IOT Based Automated Indoor Hydroponic Farming

Dr.S.Suresh[1], D.Yeswanth Kumar Reddy[2], R.VishnuVardhan Raju[3], S.Thayeeb Basha[4], M.Haritha[5]

[1,2,3,4,5]Electrical and Electronics Engineering

Annamacharya Institute of Technology and Sciences-Rajampet

Abstract:

Hydroponics is changing the agriculture industry slowly. The ability to grow indoors brings another dimension to agriculture. Here we develop a fully automated mini fodder grow chamber to grow fodder indoors within a week. The system makes use of a temperature controlled chamber to maintain a cool air flowing environment along with grow lights to simulate sunlight along with water and moisture monitoring to ensure proper indoor grow conditions. The system makes use of arduino controller interfaced with a keypad to get user inputs on the water change and flow, indoor optimum temperature parameters. The system then monitors the indoor conditions using water sensor, moisture and temperature sensor to always keep a tap on indoor conditions. The system uses the motor to ensure water level is maintained using the pump motor to adjust water level, the moisture and temperature sensors are monitored to maintain best temperature and moisture conditions for growth. The indoor artificial sunlight is switched on and off as per specified by the user automatically. This entire operation is efficiently managed by an arduino controller to ensure the entire process is repeated regularly without fail. The system also sounds an alarm if the water tank runs out of water. Thus the system ensures automatic indoor fodder grow system using arduino controller.

Introduction:

The world population is increasing every day and it is expected to reach 9.3 billion in 2050. Therefore, crop production has to be increased in order to maintain a sufficient amount of food. However, the production of crops is affected by many factors like the unusual weather changing, lack of water and the lack of sufficient arable lands available to grow the crops. As a result, people started to use different methods of farming to reduce water consumption and the space for farming, one of the most famous methods is the vertical hydroponic farming. Vertical hydroponic farming is a combination of two old methods, which are vertical method and hydroponic method. These methods are old, but recent research and studies by scientists worldwide have proved its usefulness. The hydroponic system is a method that depends on growing the plants in the water without the use of soil, it has been proved that the plants do not need soil as long as the essential nutrients, minerals and the suitable pH maintained stable within a certain range inside the water. There are different types of hydroponic systems that are known, such as wick system, drip system, nutrient film technique (NFT), deep flow technique, and aeroponic system. The hydroponic systems are currently developed to solve the problems that affect the plant growth by controlling all the parameters automatically, which made it possible to make an indoor farming without consuming large space of land. The automatic vertical hydroponic systems portend a huge revolution in food production, where different kinds of crops can be grown in homes that can satisfy peoples' needs.

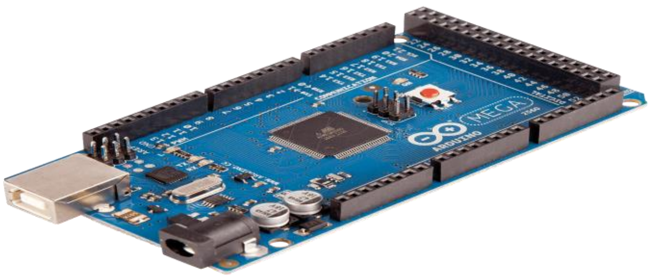
Research Survey:

Various vertical hydroponic systems such as A-frame, Zig-zag, vertical hydroponic tower, ZipGrow tower and vertical Nutrient Film Technique (NFT) system were available. Amongst the various vertical hydroponic systems available, the concept and design of the vertical NFT system was considered to be used for this study. It is due to the simplicity in the design, ease in its assembly, easy configurability of the LED, high productivity of plants within a small place, and the strong supporting system that holds the structure. Many organization, such as Plenty, Bowery, Aerofarms, and Ikea etc., are commercially producing different vegetables in urban areas using proprietary architecture and technologies with the help of the professionals using large scale indoor farming with high scale investments. Even though these are helping fulfilling food demand and promoting urban farming, however, these are not suitable for individual level and cannot be done by the people without technological knowledge.

Our aim is to develop a simple, automated, and scalable cost-effective system which can be used by general people for personal farming as well as large scale farming. External environmental conditions during the summer are not in favour of farming and greenhouse and indoor farming with continuous air conditioning is a must for farming. However, every house can be a small farm utilizing a small space of the house/flat without much increasing water and power consumption while can grow the basic needs of the households. This is the major motivation of this project.

Components:

Arduino mega (2560):



The controller used in this board is ATmega2560 which has a clock speed of 16 MHz and provides a flash memory of 256 kilobytes to the board. The operating voltage of the Arduino Mega 2560 is 5 volts and the controller for the Arduino Mega 2560 has a static RAM of 8 kilobytes and EEPROM of 4 kilobytes. The image below shows the Arduino mega2560 board. The Arduino mega2560 comes with 54 pins for digital inputs and outputs whereas 16 pins are for the analog input and outputs. To supply power to the peripherals connected with Arduino Mega 2560 there are a total 9 pins including the pins for providing the reference signal for analog and digital devices. For communication there are SCL, and SDA pins given, however we can use pins 21 and 20 for the SCL and SDA as well. Arduino Mega 2560 is the one of the Arduino boards that has a large number of pins and has a powerful controller which makes it different from other boards provided by the Arduino platform. However, to use this board, one must be aware of the board specifications and also the pinout of the respective Arduino board so that the board can be used effectively. For ease of the learners, we have described the purpose of each pin of the Arduino in a very comprehensive way.

Ph sensor:

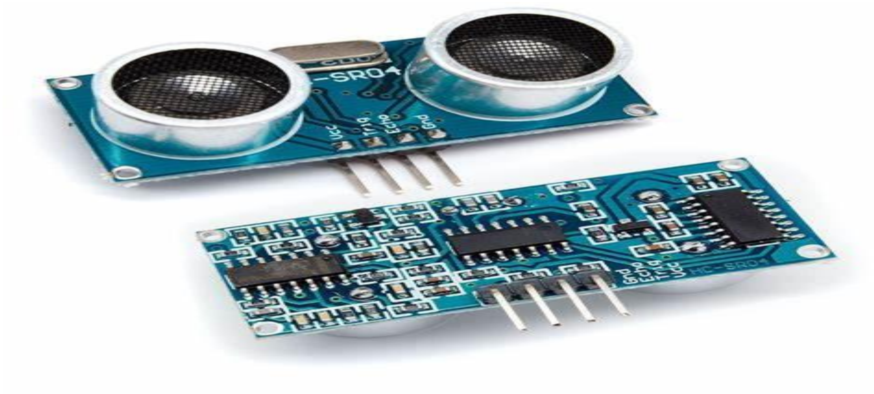
It describes pH sensor used and mentions arduino code**.** As we know pH sensors are used in chemical labs for acidity test in order to determine nature of any liquid. Acidity test consumes lot of time if it is done without the use of pH sensor. Measurement of acidity test is very quick when pH sensor is interfaced with arduino board. The sensor which detects hydrogen ion (H^+) concentration of liquid is known as pH sensor. This indicates acidity or alkalinity of a liquid. When pH sensor is immersed in liquid solution, smaller ions get penetrated in the boundary area of the glass membrane where as larger ions remain in the liquid solution. This develops potential difference. pH meter measures potential difference between electrodes.

TDS Meter:

Analog TDS Conductivity sensor is used for measuring the TDS value of the water, this TDS values define the cleanliness of the water. It can be used to check the quality of domestic water, hydroponic liquids, and in other fields of water quality testing. TDS stands for Total Dissolved Solids(TDS). It indicates the water quality. In general high TDS, the value indicates high dissolved solids in water and low quality. So TDS values define the cleanliness of the water. The below Image shows the acceptable TDS values for different water sources.

Ultrasonic Sensor:

Ultrasonic Sensor HC-SR04 is a sensor that can measure distance. It emits an ultrasound at 40 000 Hz (40kHz) which travels through the air and if there is an object or obstacle on its path It will bounce back to the module. Considering the travel time and the speed of the sound you can calculate the distance. The configuration pin of HC-SR04 is VCC (1), TRIG (2), ECHO (3), and GND (4). The supply voltage of VCC is +5V and you can attach TRIG and ECHO pin to any Digital I/O in your Arduino Board.



Temperature Sensor:

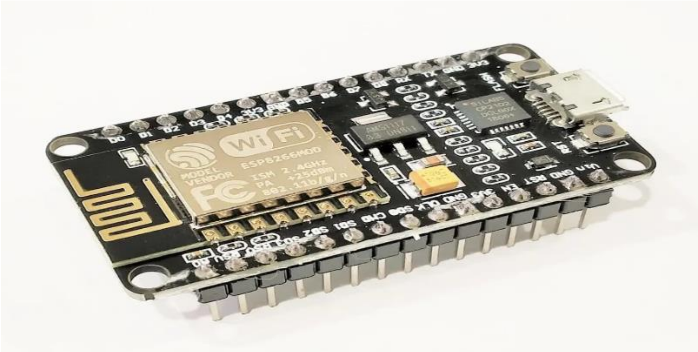
The temperature sensor in Arduino converts the surrounding temperature to voltage. It further converts the voltage to Celcius, Celcius to Fahrenheit, and prints the Fahrenheit temperature on the LCD screen. We will use a temperature sensor **(TMP 36)** of low voltage. Such sensors are also stable while dealing with large capacitive loads**.**

Waterflow sensor:

The water flow sensor consists of a plastic valve body, a water rotor and a hall-effect sensor. When the water flows through the rotor, rotor rolls and the speed of it changes with a different diameters, water pressure (MPa) and flow rate (L/m) ranges. Make sure to select one that will cover your needs. The sensor that I have it has 20mm diameter, <1.75Mpa water pressure. In this tutorial we will use the serial monitor for printing the water flow rate in liters per hour and the total of liters flowed since starting.

ESP8266 NODEMCU:

Today, IOT applications are on the rise, and connecting objects are getting more and more important. There are several ways to connect objects such as Wi-Fi protocol. NodeMCU is an open source platform based on ESP8266 which can connect objects and let data transfer using the Wi-Fi protocol. In addition, by providing some of the most important features of microcontrollers such as GPIO, PWM, ADC, and etc, it can solve many of the project's needs alone.



Relays:

A relay is an electrically operated switch that can be turned on or off, letting the current go through or not, and can be controlled with low voltages, like the 5V provided by the Arduino pins.Controlling a relay module with the Arduino is as simple as controlling any other output.

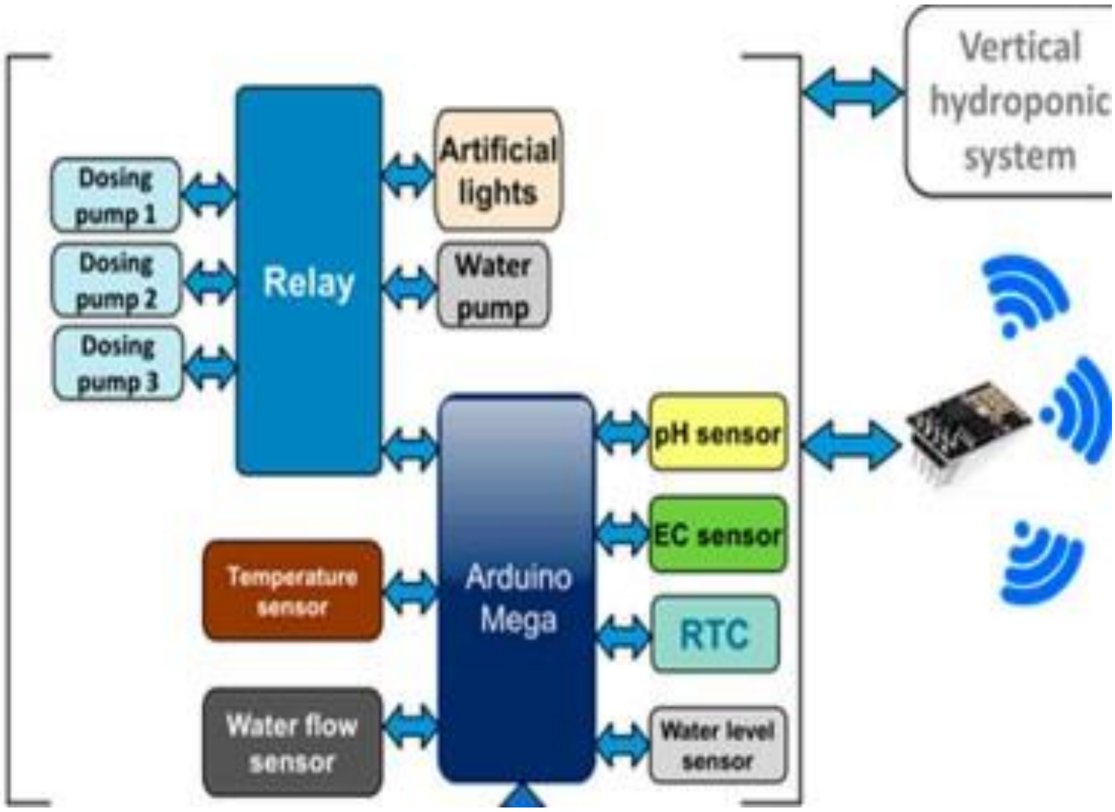
This relay module has two channels (those blue cubes). There are other models with one, four and eight channels. This module should be powered with 5V, which is appropriate to use with an Arduino. There are other relay modules that are powered using 3.3V, which is ideal for ESP32, ESP8266, and other microcontrollers.

Dc Pumps:

DC powered **pumps** use direct current from motor, battery, or solar power to move fluid in a variety of ways. Motorized **pumps** typically operate on 6, 12, 24, or 32 volts of **DC** power. Dc pumps are used to inject the nutrition's and PH balancer to the system.

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 05 | May - 2022 Impact Factor: 7.185 ISSN: 2582-3930

BLOCK DIAGRAM:

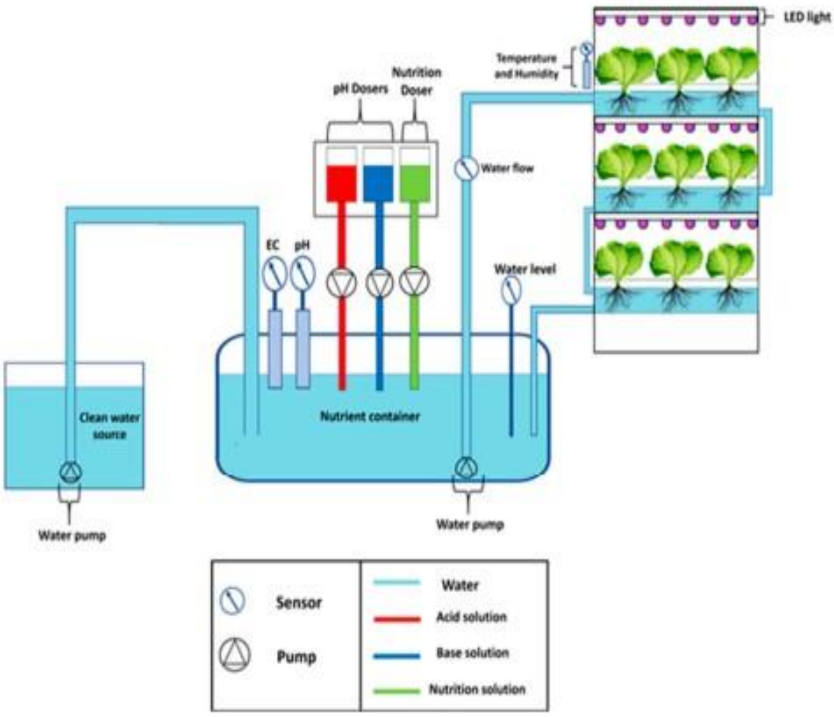


Operation:

The data of the following parameters like the Total dissolved particles in solution, PH of the water, water level ,Temperature, water flow, light intensity etc, will be collected from respective sensors.

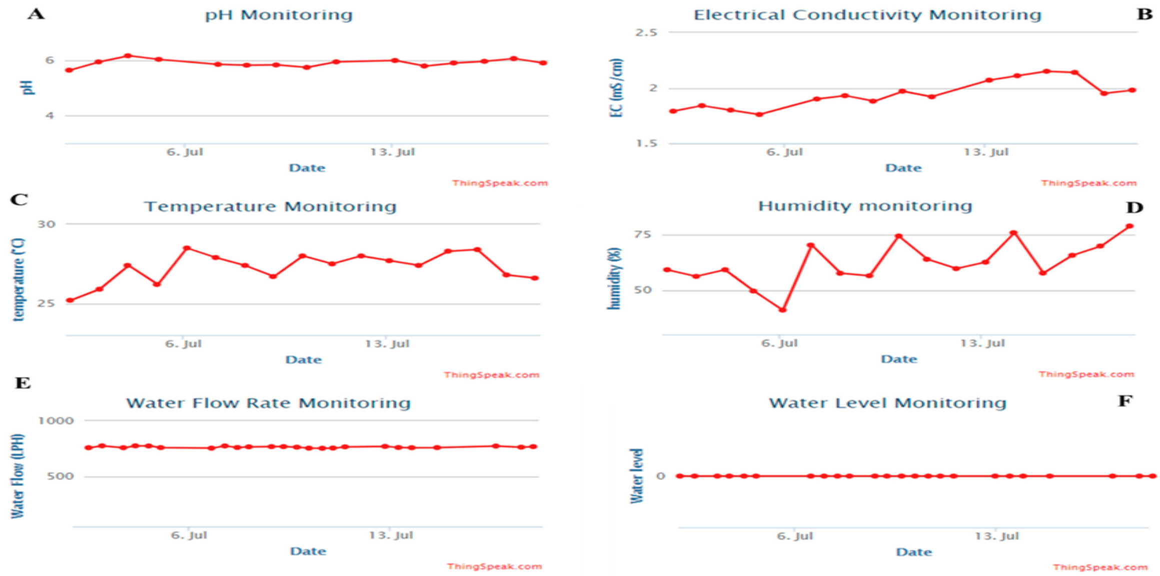
The collected data will be analysed by micro controller the practical values will be compared to the reference inputs given by the user. if the values are not as per user defined the required actions will be taken to make the values equal to refereed values. Then the updated values will be uploaded to the server by wifi module. The data can be accessed by the user from any where in the world through means of internet.

MODEL DIAGRAM:



Results:

After the calibration and testing of the sensors and different modules, the complete indoor vertical hydroponic system was implemented and tested. In the initial implementation, it was used to cultivate mint in an indoor area as shown in Figure 3 and the operation of the system was demonstrated in Supplementary Video S1. Later on, lettuce, tomato, cucumber, coriander, capsicum, strawberry, chili seeds, and mint stem were planted in the vertical hydroponic system. In this section, system performance is illustrated using IoT interface in the Thing speak web-site and mobile application, along with power and water consumption analysis, illustration of plant growth, and comparative analysis between the proposed and other research and commercial projects.



Conclusion:

By using this auto machine technique we can produce essential food needs by one self are a group of people in any environmental conditions in any time. With a minimal amount of investment. Which meets the future requirements of people. This will leads to a new Era of automatic soil less farming.