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IOT BASED PRECISION AGRICULTURAL SOLUTION AND AUTO FERTIGATION SYSTEM

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Abstract-Fertigation is the modern agro-technique in which fertilizer is dissolved and distributed to the plants along with water in drip or spray irrigation to produce quality crop with higher yield. Modern Fertigation methods improve the efficiency of fertilizer use, save 20-40% of fertilizer without affecting growth & Yield as well as reduce the pollution. The main objective of this project is to develop an IoT based automated fertigation system to maintain the required moisture level in the soil and to add the required nutrients at different time period to obtain the balanced N-P-K rating in a liquid. The nutrients are provided to plants through drip irrigation. The technique basically helps farmers cultivate crops with significantly higher yield in a short span of time & save 20-50% of water usage. The system consists of designing a control system for mixing the fertilizer with water to obtain required NPK concentration ratio and delivering parts of it to the crop. The prototype auto fertigation model designed using Arduino Uno microcontroller board & other peripherals to control & communicate the status of the tomato and palak plant. The microcontroller is programmed to control the devices to operate the control valve & other devices to supply the required quantity of N-P-K and water for the plant as per scheduled days. Therefore depending on the type of crop and their nutrient requirements they are fed through irrigation at specific time & intervals. The system is connected to internet through a wifi module and user can enter the parameters in a mobile application which will transmit the data to the system over internet.

1.0 Introduction

The fertigation system is the modern agricultural technique and is widely used in a smart farming. Fertigation method is where besides irrigation, the fertilizer mixture is also fed to the plants. The fertilizer nutrients along with water are uniformly distributed and delivered to make sure about the water management precisely, hence the technique is known as precision agriculture. Our smart devices calculates and analyzes several parameters to ensure proper supply of water and nutrients to the crops.

This technology provides the opportunity to apply accurate rates of water and fertilizers to the crop and can therefore be an important precision agricultural technology if designed correctly. The properties of fertigation that makes it a precision agriculture technology is precise time, precise rate of pumping fertilizer and precise amount of fertilizers taken. Fertigation has the potential to be considered a precision technology in agriculture. It is possible to achieve very high precision fertilization and irrigation by choosing the system that is most suitable for crop and field conditions and by correctly designing it.

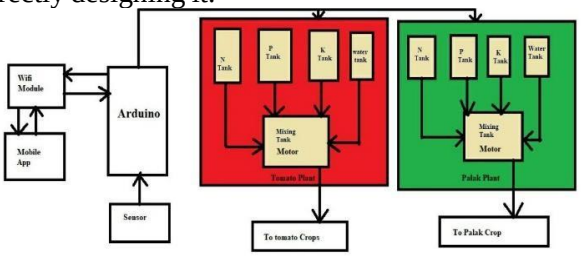


Figure: System Block Diagram

The system block describes the hardware part of the fertilizer mixing tank along with supply of required water to obtain precision solution for crop growth of tomato and palak plants. The connected hardware devices are Arduino Uno microcontroller, dc immersible pumps, sensor and Wi- Fi module. The three major macronutrients, nitrogen (N), phosphorus (P), and potassium (K) are stored 3 in the different tanks. The N, P, and K amounts in the soil sample are determined by comparing the solution with the chart for each crop. The mixing tank is where the fertilizers are mixed along with water and given to crops through drip irrigation. Whenever there is a change in temperature and humidity of the surroundings, these sensors sense the change in temperature and humidity and give an interrupt signal to microcontroller, thereby initiating the irrigation. Four stages of growth process are involved to achieve precise solution of tomato and palak crop growth. A Wi-Fi module is connected to internet, which sends sensor output status and current stage fertilizers mixing process status to the user. A mobile application is also developed in which the user can control the process manually based on current sensor's output. All this functioning will be updated to the user sent by the system through IoT.

2.0 Fertilizer Mixing and Delivery Process

The mixing & delivery process of the three water soluble fertilizers N, P and K are carried out as per calculation. Automatic adjustment of injection ratios of the fertilizer solutions from the stock tanks to the irrigation water relies on input. As input to the device, the quantities of the three fertilizer solutions and the sum of each constituent needed in the final mixture supplied to the plants are given. The rate of flow calculated using formula:

Time (seconds) = (quantity needed (Kg)) ÷ {conc (Kg/Liter) × Flow rate (Liter/second)}

The concentrated fertilizer solutions are prepared in mixing tanks, and are then injected into the irrigation water, using fertilizer injectors. The irrigation system can be drip irrigation, sprinkler system, pivot or different configurations of hydroponic systems.

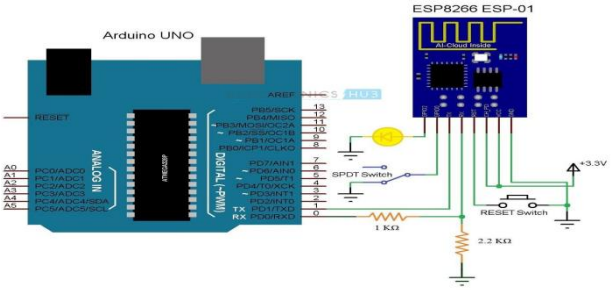
3.0 Circuit Design

Relay module Connection

A Relay is actually a switch which is electrically operated by an electromagnet. The electromagnet is activated with a low voltage of 5 volts from an Arduino microcontroller and it pulls a contact to make or break a high voltage circuit. The DC submersible pump used in the fertilizer tank & water mixing pump operated through relay module. The relay is connected in series with the power supply supplied through a switching mode power supply module.

ESP8266 Wi-Fi module connections and configurations

The ESP8266 is a user friendly and low cost device to provide internet connectivity the module can work both as an access point and as a Wi-Fi connect station; hence it can easily fetch data and upload it to the internet making Internet of Things as easy as possible. ESP8266 Wi-Fi module is powered by a 3.3 V voltage source. The VCC Pin and CH_PD Pin of ESP8266 ESP-01 Module are connected to a 3.3V Supply. The 3.3 V in the Arduino board is connected to Vcc of the ESP8266 module. Circuit diagram shows ESP8266 Arduino interface.



Interfacing of sensor with Arduino

The sensor's output is connected to an Arduino analog input. The Arduino's analog-to-digital converter (ADC) then converts that value to a value between 0 and 1023.The sensor output is given to a signal conditioning circuit to convert the analog signal to digital. The ADC module is used to convert sensor output to digital and is connected to Digital I/O pins. The analog output is recorded for different environmental factor content and displayed to the user.

4.0 Theoretical Analysis

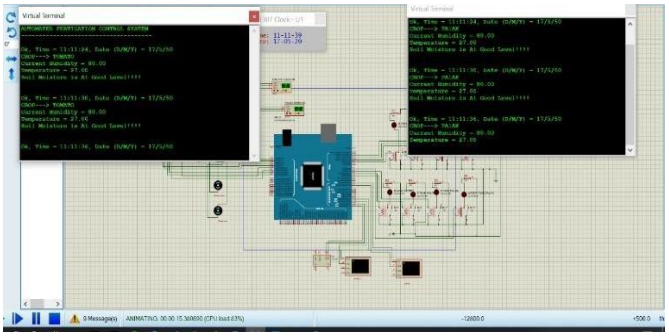
Data analysis is a procedure of studying the data to extract useful information. Control decision is taken based on the data collected about the fertilizer requirement controller drive the motors until which mixing needs to be done as per driven data.

For specific plants generally following numerical methods are used to calculate the required quantity:

*Formula for mixing the fertilizer is: Time (seconds) = quantity of fertilizer (g/plant) * 0.027L/second*

Formula for calculating time for motor: Time (sec) = total grams of fertilizer /26.67

5.0 Simulation Model



The simulation result of the system with different operating mode was obtained using the PROTEUS software. The precision agricultural solution obtained from this system is compared with an existing system. This system provided more accuracy for one or more crop and avoided setting up of Fertigation system individually for different crops. In this system a single Fertigation system is developed and it can be switched to execute conditions based on the selected crop.

6.0 Applications

Wireless Sensor Networks (WSN) are the technology enabling efficient and cheap Precision Agriculture (PA).

Precision Agriculture has the advantage of providing real time feedback on various crop and site variables.

WSN technology enables monitoring and specific targeting of each crop, making the implementation of Precision Agriculture practical and cost-effective regardless of the growing area.

The addition of additional communication hubs and sensors also makes this approach easily scalable.

7.0 Conclusions

Today's technologies can help get the right harvest, measure different parameters such as wind, soil temperature, and air moisture, and help the farmer optimize their benefits. The agricultural production can be improved with the assistance of automation. Farmers will be supported by this project to increase their production with fewer budgets because labor costs would be cut. Hence this project greatly helps the farmers. A modern system, an interface and a wireless computer software device and a sensor network is used to view environmental parameters useful for farming. Input parameter optimization helps in more effective execution. A new program is being created to support individuals with zero development awareness. The goal of this project was to mix the fertilizers in the

appropriate ratio for the crops and to feed them through the irrigation pipes, and to maintain the soil moisture content at optimum levels, thus helping the framers to grow high yield crops.

Future developments

Leaf sensors are another means of calculating the plants water level

Conventional WSNs consist of a node network (possibly in mesh architecture) that passes tracked environmental data to a base station

Using backscatter radio transmission, the front end of each sensor node is reduced to a reflector (an antenna attached to a transistor) that modulates information about the reflection coefficient of the antennaload sensor

The swarm intelligence and quorum sensing are two well-known examples of cognitive sensing

Quorum sensing is a biologically inspired example of sensing and networking

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