold value already stored in microcontroler. If the NPK values are less than the threshold values corresponding relay will be switched on & message will be displayed on LCD display.

Relay, is switching device placed between controller and the nutrient tank. The fertilizers needed to increase nitrogen, potassium and phosphorus are mixed with water and then stored in the nutrient tank.
Liquid level sensor(UM 0022) is used to detect the level of liquid in tank and send data to machine.
If the PH range is between 3-5, the nitrogen content is not available in soil. If the range is between 8.4-9.1, potassium content is not available in the soil.
NPK content need varies for each plant. So, the threshold values of the nutrients are set based on plant cultivated. The PH values are measured and displayed on mobile application.
An efficient irrigation system is used to inject specified solution. And nutrient less in content is balanced. All the process is controlled using Rasberry Pi.
As this is a web based system, farmer can get information from anywhere.

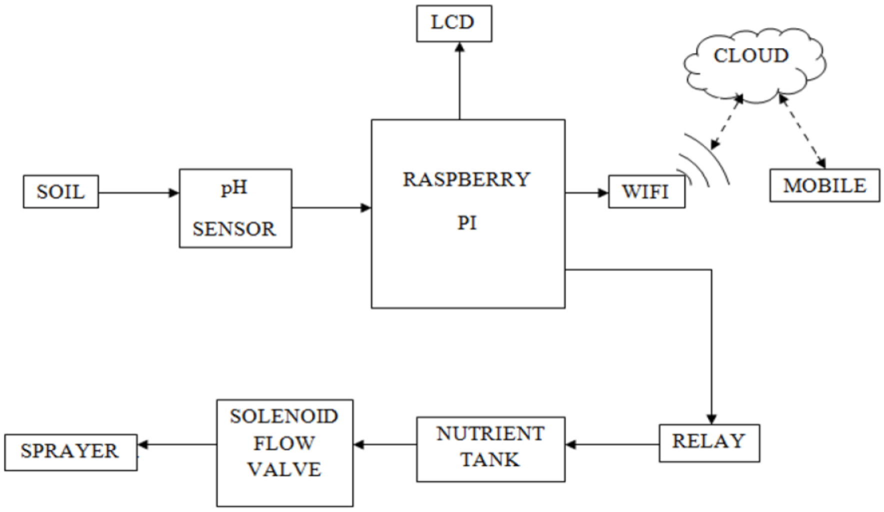

Figure 1. Block Diagram of nutrient dispense system

Conclusion : This paper concludes following points.

- The soil is preserved health from land pollution and water pollution. This is implemented using Internet of Things.
- The data obtained from sensor are stored in the cloud storage. The data along with a message is sent to the user through mobile phone. This reduces manpower in the agricultural field.
- For particular 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, 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.

2. Fertigation System to Conserve Water and Fertilizers Using Wireless Sensor Network. [2]
This paper describes a crop monitoring system for citrus tree which maintains soil proper PH level and soil water content. Wireless Sensor network is used to communicate between sensory unit and main station. The ZigBee network is used for communication. Main sensors used are moisture sensor and soil PH sensor.
The entire fertigation system shown in figure will be set up at main station. The GUI is built up using VB software. Sensory data will be displayed on GUI. Also, t has an alert alarm for wrong soil water content and soil PH value. User can control the entire system manually from main station.
As shown in block diagram, sensors are interfaced with MSP 430 microcontroller. It is 16 bit RISC processor. Microcontroller processes all input sensory data and sends it to Zigbee module located at sensing unit means microcontroller's end
Where as at main station ,ie. receiving end ,another ZigBee module will be receiving sensory data which is displayed on GUI of computer. User can start and stop the system from GUI. GUI have full control and command over entire fertigation system.
When water scarcity occurs, relay of submersible motor pump in tank 2 will trigger and pour water to plants through drip irrigation pipelines. In the same way, when soil PH is not adequate for citrus tree (5.5-7.0), necessary soil improver fertilizer will flow through tank 1.

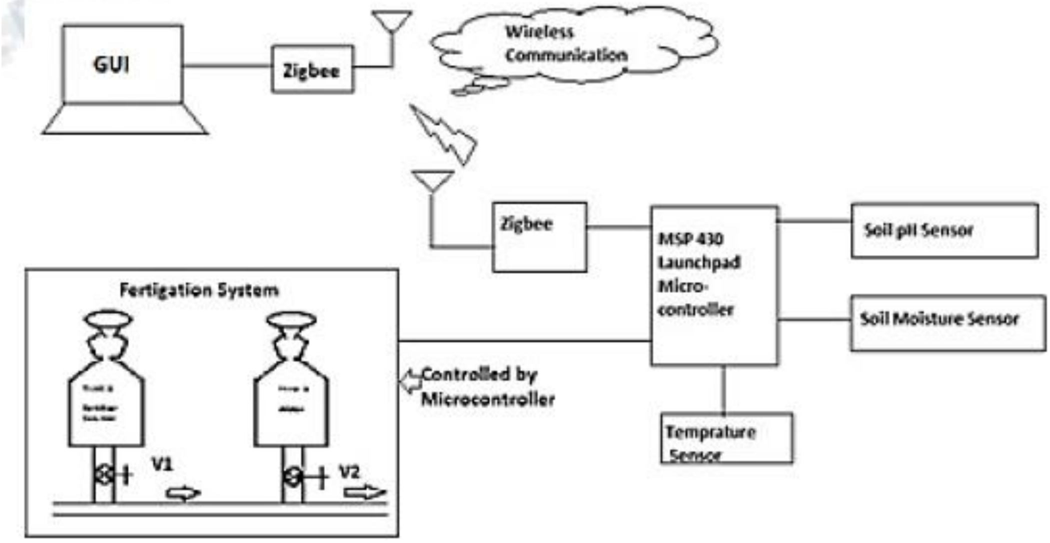

Figure 2. Fertigation System using WSN Diagram

Conclusion: This paper concludes following points.

- Fertigation System Using MSP 430 launch pad microcontroller, soil moisture sensor, soil pH sensor, Temperature sensor and wireless sensor network for communication using Zigbee modules is designed.
- Using Soil moisture sensor we have controlled the valve of water tank to avoid excess water supply to Citrus plants.
- And using soil pH we controlled the valve of water soluble fertilizer tank. As soil pH value 5.5-7 is considered to be suitable for citrus plant the programming is being done on MSP 430 microcontroller such that when the soil pH is below 5.5 i.e. soil is acidic so valve of fertilizer tank will be opened to make the soil pH between 5.5-7 i.e. by pouring alkaline solution, when it reaches value.
- 5.5-7 valve will be closed and vice versa for very alkaline soil.
- Therefore by controlling water supply and water soluble fertilizer supply adequate amount of water and fertilizer will be needed for farm fields. Hence we can conserve the Water as well as can avoid over use of fertilizer.
- All sensory data from sensing unit have successfully sent to the receiving terminal i.e. remote location. All data has been displayed on VB based GUI at remote location.

3. Implementation of Automated Organic Fertigation System by Measuring the Plant Parameters [3]

This paper describes an autonomous irrigation system of soil with features like determining PH levels using electrodes, minerals, type of fertilizer to be used . Here nutrition level of plant is balanced using PH value. The temperature and moisture of soil using the sensor is measured and monitored. Depending upon the results of sensors Arduino microcontroller performs corrective action and intimates the relay. The action is displayed on LCD. This action is nothing but selection of percentage of fertilizer to be fed for corresponding PH range. The relay module's on off timing is already programmed. Then the relay triggers with the motor with the indication of fertilizer supply duration. The solenoid valve is turned on or off according to relay on off timing. The continuous monitoring can be viewed in the web page.

This paper also states the tables for suitable PH value for particular crops, PH denomination for particular PH and PH required for tomato plant.

Hardware components used are Arduino UNO,PH sensor, LM 35 temperature sensor, soil moisture sensor, relay, LCD, Wi-Fi module, solenoid valves, power supply.

Arduino IDE software is used.

Conclusion : This paper concludes following points.

- This system is feasible and cost efficient for optimizing nutrient supply as well as it will also maintain a balanced nutrient content in the soil using pH sensor.
- Precision irrigation will minimize the waste of water and energy, while maximizing the crop yield also it dispenses fertilizers in proper proportion.
- It is time saving, led to removal of human errors in adjusting the soil moisture level.

- Continuous monitoring of recorded process by the web page created through IoT is used to analyse the net profit of the crops.
- This Fertigation system allows cultivation in places with water scarcity thereby improving sustainability.

4. Remote agriculture and automation control using internet of thing (Iot) design and implementation [4]

This paper the conceptual Design of the system, Remote and and automation layers model, and system implementation using IOt technology is presented.
Conceptual Design:

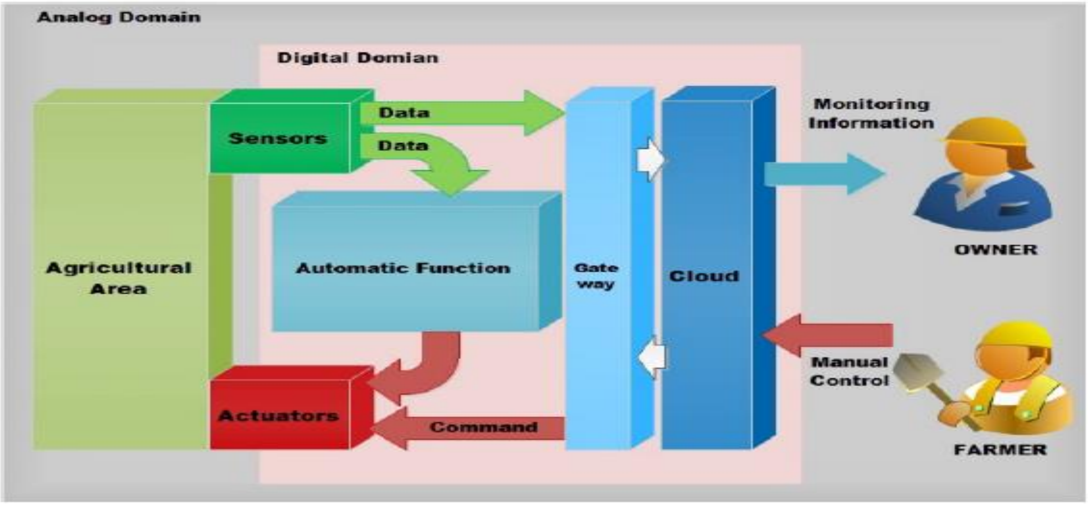

Figure 4. Conceptual Design of Fertigation System

Figure shows the connections from farmland to sensors and actuators. The point of gathering information from the agricultural area is through the internet connection with the cloud system. Information is provided to the farmers to make decisions in handling unexpected events.

The system consists of 1. routing basic functions of agricultural system with automation. 2. Data input from sensor device 3. Equipment to handle the farmland according to requirement set.4. Internet is used to send data to cloud database. 5. The data retrieved from the cloud is displayed. 6. Farmers analyse the data.

3. Remote and automation Layers Model

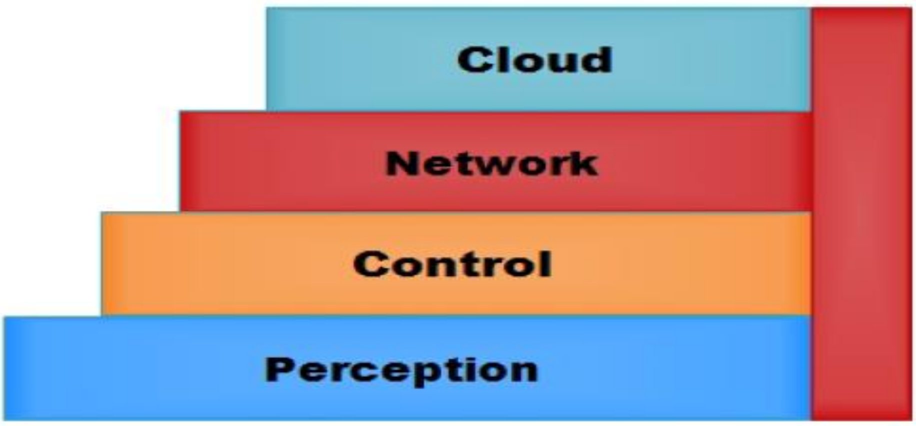

Figure 5. Layers Model

1> Perception Layer :consists of sensors and models
2> Control Layer: consists of microprocessor ,ports required to connect to sensors and actuators. It has ability to convert analog data to digital and digital to analog. The control layer is distributed into sub nodes, if the system is large.
3> Network Layer: Consists of LAN and WAN depending upon agricultural area & cost of internet connection. In LAN owner manages the connection. Internal data transmission takes place. Low power wireless connections can be included. The internal device is connected using WSN. The control layer is then transferred to WAN connections.

WAN depends upon ISP (Internet service provider) in that area. It may be a direct connection from node sensors or a connection from LAN.

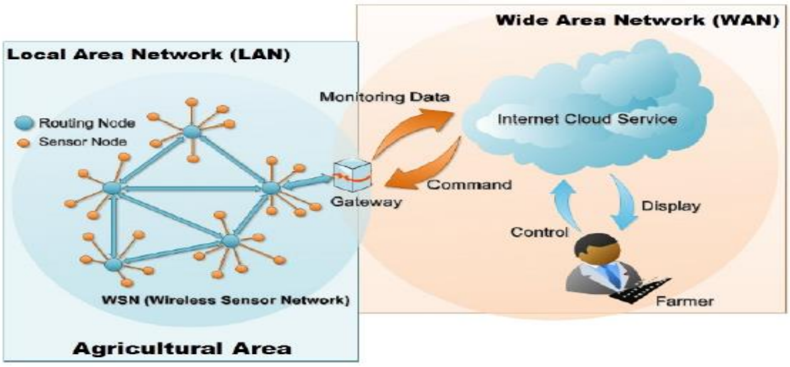

Figure 6. Network Layer

4> Cloud Layer: IOT based agriculture is connected to the cloud service to store data on the cloud & use that data by web service. It needs the wen or application interface to control access to the control layer over the internet.

JSON (Javascript Object Notation) is a standard text based format for representing the structured data. It is used for sending data between Iot devices and loud services. JSON format is created and sent to JSON cloud database using microprocessor.

System Implementation:

Sensors used are soil moisture sensor, humidity sensor, EC (PH) sensor humidity, temperature, light sensor. Actuators are used with solenoid water valves and pumps. Fog pump control switch, temperature actuators, light actuators with light control switch are used.

Conclusion: This paper concludes following points.

- We have presented a conceptual design and implementation of remote and Automation agriculture using IoT Technology.
- It reduces the number of labourers are replaced with technology.
- But because of the complexity of agriculture, there are some factors that also depend on human experience and decisions.
- The system has both automatic and manual parts. Enhanced by the Internet through reduced distance.
- System development is at the heart of the performance of sensors and Node Microprocessor to be more capable.
- It can control more and more factors.
- There may be no human involvement in the system at all in future.

5. Soil nutrient measurement in paddy farming using IoT [5]

Continuous monitoring of soil done by interfacing fibre optic sensor. The data like soil mineral percentage and number of fertilizers to be added is uploaded to the cloud using wi-fi module in the NODE MCU. Soil parameter values are sent to farmers in real time using NODEMCU V3 through cloud Think Speak. The data is verified in the thing Speak cloud in the form of graphs. These values are displayed on farmers' personal account. As well as notification is sent to mobile phones. The data is then saved for weekly and yearly analysis.

Algorithm:

Step 1: Initializing the sensor to measure the values
Step 2: Collecting the values and send them to NODEMCU for further processing
Step 3: Data is sent to the cloud from NODEMCU for further processing
Step 4: Values of NPK are classified by their percentage. If the value is >65 %, nutrient levels are good. If the value is >45% & <65 % nutrient value is ok but low amount of fertilizer is suggested. If value is <40 % nutrient levels are poor immediate fertilizing is suggested
Step 5: Information is sent to the farmer through SMS.

Conclusion: This paper concludes following points.

- The system is farmer friendly.
- It consumes less power.
- It is cost efficient and suitable for any type of climate condition.
- Thus we have designed a low cost, efficient system which can help farmers in many ways.

Conclusion: Five papers are studied which present smart automated fertigation system.
The systems designed are time saving.

- Less manpower is needed in comparison with manual procedures.
- These are user friendly having GUI or web page for communication.
- The systems are cost efficient also.
- They are easy to install.
- Hardware easily available.
- The systems promote precise agriculture by improving soil quality.

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