SMART SOIL MOISTURE MANAGEMENT

A DISSERTATION

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF DEGREE
OF

MASTER OF TECHNOLOGY
IN
COMPUTER SCIENCE ENGINEERING

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I, Manish Kumar, Roll No. 2K17/CSE/07 student of M.Tech (Computer Science and Engineering), hereby declare that the project Dissertation titled **"SMART SOIL MOISTURE MANAGEMENT"** which is submitted by me to the Department of Computer Science & Engineering, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Technology, is original and not copied from any source without proper citation. This work has not previously formed the basis for the award of and Degree, Diploma Associateship, Fellowship or other similar title or recognition.

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I hereby certify that the Project Dissertation titled **"SMART SOIL MOISTURE MANAGEMENT"** which is submitted by Manish Kumar, 2K17/CSE/07 Department of Computer Science & Engineering, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Technology, is a record of the project work carried out by the students under my supervision. To the best of my knowledge this work has not been submitted in part or full for any Degree or Diploma to this University or elsewhere.

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MANISH KUMAR

ABSTRACT

Internet of Things (IoT) is an environment of inter-connected physical objects over the internet. The ‘thing’ in IoT may comprise of a wide range of objects that are assigned IP address and can collects and sends data over a network without human involvement. Internet of Things (IoT) is one of the promising technologies used to connect, manage and control smart objects connected to the Internet. IoT's main goal is to smarter and more meaningful management and control of physical objects around us and improving life quality by offering economic, secure and entertaining livelihoods. In the development of smart automation system IOT application plays major role. Various tech giants have provided various devices like Google home, Amazon echo which allows you to control lighting in your home, play music, read news and various other features which are controllable with voice.

The main aim of this project is to determine the moisture content of the soil on a regular interval and update the value of the soil moisture over the cloud. Upon receiving the update of the moisture of the soil a particular level is set for the determination of the condition for the on and off of the motor for the retention of the moisture of the soil and shuts down the motor as the moisture level is retained to a particular level. Data that is acquired from the sensor is sent to the ThingSpeak API for the graphical representation and real time simulation. Also an mobile application is used for the purpose of displaying the sensor data and the message for the taking the necessary step to cope with the situation by triggering the alarm and sends an E-mail to the concerned person whose E-mail id is already put in the application.

CONTENTS

List Of Figures

CHAPTER 1

INTRODUCTION

1.1 Internet of Things

Internet is a fantastic thing and it gives us all kinds of advantages, which were previously not possible. Think about your mobile phone before it became a smart phone. Now, you can read every book, look into any movie, listen to all the songs in the hand palm. These are just to name some of your smart phone's incredible stuff. It comes down to the fact that connecting to the Internet has many incredible advantages. Truly, the Internet of Things is a straightforward idea, it intends to take and interface everything on the planet with the internet. IoT is a system of a huge number of gadgets furnished with some sort of sensors that accumulate a few information and this information are transmitted over the system. The things in IoT alludes to any gadget like sensor present in car, a heart screen conveyed by an individual, cameras getting live feed of creatures in woods. These things are then associated with the internet and the information gathered by these gadgets are then moved over the system. In light of these information different activities can be performed. With IoT the objects can be controlled remotely over the network making the environment smart. It is currently one of the emerging topics now a days. So, when one gets out of town for few days this can actually help to water the flower pot in our home so as to protect it from getting dry.

Figure 1.1 : Application of IoT

This framework is totally automated and there is no requirement for any human intercession however can be controlled remotely utilizing the application named virtuino physically moreover.

All the things that are connected to Internet can be classified into three categories:

1.Things that gather and transmit information

This includes sensors like air quality sensor, temperature sensor, IR sensor and many more. These sensors gather information from their environment and send it forward. Example, farmers can get information regarding soil moisture and can decide accordingly to water right amount of water to crops

2.Things which obtain information and act accordingly

The sensors receives some information and act accordingly. For example, car receives signal from keys and the door opens, printer receives information and prints. There are numerous examples, but the real IoT emerges when things can perform both above.

3.Things that does both

Taking the cultivating model, the sensors assemble data of soil dampness and tell ranchers the measure of water expected to crops. Rather than involving a farmer the system can automatically decide the amount and provide the water itself. Extending it a step further, if the system receives information regarding weather, then it would also know if it's going to rain or not and can decide to water the crops or not

1.2 Scope of IoT

With the increase in demand of IoT, it is predicted the count of the connected devices will reach approx. 24 billion by 2020. Following are some of the areas where IoT is being used to carry out the task efficiently:

1. Smart Home

Living in a home that acts smartly where we can control appliances remotely through smart phone or appliances take actions on their own based on the Environment for example turning the lights on/off based on the people present in the room, turning on the air conditioner remotely in a hot summer weather, monitoring of the appliances.

2. Wearables

Wearable devices are equipped with different sensors that collect data and this data is processed to provide user with meaningful information. These wearable generate information mainly related to fitness, entertainment and health.

3. Connectedcars

A car connected to the internet where the onboard sensors gather data to provide comfort, optimise operation, maintenance. For example a sensor monitors the pressure in the tyre and it alerts user if pressure below certainthreshold.

4. IndustrialIoT

The Industrial Internet of Things (IIoT), combines machines, people at work and advanced analytics. It is the network of devices that are connected to each other leading to systems, which like never before can monitor, collect, analyse and provide new outputs. These insights can then assist industrial companies in making beneficial business decisions.

5. Agriculture

IoT is utilized to distinguish soil clamminess and supplements, control the progression of water for plants and manure. The information produced by the ranchers are utilized to improve the productivity of the ranchers.

6. Smart Retail

Use of IoT in shops would give a chance to retailers improve the experience of consumers for in-store shopping. Retailers can use Beacon technology to interact with smartphones for providing better service to the consumers. They may improve

their profit by tracking the users path and modifying the layout of the store accordingly.

7. Medical

IoT in the field of medical aims at providing a healthier life to people by wearing devices connected to internet that collects different data. This data can then be used in the analysis of health and provide strategies to fight illness.

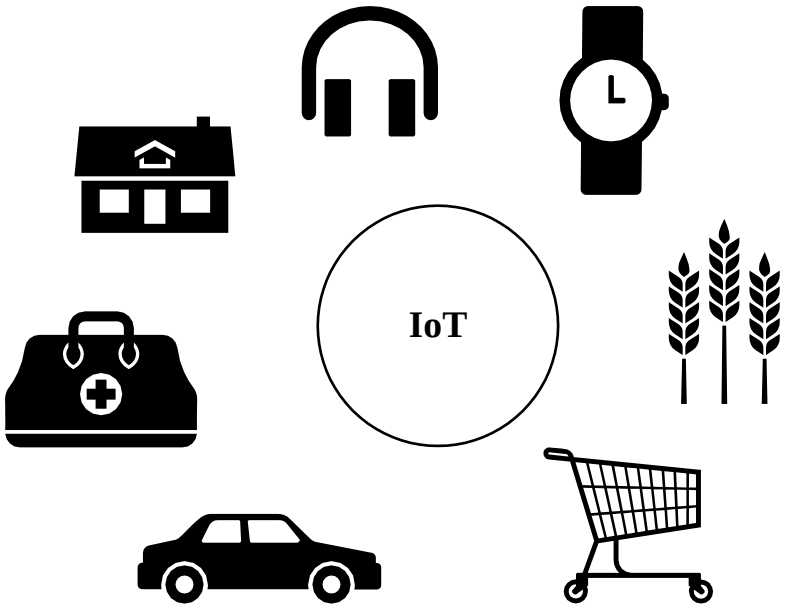


Figure 1.2: Domain of IoT

1.3 Layout of IOT

The architecture of IoT varies, depending on the type of solution we want to build. IoT as a technology consists mainly of four main components, which are structured around an architecture.

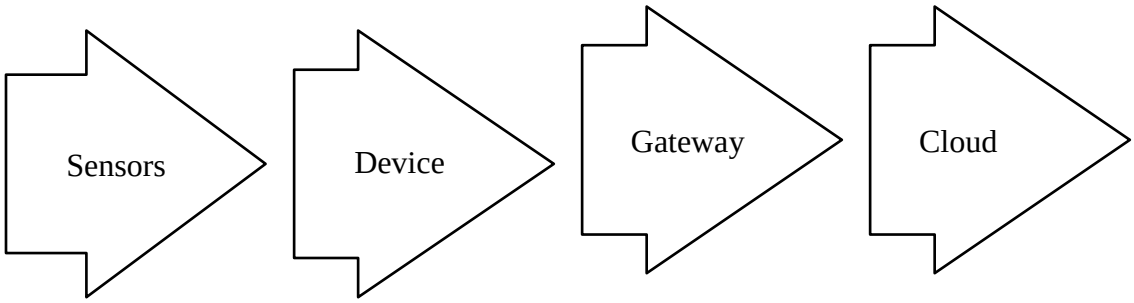


Figure 1.3: IoT Architecture

Sensor

Sensors are utilized to gather the information from the source and change them in useable information for the further procedure.

Devices

Devices collects the data that is sent by the sensors and is further processed and digitized for subsequent use.

Gateway

Gateway provides the means for the transfer of data through the network to cloud.

Cloud

The data collected above and is transmitted to a cloud, where more robust technology systems can manage, analyze and save data. Further processed data is used by different applications as needed.

CHAPTER 2

RELATED WORK

Internet of things is an aggregation of many technologies that allows many social services to be improved by using all the smart sensors and smart objects. These brilliant gadgets can be gotten to and worked whenever and from wherever utilizing the web convention and furthermore in view of the accessibility of the gigantic measure of information accumulation and handling, security of information and trustworthiness of the information is consistently in danger by the programmers. There are mainly two classified attack one is active attack and other is passive attack in which the first one involves subversion of privacy or robbery and the other one concern about the destruction of data in network.

In shrewd soil dampness the board framework the dampness of the dirt is kept up by keeping a nearby look on the dampness substance of the dirt and after that sending sign dependent on the gathered information from sensor that thusly keeps the dampness kept up between a specific range.

Different methodologies have been proposed for the usage of the accompanying framework. Furthermore, every one of the proposed methodologies and advancements has its own upsides and downsides so relying upon the application as well as can be expected be picked. Numerous such methodologies are as of now utilized and performs great. A SMS based arrangement is as of now suggested that trades SMS dependent on the information procured from the sensors and numerous different works are additionally carried on for the equivalent.

CHAPTER 3

PROPOSED WORK

3.1 Problem statement

A lot of problem is faced when dealing with the moisture of the soil, there can be many reasons to do so but here we will mainly discuss in respect to agricultural needs and also for domestic use. There are chances when we stay away from our houses for days and in that the plants that are planted in flower pot may die because of low moisture of the soil so in that case it can serve useful. Also in the case of farmer it can serve in purpose of irrigation remotely in case of unavailability of the farmer away from its field thus can be of great use by making life easy to some extent.

3.2 Proposed Solution

The fundamental objective of this undertaking is to decide the dampness substance of the dirt on an ordinary interim and update the estimation of the dirt dampness over the cloud. After getting the update of the dampness of the dirt a specific level is set for the assurance of the condition for the on and off of the engine for the maintenance of the dampness of the dirt and closes down the engine when the dampness level is held to a specific level. The information that is procured from the sensor is sent to the ThingSpeak API for the graphical portrayal and constant recreation. Likewise a portable application is utilized to show the sensor information and the message for the making the vital move to adapt to the circumstance by setting off the caution and sends an E-mail to the concerned individual whose E-mail id is as of now put in the application.

CHAPTER 4

INTERNET AND WIRELESS DEVICES

4.1 How internet works

Web has turned into the most significant part for the general population around the globe. It is the worldwide system of billions of PCs and other electronic gadgets associated together for the procedure of exchange of information and assets.

With the web it is conceivable to get to any data and any gadget associated with the web anyplace on the planet

Figure 4.1: Internet

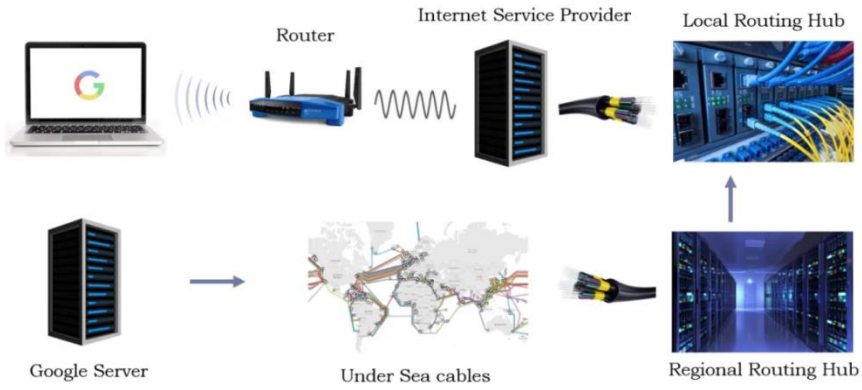


Figure 4.2: Path of the request from the user over internet from server

- Computer makes the solicitation for the site page from the server by sending the solicitation in the virtual wrap called bundle and incorporates the Google server address called the IP address.

  This solicitation is sent to switch utilizing Wi-Fi association.

  This bundle at that point travel through the medium and achieves the ISP. ISP forwards the packet to local routing hub.

- Local routing hub then forward it to specific regional routing hub based on the address on the packet.

- After reading the packet the regional hub knows where to redirect the packet and then it is forwarded via the undersea cables.

- The server then responds after receiving the request and hence the process completes.

  The data is usually transmitted in the form of electricity, light, radio waves or combination of all three.

4.2 Why wireless technology?

- Freedom from wires
- Global communication coverage
- Better feasibility

Figure 4.3 : Wireless Technology

4.3 Types of wireless devices

- Radio frequency
- Bluetooth
- Infrared
- Wi-Fi
- GSM
- GPS
- Li-Fi

Figure 4.4 : Types of wireless devices

4.4 Short range wireless communication

- Range of less than 10 meters

Figure 4.5 : Short range wireless communication devices

4.4 Mid range wireless communication

Figure 4.6: Mid range wireless communication devices

Li-fi has advantages of being useful in electromagnetic sensitive areas where interference can be hazardous like aircraft, hospitals and nuclear power plant etc. Li-fi uses the light as the medium for the data transfer

4.5 Long range wireless communication

GSM innovation utilizes TDMA to part the recurrence into schedule openings. GSM is worldwide standard and it is just sort of cell administration accessible all through the globe. It works free of any telephonic or web gathering. It serves value in military, common and business utilization around the globe.

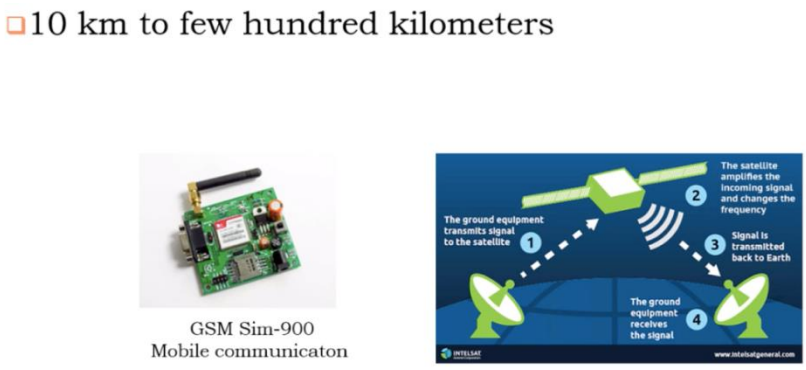


Figure 4.7: Long range wireless communication devices

CHAPTER 5

SYSTEM IN-DEPTH OVERVIEW

5.1 Smart soil moisture management system

Schematic for soil moisture management system :-

- Read data from Soil moisture sensor
- Activate pump based on sensor data
- Connect ESP8266 to Arduino

Connect Arduino to Wi-Fi and send information to ThingSpeak API

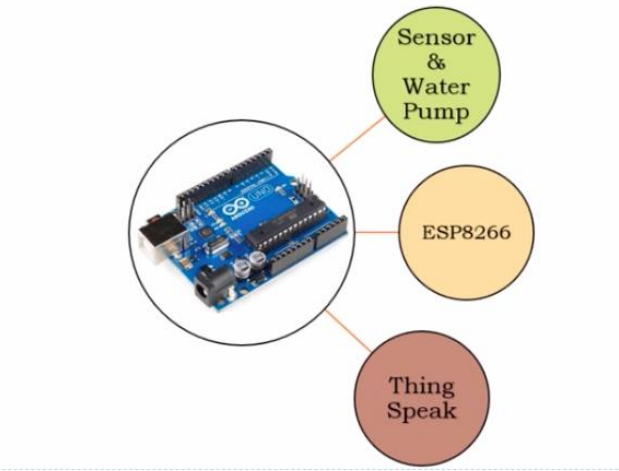


Figure 5.1 : Overview of system

5.2 Kit required

1. **Arduino UNO Board**

Key features of Arduino UNO board:-

- Arduino is an open source platform Hardware and Software Development platform.

- Microcontroller units for structure computerized gadgets and a few intuitive articles.
- Design records including board schematics, PCB Files, codes – openly accessible Flexiblity to adjust the plan.

What does Arduino have?

- Hardware - Arduino Boards, Shields, kits
- Software - ArduinoIDE(Integrated Development Environment)

5.3 Arduino Architecture and structure

5.3.1 AVR Architecture

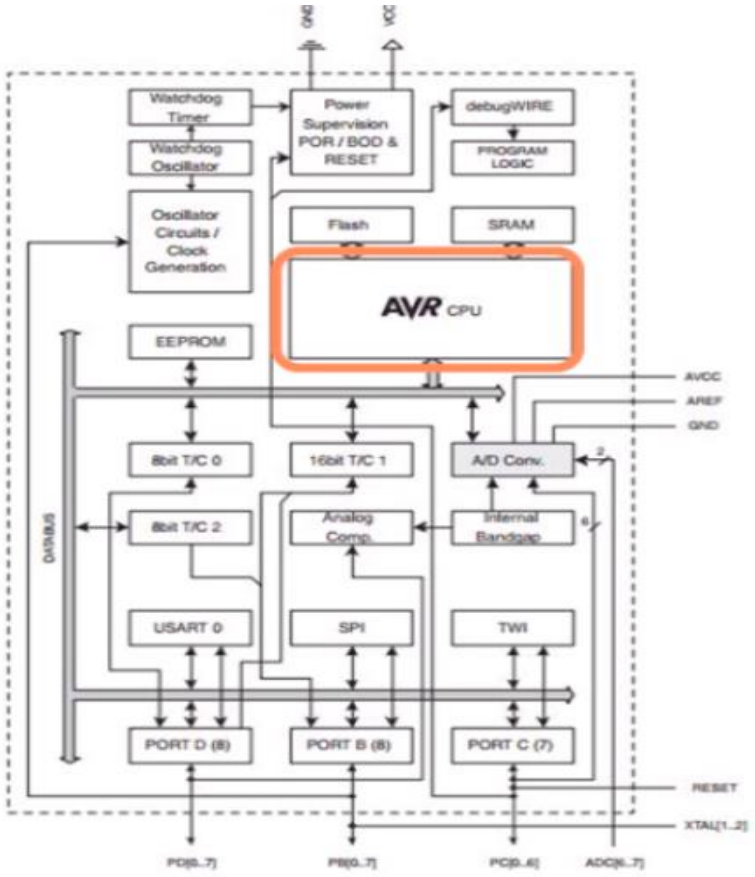


Figure 5.2: AVR Architecture

5.3.2 AVR CPU (Central Processing Unit)

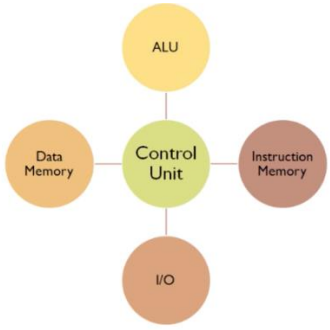


Figure 5.3: CPU

- ALU - Performs all the arithematical and coherent computations and activities
- General reason registers - Small information stockpiling region where information is stacked from the principle memory to play out the activities in order to expand handling velocity of the tasks.
- Interrupts - Used to alarm the microcontroller on unique guidelines by sparing and suspending ordinary control stream and utilizing high need directions.
- Instruction control unit - It gets the guidance from the memory disentangles them and executes the directions.

➢ Memory

- EEPROM (Electrically Erasable Programmable ROM) Non-Volatile.
- Flash-Non-Volatile
- SRAM (Static RAM)- Volatile

➢ Timers

- Counting and Timing
- Frequency of instruction
- Generate hinders

- PWM signals

➢ I/O Ports

- 8-bit port
- Each bit-one I/O pin
- Digital pins

➢ Analog Port

- Used to deal with analog data
- Analog-Digital Conversion
- Application in PWM

➢ Microcontroller used mostly in Arduino

- ATmega8
- ATmega168
- ATmega328
- AVR microcontroller developed by Atmel

Figure 5.4: Arduino board

5.4 What is microcontroller?

It is a small computer on an integrated circuit that perform specific task based on pre-programmed instruction set.

Major components of Microcontroller:-

- ALU
- Memory
- I/O Ports
- Control Unit

It is a microcontroller board based on the ATmega328. It has 6 analog inputs,14 digital input/output pins (of which 6 can be used as PWM outputs) a power jack, a USB connection, an ICSP header, a 16 MHz crystal oscillator and a reset button. It contains almost everything needed to support the microcontroller; simply connect

Arduino to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. Arduino UNO differs from all preceding boards because it does not use the FTDI USB-to-serial driver chip.

Additional features coming with the REV3 version are:

- ATmega16U2 instead of 8U2 as USB-to-Serial converter.
- Pin-out: added SDA and SCL pins for TWI communication placed near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board and the second one is a not connected pin that is reserved for future purposes.
- Stronger RESET circuit

5.5 General Pin Functions

- LED: Digital pin 13 drives the inbuilt LED. The LED is on when the pin is HIGH, and off when the pin is LOW.
- VIN: The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- 5V: This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 20V), the USB connector (5V), or the VIN pin of the board (7-20V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage the board.
- 3V3: A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- GND: Ground pins.

- IOREF: This pin on the Arduino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs to work with the 5V or 3.3V.
- Reset: Typically used to add a reset button to shields which block the one on the board.

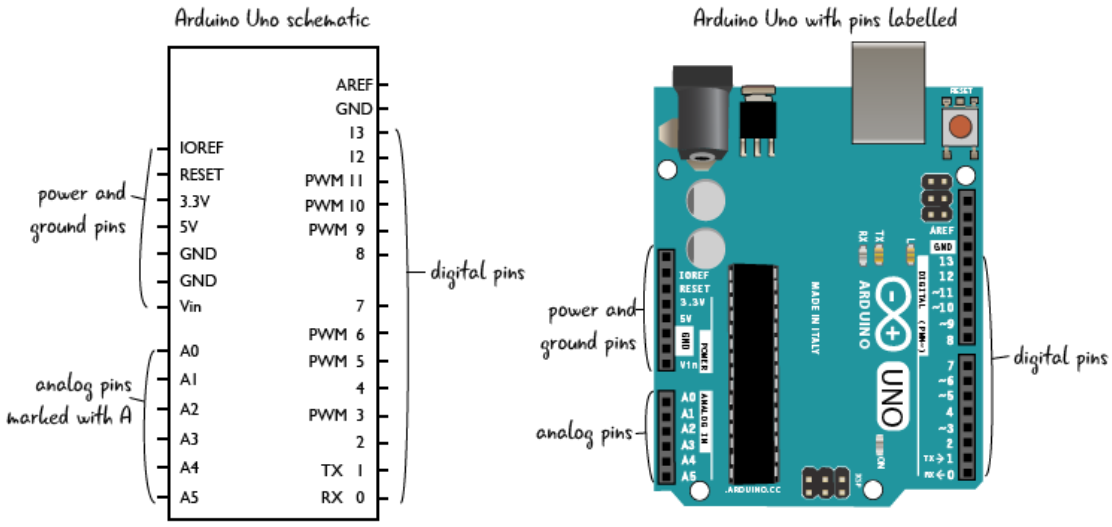


Figure 5.5: Pin architecture of Atmega

5.6 Special Pin Functions

- **Serial**: pins 0 (RX) and 1 (TX). RX is used to receive and TX is used to transmit TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.
- **External Interrupts**: pins 2 and 3 are the interrupts. These pins can be configured to trigger an interrupt on a change in value, rising or falling edge.
- **PWM**(Pulse Width Modulation): Pins 3, 5, 6, 9, 10, and 11 are PWM data pins. It can provide 8-bit PWM output using the analogWrite() function.

- **SPI**(Serial Peripheral Interface): 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.
- **TWI**(Two Wire Interface): A4 or SDA pin and A5 or SCL pin. Support TWI communication using the Wire library.
- **AREF**(Analog Reference): Reference voltage for the analog inputs.

CHAPTER 6

SENSING IN IOT

6.1 Connectedness of the sensor and data flow

Figure 6.1 An overview of data flow from sensor to other devices

- **Sensor and Sensor Networks**
  - Interface between IoT application and the real physical world
  - Capture Real time data from the IoT System
  - Widely available due to micro-electro-mechanical-system(MEMS) low cost and compact size
- **Working of Sensors**

Transducers - Converts energy/power from one form to the another and it can be used as sensors as well as actuators.

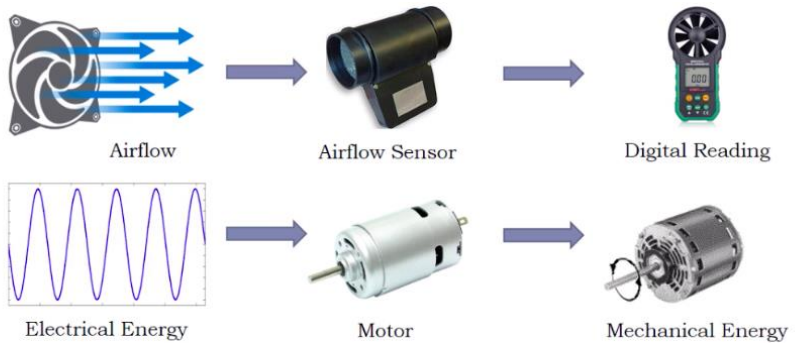


Figure 6.2 Transducer type

6.2 Types of Sensor

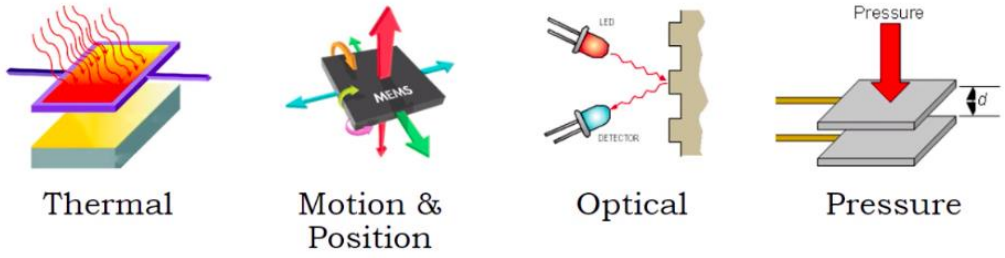


Figure 6.3: Types of sensors

- **Thermal-** Enables the IoT devices to measure the temperature.
- **Motion and position –** Measure the movement and position of any object, the movement can be linear or angular.
- **Optical –** Used to detect presence and absence of any object and the distances, these are widely used in digital cameras that are widely used in IoT applications.
- **Pressure-** Used to measure pressure of liquids and gases, they convert physical power into electronic signals which are the functions of the pressure imposed, the can also be used to measure the speed of the fluid and altitude.

6.3 Sensor Fusion

Sensor fusion is basically the decision that is made on the information gathered from multiple sensors and also helps in predicting the more elaborate decision from multiple sensors. Gathering same data from multiple sources increases the accuracy and reliability of the data so the multiple sensors can be combined to get gather more information of the complete environment under observation.

For example a stereoscopic vision of combining two dimensional images from two cameras from slightly different view point to derive three dimensional images of the scene from the cooperative sensors gathering the complete video coverage from multiple camera so as to combine as one.

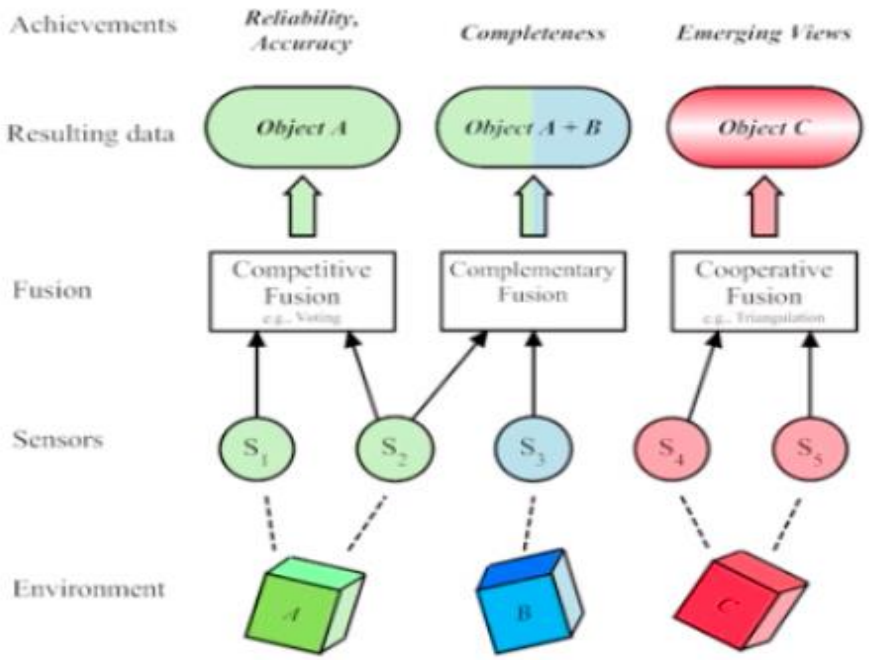


Figure 6.4: Sensor Fusion

6.4 Wireless sensor network

When many different sensors nodes spread over a huge area is called wireless sensor network, every individual node sends data to a master node that acts as gateway between all the other nodes.

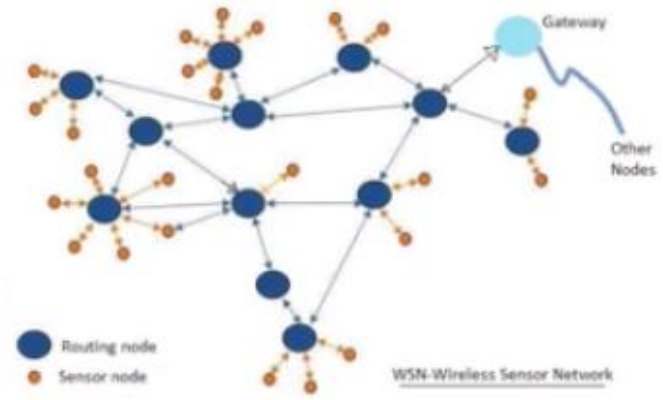


Figure 6.5: Wireless sensor Network

- Spatially distributed sensing nodes
- Application in following area:-
- Area Monitoring
- Environmental Sensing (Air pollution, natural disaster etc)
- Industrial Monitoring (Machine Health, Structural Health)

6.5 Architecture of a Sensor Node

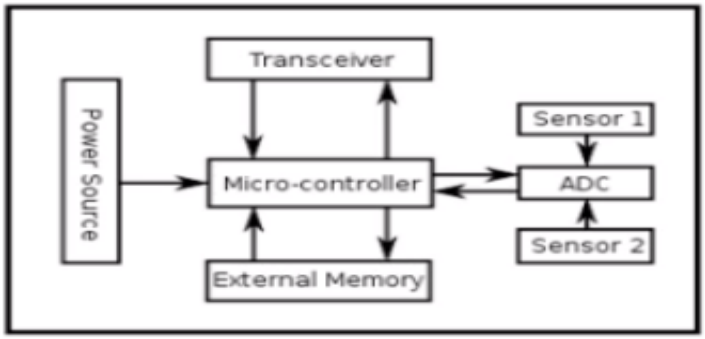


Figure 6.6: Architecture of sensor nodes

- A sensor node has following :-
- Micro-controller – Perform all the assignment, process information and control the usefulness of different segments of the hubs. It is likewise in charge of enhancing the power utilization of the hub.
- Transceiver – Sends and gets the information from the earth and to the gadget remotely.
- External Memory – For data storage
- Power Source – For running the sensor
- Sensors – For maintaining the flow of data from environment to device.

Few challenges of wireless sensor networks are depicted below:-

- Power consumption
- Range of communication
- Node Failure
- Scalability

6.6 Soil Moisture Sensor

It is utilized to detect the dampness substance of the dirt by plunging the sensor test in the dirt that leads the power to discover the dampness substance of the dirt. The length of the sensor plunged in soil additionally assumes a noteworthy job in expanding and diminishing perusing for dampness substance of soil.

Sensor is covered with platinum, and hostile to rust concoction to make productivity high just as keep going long. The detecting reach is likewise high which will pay for the rancher at a most minimal expense.

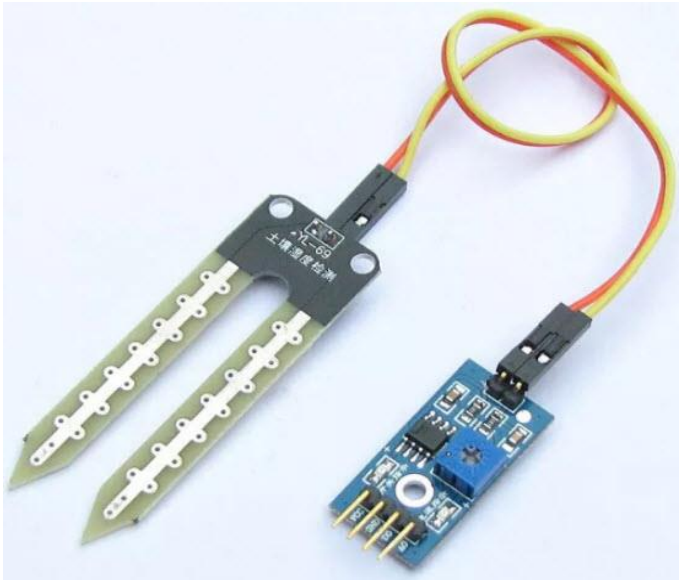


Figure 6.7: Soil moisture sensor probe

- Electrical Conductivity: Measure of the ability of a material to conduct electricity, current flows due to movement of charged particles typically due to ion, these ions are formed due to the ionic compound dissolved in water as a result of which the conductivity of water is increased and this principle is used to measure the water content of the soil.

6.7 Pin diagram

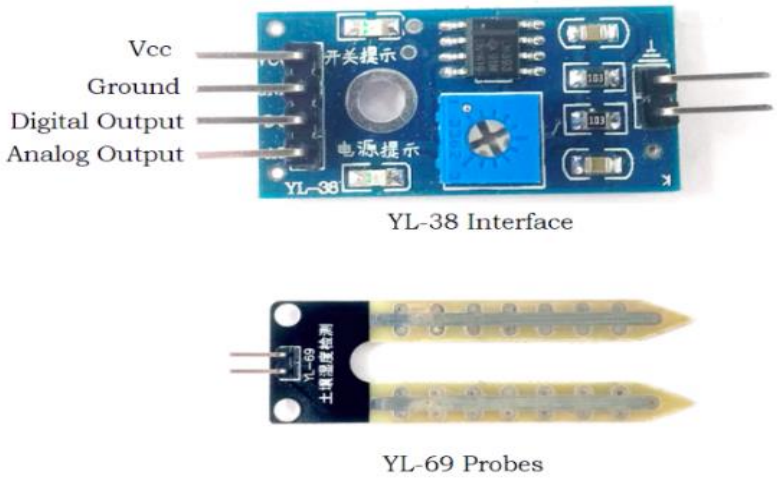


Figure 6.8: Pin diagram of probe and YL-38 interface

6.8 YL-69 Probe

It is utilized to quantify the obstruction of current in the dirt, better the dampness substance better the progression of present and lesser the dampness content higher the opposition of the dirt and lesser the conductivity.

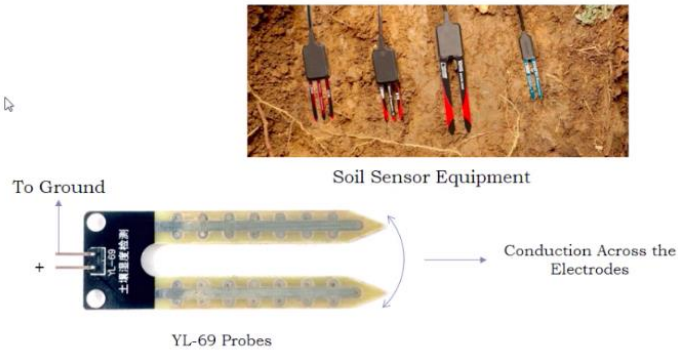


Figure 6.8: YL-69 Probe

- Conductivity of a solution depends on:

- Concentration of ions in the soil
- Temperature of ions
- Nature of ion

CHAPTER 7

DATA ACQUISITION FROM SENSOR

7.1 Reading data from soil moisture sensor

After the effective aggregation of the program, the program is transferred to the Arduino board by means of the USB link. When the code is effectively transferred on the Arduino the baud rate is changed to 9600 and NL and CR are chosen. Presently the dirt sensor begins perusing information from the test and shows the dampness substance of the dirt on the sequential screen window as appeared in the figure underneath. We can see that the sensor perusing changes when the dampness substance of the dirt changes and furthermore the length of the test that is presented to the dirt.

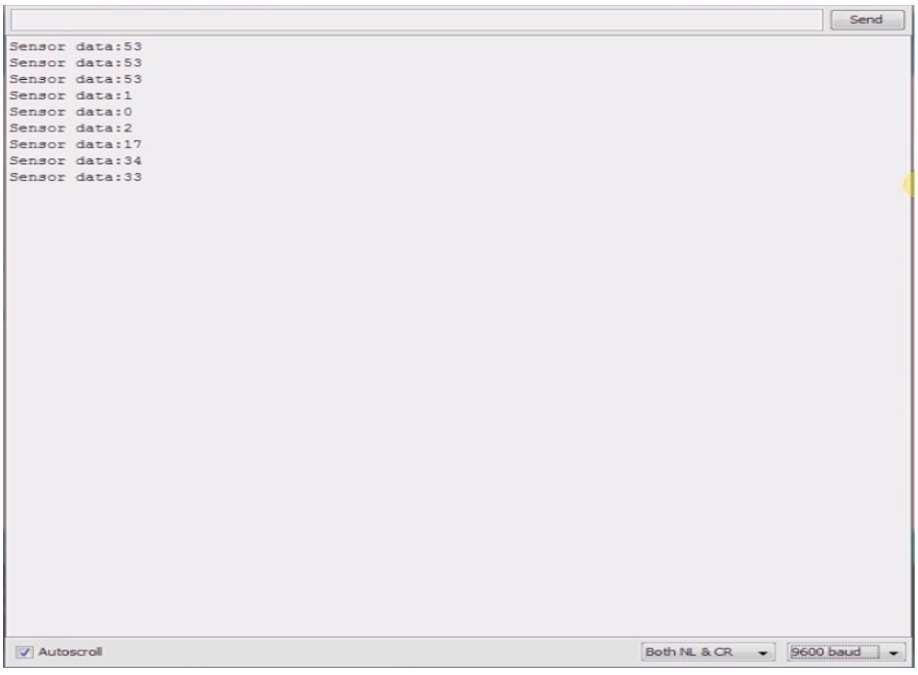


Figure 7.1 : Soil Sensor data

7.2 Voltage Divider circuit

Voltage divider is the circuit that partitions the enormous voltage into littler one. In the beneath figure we can see that an info voltage is connected in the circuit and a yield voltage V-out is estimated crosswise over R2 .

The equation to discover the yield voltage is as appeared

*Vout =Vin*R2/R1+R2*

Where altering R2, Alters Vout.

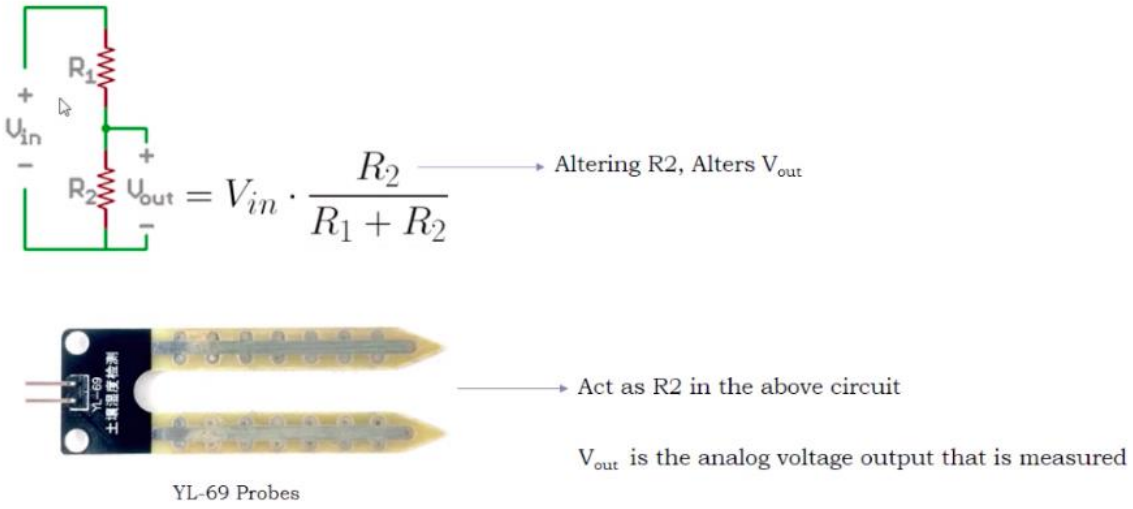


Figure 7.2: Circuit diagram of voltage divider

If there should be an occurrence of soil sensor module the cathodes dunked in the dirt goes about as the opposition R2 and yield voltage Vout is the simple voltage the is estimated.

From this we can conclude that as the moisture level rises then resistance decreases and when the moisture level decreases the resistance increases and output voltage increases.

7.3 YL-38 Bridge interface

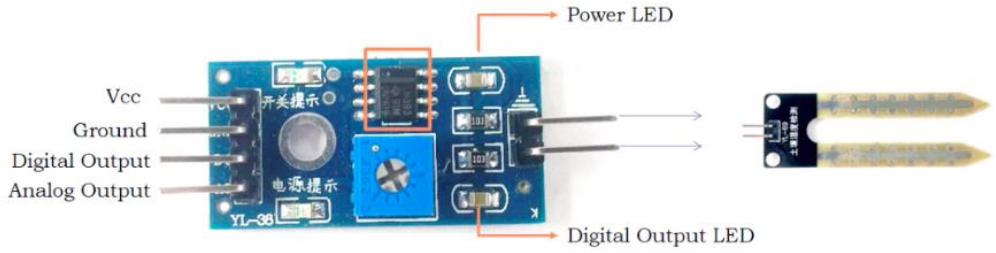
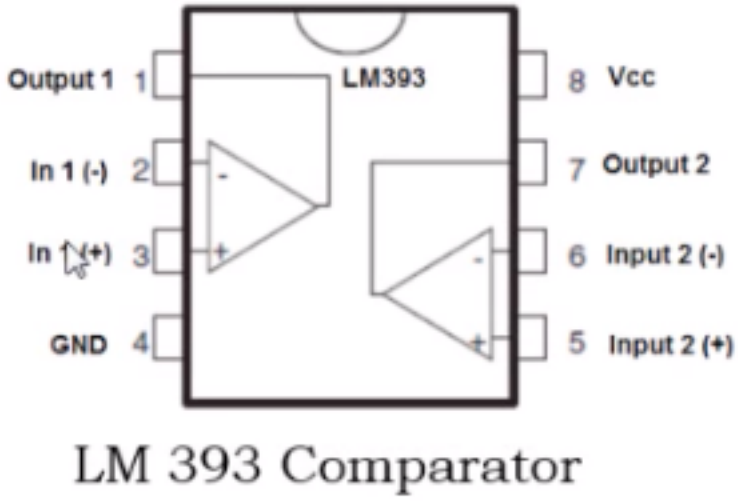


Figure 7.3 : YL-38 Pin diagram

7.4 Comparator of YL-38

This comparator is utilized to get the digital output from the sensor.



LM 393 Comparator

Figure 7.4: Architecture of YL-38

7.5 ESP8266 Wi-Fi Module

1. The Wi-Fi module ESP8266 is an ease module, used to interface the chip. It is conspicuous in light of its double usefulness that are: -
2. Self-contained to host entire application.

3. Wifi adopter to other microcontroller.

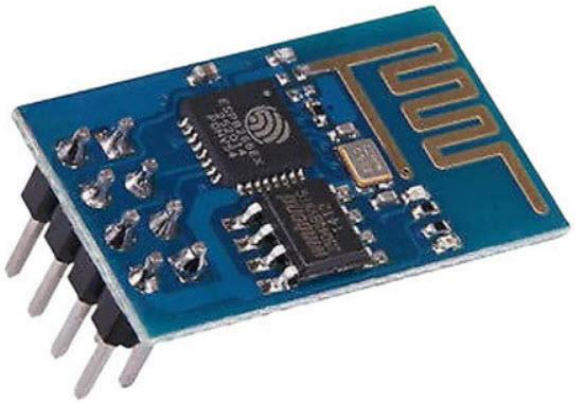


Figure 7.5: ESP8266 Wi-Fi module

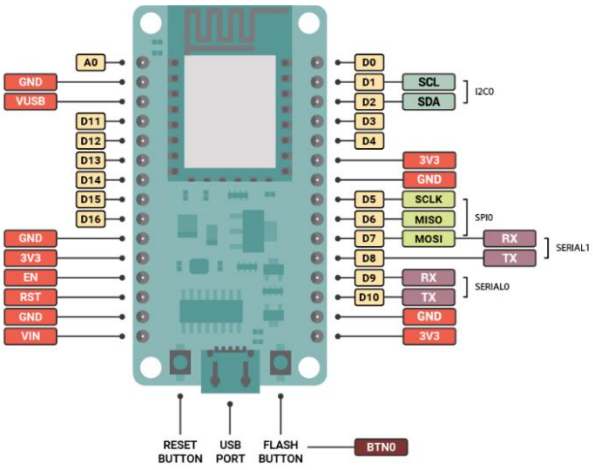


Figure 7.6: Pin configuration Diagram of ESP8266

The feature list is impressive and includes:

- Processor: L106 32-bit RISC chip center dependent on the Tensilica Xtensa Diamond Standard 106Micro running at 80 MHz
- IEEE 802.11 b/g/n Wi-Fi
- Integrated TR switch, balun, LNA, control enhancer and coordinating system

- WEP or WPA/WPA2 validation, or open systems
- 16 GPIO pins SPI

- Memory:
  - 32 KiB instruction RAM
  - 32 KiB instruction cache RAM
  - 80 KiB user data RAM
  - 16 KiB ETS system data RAM
- External QSPI flash: up to 16 MiB is supported (512 KiB to 4 MiB typically included)
- PC (software implementation)
- PS interfaces with DMA (sharing pins with GPIO)
- UART on dedicated pins, plus a transmit-only UART can be enabled on GPIO2
- 10-bit ADC (successive approximation ADC)
- Working power range is 3.0V to 3.6V
- It is system on chip (SOC) with capabilities for 2.4GHz Wi-Fi
- Built-in TCP/IP stack

7.6 Major Applications of ESP8266:-

- Internet of things
- Home automation
- Industrial wireless control
- IP cameras
- Sensor network

- Wearable Electronic

7.7 Powering up ESP8266

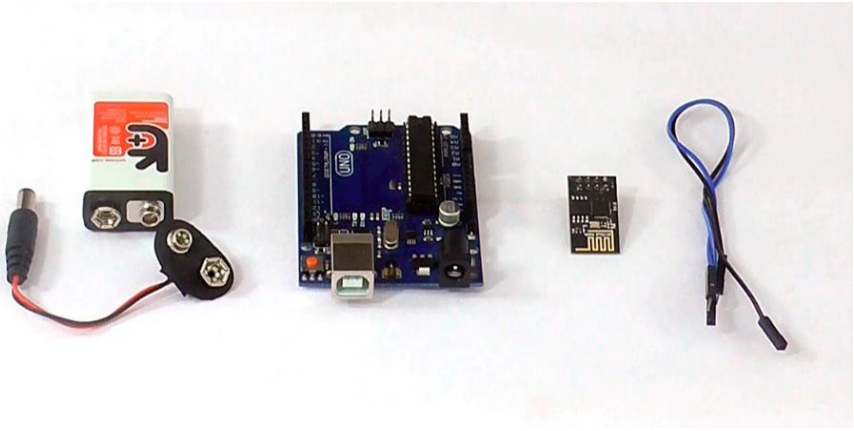


Figure 7.7: Kit For interfacing ESP8266 with Arduino

Following are required to power up the ESP8266:-

1. ESP8266 board
2. Arduino UNO
3. Barrel connector
4. Jumper Wire
5. Battery

ESP8266	Arduino UNO
VCC	3.3 V
CH_PD	
GND	GND
RX	Pin 4
TX	Pin 3

Figure 7.8: Connection of the pins between ESP8266 and Arduino

Following as shown in above figure is the connections made to power up the ESP8266. When the ESP8266 is connected to the power source the three led indicator fires up showing that the ESP8266 is functional as shown in the figure below.

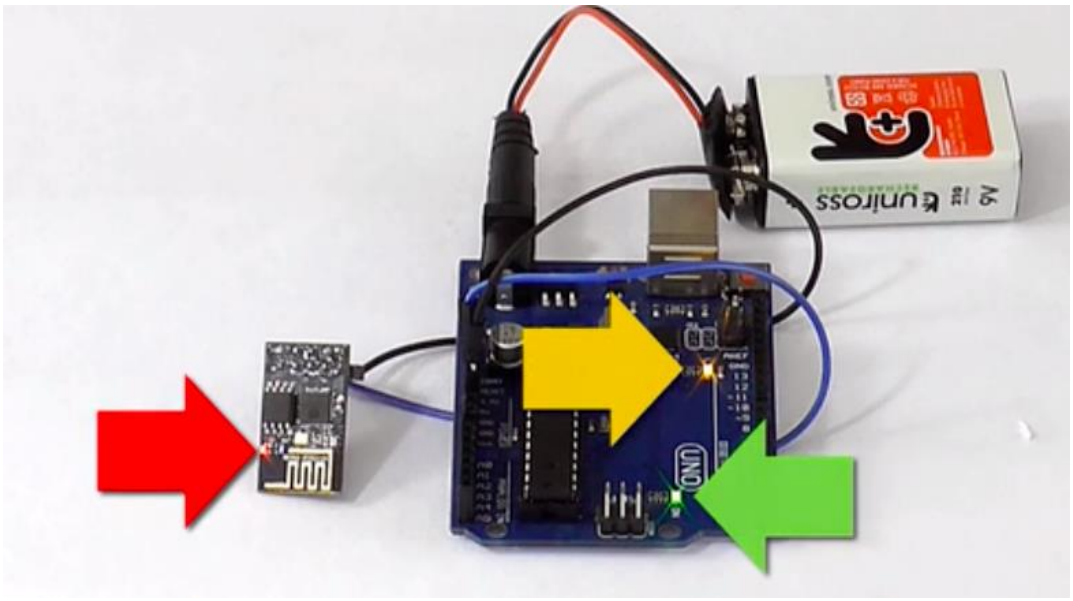


Figure 7.9: Interfaced ESP8266 with Arduino with blinking lights

7.8 JUMPER WIRES

Jumper wire is an electrical wire for associating gadgets on brief premise. It has a connector at each end, it is typically used to interconnect the parts of a breadboard or other model circuit, inside or with other hardware without welding.

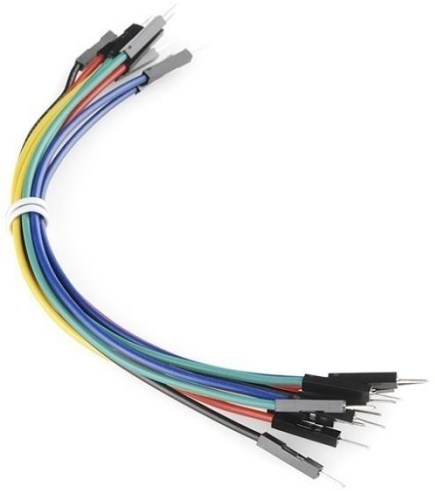


Figure 7.10: Jumper wires for making connections

7.9 CENTRIFUGAL WATER PUMP

Centrifugal pump utilizes the pivot offer velocity to the liquid changing over the velocity into stream. At the core of the pump lies the impeller and it is constantly submerged in water and when it pivots it makes the liquid encompassing it likewise turn this grant centrifugal power as delineated in the figure.

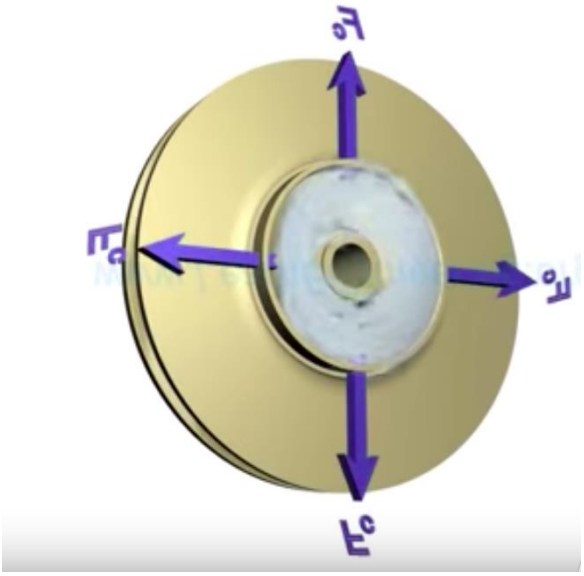


Figure 7.11: Representation of centrifugal force

Then water moves radially outwards since rotational mechanical energy is transferred to the fluid both kinetic energy and pressure increases .

Negative pressure is induced at eye as shown in the below figure. And because of this induced negative pressure on the eye and such low pressure helps sucking the water stream from the source into the system and this process continues.

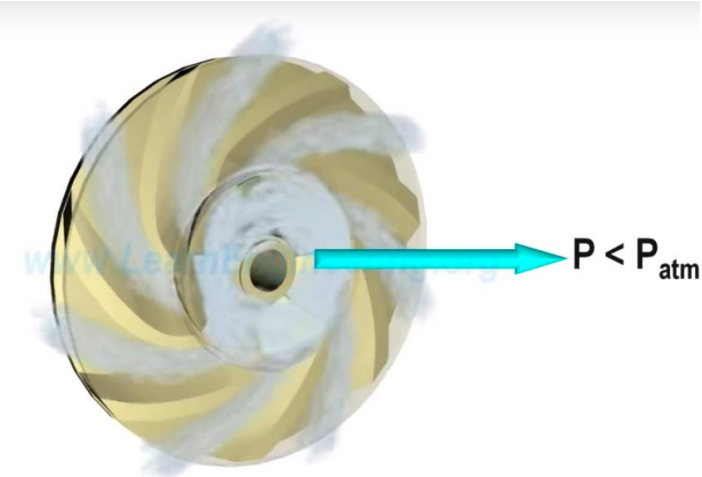


Figure 7.12: Impeller of water pump

Now this impeller is fitted inside the case so that the water moving outwards is collected and is pushed out through the discharge nozzle.

"**A centrifugal pump uses rotation to impart velocity to a liquid**." Every centrifugal pump has an impeller. It is the hydraulic component that rotates to gives velocity to the pumped liquid.

"**A centrifugal pump converts velocity into flow."** Every centrifugal pump has a casing. It hydraulic component that captures the velocity given by the impeller and directs the pumped substance to the pump outlet point.

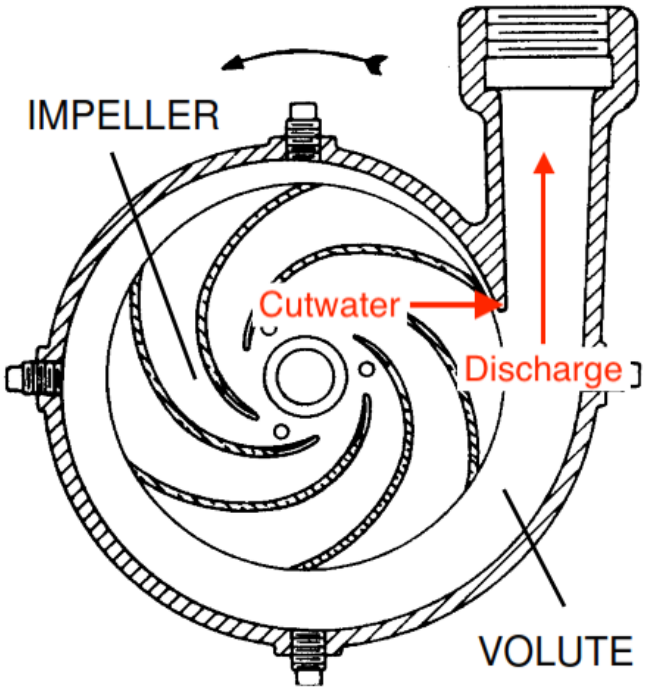


Figure 7.13: Water Pump cabinate architecture

7.10 Motor and motor driver used for the project

Motor is used to convert electrical energy into mechanical energy

Types of motors:-

- Induction Motor
- DC motor – It converts DC electrical power to mechanical power, it has shaft at the center that rotates at particular RPM based on the voltage supplied to it.
- Stepper motor – It rotates at 360 degrees in step by step manner and each step is divided in degrees.
- Servo motor – It is used for angular motion control and it has a DC motor, gear setup and feed back system.

  In this project the DC motor system is used in which motor with the shaft is attached to a gear setup and the motor is chosen based on RPM of the shaft.

  The direction of rotation of the DC motor can be changed by changing the polarity

of the current applied to it.

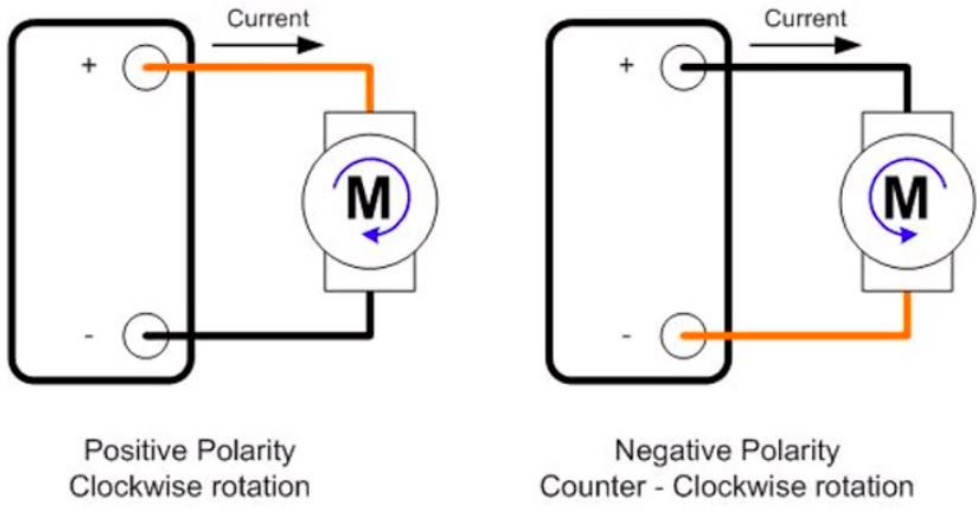


Figure 7.14: Polarity rotation changing direction of current

7.11 L293D MOTOR DRIVER

As the Arduino UNO has 5V pin but the motor needs 9V to run so for this we use the controller motor driver and same is depicted in the figure below.

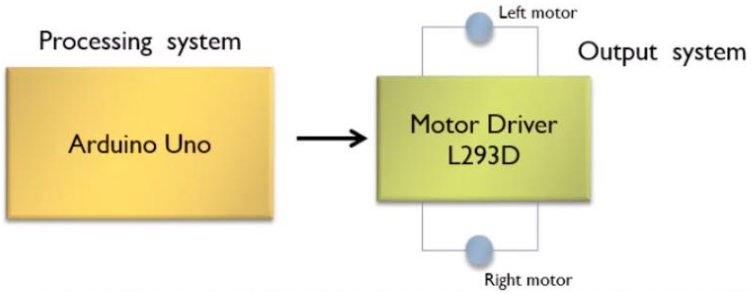


Figure 7.15 : L293D motor driver

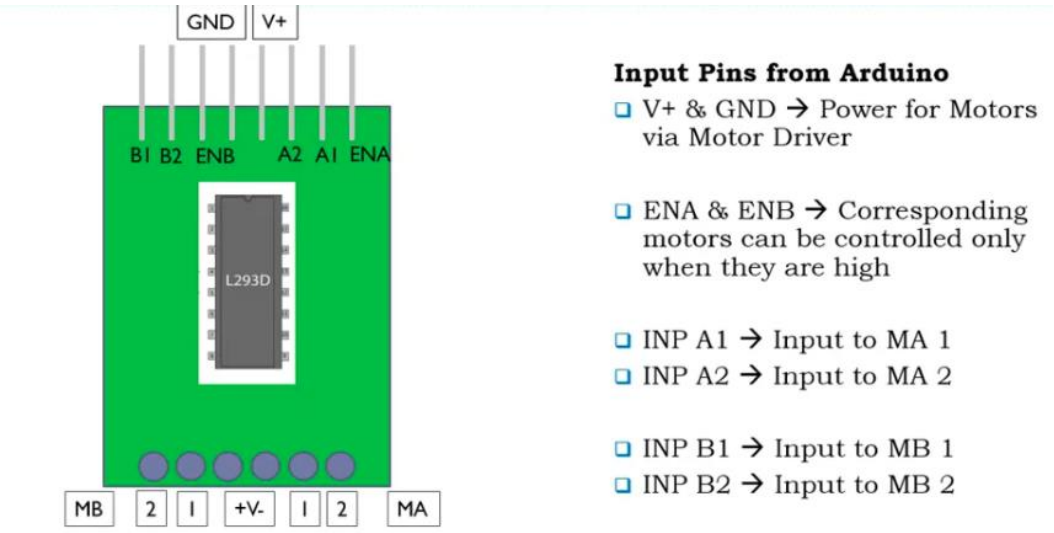


Figure 7.16: L2935 motor driver Pin configuration

- Controllers used to drive motors
- Microcontroller can not provide enough power for the motor that is current or voltage to the required motor.
- Motor driver is the interface between microcontroller and motor.
- Motor driver provides the power requirement

7.12 Interfacing water pump with Arduino and Powering up water pump

Steps:-

- Connecting the red wire (+ve) terminal to MA1 of the motor driver.
- Connecting the black wire (-ve) terminal to MA2 of the motor driver.
- Connecting the V- pin to the ground pin of Arduino uno board.
- Motor driver needs the external power that can be supplied to the motor by external power source (9v Battery) in this case.
- Connect the enable A pin to 5v pin of Arduino.

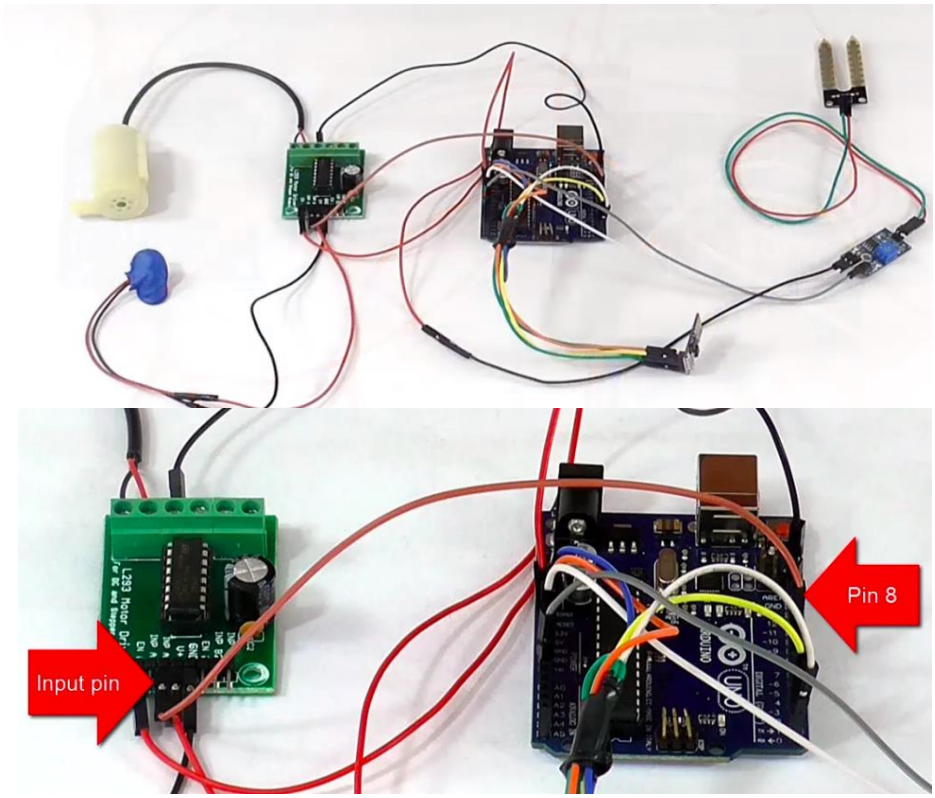


Figure 7.17: Connection for the final test

CHAPTER 8

MODEL DESCRIPTION

8.1 Application Programming interface(API)

- Set of apparatuses, Protocols and routine used to assemble programming applications

- Block of code that help in speaking with either equipment and programming.

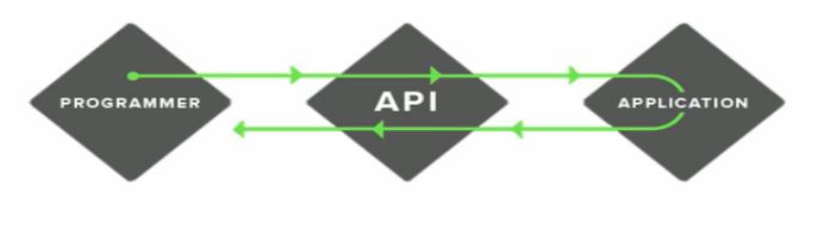


Figure 8.1: API overview

For example an weather application when needs to display the weather it sends a request to the website in structured manner and then the website reply by sending the requested data to the weather application and hence the weather is displayed and this happens as long as the request is sent in structured manner to the website.

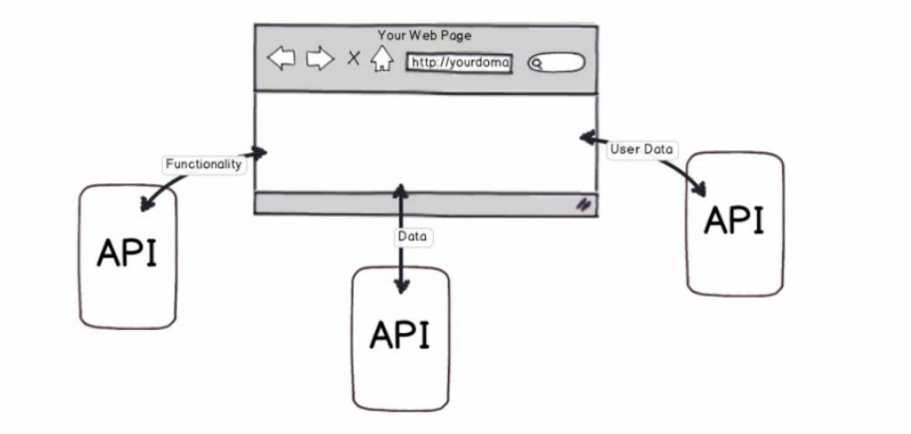


Figure 8.2: API in close relation with web

Some examples of web based API are as follows:-

- YouTube
- Google Maps API

For the most part to get to the information from the API we need API keys go in by the projects calling an API to distinguish the calling system, designer or client. API keys are based on UUID (Universally Unique Identifier) and is unique to each user and act as the secret token for authorization. In this project we will be using ThingSpeak API for displaying the historical data that the DHT11 sensor reads.

The channel is setup on the ThingSpeak API for showing the data and the data is read and write by using a unique code called API key as this ensure the security for the data and the data login.

There are two keys:-

1. Read Key – When data is being read from the channel, it will be used by the

2. Write Key – When data is being written on the channel in this project it will be used by the Arduino to write the data on the ThingSpeak.

   Along with these keys there is also a unique number allotted to the channel and it identifies our channel from thousands of available channel on ThingSpeak.

8.2 Learning Outcomes

Components and connection schematic of smart soil moisture management system.

Programming logic that is practiced in the projects are as follows:-

- ❖ Reading Data from Soil Moisture Sensor
- ❖ Running Pump based on Sensor Data
- ❖ Connect and send command to ESP8266
- ❖ Connect System to internet and send data.

The final connection Schematic along with all the connection with pins is shown in the diagram below:-

Component 1	Pin	Pin Description		Pin	Pin Description	Component 2
Arduino Uno	A0	Analog Read	→	A0	Analog Data	YL – 38 Soil Moisture Sensor Module
	5V	Vcc		Vcc	-	
	GND	Ground		GND	Ground	
Arduino Uno	8	Digital I/O	→	A2	Input 2	L293D Motor Driver connected to Water Pump
	GND	Ground		A1	Input 1	
	5V	Vcc		ENA	Enable	
	GND	Ground		GND	Ground	
Arduino Uno	3 (Rx)	Receiver	→	Tx	Transmitter	ESP8266
	4 (Tx)	Transmitter		Rx	Receiver	
	3V3	3.3 V		Vcc	-	
	3V3	3.3V		CH_PD	Chip Enable	
	GND	Ground		GND	Ground	

Figure 8.3: All the final connections of the module

8.3 Running the Pump

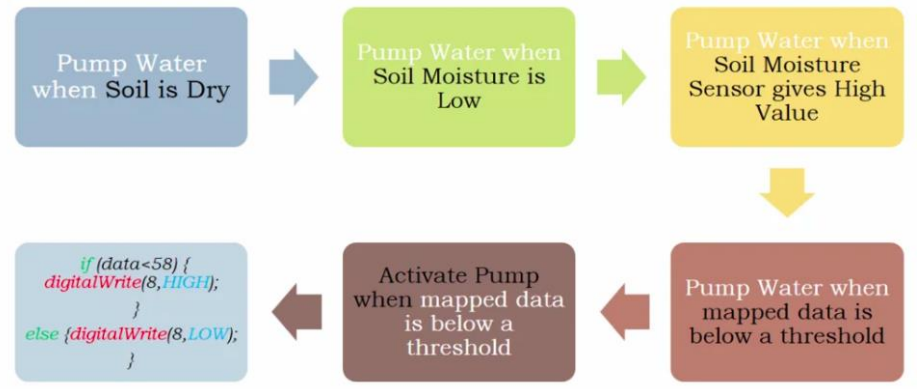


Figure 8.4 : Functionality of the water pump

8.4 Programming logic

For Connecting ESP8266 to Arduino Inbuilt Functions of Arduino and its library used in the programming:-

SoftwareSerial()

To peruse and send information to it we utilize a capacity called Software Serial this capacity shows that the gadget associated with the particular pin(pin 3 and 4) on Arduino is utilized for sequential correspondence. What's more, this capacity is from "Programming Serial" Arduino library. Desc makes an example of an item for sequential correspondence language structure is SoftwareSerial(rxpin,txpin). Parameters:

- Rxpin- The pin on which to receive serial data
- Txpin- The pin on which to transmit serial data

```
SoftwareSerial esp8266(3,4)
```

Pin 3 is the receiver pin and pin 4 is the transmitter pin.

sendAT() – user defined function

As we will have to send At command multiple time so it will be easy to define the function that does this work for us so we can simply call that function whenever we need to send AT command. This will simplify the code and the program more robust to write and execute.

- Desc – Send AT command to ESP8266 from Arduino
- Syntax – SendAT(String command, cons tint timeout)
- Parameters:
  - String command – AT command sent in string format
  - Constant timeout – Time set for every AT command send
- It does not return any value

Definition of the user defined SendAT command

```
void sendAT (String command, const int timeout)
{
  String response = " ";
  esp8266.print(command);
}
```

Use case of the AT command, It has multiple use in Sketch

- Use case 1 –Set ESP8266 to station mode.
- Use case 2 – Check for available network and return the list of the all available

networks.

- Use case 3 – To connect to an access point like Wi-Fi module.

Sending the sensor information and the siphon information to ThingSpeak API associated with Wi-Fi which is web empowered. For this we characterize a capacity updateTS and it is client characterized work. It sends the information from Arduino to thingsSpeak by means of ESP8266 and the web.

Syntax for the same is *Update(String T, String P)*where T represents the soil moisture data stored as string and P represents the pump data stored as string and returns none.

The definition of the function is shown below:-

```
void updateTS (String T, String P) {
        …
        sendAT (“AT+CIPSTART=\"TCP\",\"api.thingspeak.com\",80”;)

        …
        cmd = “GET/update?key=XXXX&field1="+T+"&field2="+P+"\r\n";

        }
```

From above it is shown that the function is not returning any value and taking two parameters namely Soil moisture data and pump data. Then TCP/IP connection is established with the ThingSpeak API for this AT command is used and once the connection is established all the necessary data is sent to ThingSpeak using “GET” request. The “GET” request is used to retrieve information from server with the URL. This request can only retrieve data but can not change the data at the source. In this project ESPA8266 will use the “GET” request to update the values of sensor and pump status on the ThingSpeak API. The following is the progression of the get demand from the ESP8266 to the ThingSpeak where it utilizes the way to locate the correct channel where the information must be refreshed. It will at that point utilize the field names and the URL and the qualities relegated to every one of the names to refresh every one of the field on the ThingSpeak graph.

CHAPTER 9

RESULTS AND FINDINGS

The head of this task is to identify the dampness substance of the dirt. In this manner it ought to give the exact outcome in structure the dependable, helpful and shrewd framework.

9.1 How module works?

- Wi-Fi module ought to be associated with the web by a web access supplier, for example, switch, portable hotspot and so on.
- Firstly the module check for the dampness of the dirt utilizing the terminal test that is soil sensor then it continues.
- The specific defined range is set for the moisture level on both the end that is on the lower end and also on the higher end.
- The soil sensor senses the moisture content of the soil and then it sends the data further for the processing.
- Upon receiving the data from the soil sensor the water pump gets activated or deactivated.
- Water pump activates when the moisture content of the soil is less than the set value so as to replenish the the soil with the moisture and bring it to certain level.
- Once the specific level is achieved the water pump gets the instruction from the program to shut down and the water flow stops from the pump
- The system usually in off state and functions only on specific requirement based on the moisture.
- All the data is sent to ThingSpeak API through the web and it shows the pictorial and graphical representation of the status of the condition of the soil.

- All the data can also be seen on the mobile application named “Virtuino” in real time after it fetches the data from the ThingSpeak channel.
- In the virtuino application in the mobile phone email can be sent to the user whenever the moisture content is below/above the defined threshold automatically with the warning message.
- There is also the alarm for the warning that triggers based on the data from the soil sensor

9.2 Checking and establishing the Wi-Fi connection

Wi-Fi connection is set up using the following command “AT+CWJAP” and then providing the Wi-Fi name and Password. When the connection is established the success message is shown in the serial monitor as show in the below figure.

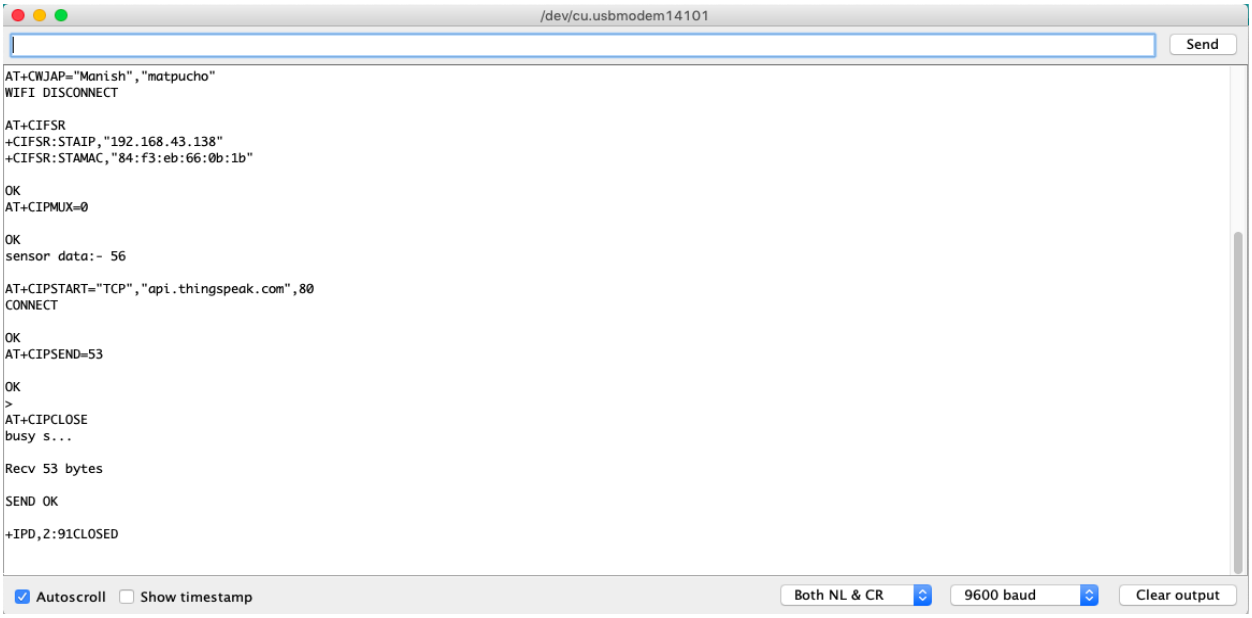


Figure 9.1: AT+CWJAP command

9.3 Establishing the TCP/IP connection

After establishing the Wi-Fi connection “AT+CIFSR” gets the local IP address and flash message as OK when successfully fetched the IP address as shown in below figure.

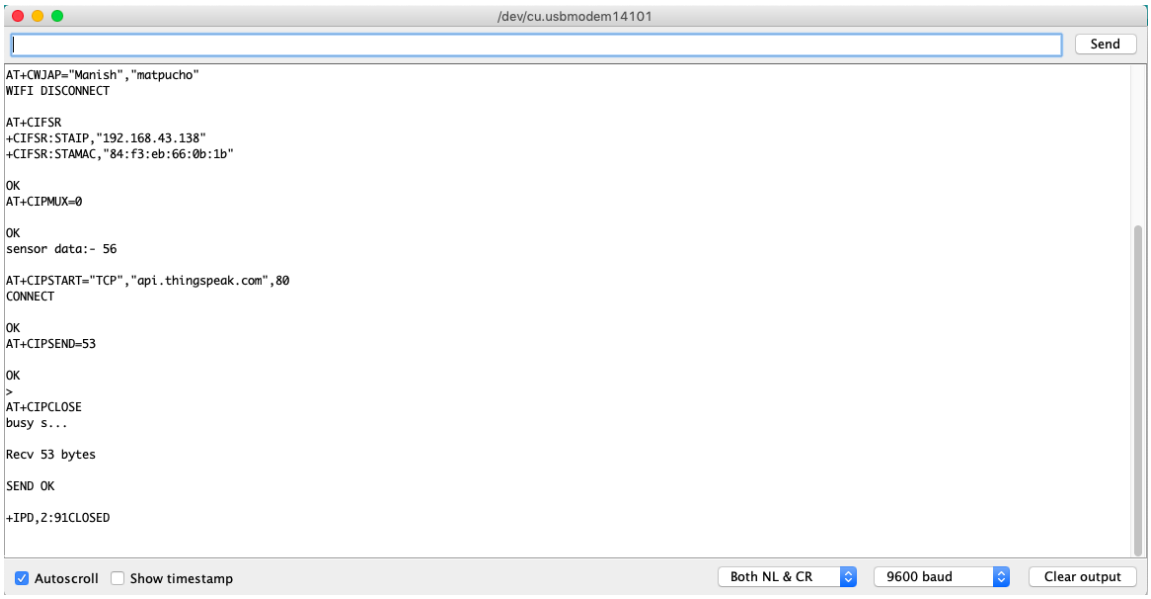


Figure 9.2: AT+CIFSR command

9.4 Enabling multiple connection

“AT+CIPMUX” is used for enabling multiple connections as shown in the below figure.

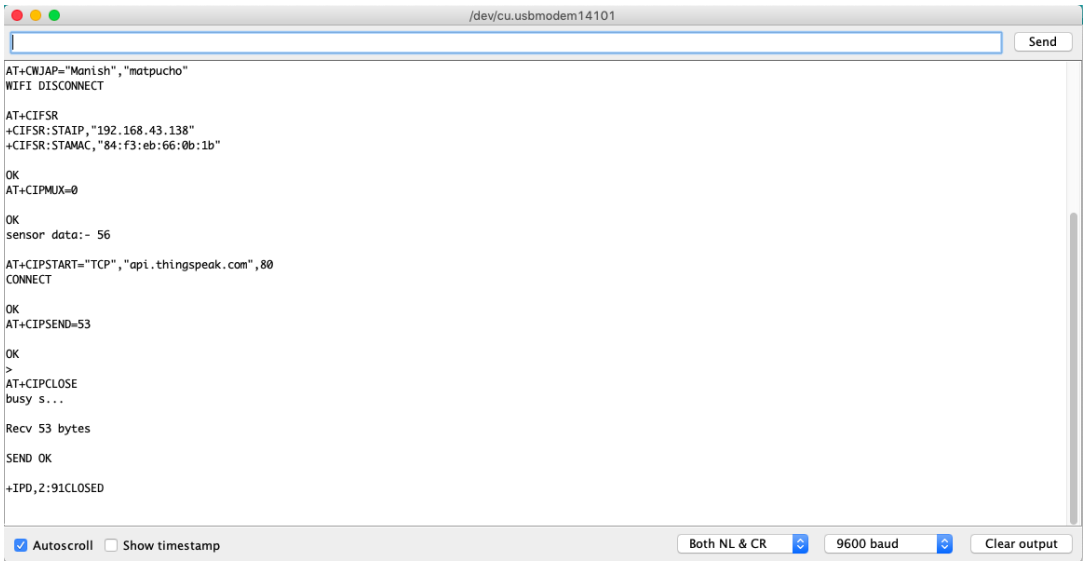


Figure 9.3: AT+CIPMUX command

9.5 Soil Moisture Detection

The soil moisture detection system is an IOT system for detection of the moisture in the soil. The data retrieved by the sensor is shown as “sensor data” and then this data is sent to ThingSpeak where the graphical representation of the data is depicted that is shown in the below figure.

In the below fig it is well shown that when the soil moisture drops below the low limit that is set as per the requirement the water pump starts and hence the water flows out of water pump and thus increasing the moisture of the soil.

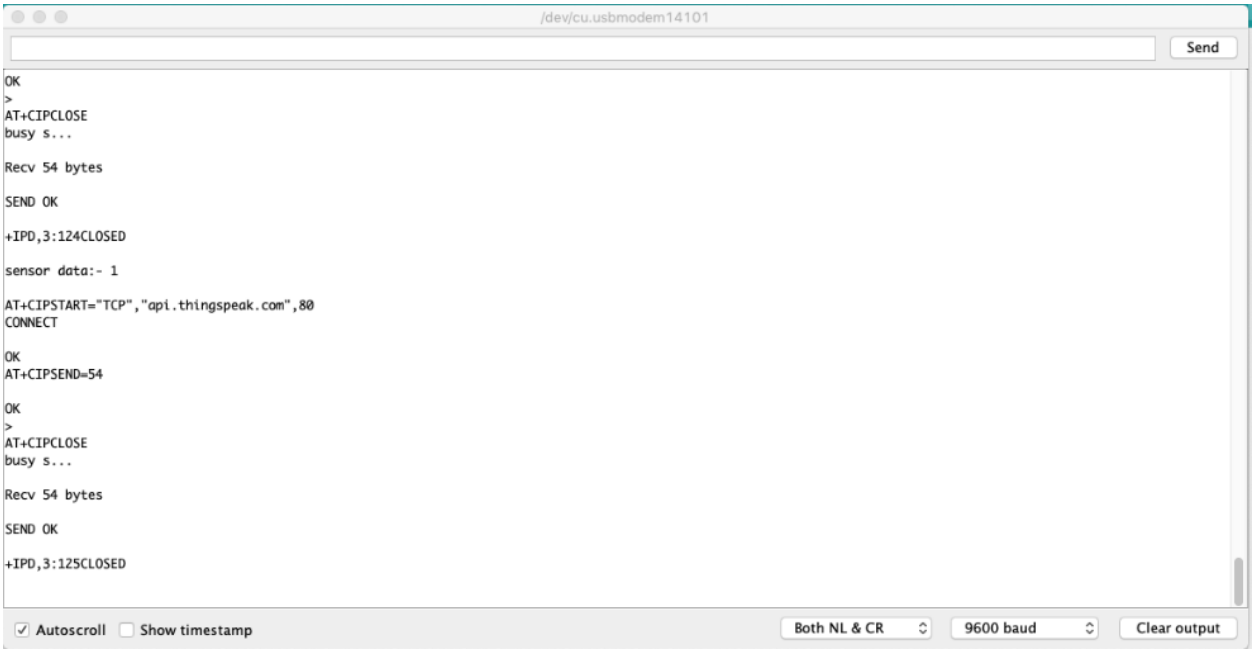


Figure 9.4: Soil sensor data readings (Low moisture)

In the shown figure when the moisture content goes below 10 that is the manually set level for the low moisture content indicator the water pump starts hence maintaining the moisture of the soil to higher than the lowest value that is 10 in this case.

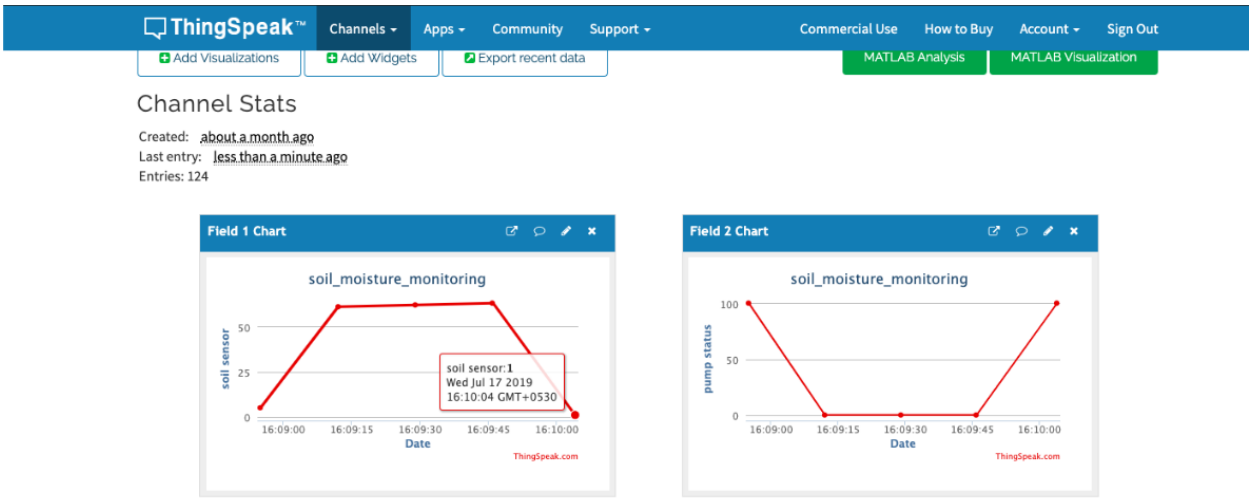


Figure 9.5: ThingSpeak graphical representation of the soil data (low moisture)

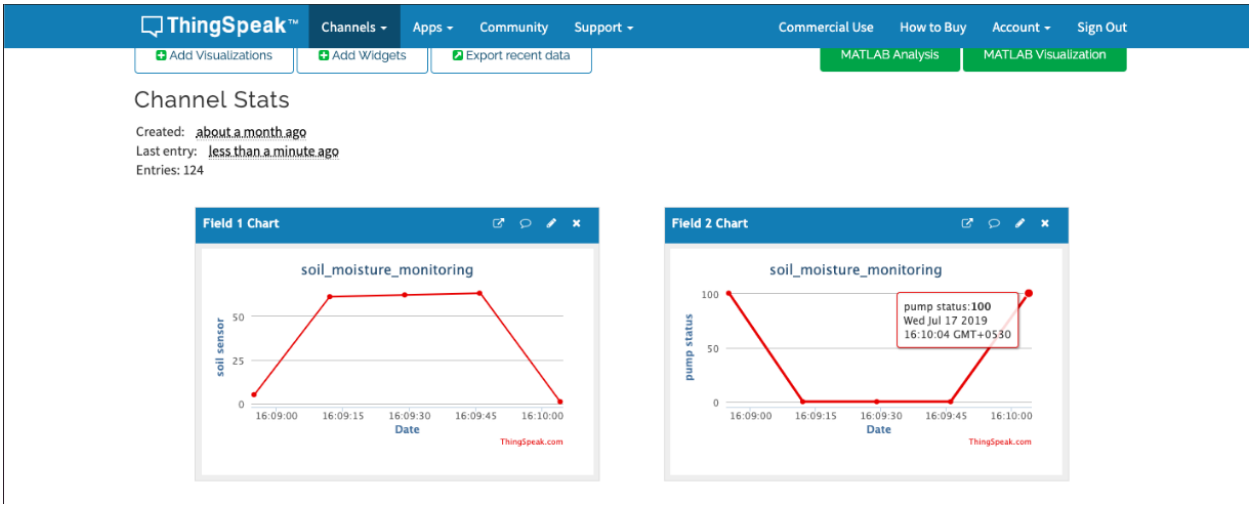


Figure 9.6: ThingSpeak graphical representation of the pump data (low moisture)

In the below fig it is well shown that when the soil moisture increases above the high limit that is set as per the requirement the water pump stops and hence the water flow stops out of water pump.

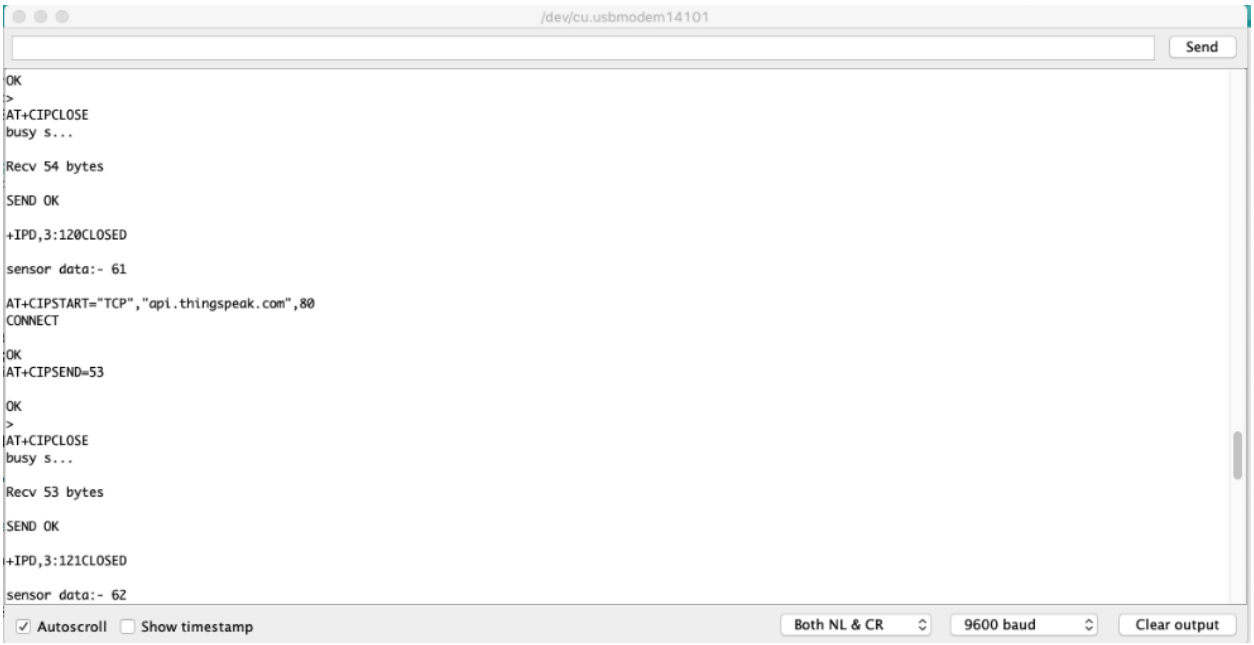


Figure 9.7: Soil sensor data readings (High moisture)

In the shown figure when the moisture content goes above 50 that is the manually set level for the high moisture content indicator the water pump stops hence maintaining the moisture of the soil to lower than the highest value that is 50 in this case

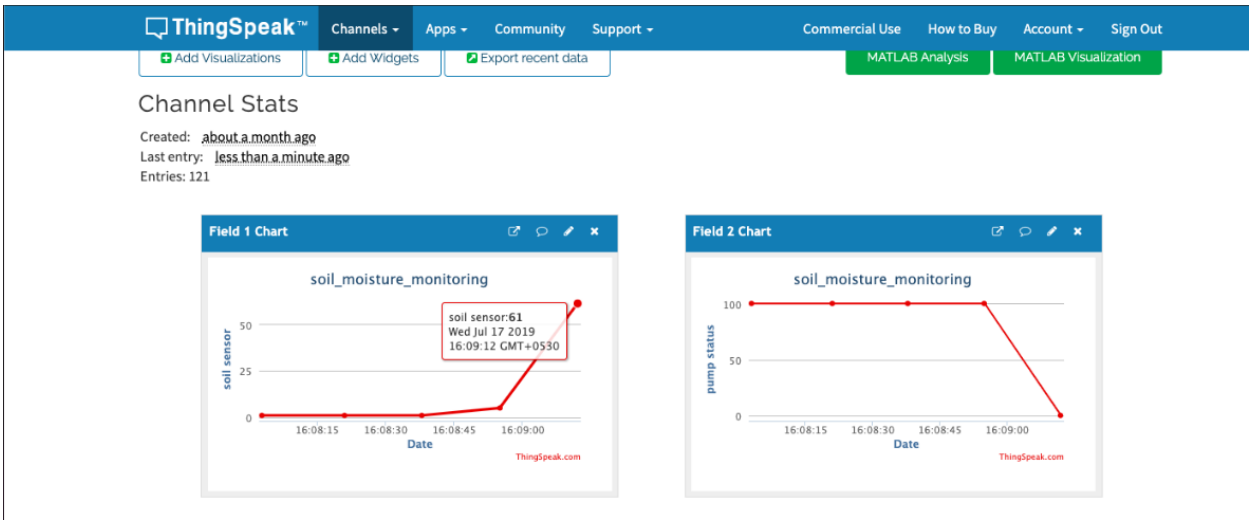


Figure 9.8: ThingSpeak graphical representation of the soil data (high moisture)

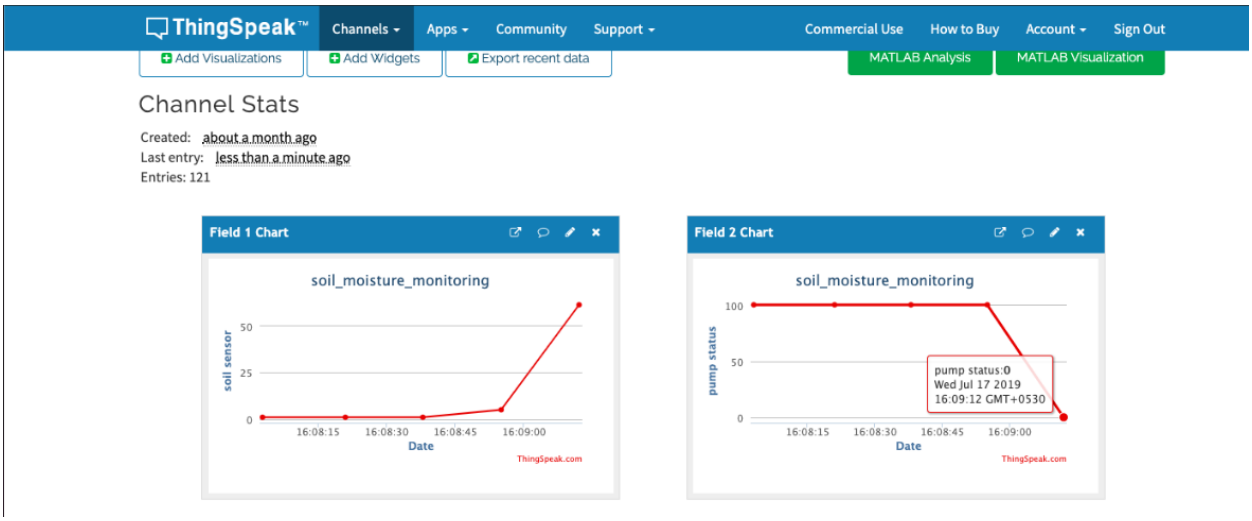


Figure 9.9: ThingSpeak graphical representation of the pump data (high moisture)

9.6 Results on the Virtuino application on mobile phone

ThingSpeak continuously keeps updating the sensor data to the virtuino application (in this case it sends updates after every 15 seconds) via the web and all the data received henceforth is displayed on the mobile application in real time. For example in the below shown picture it is clearly seen that when the moisture content is below the lower value set it automatically shows the message and an alarm is set for the quick action similarly for the moisture when greater than 50 which is set manually when goes above 50 the alarm is triggered automatically and message is displayed.

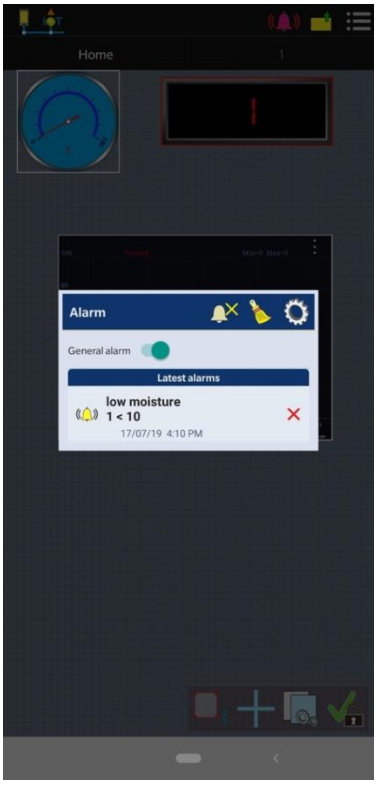


Figure 9.10: Moisture below lower threshold

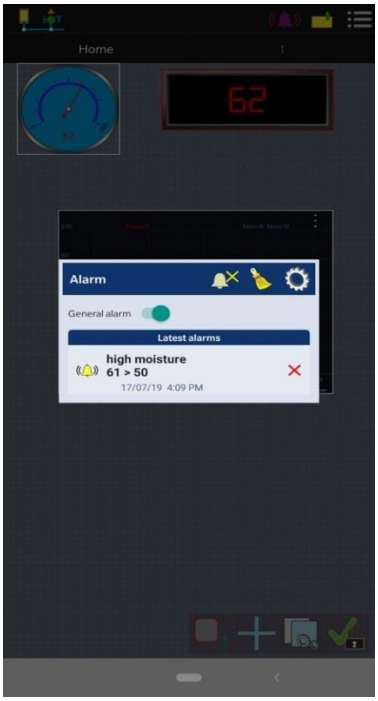


Figure 9.11: Moisture above higher threshold

Also additionally Virtuino sends an email to the user in real time if either of the condition is not satisfied that is when moisture level is low or high an email to the registered user is sent in real time for the quick action as is depicted in the below figure that series of email is sent depending upon the data received from the sensor via the ThingSpeak API.

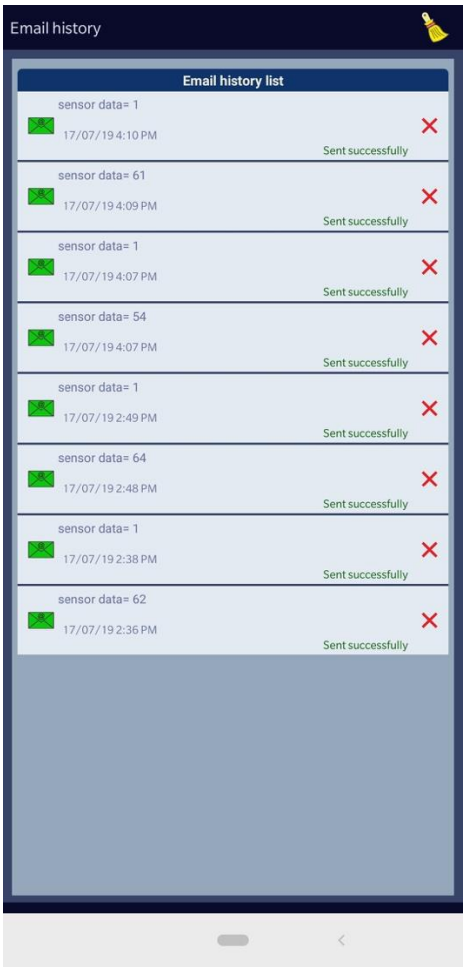


Figure 9.12: E-mail sent to user

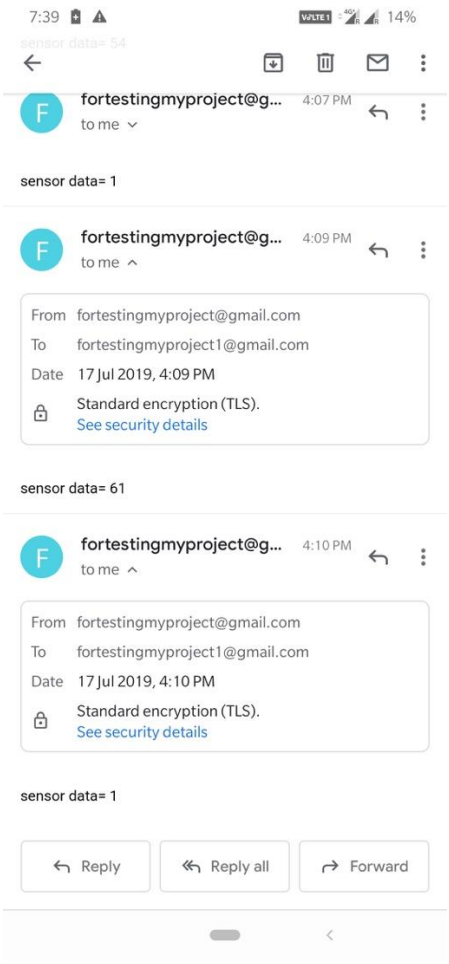


Figure 9.13: E-mail received to user

CHAPTER 10

CONCLUSION AND FUTURE WORK

IoT is one of the hottest topic that is pacing at a great rate and lots of research and development is going on in this field and in the coming years we can see lots of application of IoT in every sectors be it home, industry, hospital e.t.c helping the user to improve their experience and hence making the life easier. IoT has played an important role in making our environment smart and efficient and allowed the environment to take decision on its own on the basis of the data retrieved from the sensors. Smart soil moisture management system is one of them and various other bodies have proposed system. This allows to control the moisture content of the soil remotely and can serve great purpose to many consumers and thus helping in many situation and finding its use in many field as well.

Smart soil moisture management system is the way of maintaining the moisture of when the moisture if the soil goes down below certain limit the water pump switches on and the moisture is retained and when the moisture goes up the pump shuts down to avoid the over flow of water. This will help to overcome various issue related to water moisture management and hence can find its use in many day-to-day activities. Also this can find its way in helping farmers in irrigation of the field remotely. It can also be used in home for maintaining the moisture of the flower pot remotely in case of absence from the home and also it can find its use in many such places and can serve its purpose.

The proposed solution does not include many sensors and devices it just use a single moisture sensor that senses the moisture and based on the data acquired from the sensor the water pump is managed. There are many such technologies that are being used in the industry to carry out many such activities and helping people ease their life. The project has been successfully carried out and gives the desired result that can serve the purpose.

This smart soil moisture management can be extended to the fully remotely controllable smart system and can be controlled remotely in the absence at the particular location. With

the addition of more sensors and devices it can be taken to another level where it can serve great use and help millions of people over the globe.

REFERENCES

[1] Gondchawar, Nikesh, and R. S. Kawitkar. "IoT based smart agriculture." *International Journal of advanced research in Computer and Communication Engineering* 5.6 (2016): 838-842.

[2] TongKe, Fan. "Smart agriculture based on cloud computing and IOT." *Journal of Convergence Information Technology* 8.2 (2013).

[3] Sanchez, Luis, et al. "SmartSantander: IoT experimentation over a smart city testbed." *Computer Networks* 61 (2014): 217-238.

[4] Prathibha, S. R., Anupama Hongal, and M. P. Jyothi. "IOT Based monitoring system in smart agriculture." *2017 International Conference on Recent Advances in Electronics and Communication Technology (ICRAECT)*. IEEE, 2017.

[5] Rawal, Srishti. "IOT based smart irrigation system." *International Journal of Computer Applications* 159.8 (2017): 7-11.

[6] Rajalakshmi, P., and S. Devi Mahalakshmi. "IOT based crop-field monitoring and irrigation automation." *2016 10th International Conference on Intelligent Systems and Control (ISCO)*. IEEE, 2016.

[7] Solanki, Vijender Kumar, Muthusamy Venkatesan, and Somesh Katiyar. "Conceptual Model for Smart Cities: Irrigation and Highway Lamps using IoT." *IJIMAI* 4.3 (2017): 28-33.

[8] Suma, N., et al. "IOT based smart agriculture monitoring system." *International Journal on Recent and Innovation Trends in computing and communication* 5.2 (2017): 177-181.

[9] Rao, R. Nageswara, and B. Sridhar. "IoT based smart crop-field monitoring and automation irrigation system." *2018 2nd International Conference on Inventive Systems and Control (ICISC)*. IEEE, 2018.

[10] Zhao, Wenju, et al. "Design and implementation of smart irrigation system based on

LoRa." *2017 IEEE Globecom Workshops (GC Wkshps)*. IEEE, 2017.

[11] Kodali, Ravi Kishore, and Borade Samar Sarjerao. "A low cost smart irrigation system using MQTT protocol." *2017 IEEE Region 10 Symposium (TENSYMP)*. IEEE, 2017.

[12] Mekala, Mahammad Shareef, and P. Viswanathan. "A Survey: Smart agriculture IoT with cloud computing." *2017 international conference on microelectronic devices, circuits and systems (ICMDCS)*. IEEE, 2017.

[13] Singh, Pushkar, and Sanghamitra Saikia. "Arduino-based smart irrigation using water flow sensor, soil moisture sensor, temperature sensor and ESP8266 WiFi module." *2016 IEEE Region 10 Humanitarian Technology Conference (R10-HTC)*. IEEE, 2016.

[14] Kodali, Ravi Kishore, and Borade Samar Sarjerao. "A low cost smart irrigation system using MQTT protocol." *2017 IEEE Region 10 Symposium (TENSYMP)*. IEEE, 2017.

[15] Srivastava, Prakhar, Mohit Bajaj, and Ankur Singh Rana. "Overview of ESP8266 Wi-Fi module based Smart Irrigation System using IOT." *2018 Fourth International Conference on Advances in Electrical, Electronics, Information, Communication and Bio-Informatics (AEEICB)*. IEEE, 2018.

[16] Kodali, Ravi Kishore, and Archana Sahu. "An IoT based soil moisture monitoring on Losant platform." *2016 2nd International Conference on Contemporary Computing and Informatics (IC3I)*. IEEE, 2016.

[18] Srisruthi, S., et al. "Sustainable agriculture using eco-friendly and energy efficient sensor technology." *2016 IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT)*. IEEE, 2016.

[19] Srisruthi, S., et al. "Sustainable agriculture using eco-friendly and energy efficient sensor technology." *2016 IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT)*. IEEE, 2016.

[20] Kansara, Karan, et al. "Sensor based automated irrigation system with IOT: a technical review." *International Journal of Computer Science and Information Technologies* 6.6 (2015): 5331-5333.

[21] Prathibha, S. R., Anupama Hongal, and M. P. Jyothi. "IOT Based monitoring system in smart agriculture." *2017 International Conference on Recent Advances in Electronics and Communication Technology (ICRAECT)*. IEEE, 2017.

[22] Mohanraj, I., Kirthika Ashokumar, and J. Naren. "Field monitoring and automation

using IOT in agriculture domain." *Procedia Computer Science* 93 (2016): 931-939.

[23] Athani, Suhas, et al. "Soil moisture monitoring using IoT enabled arduino sensors with neural networks for improving soil management for farmers and predict seasonal rainfall for planning future harvest in North Karnataka—India." *2017 International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud)(I-SMAC)*. IEEE, 2017.

[24] Bitella, Giovanni, et al. "A novel low-cost open-hardware platform for monitoring soil water content and multiple soil-air-vegetation parameters." *Sensors* 14.10 (2014): 19639-19659.

[25] Quadri, Syed Ali Imran, and P. Sathish. "IoT based home automation and surveillance system." *2017 International Conference on Intelligent Computing and Control Systems (ICICCS)*. IEEE, 2017.

[26] Gonzalez, Jose, et al. "Numerical simulation of the dynamic effects due to impeller-volute interaction in a centrifugal pump." *Journal of Fluids Engineering* 124.2 (2002): 348-355.

[27] Alfayez, L., David Mba, and G. Dyson. "The application of acoustic emission for detecting incipient cavitation and the best efficiency point of a 60 kW centrifugal pump: case study." *Ndt & E International* 38.5 (2005): 354-358.

[28] Luo, Xianwu, et al. "Effect of impeller inlet geometry on centrifugal pump cavitation performance." *Journal of Tsinghua University (Science and Technology)* 5 (2008): 018.

[29] Badamasi, Yusuf Abdullahi. "The working principle of an Arduino." *2014 11th International Conference on Electronics, Computer and Computation (ICECCO)*. IEEE, 2014.

[30] D'Ausilio, Alessandro. "Arduino: A low-cost multipurpose lab equipment." *Behavior research methods* 44.2 (2012): 305-313.

[31] Rajalakshmi, P., and S. Devi Mahalakshmi. "IOT based crop-field monitoring and irrigation automation." *2016 10th International Conference on Intelligent Systems and Control (ISCO)*. IEEE, 2016.

[32] Heble, Soumil, et al. "A low power IoT network for smart agriculture." *2018 IEEE 4th World Forum on Internet of Things (WF-IoT)*. IEEE, 2018.

[33] Ezhilazhahi, A. M., and P. T. V. Bhuvaneswari. "IoT enabled plant soil moisture monitoring using wireless sensor networks." *2017 Third International Conference on*

Sensing, Signal Processing and Security (ICSSS). IEEE, 2017.

[34] Mohanraj, I., Kirthika Ashokumar, and J. Naren. "Field monitoring and automation using IOT in agriculture domain." *Procedia Computer Science* 93 (2016): 931-939.

[35] Pallavi, S., Jayashree D. Mallapur, and Kirankumar Y. Bendigeri. "Remote sensing and controlling of greenhouse agriculture parameters based on IoT." *2017 International Conference on Big Data, IoT and Data Science (BID)*. IEEE, 2017.

[36] Singh, Pushkar, and Sanghamitra Saikia. "Arduino-based smart irrigation using water flow sensor, soil moisture sensor, temperature sensor and ESP8266 WiFi module." *2016 IEEE Region 10 Humanitarian Technology Conference (R10-HTC)*. IEEE, 2016.

[37] Srisruthi, S., et al. "Sustainable agriculture using eco-friendly and energy efficient sensor technology." *2016 IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT)*. IEEE, 2016.