Implementation of Automated Organic Fertigation System by Measuring the Plant Parameters

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ABSTRACT

This paper elucidates about the concept of smearing automation on agronomy. The agricultural industry is very much enclosed when compared to all other industries because of the sort of job involved in agriculture which cannot be predicted and many monotonous tasks are not exactly the same at every time. Lots of factors have to be considered (i.e. atmospheric condition, land status, etc.) before the emerging of the task. The prototype – "IMPLEMENTATION OF AUTOMATED ORGANIC FERTIGATION SYSTEM BY MEASURING THE PLANT PARAMETERS" an autonomous agricultural contraption for determining pH levels using electrode, minerals, type of fertilizer to be used and automatic irrigation to the soil. The type of crop to be planted is based on pH value of the soil and it can be determined from the soil fertility test report. The pH value, temperature, moisture of the soil is determined using pH sensor, temperature sensor, moisture sensor respectively and the corrective action for that particular range will be displayed. The displayed corrective action occurs accordingly with the help of relay and valve setup. So with the help of this setup automatic Fertigation can be implemented. The entire process is monitored and recorded using IOT on Webpage.

Keywords: pH level, Temperature sensor, Moisture sensor, Relay, Wi-Fi module (IOT).

1. INTRODUCTION

Inefficient management of nutrient inputs has put a large constraint on the environment and human's health. So there is a need for the farmers to control the fertilizer supply to the crops as well as to avoid ground water pollution. Using pH, the nutrition level of the plant is balanced. The temperature, moisture of the soil is measured by sensors and maintained accordingly. Arduino microcontroller performs corrective actions according to the results of sensors and intimates the relay. The relay triggers the motor with the indication of fertilizer supply duration. Fertilizer is supplied appropriately to the plant by analyzing the recorded values from pH table. Nutrient content of the soil is maintained based on the standard requirement of the plant. The continuous monitoring of nutrient supply can be viewed in web page created through IOT.

2. BLOCK DIAGRAM

2.1 Block Diagram and Block Illustration

This segment explains the block of 'Implementation of automated organic Fertigation system by measuring the plant parameters'. It consists of some blocks where the main

operations are held. The block diagram is considered to be an important factor and thus only using this easy implementation is held in case of many projects. Fig 2.1 shows the block diagram.

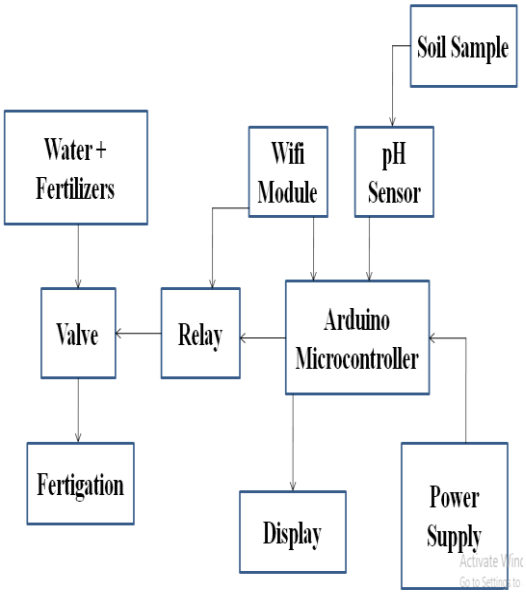

Fig.2.1 Block diagram

3. HARDWARE COMPONENTS

3.1 Arduino

Arduino is an open-source electronics platform based on easy-to- use hardware and software. Arduino boards are able to read inputs and turn it into an output, activate a motor and turns on an LED. A set of instructions are to be given to the microcontroller on the board with the use of Arduino programming language (based on Wiring) and the Arduino Software (IDE) based on Processing. The Arduino UNO microcontroller operates at 5 V with 2 Kb of RAM, 32 Kb of flash memory for storing programs and 1 Kb of EEPROM for storing parameters. It operates at a clock speed of 16 MHz, which translates about 300,000 lines of C source code per second. The board has 14 digital I/O pins and 6 analog input pins. The device holds a variety of configurations featuring the usual peripherals: internal oscillator, timer including PWM, Watchdog, USART and SPI. Flash memory of 32k bytes (of which .5k is used for the boot loader), SRAM of 2k bytes, EEPROM of 1k byte are in the system.

The Arduino Uno can be powered via USB connection or with an external power supply. External (non-USB) power can be either from an AC-to-DC adapter (wall-wart) or battery. The board can operate on an external supply of 6 to 20 volts. If supply is used more than 12V, the voltage regulator may overheat and damage the board and if used less than 5V the board becomes unstable. The recommended range is 7 to 12 volts.

Fig 3.1 Arduino microcontroller

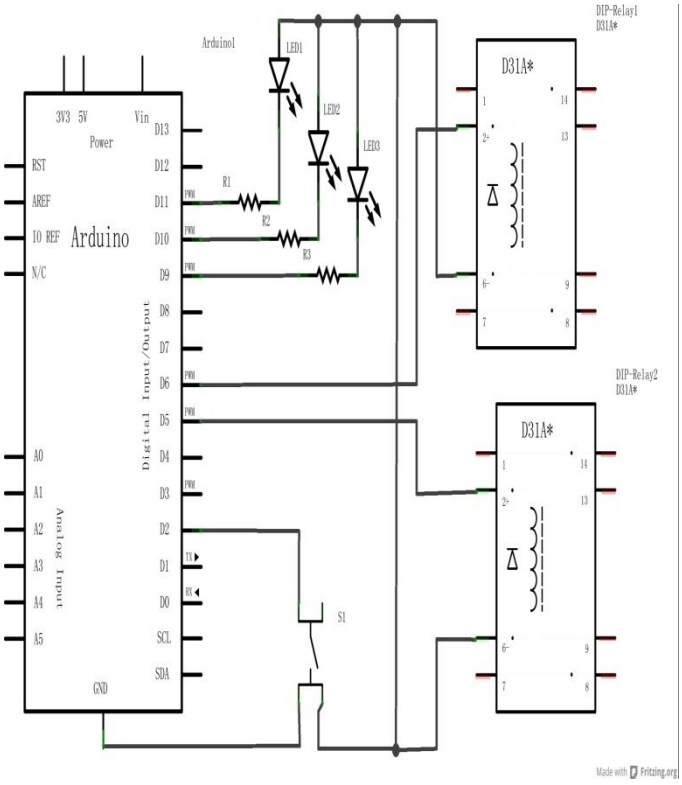

Fig 3.2 Arduino circuit

3.2 pH sensor

The pH value of the soil is an important factor affecting the growth of plants. Suitable pH value for different plants differs

from each other. pH is a measure of acidity or alkalinity of a solution, the pH scale ranges from 0 to 14. The pH indicates the concentration of hydrogen [H] + ions present in certain solutions. It can accurately be quantified by a sensor that measures the potential difference between two electrodes: a reference electrode (silver / silver chloride) and a glass electrode that is sensitive to hydrogen ion. This is forms the probe. We should use an electronic circuit to condition the signal appropriately and we can use this sensor with a micro-controller, such as Arduino. The pH value of the soil is measured and calibrated using the standard pH range table for planted crop.

pH VALUE	CROPS
4.5-5.0	Azalea, Bilberry, Blueberry, Cranberry, Heather, Orchid, Pine
5.1-5.5	Ferns, Iris, Orchids, Parsley, Conifers, Maize, Millet, Rye, Oat, Radish, Potato, Sweet Potato
5.6-6.0	Aster, Carrot, Cucurbit, Ales, Bean, Crimson clover, Pea nut, Soya Bean, Rice, Rhubarb, Violet
6.1-6.5	Cabbage, Cauliflower, Turnip, Cucumber, Pumpkin, Squash, Peas, Strawberry, Tomato, Sweet Corn
6.6-7.0	Beetroot, Spinach, Onion, Watermelon

Table-1: Classification of Crops According to The pH Value

DENOMINATION	pH RANGE
Extremely Acid	4.5 pH
Very Strong Acid	5.0 pH
Strongly Acid	5.5 pH
Medium Acid	6.0 pH
Neutral	7.0 pH
Alkaline	7.5 pH

Table-2: pH table

SOIL ACIDITY(pH)	NITROGEN (%)	PHOSPHATE (%)	POTASH (%)
4.5	30	23	33
5.0	53	34	52
5.5	77	48	77
6.0	89	52	100
7.0	100	100	100

Table-3: Nutrient Analysis for Tomato Plant

3.3 LM35 Temperature sensor

LM35 is an integrated analog temperature sensor whose output is proportional to Degree Centigrade. For every degree rises in temperature the output of LM35 rises by 10mV. LM35 Sensor does not require any external calibration or trimming to provide typical accuracies. The LM35 consists of low output impedance, linear output, and precise inherent calibration making the interface to readout or control circuitry. In LM35, temperature can be measured more accurately compared to Thermistor.

Some of the Features of LM35:

- Can be calibrated in Degree Celsius (Centigrade)
- Linear at 10.0 mV/°C scale factor
- Rated for full -55°C to a 150°C range
- Operates from 4 to 30 volts
- Less than 60 mA current drain
- Low self-heating, 0.08°C instill air
- Low impedance output, 0.1Ωfor 1 mA load
- Suitable for remote applications
- Low cost due to wafer-level trimming.

3.4 Soil Moisture Sensor

Soil moisture sensors measure the volumetric water content in the soil. The soil provides a major reservoir for water within a catchment. Soil moisture rise when there is a sufficient increase in water content or when there is sufficient rainfall. Water contained in soil is called soil moisture. The water is held within the soil pores. Soil water is the major component of a soil is optimum for plant growth; plants can readily absorb soil water. Not all the water, held in soil is available to plants. Much of water remains in the soil as a thin film. Soil water dissolves the salts and makes up the soil solution, which is important as medium for supply of nutrients to growing plants.

The Soil Moisture Sensor is a simple module for measuring the moisture in soil and similar materials. The soil moisture sensor is straightforward to use. The two large exposed pads function as probes for the sensor, together acting as a variable resistor. The more water in the soil, the better the conductivity between the pads will be and will result in a lower resistance, and a higher SIG out. To make the Soil Moisture Sensor to

function, connect the VCC and GND pins to the Arduino-based device (or compatible development board) and SIG read out which depends on the amount of water in the soil. One commonly known issue with soil moisture sensor is their short lifespan when exposed to a moist environment.

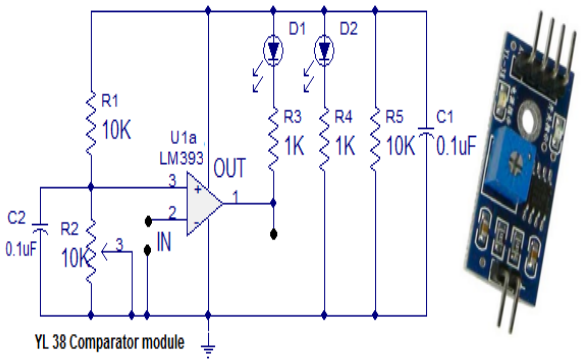

Fig 3.3 Moisture sensor

3.5 Relay

Relays are electrically operating switches that can open and close electronically or electromechanically. Relays are generally used to switch smaller currents in control circuit. Arduino2 Relay module is designed for a wide range of microcontrollers. Input is Vcc which is connected to 5V current on Arduino board and GND is connected to ground and 2 digital inputs. Output is like a series switches: 2 normally open (NO), 2 normally closed (NC) and 2 common pins (COM). It consists of contact action time of 10ms/5ms and has standard interface that can be controlled directly by microcontroller (Arduino).

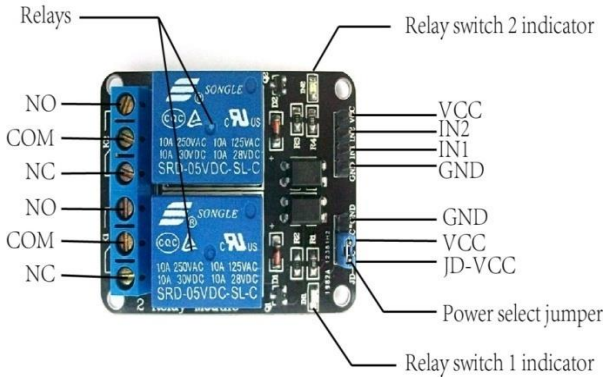

Fig 3.4 Relay module

3.6 LCD

Liquid Crystal Display is composed of several layers which include two polarized panel filter and electrodes. An LCD is either made up of an active matrix display grid or passive display grid. LCD works on the principle of blocking light rather than emitting light. The basic structure of LCD should be controlled by application of polarized current. LCD consumes less amount of power and provides excellent contrast when compared to CRT and LED.

3.6.1 LCD Interfacing Diagram

The figure shows the Arduino with LCD interface circuit diagram. LCD (Liquid Crystal Display) displays are used to show the output what we anticipated. Here we use this screen for displaying the pH values of the soil, proportion of macro nutrients and also to display the corrective action to be taken for the particular pH value.

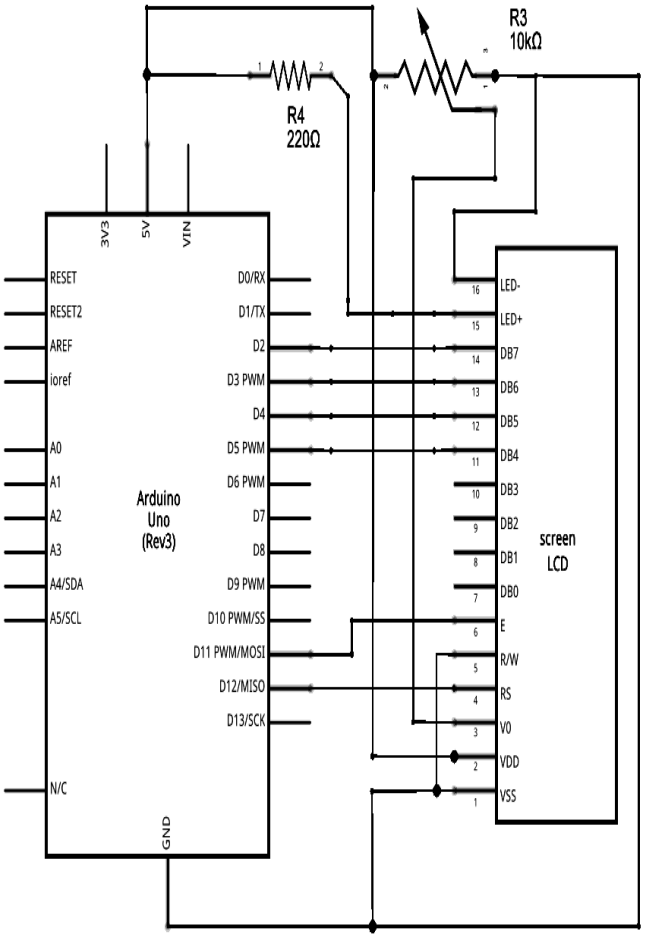

Fig 3.5 LCD Interfacing with Arduino

3.7 IoT and Wi-Fi module

The Internet of Things (IoT) is a system which can be connected to devices and objects with built in sensors. Devices with unique identity shares most valuable information without human to human or human to computer interaction. Smart farming based on IoT helps the farmers to enhance productivity by reducing the wastage of water and fertilizers.

Crop fields can be monitored by sensors like temperature, soil moisture and humidity sensors and the parameters are sent to IoT module for automating the irrigation and fertilization system. Not only target conventional and large farming operations use IoT-based smart farming but also organic farming and family farming make use of IoT and provide high quality varieties and enhance highly transparent farming.

The ESP8266EX microcontroller integrates a Tensilica L106 32-bit RISC processor, which achieves extra-low power consumption and attains a maximum clock speed of 160 MHz. The Real-Time Operating System (RTOS) and Wi-Fi stack allow about 80% of the processing power to be available for user application programming and development. The ESP8266EX microcontroller has three modes of operation: active mode, sleep mode and deep sleep mode. This allows battery-powered designs to run longer. Due to its wide operating temperature range, it is capable of functioning consistently in industrial environments with highly-integrated on-chip features. It consists of minimal external discrete component count and the chip offers reliability, compactness and robustness.

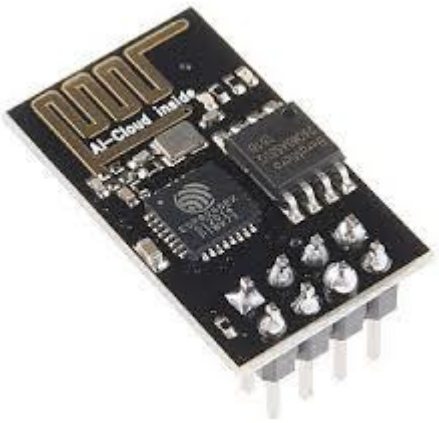

Fig 3.6 Wi-Fi module

3.8 Solenoid Valves

A solenoid valve is an electromechanical controlled valve. The valve features a solenoid, which is an electric coil with a movable ferromagnetic core in its centre. This core is called the plunger. In rest position, the plunger closes off a small orifice. An electric current through the coil creates a magnetic field. The magnetic field exerts a force on the plunger. As a result, the plunger is pulled toward the centre of the coil so that the orifice opens. This is the basic principle that is used to open and close solenoid valves."A solenoid valve is an electromechanical actuated valve to control the flow of liquids and gases."

Fig 3.7 Solenoid valves

Solenoid valves are amongst the most used components in gas and liquid circuits. The number of applications is almost endless. Some examples of the use of solenoid valves include heating systems, compressed air technology industrial automation, swimming pools, sprinkler systems, washing machines, dental equipment, car wash systems and irrigation systems.

3.8.1 Circuit functioning

Solenoid valves are used to close, dose, distribute or mix the flow of gas or liquid in a pipe. The specific purpose of a solenoid valve is expressed by its circuit function. A 2/2 way valve has two ports (inlet and outlet) and two positions (open or closed). A 2/2 way valve can be 'normally closed' (closed in de-energized state) or 'normally open' (open in de-energized state). A 3/2 way valve has three ports and two positions and can therefore switch between two circuits. 3/2 way valves can have different functions such as normally closed, normally open, diverting or universal. More ports or combinations of valves in a single construction are possible. The circuit function can be expressed in a symbol. Below are some examples of the most common circuit functions. The circuit function of a valve is symbolized in two rectangular boxes for the de-energized state (right side, visualized by) and energized state (left). The arrows in the box show the flow direction between the valve ports. The examples show a 2/2-way Normally Open (NO) valve, a 2/2-way Normally Closed

(NC) valve and a 3/2-way Normally Closed valve. For more information about valve symbols and circuit functions, please visit the page about valve symbols.

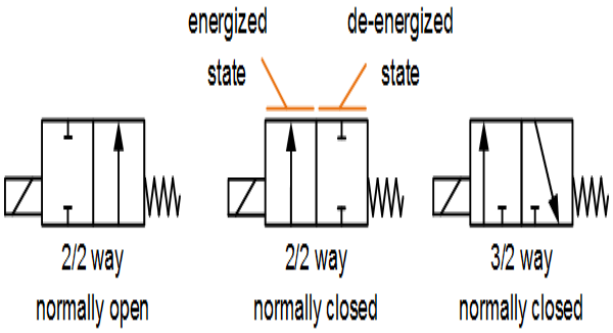

Fig 3.8 Valve circuit functions

3.9 Power Supply

Power Supply is a reference to a source of electrical power. A device or system that supplies electrical or other types of energy to an output load or group of loads is called a power supply unit. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others. This typically involves converting 240V AC supplied by a utility company to well- regulated lower voltage (+5V) DC for electronic devices shown in the figure 3.10

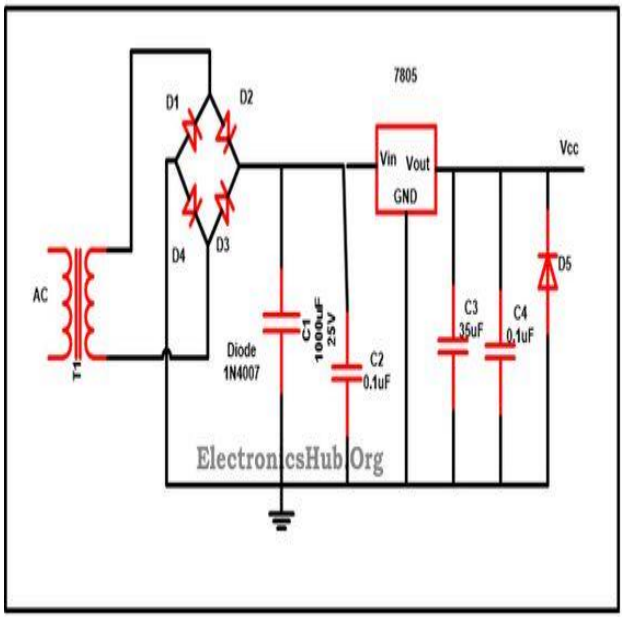

Fig 3.9 Power supply circuit

4. SOFTWARE

Figure 4.1 shows the logo of ARDUINO IDE software. Arduino is an open source computer hardware and software company, project, and user community that designs and manufactures single board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical and digital world. The project's products are distributed as open source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form, or as do-it-yourself (DIY) kits.

Fig 4.1 LOGO of Arduino IDE Software

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards or Breadboards (shields) and other circuits. The boards feature serial communications interfaces, including Universal Serial BUS (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler tool chains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.

5. WORKING

The pH valve from the soil sample is determined by using the pH sensor and the analog valve of pH is fed into the controller serially. After processing the pH value with the threshold ranges, the pH value of the soil sample and the corrective action to be held is displayed in the LCD interface. The corrective action includes selection of percentage of fertilizer to be fed for the corresponding pH range which will be performed as per the program. The Relay module on-off timing is also done as programmed so that the corresponding value of fertilizer has been supplied. The action of supply is controlled by the solenoid valve which is interfaced with the two channel relay module. The solenoid valve is turned on and off according to the relay on-off timing.

Thus the corresponding amount of fertilizer is supplied to the soil accordingly with respect to the pH value determined. The whole process is monitored and recorded by the web page created for further analysis. This work is carried out by the Wi-Fi module interfaced with the controller. Whenever the pH value is altered, the corrective measure is progressed and fertilizer is supplied and consequently the soil nutrient content is maintained.

6. CONCLUSION

This system is found to be feasible and cost efficient for optimizing nutrient supply in agricultural production and 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. Automated Fertigation system has a huge demand and future hope too. It is time saving, led to removal of human errors in adjusting the soil moisture level. Continous monitoring of recorded process by the web page created through IoT is used to analyze the net profit of the crops. This Fertigation system allows cultivation in places with water scarcity thereby improving sustainability.

7. FUTURE SCOPE

This system has a vast scope for future expansion including the addition of more parameters to be monitored and controlled. We can also update the user about the system functioning through a mobile application. In this paper IoT platform is a viable solution in improving the agricultural techniques in run of making a “Digital India”. Due to scale of activities, participation of large companies and the Government will play a vital role in the success of this emerging technology.

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