A PROJECT REPORT ON

"Cost Effective Smart Hydroponic Monitoring andControlling System using IoT"

Submitted to the Savitribai Phule University, Pune in the partial fulfillment of the requirement for the award of the degree

Of

BACHELOR OF ENGINEERING

In

ELECTRICAL ENGINEERING

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AMRUTVAHINI COLLEGE OF ENGINEERING

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2023-24

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"Cost Effective Smart Hydroponic Monitoring andControlling System using IoT"

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For academic year 2023-24

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INTERNAL EXAMINAR **EXTERNAL EXAMINAR**

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ACKNOWLEDGEMENT

It is indeed a matter of great pleasure and proud privilege to be able to present this project on **“Cost Effective Smart Hydroponic Monitoring and Controlling System using IoT”.**

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ABSTRACT

High yielding and high grade of crops are essential in modern day agriculture, this can only be achieved by smart farming technology which is used for making farms more intelligent in sensing its controlling parameters. Manual monitoring is in practice which is a very trivial task because the plants may die out if there is no proper care is taken. The architecture of this hydroponic system which is fully automatic that can be integrated into the agricultural curriculum while introducing business skills. The automatic monitoring and control of the environmental events such as light intensity, pH, electrical conductivity, water temperature, and relative humidity is carried out by lodging sensors and actuators onto the system. The maintenance and automated monitoring are done by the intervention of the IoT that are used to transfer and retrieve data to the internet (mass storage) and a mobile app is used to communicate the current status of the hydroponic system to the user through the use of internet to their mobile phones. This futuristic system can use high data analytics and prolonged data gathering to improve the accuracy of reckoning.

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CHAPTER 1

INTRODUCTION

1.1 Introduction:-

Hydroponic is a method where the crops are grown in the absence of soil the nutrients that are acquired from the soil are given to them artificially. The term Hydroponics was acquired from the Greek words „hydro" means water and „ponos" means labour. This soil less culture of originating crops often involves their roots to be immersed in the nutrient solution along with some gravels or perlite medium. The maximum yield is achieved by the supply of sufficient quantity of nutrients and optimum microclimatic conditions are the main goal of hydroponics. Since soil is excluded from production process there will not be any problem related to soil borne diseases, pests and weeds. By the exclusion of these problems, there will not be any usage of harmful plant protection chemicals, so that there is a fresh and healthy yield of crops by the hydroponic method. The set-up of hydroponic only Demands limited space and limited quantity of water as they recirculate and reuse the water. This eliminates the problems that are caused by soil. This limited space requirement also favors hydroponic as it can be accommodated in terraces, balconies and courtyards. So, there is a high probability of growing crops in urban areas, where cultivable land islimited. Hydroponics does not cause any adverse effect on the quality of fruits and flowers produced by it Hydroponics is an agricultural method of producing plants in an artificial environment without using soil – nutrients which are provided through water – and by optimizing the growing conditions to improve the production. Hydroponically cultivated plants have a growth rate that is much faster and highly yielding than that of plants grown in soil. Because they are cultivated in containers, pest and disease control is at an optimum. In natural conditions, soil itself acts as a mineral nutrient reservoir but it is not essential for plant growth. The roots can easily absorb the mineral nutrients in the soil if it is dissolved in water. If the minerals are present in the supply of plants water 11 artificially, then the plant no longer requires soil to thrive. We can grow any terrestrial plant by this method. The method for growing plants by using mineral nutrient solutions, in water, without planting in soil is known as hydroponics. For simplifying and automating many complex real-world tasks the information and communication technology methods are used. The internet plays a major role in implementing information and communication technology sectors. Communications in the internet mainly involve client server connections. The information and communication technology moves to the next stage on creating and sharing information where the humans rely on machines such as weather monitoring system, etc. At this time the machine-to-machine (M2M) communication is also in a peak where one machine receives the information of other machines. In future, everything around us could be connected and they are able to sense and cooperatively communicate over the Internet, thereby giving birth to the Internet of Things (IoT). The basic idea behind IoT is the pervasive and ubiquitous presence of the things or objects around us like mobiles, sensors, radiofrequency identification (RFID) tags, etc. This leads to the Generation of huge amount of data that need to be stored, processed, and presented in an energy efficient manner.

1.2 Need of project:

The effects of the global warming make more difficult for planting in uncontrolled environment. In traditional farming method, farmers require fine quality of soil with natural mineral strengths. It also requires working cost for ploughing and removal of weeds and also needs large amount of space and water. In case of seasonal plants, the yield does not satisfy the customer needs and the expectation of farmers in productivity. For these reasons, a farming method which needs lesser requirements in cost factor and also it easy to maintain and control the important factors such as light, water level temperature, and humidity throughout the year is needed. This proposed work presents a Hydroponic style of farming which is the method of growing plants without soil & sunlight.

1.3 Aim and Objectives of project:

1. To study the hydroponics farming and related aspects

2. To gather and analyze information from different research papers related to our topic(Literature survey).

3. To design and implemented hydroponics systems using IoT for monitoring various parameters such as pH level of water, nutrients contain in water, temperature and humidity.

4. To provide real time access of the hydroponics system on mobile app to Monitor andimprove crop yield.

1.4 Theme of project:

Food, water and land, are the most essential resources to mankind, and these three resources are dependent on each other. Without proper soil or land and proper quantity of water, one cannot produce a healthy batch of crops. This is the problem of the current age due to lack of quality water and land. Climate change also affects the quantity and quality of the yield which, in coming years, may directly affect the economy of a country directly. Many countries may suffer from economic crisis due to lack of food production. A solution is needed to preserve the water resources and to maximize the profit per square feet of land which will help in production of higher quality and quantity yield, and directly or indirectly, profits the farmer or economy of the country or region. Hydroponics is such a system for farming which uses only water and nutrients for growing most terrestrial plants without the use of soil. Hydroponics can be implemented in urban location but it requires prerequisite knowledge and regular monitoring. To solve the above problem, automatizing of the entire process with sensors and micro-controller has been reported in this paper. Here an IoT based hydroponics system parameters are monitored via Android application. This will further help for improvement in system based on data generated from multiple hydroponics farms.

CHAPTER 2

LITERATURE SURVEY

2.1 Comparison of your system with same system available in market:-

Dr. D.K. Sreekantha et.al [1] analyzed that the Internet of things (IOT) is remodeling the agriculture enabling the farmers with the wide range of techniques such as precision and sustainable agriculture to face challenges in the field. IOT technique helps in collecting information about conditions like weather, moisture, temperature and fertility of soil, Crop online monitoring. It enables the detection of weeds, level of water, pest detection, and animal intrusion in to the field, crop growth, and agriculture. IOT leverages farmers can get connected to this farm from anywhere and anytime. Wireless sensor networks are used to monitor the farming conditions and micro controllers are used to control and automate the farming processes. To view the conditions remotely in the form of image and video, wireless cameras have been used. A smart phone empowers the farmer to keep updated with ongoing conditions of his agricultural land using internet at any time and any anywhere. IOT technology can reduce the cost and enhance the productivity of traditional farming. In this paper they proposed an application prototype for precision farming using a wireless sensor network with an IOT cloud.

Foughali Karim et.al [2] reviews that, as water supplies become scarce because of climatically change, there is an urgent need to irrigate more efficiently in order to optimize water use. In this context, farmers' use of a decision-support system is unavoidable. Indeed, the real- time supervision of microclimatic conditions is the only way to know the water needs of a culture. Wireless sensor networks play an important role with the advent of the IoT and the generalization of the use of web in the community of the farmers. It will be judicious to make supervision possible via web services. The IoT cloud represents platforms that allow to create web services suitable for the hardware integrated on the Internet. In this paper they proposed an application prototype for precision farming using a wireless sensor network with an IoT cloud.

Jumras Pitakphongmetha et.al [3] analyzed that, the effects of the global warming, and the plants are affected with UV rays. For this reason more difficult to planting in uncontrolled environment. On the other hand, the yield does not match customers‟ needs. For these reasons, planting in a greenhouse is easy to maintain and to control important factors such as light, temperature, and humidity. Using of sensors in a greenhouse as Wireless Sensor Networks System are the efficiency of technology used in agricultural development by sending data to the cloud and controlling values such as temperature, light, etc. The results of his study will be useful for the farmer and related organizations applying in the farm.

Srisruthi.S et.al [4], analyzed that Agriculture requires the dedication of many natural resources, including land, water, and energy. So, they adopted sustainable agriculture which supports careful management and cultivation of crops involving less use of fertilizer, pesticides, calculated use of precious natural resources like energy, water through controlled irrigation and fertigation practices with the help of green sensor technology and electronic control systems. In this paper, they proposed an efficient automated farm monitoring and irrigation techniques which incorporate wide range of sensors to remotely sense and monitor various parameters of the soil like temperature, moisture, fertility and regulate the supply of water and fertilizer to the land based on the requirement. An algorithm formulated with the threshold values of sensor outputs is used to code the microcontroller which performs the required actions by employing relays until the strayed-out parameter has been brought back to its optimum level. The cloud based user friendly interface facilitates real-time data logging of the environmental parameters while also supporting analysis of past statistics for future growth by means of a web-based customizable application. Furthermore, the project aims to optimize the use of land and labour, conserve water, increase crop yield, avoid wastage of energy and provide maximum automation and benefit the society by adopting smart environment friendly technology to implement newer and sustainable ways of agriculture.

Tsung-Han Wu [5], developed an Intelligent Plant Care Hydroponic Box, From the experimental measurement results of IPCH-Box, the developed environment driven control methods include light, water sprinkler and water pump which can effectively lower the CO2 concentration, the temperature and increase water level, respectively. Specifically, the time of CO2 concentration reduction in IPCH-Box is 38.53% faster than the plant system without our mechanism. Sensor technology has been intensively applied to plant care system. There exist two kinds of plant care systems. A large-scale plant care system can be a plant factory or a green houses. On the other hand, a small-scale plant care system with the size of several square feet is typically installed in a green laboratory. Generally, a small-scale plant care system can be transformed from a large-scale system.

Chanya Peuchpanngarm et.al [6], developed control for hydroponics via different types of sensors including water, temperature sensor, temperature and humidity sensor, and light intensity sensor. It also consists of the functions for planning, monitoring, as well as harvest data recording, of hydroponic gardening to fulfill the planting demands. The harvests data will be used for hydroponics planning in the next grow. In addition, users can monitor the plant growing progress remote l

2.2 Survey of components required for your system:-

2.2.1 PIC 18f4520:-

It is an 8-bit enhanced flash PIC microcontroller that comes with nano Watt technology and is based on RISC architecture. Many electronic applications house this controller and cover wide areas ranging from home appliances, industrial automation, and security system and end-user products. This microcontroller has made a renowned place in the market and becomes a major concern for university students for designing their projects, setting them free from the use of a plethora of components for a specific purpose, as this controller comes with inbuilt peripheral with the ability to perform multiple functions on a single chip.

- PIC18F4520 is a PIC microcontroller, introduced Microchip, and mainly used in automation and embedded systems. It comes in three packages known as PDIP, QFN, and TQFP where the first one is 40-pin (mostly used) while other two come with a 44-pin interface.
- This microcontroller version comes with CPU, timers, 10-Bit ADC and other peripherals that are mainly used to develop a connection with external devices.
- This PIC version, like other models in the PIC community, contains everything that is required to make an embedded system and drive automation.
- The PIC18F4520 contains 256 bytes of EEPROM data memory, 1536 bytes of RAM, and program memory of 32K.
- It also incorporates 2 Comparators, 10-bit Analog-to-Digital (A/D) converter with 13 channels, and houses decent memory endurance around 1,000,000 for EEPROM and 100,000 for program memory.
- The Enhanced Universal Asynchronous Receiver Transmitter (EUSART) feature is useful for developing the serial communication with other devices.

Photograph 2.2.1(a): PIC 18f4520 microcontroller

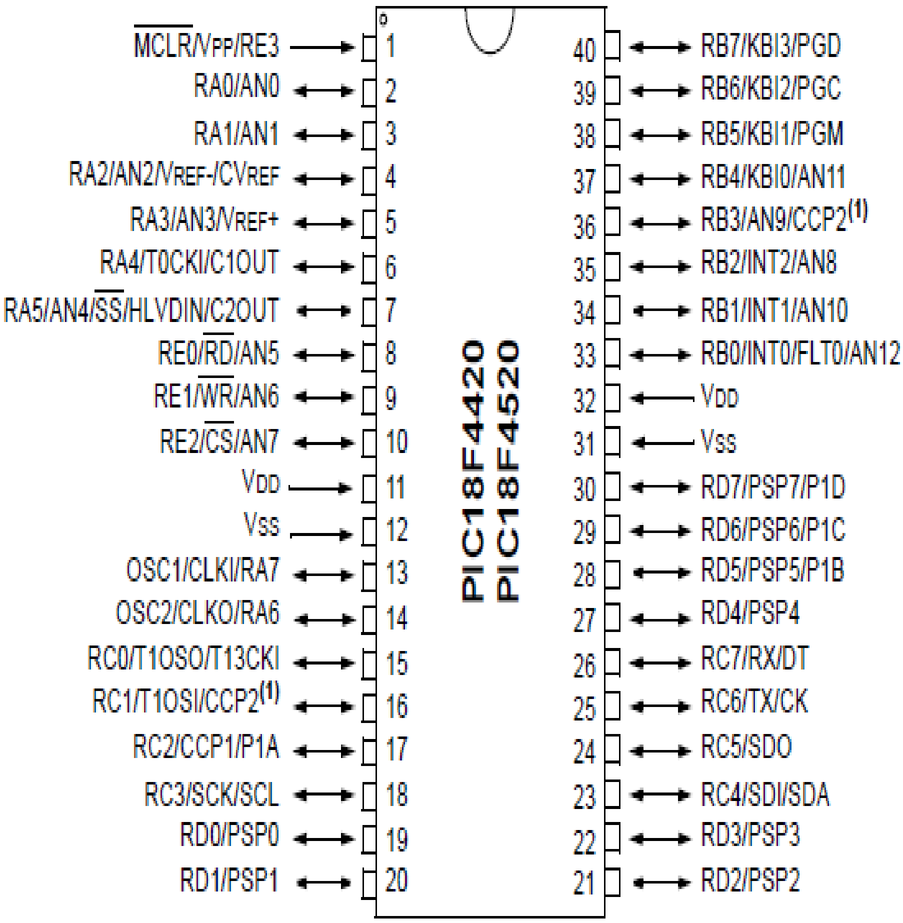


Figure 2.2.1(b): Pin Diagram PIC 18f4520 microcontroller

2.2.2 Humidity Sensor:

DHT11 is a Humidity and Temperature Sensor, which generates calibrated digital output. DHT11 can be interface with any microcontroller like Arduino, Raspberry Pi, etc. and get instantaneous results. DHT11 is a low-cost humidity and temperature sensor which provides high reliability and long-term stability.

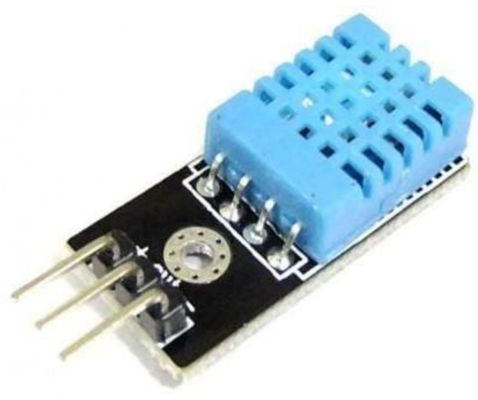
It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and outputs a digital signal on the data pin (no analog input pins needed). Its very simple to use, and libraries and sample codes are available for Arduino and Raspberry Pi.

This module makes is easy to connect the DHT11 sensor to an Arduino or microcontroller as includes the pull up resistor required to use the sensor. Only three connections are required to be made to use the sensor - Vcc, Gnd and Output.

It has high reliability and excellent long-term stability, thanks to the exclusive digital signal acquisition technique and temperature & humidity sensing technology.

Model: Humidity & Temperature DHT 11

This DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness. Each DHT11 element is strictly calibrated in the laboratory that is extremely accurate on humidity calibration. The calibration coefficients are stored as programmers in the OTP memory, which are used by the sensor's internal signal detecting process. The single-wire serial interface makes system integration quick and easy. Its small size, low power consumption and up-to 20 meter signal transmission making it the best choice for various applications, including those most demanding ones. The component is 4 -pin single row pin package. It is convenient to connect.



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Photograph 2.2.2(a): Humidity Sensor

2.2.3 16*2 LCD Display:

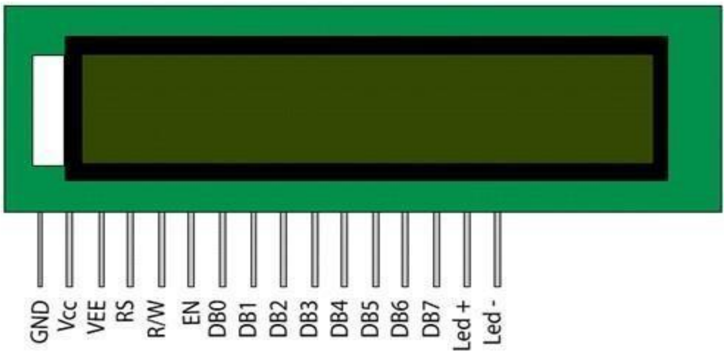
LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. Click to learn more about internal structure of a LCD.

The purpose of using 16x2 LCD in our project is to display all the parameters of electricity meter and is connected to the port 0 of ARM microcontroller.

Features:

1. 16x2 matrix
2. Low power operation support: 2.7 to 5.5V.
3. Duty cycle: 1/16
4. Connector for standard 0.1-pitch pin headers.



Photograph 2.2.3: 16*2 LCD Display

Pin no.	Symbol	External connection	Function
1	Vss	Power supply	Signal ground for LCM
2	V_{DD}		Power supply for logic for LCM
3	V_0		Contrast adjust
4	RS	MPU	Register select signal
5	R/W	MPU	Read/write select signal
6	E	MPU	Operation (data read/write) enable signal
7~10	DB0~DB3	MPU	Four low order bi-directional three-state data bus lines. Used for data transfer between the MPU and the LCM. These four are not used during 4-bit operation.
11~14	DB4~DB7	MPU	Four high order bi-directional three-state data bus lines. Used for data transfer between the MPU
15	LED+	LED BKL power supply	Power supply for BKL
16	LED-		Power supply for BKL

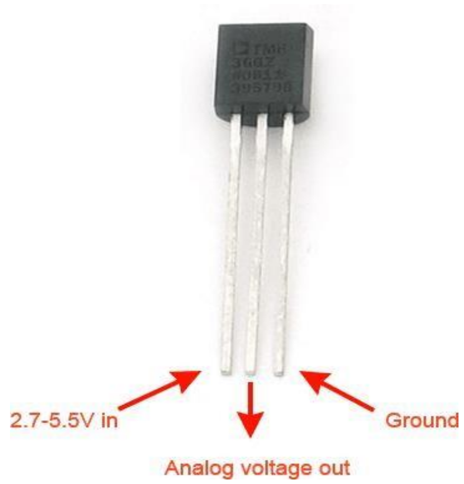
Table 2.2.3: Pin Diagram of display

2.2.4 Temp Sensor:

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full -55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35D is rated to operate over a 0° to +100°C temperature range.

Features:-

1. Calibrated directly in Celsius (Centigrade)
2. Linear + 10.0 mV/ C scale factor
3. 0.5 C accuracy guaranteeable (at +25 C)
4. Rated for full -55 to +150 C range
5. Suitable for remote applications
6. Low cost due to wafer-level trimming
7. Operates from 4 to 30 volts
8. Less than 60 A current drain
9. Low self-heating, 0.08 C in still air
10. Nonlinearity only 1/4 C typical
11. Low impedance output, 0.1 W for 1 mA load



Photograph 2.2.4: Temp Sensor

2.2.5 PH Sensor:

pH, commonly used for water measurements, is a measure of acidity and alkalinity, or the caustic and base present in a given solution. It is generally expressed with a numeric scale ranging from 0-
14. The value 7 represents neutrality. The numbers on the scale increase with increasing alkalinity, while the numbers on the scale decrease with increasing acidity. Each unit of change represents a tenfold change in acidity or alkalinity. The pH value is also equal to the negative logarithm of the hydrogen-ion concentration or hydrogen-ion activity. pH values for some common solutions are listed in the table to the right.

Features:

1. They give more accurate measurements.
2. They can be easily used.
3. The pH reading is easier comparatively.
4. They give more precise measurements as they can measure up to 1/100th of pH unit.
5. They are reusable.

Principle of pH Meter or pH Sensor

pH meter basically works on the fact that an interface of two liquids produces an electric potential which can be measured. In other words, when a liquid inside an enclosure made of glass is placed inside a solution other than that liquid, there exists an electrochemical potential between the two liquids.

Photograph 2.2.5: PH Sensor

2.2.6 GSM Module

This GSM modem has a **SIM800A chip and RS232** interface while enables easy connection with the computer or laptop using the USB to Serial connector or to the microcontroller using the RS232 to TTL converter. Once you connect the SIM800 modem using the USB to RS232 connector, you need to find the correct COM port from the Device Manger of the USB to Serial Adapter. Then you can open Putty or any other terminal software and open an connection to that COM port at 9600 baud rate, which is the default baud rate of this modem. Once a serial connection is open through the computer or your microcontroller you can start sending the AT commands. When you send AT commands for example: "AT\r" you should receive back a reply from the SIM800 modem saying "OK" or other response depending on the command send.

SIM800 is a complete **Quad-band GSM/GPRS** solution in a LGA type which can be embedded in the customer applications. SIM800H support Quad-band 850/900/1800/1900MHz, it can transmit Voice, SMS and data information with low power consumption. With tiny size of 15.8*17.8*2.4 mm, it can fit into slim and compact demands of customer design. Featuring and Embedded AT, it allows total cost savings and fast time-to-market for customer applications.

Features of SIM800A:

- Bands: GSM 850MHz, EGSM 900MHz, DCS 1800MHz, PCS 1900MHz
- GPRS class 2/10
- Control via AT commands (3GPP TS 27.007, 27.005 and SIMCOM enhanced ATcommand set)
- Supply voltage 3.4-4.4V
- Coding schemes: CS-1, CS-2, CS-3, CS-4 Tx power: Class 4 (2W), Class 1 (1W)
- Small package: 23 * 23 * 3mm
- Low power: down to 1mA in sleep mode
- TCP/IP AT firmware
- Operating temperature: -40C to +85C
- Audio channels which include a microphone input and a receiver output.

Modem Features:

- High Quality Product (Not hobby grade)
- Quad-Band GSM/GPRS 850/ 900/ 1800/ 1900 MHz
- RS232 interface @ RMC Connector for direct communication with computer or MCU kit
- Configurable baud rate
- SMA connector with GSM Antenna.
- SIM Card holder.
- Built in Network Status LED
- Inbuilt Powerful TCP/IP protocol stack for internet data transfer over GPRS.

- Audio interface Connector
- Normal operation temperature: -20 °C to +55 °C
- Input Voltage: 5V-12V DC

Interfacing with controller:-

GSM module is used in many communication devices which are based on GSM (Global System for Mobile Communications) technology. It is used to interact with GSM network using a computer. GSM module only understands **AT commands**, and can respond accordingly. The most basic command is “AT”, if GSM respond OK then it is working good otherwise it respond with “ERROR”. There are various AT commands like ATA for answer a call, ATD to dial a call, AT+CMGR to read the message, AT+CMGS to send the sms etc. AT commands should be followedby Carriage return i.e. \r (0D in hex), like “AT+CMGS\r”. We can use GSM module using these commands.

Photograph 2.2.6: GSM Module

2.2.7 BUZZER:

A buzzer or beeper is an audio signal device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of user input such as a mouse click or keystroke. If embedded system is misplaced from dashboard, the IR sensor becomes active. The signal is sent to ARM microcontroller to ring the buzzer. It is connected to the port pin P0.21via jumper J10 of microcontroller.

Photograph 2.2.7: Buzzer

2.2.8 RELAY:

A relay is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. A relay is an electrically operated switch.

Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and most have double throw (changeover) switch contacts as shown in the diagram.

Photograph 2.2.8: Relay

- **Normally Open (NO):** Contacts connect the circuit when the relay is activated, the circuit isdisconnected when the relay is inactive.
- **Normally Closed (NC):** Contacts disconnect the circuit when the relay is activated, the circuitis connected when the relay is inactive.
- **Change Over (CO):** It's the common contact.
- **Coil:** It's the electromagnet coil inside relay.
- **Coil rating:** It's the Voltage at which the coil gets fully activated. Some also have coil resistance mentioned on them. Relay coil voltage rated 6V and 12V are the most commonly available.

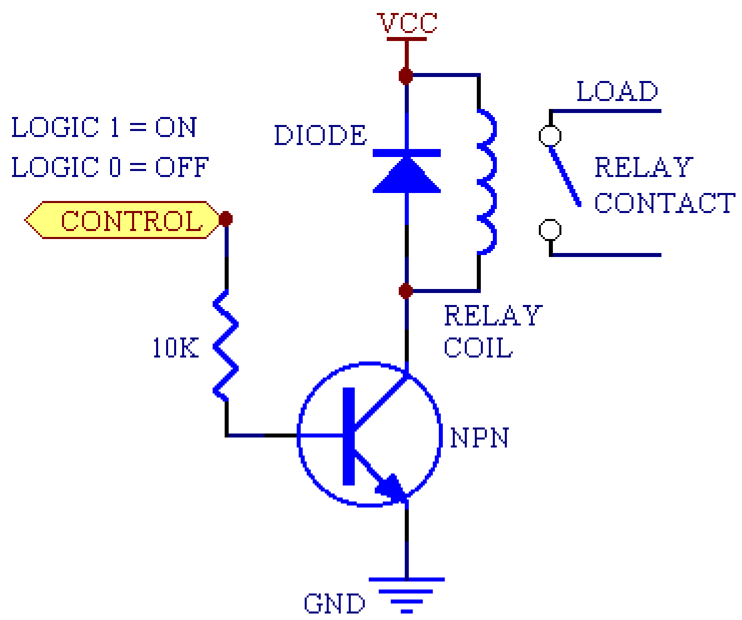


Figure 2.2.8(**b**): Relay Driver Circuit

The figure shows a relay with its coil and switch contacts. You can see a lever on the left being attracted by magnetism when the coil is switched on. This lever moves the switch contacts.

Applications of relays:

Control a high-voltage circuit with a low-voltage signal, as in some types of modems or audio amplifiers.

Control a high-current circuit with a low-current signal, as in the starter solenoid of automobile.

Detect and isolate faults on transmission and distribution lines by opening and closing circuit breakers.

CHAPTER 3

SYSTEM DEVELOPMENT

3.1 Block Diagram Development of Block diagram:-

The IoT plays a major role in the automation process. Automating this hydroponic system is the most crucial part, this can be easily achieved by integrating the hydroponic system with the IoT. Cloud database acts as the hub for the whole automation process; this database contains all the information on the hydroponic system that is it has the information on the data that has been retrieved from the crops and the water tank. Sensors and actuators are used in order to automate the hydroponic system, these sensor values are sent to the cloud database from which the user is updated with the real time information about crops condition. The user can also adjust the configuration of the sensors and actuators from the developed mobile application. The mobile application has all the specification about the hydroponic system; the user must have a unique login ID. The user name and the password are registered with the cloud database; by this the user can operate with his crop field without any interruptions. Through this mobile application the user can select which seed are to be planted in the crop bed, the water flow can also be controlled with the help of this mobile application. The user can control the flow of water from one tank to other tank with water level sensors and solenoids.

3.2 Developed Block Diagram Schematic:-

Block diagram is as follows:-

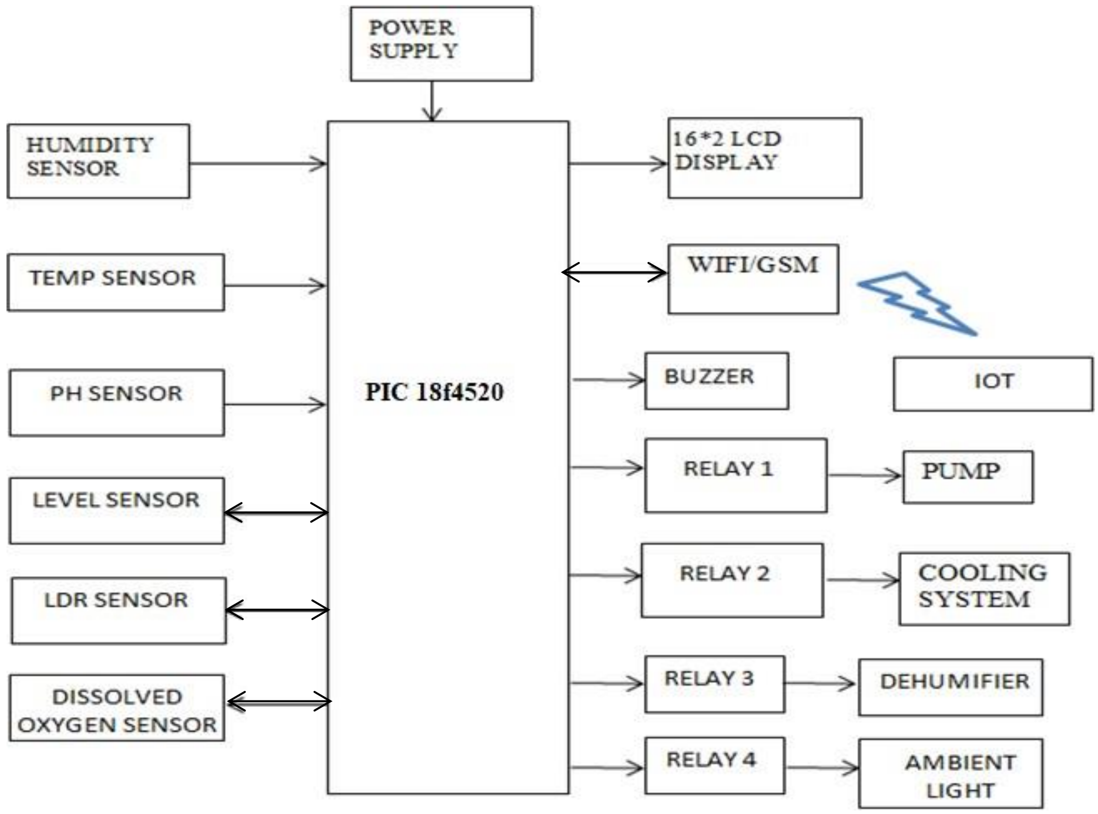


Figure 3.2: Block Diagram

3.3 Design of Signal Conditioning Module :-

3.3.1: PH Sensor signal Conditioning:-

The circuit shown in Figure 1 is a completely isolated low power pH sensor signal conditioner and digitizer with automatic temperature compensation for high accuracy. The circuit gives 0.5% accurate readings for pH values from 0 to 14 with greater than 14-bits of noise-free code resolution and is suitable for a variety of industrial applications such as chemical, food processing, water, and wastewater analysis. This circuit supports a wide variety of pH sensors that have very high internal resistance that can range from 1 MΩ to several GΩ, and digital signal and power isolation provides immunity to noise and transient voltages often encountered in harsh industrial environments

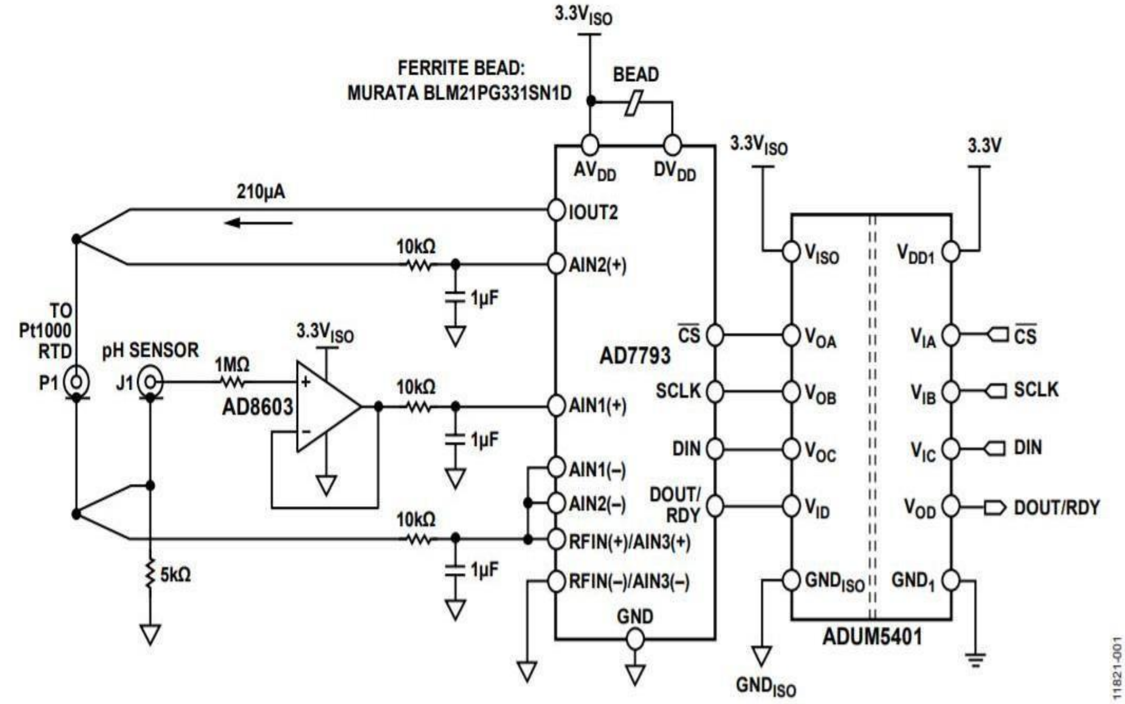


Figure 1. pH Sensor Circuit (Simplified Schematic: All Connections and Decoupling Not Shown)

Figure 3.3.1:PH Sensor Signal Conditioning

3.3.2: Temp sensor signal conditioning:

Temperature signal conditioners receive AC and DC voltages and signal inputs from resistance temperature detectors (RTDs), thermocouples, thermistors, and other sensors. They provide voltage, frequency, and current outputs to devices such as timers, counters, relays, and potentiometers. Temperature signal conditioning devices filter, amplify, and convert analog inputs to digital signals, or to levels suitable for digitization. Devices that include integral sensors or transducers often provide voltage and current excitation. Temperature signal conditioners work with 2, 3, and 4 -wire RTDs that are made from a variety of metals and that feature a variety of reference resistances. They can receive signal inputs from thermocouples with or without cold junction compensation, and from thermocoupleswith types E, J, K, N, T, B, S, R, and W.

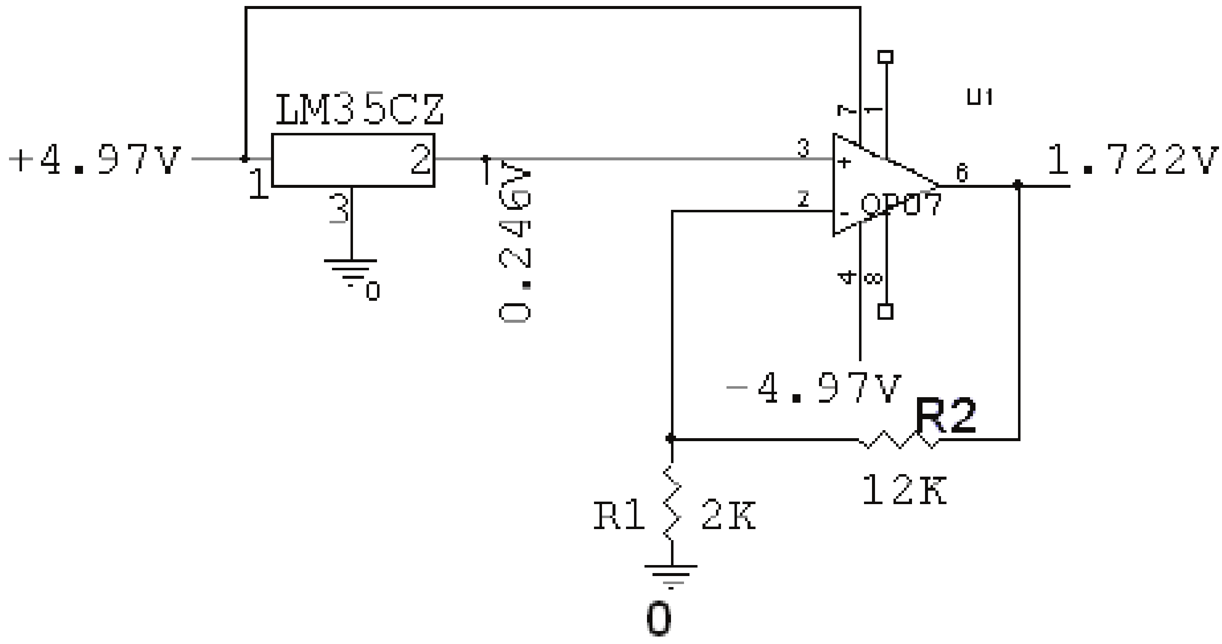


Figure 3.3.2: Temp. Sensor Signal Conditioning

3.3.3: Humidity Sensor Signal Conditioning:

Multiple circuit architectures may be used with a capacitive humidity sensor. Extra care must be taken during the layout of the pc board in these designs. Any stray capacitance must be minimized in the layout since any added capacitance will act as a parallel capacitance with the sensor and create a measurement error. A careful conformal coating of the pc board and components is advised to prevent unexpected deviations in FOUT of the 555 timers, especially in high humidity conditions.

The first and simplest is the capacitance-to-frequency conversion circuit. Figure 1 shows the circuit diagram using the Honeywell HCH-1000 series, a polymer-based sensor with a delta C form factor.

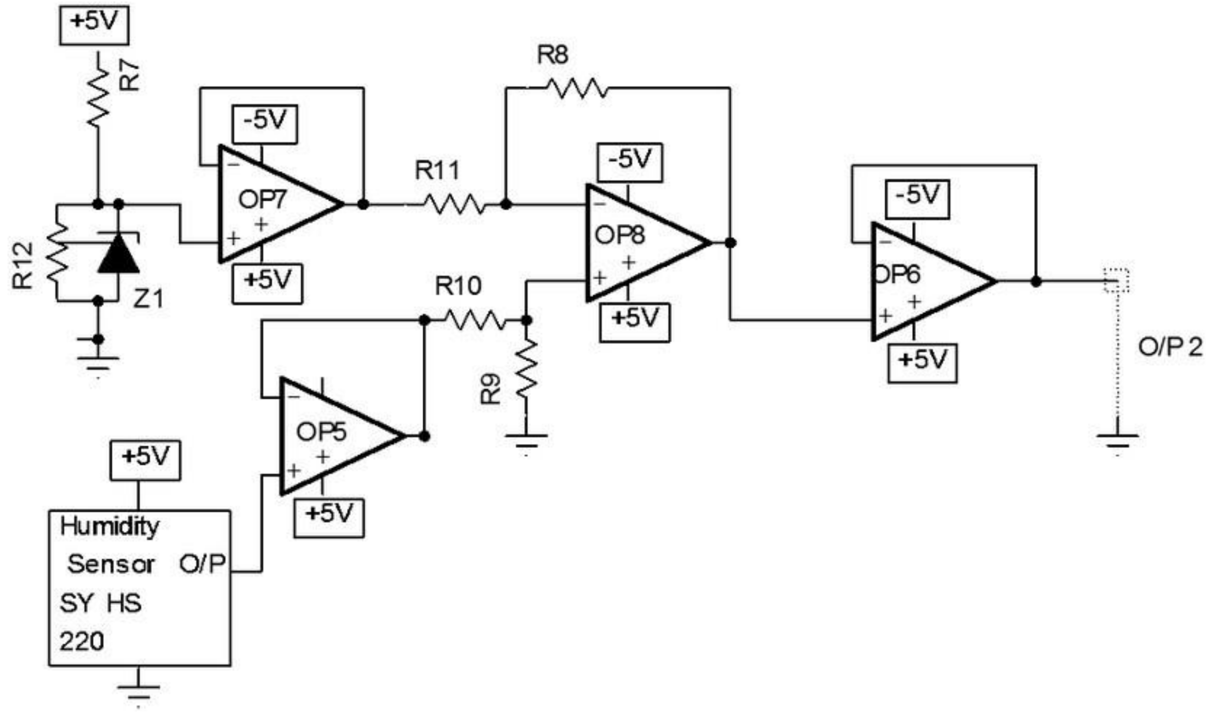


Figure 3.3.3: Humidity Sensor Signal Conditioning

3.4: LCD DISPLAY INTERFACING:

First of all, to interface LCD with a pic microcontroller, we used GPIO pins. GPIO pins are general- purpose input-output pins. Because we send control and data signals to LCD through these I/O pins. Therefore, you should know how to use digital input-output pins of the pic microcontroller.

It consists of 14 pins. There are 8 data pins from D0-D7 and three control pins such as RS, RW, and E. LED+ and LED- pins are used to control the backlight LED.

It can work in two modes, 4-bit and 8-bit. In this tutorial, we have used the 4-bit mode which uses only4 data lines, thus saving pins of the microcontroller. So It is recommended to use LCD in four bits mode to save pins of the microcontroller for other applications.

As you can see in this diagram, if we use 8-bit mode interfacing, we will need to use 11 pins of pic microcontroller. On the other hand, if we use 4-bit mode, we need only 6 GPIO pins. Therefore, it is recommended to use 4-bit mode interfacing. The only difference between 4-bit and 8-bit is that data transfer speed is faster for 8-bit mode. However, it doesn’t make any major difference.

A variable resistor is used to adjust the contrast of 5×8 dot pixels according to background light. Therefore, if you are not able to see anything on LCD after programming, the maximum changes are that you need to adjust contrast with the variable resistor. This contrast register makes adjust to thevoltage applied on the VEE pin.

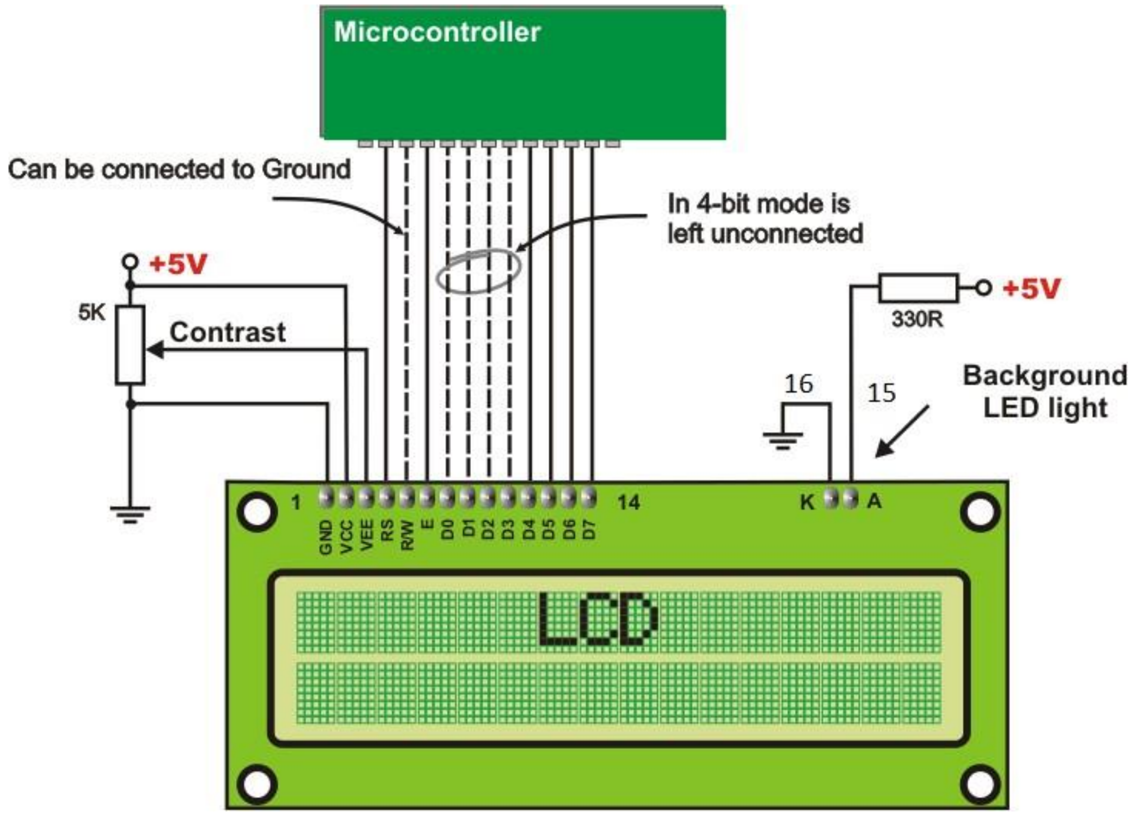


Figure 3.4: LCD Display Interfacing

3.5 Software:

3.5.1 Algorithm:

Algorithm of Parameter Measurement System

Step 1: START

Step 2: INITIALISE ALL SENSORS, INTERNET CONNECTION, CONTROLLER, DISPLAY

Step 3: ALL SENSOR START TO SENSE AND GIVE INPUTE TO CONTROLLER

Step 4: CONTROLLER GETS INPUTE FROM SENSOR AND PROCESS ON

THEM

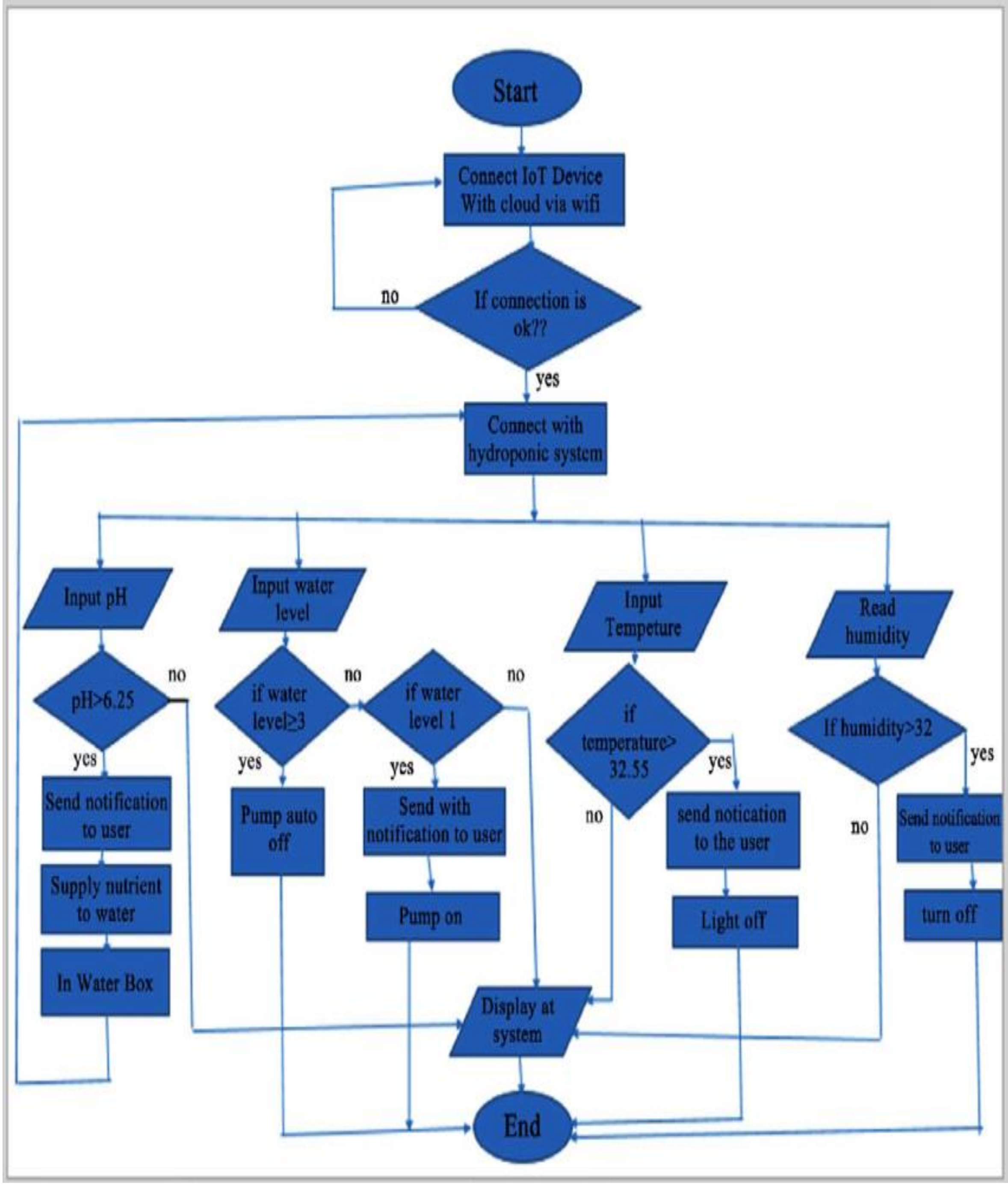
Step 5: ALL PARAMETERS WILL DISPLAY ON LCD DISPLAY

Step 6: AFTER GIVEN TIME INTERVAL ALL SENSOR OUTPUT WILL SENDTO IOT WEB SERVER

Step 7: RELAY WILL ON TO ON WATER MOTOR

Step 7: STOP

3.5.2 Flowchart:



3.6 Comparison of different equipments:-

3.6.1 Comparison between Microcontrollers:-

Point of comparison	8051	PIC	AVR	ARM
Bus width	8-bit for standard core	8/16/32-bit	8/32-bit	32-bit mostly
Communication protocol	UART,USART, SPI,I2C	PIC, UART, USART, LIN, CAN, Ethernet, SPI, I2S	UART, USART, SPI, I2C, (special purpose AVR support Can, USB, Ethernet)	UART, USART, SPI, I2C LIN, CAN USB, Ethernet, I2S, DSP, SAI(serial audio interface).
Speed	12 clock/instruction cycle	4 clock/instruction cycle	1 clock cycle	1 clock cycle
Memory	ROM, SRAM, FLASH	SRAM, FLASH	Flash, SRAM, EEPROM	Flash, SDRAM, EEPROM
ISA	CLSC	Some features of RISC	RISC	RISC
Memory Architecture	Von Neumann architecture	Hardward architecture	Modified	Modified Hardward architecture
Power consumption	Average	Low	Low	Low
Families	8051 varients	PIC16, PIC17, PIC18, PIC24, PIC32	Tiny, Atmega, Xmega, Special purpose AVR	ARMMv4,5,6,7 and series
Community	Vast	Very good	Very good	Vast
Manufacturer	NXP, Atmel, Silicon Labs, Dallas, Cyprus, etc	Microchip Average	Atmel	Apple, Nvidia, Qualcomm, Samsung, etc
Cost (As compared to features provided)	Very low	Average	Average	Low
Other features	Known for its standard	Cheap	Cheap, effective	High speed operation
Popular Microcontroller	AT89C51, P89v51, etc	PIC181XX8, PIC16t88X, PIC32MXX	Atmega8, 16,32, Arduino Community	LPC2148, ARM Cortex mo to M7, etc

3.6.2 Comparison of different Humidity Sensors:-

Parameters	**DHT11**	**DHT12**	**DHT22**
Power Supply	Dc 3.3~5.5V	DC 2.7~5.5V	DC 3.3~6V
Supply Current	Measure 0.3mA standby 60uA	Measure 800uA	Measuring 1~1.5mA
Relative Humidity	Resolution: 16 bit Repeatability: +-1%RH Accuracy: 25*C,+-5%RH Response Time: 1/e(63%) 25*C, 6s, 1m/s Air 6s	Resolution: 0.1%RH Measuring range: 20-95% RH Precision: 60%RH Repeatability: +-0.3%RH Response time: 1/e(63%)s	Operating range: 0-100%RH Accuracy humidity: +-2%RH Resolution: 0.1%RH Repeatability: +-1%RH
Temperature	Resolution: 16bit Repeatability: +-1*C Accuracy: 25*C, +-2*C Response Time:10s	Resolution: 0.1*C,16 bit Precision: 25*C, +-0.5*C Measuring range: 20~60*C Repeatability: +-0.2*C Response time: <20s	Operating Range: 40-80*C Accuracy: <+-0.5*C Resolution: 0.1 *C Repeatability: +-0.2*C

3.6.3 Comparison of different pH sensors:-

Parameters	**Glass Electrode**	**Metal electrode**	**Polymer or Carbon**
pH response	Very good pH response	Very good stability	Very good flexibility
Accuracy	High accuracy	High accuracy and low interferences to other ions	Low accuracy
life	Long life time	Less lifetime	Less lifetime
Cost	More cost	Low cost	Medium cost
Performance in extreme condition	Low performance in extreme condition	Good performance in extreme condition	Good performance
Sensitivity	Good sensitivity	good	low

3.6.4 Comparison of different temperature sensors:-

Parameter	Gravity: 12C BME280 Environmental sensor	Gravity: Analog LM35 Temperature sensor	Waterproof DS18B20 sensor kit	Gravity: DS18B20 temperature sensor	Gravity: Analog High temperature sensor
Operating voltage	3.3v/5v	3.3v/5v	3.0v~5.5v	3.3v~5v	3.3v~5.5v
Operating current	2.7uA	<133uA	<3uA	<3uA	2.8uA
Operating temperature	-40*C~85*C	-40*C~150*C	-55*C~125*C	-55*C~125*C	-20*C~400*C
Range of Temperature measurement	0*C~65*C	0*C~100*C	-55*C~125*C	-55*C~125*C	-20*C~400*C
Temperature deviation	+-0.5*C	+-0.5*C	+-0.5*C	+-0.5*C	+-2%F.S.
Dimension	30*22(mm)	30*22(mm)	30*22(mm)	22*32(mm)	42*32*18 (mm)
Interface	Gravity: IIC	Gravity: analog	Gravity: digital	Gravity: digital	Gravity: analog
Data type	Digit	Analog	Digital (unibus)	Digit (unibus)	Analog
Price	$8.80	$4.50	$8.00	$4.00	$16.00

3.6.5 Comparison of different relays:-

Characteristics	**Electromechanical relay**	**Microprocessor based relay**
Operating principle	Electromagnetic principle	Microprocessor with in built software
Parameter setting	Plug setting, dial setting	Keypad for numeric values, through computer
Function	Single function	Multi function
Visual indication	Flags, targets	LEDs, LCD
Range of setting	Limited	Wide
Relay size	bulky	Small
Maintenance	Frequent	Low
Speed of response	slow	Fast
Relay programming	no	Programmable
SCADA compatibility	no	Possible

CHAPTER 4

PERFORMANCE ANALYSIS

4.1 Deep Flow Technique (DFT) Method for Coriander Cultivation:

4.1.1 Seed Germination (Day 1-7):

- Height per Day: Coriander seeds germinate and establish roots during this stage. Growth is minimal, typically less than 1 cm per day.
- pH Requirement: Maintain pH around 6.0-6.5 for optimal germination.
- Humidity: High humidity levels (around 70-80%) to promote germination.
- Temperature: Maintain temperatures around 20-25°C for successful germination.
- Nutrients Required: Primarily nitrogen (N) and phosphorus (P) for root development.
- Nutrients Solution: Apply a nutrient solution with a ratio suitable for seedling growth, typically providing lower concentrations compared to later stages.
- Treatments: Regular monitoring for damping-off disease and maintaining optimal nutrient levels.
- Ambient Light: Limited exposure to light during germination, as coriander seeds germinate better in darkness.

4.1.2 Seedling Stage (Day 8-14):

- Height per Day: Seedlings develop first true leaves and experience accelerated growth, averaging around 1-2 cm per day.
- pH Requirement: Maintain pH between 5.8-6.3 for nutrient uptake and healthy growth.
- Humidity: Moderate humidity levels (around 60-70%) are suitable for seedling growth.
- Temperature: Optimal temperatures remain around 20-25°C to support robust growth.
- Nutrients Required: Balanced macronutrients (NPK) with additional micronutrients like calcium (Ca) and magnesium (Mg) to support leaf development.

- Nutrients Solution: Increase nutrient concentration slightly to support the accelerated growth rate.
- Treatments: Monitor for pests and diseases, provide adequate support for growing seedlings.
- Ambient Light: Seedlings require 12-16 hours of light per day, either natural or artificial, with adequate intensity and spectrum.

4.1.3 Vegetative Stage (Day 15-30):

- Height per Day: Coriander plants experience vigorous vegetative growth, increasing in height by 2-3 cm per day.
- pH Requirement: Maintain pH between 5.8-6.3 for nutrient absorption and to prevent nutrient deficiencies.
- Humidity: Moderate humidity levels (around 50-60%) are suitable for vegetative growth.
- Temperature: Optimal temperatures remain around 20-25°C for robust foliage development.
- Nutrients Required: Balanced macronutrients with increased nitrogen (N) to support leaf expansion and overall plant growth.
- Nutrients Solution: Provide nutrient solution with higher concentrations of macronutrients to meet the demands of rapid vegetative growth.
- Treatments: Regular monitoring for pests, diseases, and nutrient imbalances. Prune overcrowded foliage if necessary.
- Ambient Light: Coriander requires 14-16 hours of light per day, supplemented by artificial lighting during the winter season to compensate for reduced daylight hours.

4.1.4 Flowering and Fruiting (Day 31 onwards):

- Height per Day: Growth rate slows down as energy shifts towards flowering and seed production.
- pH Requirement: Maintain pH between 6.0-6.5 to support flowering and fruiting stages.
- Humidity: Maintain moderate humidity levels (around 50-60%) to prevent flower and seed damage.

- Temperature: Maintain temperatures around 18-22°C to prevent bolting and ensure successful flowering.
- Nutrients Required: Balanced macronutrients with emphasis on potassium (K) and phosphorus (P) to support flower and seed development.
- Nutrients Solution: Adjust nutrient solution to support flowering and seed set, reducing nitrogen (N) levels and increasing phosphorus (P) and potassium (K).
- Treatments: Continue monitoring for pests, diseases, and nutrient imbalances. Provide support for heavy seed heads if necessary.
- Ambient Light: Maintain 14-16 hours of light per day, supplemented by artificial lighting during the winter season to ensure consistent growth and flowering.
- Harvesting: Coriander can be harvested starting from around day 40 onwards, depending on the desired maturity of leaves or seeds.

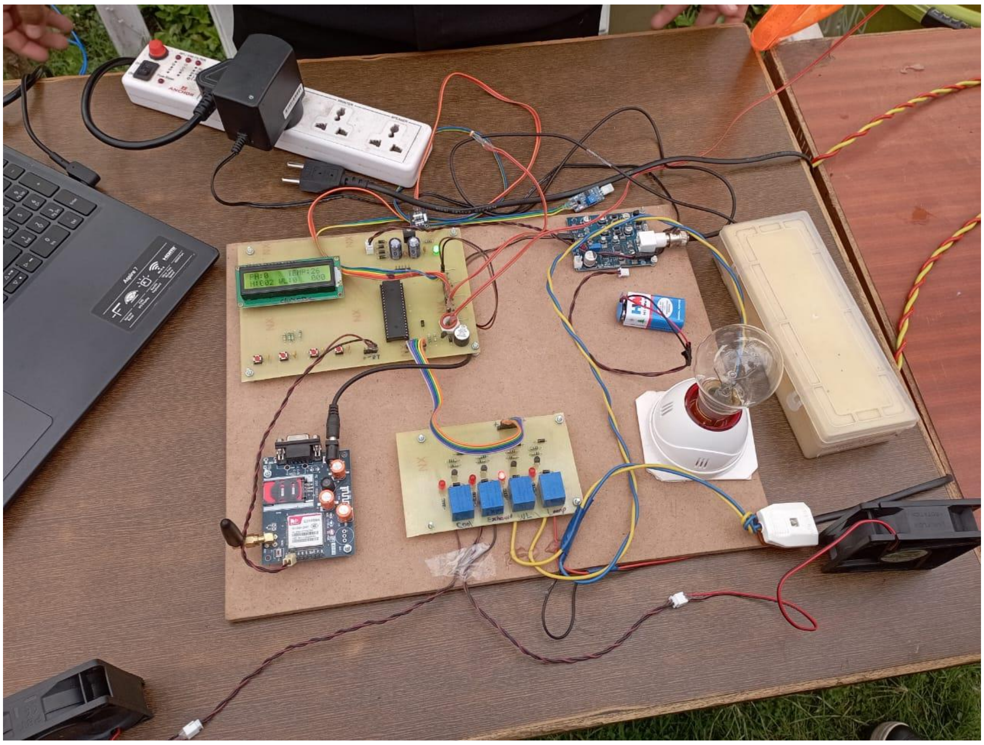


Fig 4 (a): Project kit (Top View)

4.2 Coriander cultivation data:-

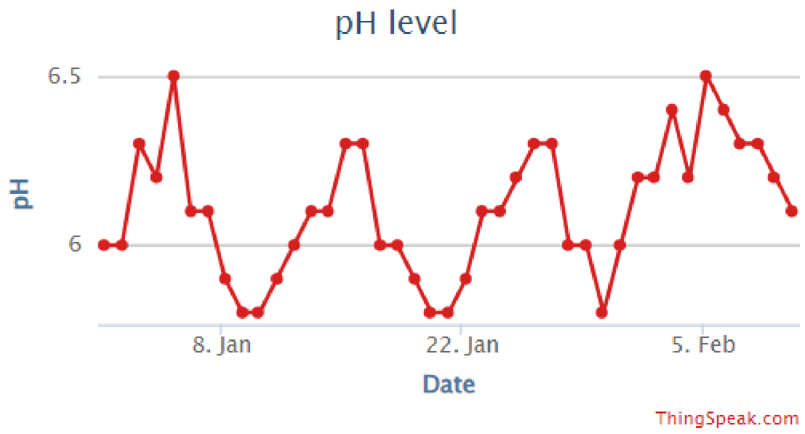
Factors	**Days (1-7)**	**Days (8-14)**	**Days (15-30)**	**Day 31 onwards**
Stage	Seed Germination	Seedling Stage	Vegetative stage	Flowering and Fruiting
Height per day	Less than 1 cm	around 1-2 cm	around 2-3 cm	-
pH	6.0-6.5	5.8-6.3	5.8-6.3	6.0-6.5
Humidity	70-80%	60-70%	50-60%	50-60%
Temperature	20-25°C	20-25°C	20-25°C	18-22°C
Nutrients	Macronutrients like N, P	Macronutrients like N, P, K, Ca, Mg	Macronutrients like N	Macronutrients like P, K
Development	Seedling growth	Accelerated growth rate	Rapid vegetative growth	Flowering and seed set growth
Ambient light in winter	Better in darkness	12-16 hours per day	14-16 hours per day	14-16 hours per day

4.3 Comparison of coriander cultivation in DFT method of hydroponic farming and soil based farming:-

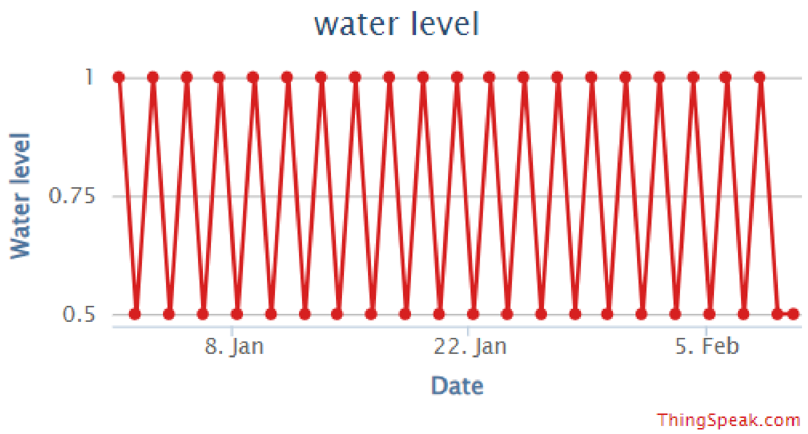
Growth Factor	Deep Flow Technique (DFT)	Soil-Based Farming
Seed Germination (Days 1-7)	Germinated in hydroponic medium	Germinated in soil
Height per Day	1-2 cm	0.5-1 cm
pH Requirement per Day	5.8-6.3	6.0-7.0
Humidity of Surrounding	60-70%	50-60%
Temperature	20-25°C	18-25°C
Nutrients Required	Balanced nutrient solution	Soil enriched with compost
Nutrients Solution	Constant supply in circulation	Absorbed from soil
Treatments in Days	Regular monitoring and adjustments	Monitoring soil moisture and nutrient levels
Harvesting Period	30-40 days	40-50 days
Ambient Light in Winter	Artificial lighting (14-16 hours)	Natural sunlight

4.4 Graphs:

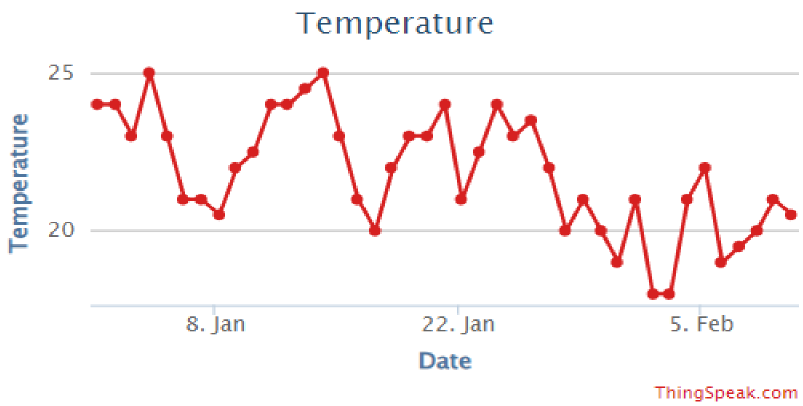
4.4.1 pH level :-



4.4.2 Water level :-



4.4.3 Temperature:-



4.4.4 Humidity:-

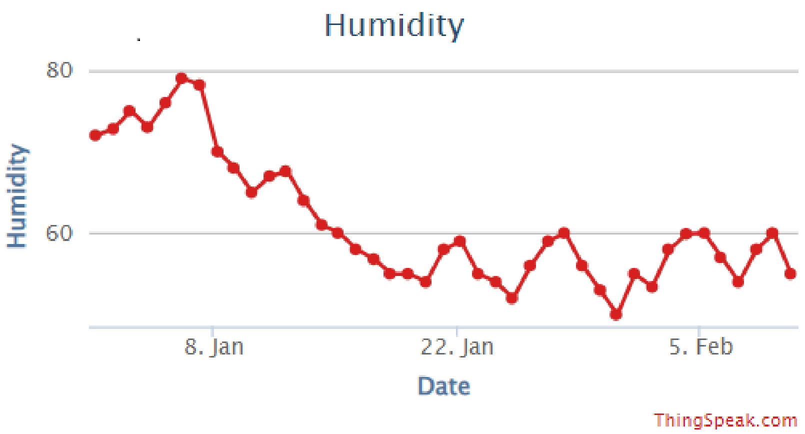


Fig 4(b) : Coriander cultivation (side view)

CHAPTER 5

CONCLUSION

Production of terrestrial crops by the usage of hydroponic system is beneficial in proper resource management and can yield much larger amount of healthy crops than traditional farming. Integration of this type of farming with internet and IOT opens up multiple opportunities to study the benefits of this system in many different regions of earth which further helps in improving the process of the system. The features of news feed or links to buy hydroponic system and its components helps to add another factor for a full, IOT backed system, for the user. Community building with the help of IOT web server can help to spread the awareness of hydroponics and also a platform for people to get connected and to share ideas and thoughts.

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