



Software Implementation for Designing an Embedded System for Stone Fruits of Meghalaya

Sumana Bhattacharjee

*Ph.D Student , Department of Electronics and Communication Engineering
CMJ University, Meghalaya, Shillong (India)*

ABSTRACT

Meghalaya being a home of wide variety of fruits and vegetables holds a unique position in production figures among other states of North-East. Fruit crops are capable of giving higher tonnage of yield per unit area than other field crops. Meghalaya produces several stone fruits such as plum, peach, pear, apricot in a restricted scale. These fruits can also be processed in several products like canned fruit, concentrates and fruit juices, dehydrated fruit, jellies and jams. Cultivation of fruits chiefly depends upon the quality of soils, harvest, plantation and a perfect ambience of brilliant minds. There are ample investment opportunities for the expansion of export market for fruit cultivation in Meghalaya. This paper focuses on details of software implementation for designing an embedded system for orchard management of stone fruits that will reduce labour cost, improve tree health, increase fruit production and will surely play an important role in the economic prosperity of Meghalaya.

Keywords: *Microcontroller, Sensors, Softwares.*

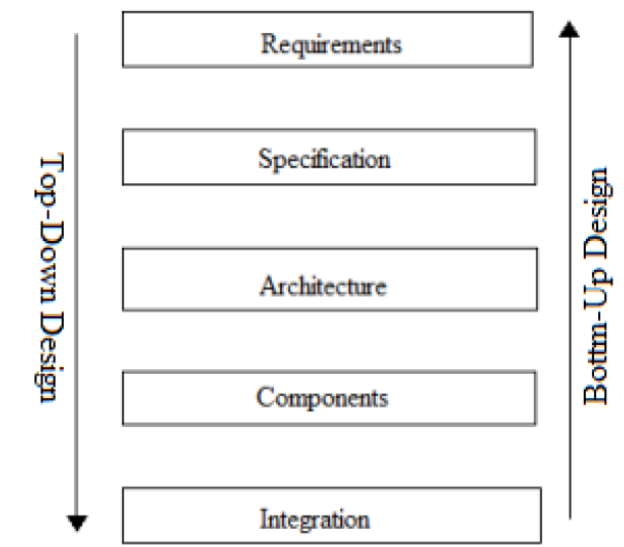
I. INTRODUCTION

Meghalaya is basically an Agricultural State with about 80% of its total population depending entirely on Agriculture for their livelihood. Meghalaya has suitable climate for cultivation of wide variety of fruits. The key fruits grown in the state are pineapple, citrus fruits, banana, papaya and strawberries. Other potential fruits include plums, peaches, apricot, pear, guava, mango, litchi, lemon, etc. Fruits are found to be a rich source of vitamins and minerals. Fruits crops are capable of giving higher tonnage of yield per unit area than other field crops. Stone fruits like Plum, Peach, Pear, Apricot are found in the central plateau of East and West Khasi Hills and Jaintia Hills and have good commercial value. As the new technologies and developments have gradually become readily available in the country, the cropping and cultivating systems and production practices have also remained witness to significant metamorphosis. Fresh fruits and vegetables export has steadily increased. The foundation of tree fruit production is built on abundant physical resources: climate, soils, and water. Equally, it has relied on the energy and perseverance of the people that make up the industry in the production, handling, and distribution sectors. A dynamic scientific base and aggressive implementation of appropriate technologies form another essential component. Each of these will be equally important in enhancing the fruit production and shaping the future of our fruit industry.

Fruit Cultivation in Meghalaya is a prominent business sector for earning a good amount of state's revenue. But the low level of industrialization and the poor infrastructure base acts as a barrier to the interest of the state's economy. Plums, peaches, pear, apricots can be grown in abundance in Meghalaya. This is because Meghalaya

has favourable soil and climatic conditions for stone fruit cultivation and thus holds a huge horticulture potential and also a great scope to augment business prospect.

There are two types of designing methods, one is Top-down method and the other is Bottom-up method. This work adopts the Top-down method. The design is a solution, the translation of requirements into the way of meeting them. The design will determine the success of the system. Based on the proposed system objectives, the major modules are identified and the operations to be carried out are determined. In the design phase of the system the data flow diagrams, flowcharts, data base tables, inputs, outputs and screen are designed by using all the necessary fields in a compact manner. Major levels of abstraction in design process is shown below:

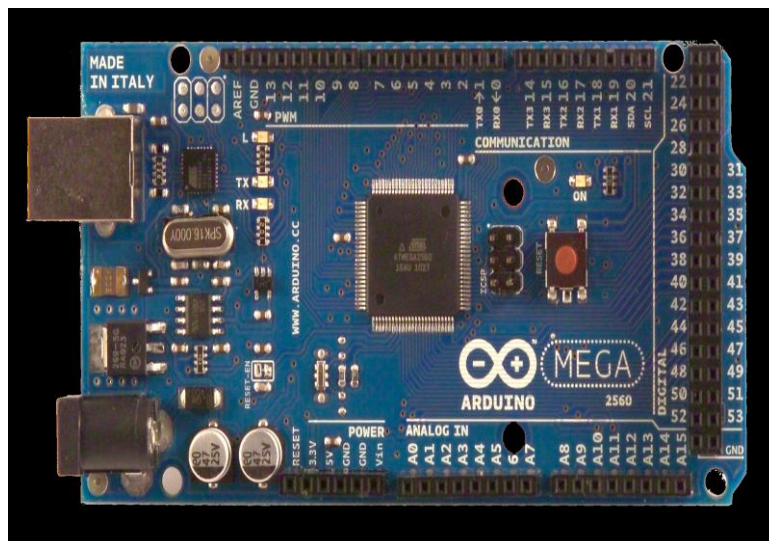


II. COMPONENT LEVEL

The Component level involves in designing the hardware and software components.

Hardware Implementation: If we buy the components then the design time will be reduced and also the implementation speed will increase. The following components are used for designing the proposed embedded system for stone fruits of Meghalaya:

Arduino mega 2560: The Arduino mega 2560 board is shown below:



Rain Sensor Module: The rain sensor module is an easy tool for rain detection. It can be used as a switch when raindrop falls through the raining board and also for measuring rainfall intensity. The rain sensor module is shown below:



Soil Moisture Sensor: The soil moisture sensor is shown below:

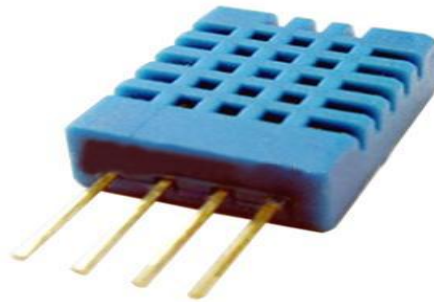


There are two types of soil moisture sensor. One is frequency domain sensor, which has an oscillating circuit. It measures the soil water content by measuring the soil's dielectric constant, which determines the velocity of an electromagnetic wave or pulse through the soil. When the soil's water content increases, the dielectric also increases, which can be used to estimate how much water the soil holds. The other one is neutron moisture gauge which utilizes the moderator properties of water for neutrons. The principle is that fast neutrons are emitted from a decaying radioactive source, and when they collide with particles having the same mass as a neutron (i.e., protons, H⁺), they slow down. As the main source of hydrogen in soil is water, so by measuring the density of slowed-down neutrons around the probe can estimate the volume fraction of water content the soil holds.

LM393 Driver: It consists of two independent low voltage comparators designed to operate from a single supply over a wide range of voltages. Operation from split power supplies is also possible. These comparators also have a unique characteristic in that the input common-mode voltage range includes ground even though operated from a single power supply voltage. Input offset voltage specifications as low as 2.0 mV make this device an excellent selection for many applications in consumer automotive and industrial electronics.

DHT11 Humidity & Temperature Sensor: This DFRobot 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. The DHT11 sensor is shown below:

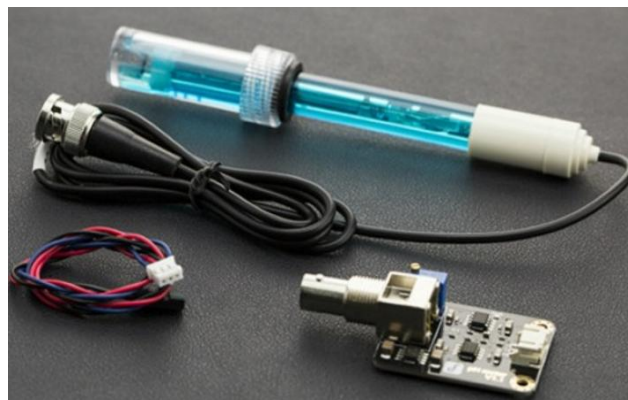


Ultra sonic Sensor: This is a low cost Ultrasonic Distance Sensor provides a non-contact distance measurement with a fine accuracy of 3mm. The module is capable of measuring distance from obstacles in range of 2 cm to 400 cm or 1" to 3 Ft. Unlike IR sensors, the performance of this sensor is not dependent on the sunlight or color of the object. The module comes in a compact form factor with a ultrasonic transmitter, receiver and signal conditioning circuit on-board.

The ultrasonic sensor is shown below:



pH Sensor: “pH stands for power of hydrogen, which is a measurement of the hydrogen ion concentration in the body. The total pH scale ranges from 1 to 14, with 7 considered to be neutral. A pH less than 7 is said to be acidic and solutions with a pH greater than 7 are basic or alkaline”. The analog pH sensor/meter kit is specially designed for Arduino controllers and has built-in simple, convenient and practical connection and features. It has an LED which works as the Power Indicator, a BNC connector and PH2.0 sensor interface. To use it, just connect the pH sensor with BNC connector, and plug the PH2.0 interface into the analog input port of any Arduino controller. The pH sensor kit is shown below:



Water flow sensor: The YF-S201 Hall Effect Water Flow Meter / Sensor sits in line with our water line and contains a pinwheel sensor to measure how much liquid has moved through it. There's an integrated magnetic hall effect sensor that outputs an electrical pulse with every revolution. By counting the pulses from the output of the sensor, the water flow can be easily calculated. The connection details are : Red wire : +5V ; Black wire : GND ; Yellow wire : PWM output.

The water flow sensor is shown below:



Solenoid Valve: The 12V Solenoid Valve - 3/4" is a controlled fluid valve. Simply connect a fluid source to the 3/4" threaded inlet and it will interrupt the flow until 12V is applied to the fast-on connectors on the solenoid.



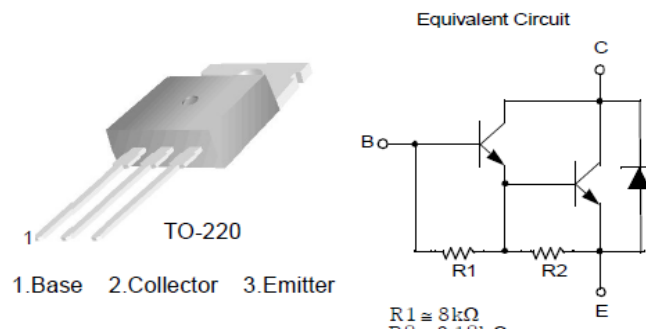
The solenoid coil is used to translate the electric pulses into hydraulic pulses that enables opening and closing of specific solenoid valves. Solenoid coil, when mounted on the valve are connected to the controller by an electric cable. The solenoid valves are power operated devices which are used to modify the fluid flow or pressure rate in a process system. It is normally closed if there is no flow across the valve in its resting position with no current on the solenoid contacts. The quick opening of the valves, consisting of a metallic circular disc at right angles to the direction of flow in the pipe, which when rotated on a shaft, seals against the seats in the valve body. Solenoids offer fast and safe switching, high reliability, long service life, good medium compatibility of the materials used, low control power and compact design.

DC motor: Here a 6V DC motor is used. The operating temperature: -10°C ~ +60°C and rated voltage: 6.0VDC.

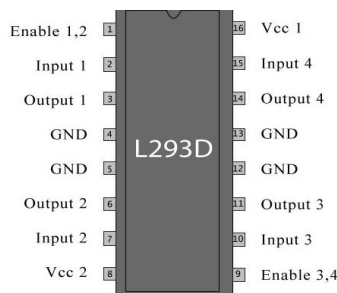


1N4007: A rectifier diode is used as a one-way check valve. Since these diodes only allow electrical current to flow in one direction, they are used to convert AC power into DC power. When constructing a rectifier, it is important to choose the correct diode for the job; otherwise, the circuit may become damaged. A 1N4007 diode is electrically compatible with other rectifier diodes, and can be used as a replacement for any diode in the 1N400x family. The 1N4007 can sustain a peak repetitive reverse voltage of 1000 volts. When the maximum allowable consistent current amount is flowing through the diode, the voltage differential between the anode and the cathode is 1.1 volts. Under these conditions, a 1N4007 diode will dissipate 3 watts of power (about half of which is waste heat).

TIP120 NPN Epitaxial Darlington Transistor: TIP120 and its equivalent circuit is shown below:



L293D IC : L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors. L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction. The L293D IC is shown below:



The motors are rotated on the basis of the inputs provided across the input pins as LOGIC 0 or LOGIC 1. In simple words we need to provide Logic 0 or 1 across the input pins for rotating the motor. Lets consider a Motor connected on left side output pins (pin 3,6). For rotating the motor in clockwise direction the input pins has to be provided with Logic 1 and Logic 0.

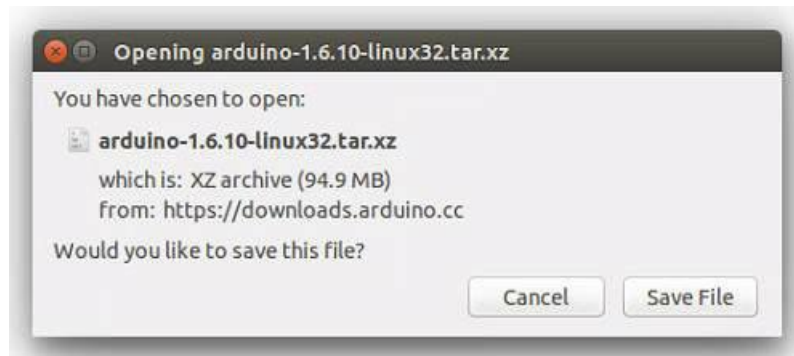
Water Tank: The same tank is used for supplying water to the field and for fertiliser application when required. Organic fertilisers such as bird and animal manures, blood meal, fish meal, feather meal, ecto and endo mycorrhizae etc can also be used. Organic-based ingredients promote stable consistent plant growth with no growth spikes.

Also connecting wire, resistors, pipe ,M Seal, breadboard etc are used.

Pest control: For pest control, traditional pest control method and electronic pest repellent are preferred.

Installing Arduino IDE:

Download the Arduino Software IDE from <https://www.arduino.cc/en/Guide/Linux>



Extract the package either using the command `tar -xvf arduino-1.6.10-linux64.tar.xz` through terminal or right click tar file and extract it.

Run the install script

Open the arduino folder created after extraction process and spot the `install.sh` file. Right click on it and choose run in terminal from the menu.

Through terminal

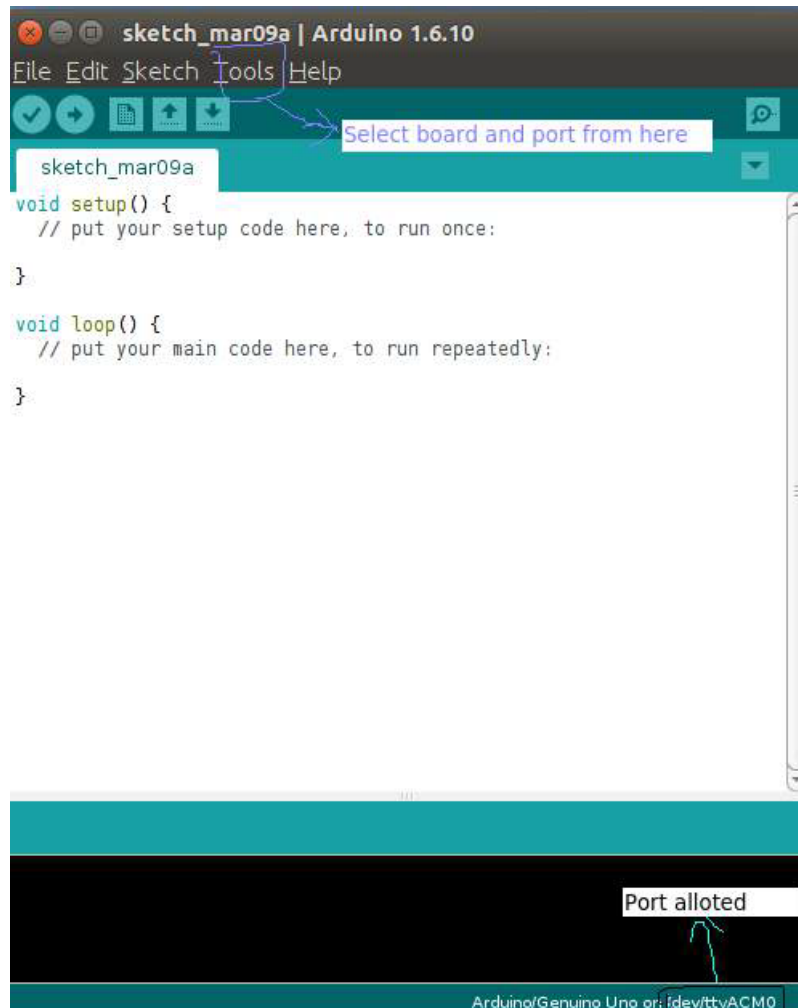
Navigate to the arduino folder through terminal and run `./install.sh` command. Installation will be done.

```
osboxes@osboxes: ~/Downloads/arduino-1.6.10
osboxes@osboxes:~$ ls
Arduino  Documents  examples.desktop  Pictures  Templates
Desktop  Downloads  Music            Public    Videos
osboxes@osboxes:~$ cd Downloads
osboxes@osboxes:~/Downloads$ cd arduino-1.6.10
osboxes@osboxes:~/Downloads/arduino-1.6.10$ ./install.sh
Adding desktop shortcut, menu item and file associations for Arduino IDE... done
!
osboxes@osboxes:~/Downloads/arduino-1.6.10$
```

Arduino IDE has been installed.

To upload our program on board

- Let's connect the board to our system through USB port.
- Now select board and port from Tools.
- We also need to select port through terminal. Command for same is `sudo chmod a+rw dev/ttyACM0`(port allotted by arduino).



This is how our IDE will look and we can select the board and port as mentioned.

Interfacing Arduino with MySQL using Python:

The following steps shows how to interface Arduino to MySQL using Python in Ubuntu-12.04.

III. INTERFACE ARDUINO TO MYSQL USING PYTHON

Step 1: First of all Installing the Latest version of Python

A) Install dependencies with the help of below command

```
$ sudo apt-get install python-software-properties
```

B) Add the repo with the help of below command

```
$ sudo add-apt-repository ppa:fkruill/deadsnakes
```

C) Update the repo index with the help of below command

```
$ sudo apt-get update
```

D) Install Python 2.7

```
$ sudo apt-get install python2.7
```

Step 2: Install PYSerial Library for taking sensor data from serial port using Python Script.



A) We can download the PYSerial library here:

`https://pypi.python.org/pypi/pyserial`

B) For mac or linux users, download the file and extract it. Open terminal and cd into the extracted folder and run the following command:

```
$ sudo python setup.py install
```

Step 3: Install Latest version of GCC .

A) Add the ppa By

```
$ sudo add-apt-repository ppa:ubuntu-toolchain-r/test
```

B) Install g++ and GCC latest version

```
$ sudo apt-get update
```

```
$ sudo apt-get install gcc-4.8 g++-4.8
```

C) Run the following command one by one

```
sudo update-alternatives --remove-all gcc
```

```
sudo update-alternatives --remove-all g++
```

```
sudo update-alternatives --install /usr/bin/gcc gcc /usr/bin/gcc-4.8 20
```

```
sudo update-alternatives --install /usr/bin/g++ g++ /usr/bin/g++-4.8 20
```

```
sudo update-alternatives --config gcc
```

```
sudo update-alternatives --config g++
```

Step 4: Install Latest version of MYSQL.

A) Update server package cache before proceeding

```
$ sudo apt-get update
```

B) Install MYSQL server with the help of below command

```
$ sudo apt-get install mysql-server-5.5
```

The only thing it will ask is to set the root password for MySQL . We should set a password instead of leaving it blank for doing it later.

C) Once installation has completed, we just need to check that mysql is running. To do this, run `$ sudo netstat -tap | grep mysql`

If MySQL is running we will see output similar to the following:

```
tcp 0 0 localhost:mysql *.* LISTEN 2480/mysql
```

D) We can also view what packages have been installed by typing:

```
$ dpkg -l | grep mysql
```

Step 5: Install MySQLdb Python module.

A) We can download the MySQLdb files from below link

`https://sourceforge.net/projects/mysql-python/`

B) We should be ready (properly ready this time!) to build and install our MySQLdb wrapper.

```
$ sudo python setup.py build
```



```
$ sudo python setup.py install
```

C) Now open python command line and import the new MySQLdb module

```
$> python  
>>> import MySQLdb  
>>>
```

Step 6: now let's set up our Arduino with Sensor and write the following codes:

```
#include <dht.h> //DHT header file
```

```
//DHT11 pin connection
```

```
#define DHT11_PIN 5
```

```
dht DHT;
```

```
//UltraSonic Pin connection
```

```
#define trigPin 11
```

```
#define echoPin 12
```

```
//Motor pin connection
```

```
#define EnPin 6
```

```
#define in1Pin 7
```

```
#define in2Pin 3
```

```
//PHmeter pin connection
```

```
#define datapin A2
```

```
int npH=7.0;
```

```
int minpH=0.0;
```

```
int maxpH=14.0;
```

```
//Solenoid valve pin connection
```

```
int solenoidPin = 50;
```

```
void setup()
```

```
{
```

```
  Serial.begin(9600);
```

```
  //Ultrasonic pin set
```

```
  pinMode(trigPin, OUTPUT);
```

```
  pinMode(echoPin, INPUT);
```

```
  //Rainsensor pin set
```

```
  pinMode(2,INPUT);
```

```
  //Motor pin set
```



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```
pinMode(EnPin, OUTPUT);
pinMode(in1Pin, OUTPUT);
pinMode(in2Pin, OUTPUT);

//PHmeter pin set
pinMode(datapin, OUTPUT);

//Solenoid valve pin set
pinMode(solenoidPin, OUTPUT);

}

void loop()
{

    long duration,distance,level ;
    int Tank_Depth_max = 18;
    int Tank_Depth_min = 4;

    //Rain drop sensor interfacing
    int RainIn = A0;
    int RainDigitalIn = 2;
    int RainVal;
    boolean blsRaining = false;
    String strRaining;

    //Soil sensor interfacing
    int value= 0;
    int SENSE = A1; // Soil Sensor input at Analog PIN A1
    // you can adjust the threshold value
    int thresholdValue = 800;
    String strSoil;

    //Ultrasonic getting data
    digitalWrite(trigPin, LOW);
    delayMicroseconds(10);
    digitalWrite(trigPin, HIGH);
    delayMicroseconds(10);
    digitalWrite(trigPin, LOW);
    duration = pulseIn(echoPin, HIGH); //EchoPin received high start counting until the receiver to the low, return to the count
    value
    distance = (duration/2)/29; //calculating the distance cm,The speed of sound is 340 m/s or 29 microsecond per
    centimeter
    level = Tank_Depth_max - distance;
```



```
//DHT getting data
DHT.read11(DHT11_PIN);

//Rainsensor getting data
RainVal = analogRead(RainIn);
bIsRaining = !(digitalRead(RainDigitalIn));

//Soilsensor getting data
value = analogRead(SENSE);

//Motor getting data
analogWrite(EnPin, 255); // Run in full speed

//PHmeter getting data
int pHval=analogRead(datapin);
pHval=map(pHval,0,255,0,14);
String strPH;

if (level >= 18){
  //Serial.println("water tank overflow");
  digitalWrite(in1Pin, LOW);
  digitalWrite(in2Pin, LOW);
}
else if(level<=4){
  //Serial.println("water tank underflow");
  digitalWrite(in1Pin, HIGH);
  digitalWrite(in2Pin, LOW);
}
else if (level<=9){
  //Serial.println("water tank half filled");
  digitalWrite(in1Pin, HIGH);
  digitalWrite(in2Pin, LOW);
}

if(bIsRaining){
  strRaining = "YES";
}
else{
  strRaining = "NO";
}

if(value<thresholdValue)
{
```

```
    strSoil = "PDNW";
    digitalWrite(solenoidPin, LOW); //Switch Solenoid OFF
  }
  else
  {
    strSoil = "PNW";
    digitalWrite(solenoidPin, HIGH); //Switch Solenoid ON
  }

  if((pHval>minpH)&&(pHval<npH))
  {
    strPH = "ACIDIC";
  }
  else if((pHval>npH)&&(pHval<maxpH))
  {
    strPH = "ALKALINE";
  }
  else if(pHval==npH)
  {
    strPH = "NEUTRAL";
  }

  //Serial.print("Humidity: ");
  Serial.print((float)DHT.humidity);
  Serial.print("\t");
  //Serial.print("Temperature: ");
  Serial.print((float)DHT.temperature);
  Serial.print("\t");
  //Serial.print("water level: ");
  Serial.print(level);
  Serial.print(" cm");
  Serial.print("\t");
  //Serial.print("raining: ");
  Serial.print(strRaining);
  Serial.print("\t");
  //Serial.print("soil_moisture: ");
  Serial.print(strSoil);
  Serial.print("\t");
  //Serial.print("pH_value_type: ");
  Serial.print(pHval );
  Serial.print(" ");
  Serial.println(strPH);
  delay(2000);
}
```



Step 7: Let's go ahead and set up our MySQL

A) Login to MySQL (we will need an account)

```
user@server:~$ mysql -u mysql_user -p
```

Enter password:

B) Create the Database

```
mysql > create database db_name;
```

C) Verify that it's there

```
mysql > show databases;
```

D) Create the User

```
mysql > create user db_user;
```

E) Grant privileges while assigning the password

```
mysql > grant all on db_name.* to 'db_user'@'localhost' identified by 'db_password';
```

The above example grants all privileges, obviously. But we will likely want to limit privileges under many circumstances. These parameters include select, insert, and delete.

Choose all that apply and separate by comma:

```
mysql > grant select, insert, delete, update on db_name.* to 'db_user'@'localhost' identified by 'db_password';
```

F) create a simple MySQL table to store this data.

```
create table weathervalue ( weathervalueID int(11) AUTO_INCREMENT NOT NULL, datetime  
TIMESTAMP DEFAULT CURRENT_TIMESTAMP, humidity decimal(4,2) NOT NULL, tempC decimal(4,2) NOT  
NULL, waterlevel decimal(4,2) NOT NULL, Raining VARCHAR(10),  
soilmoisture VARCHAR(10), PHvalueType VARCHAR(10), constraint weathervalue_PK primary  
key(weathervalueID) );
```

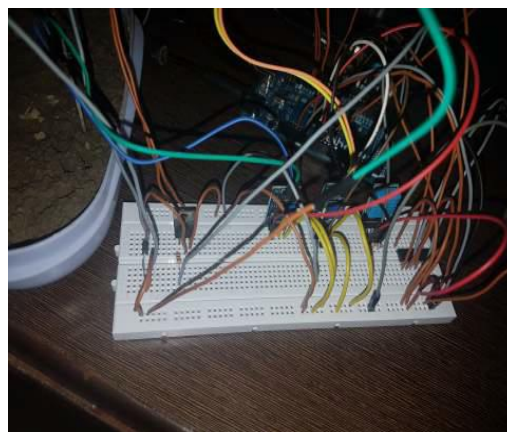
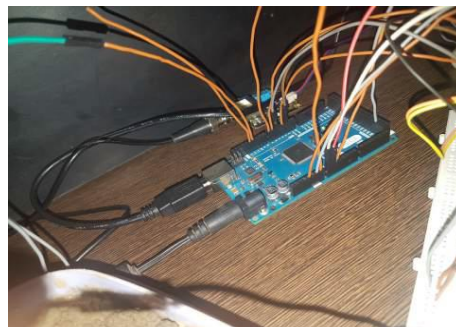
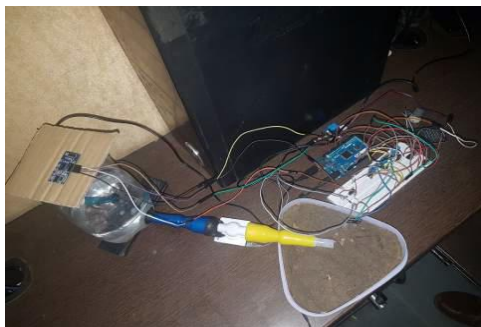
G) For lookup data into MYSQL type below command into MYSQL

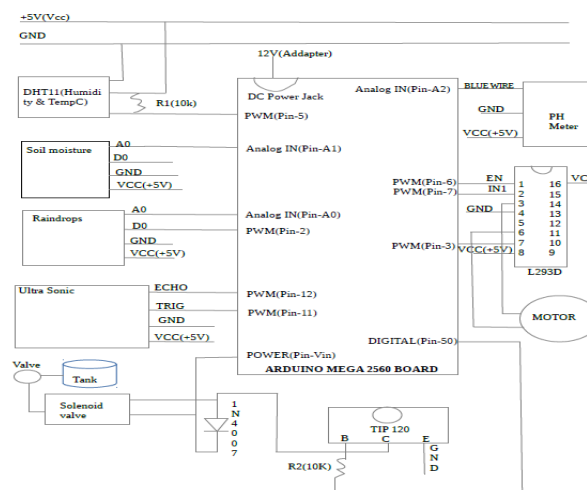
```
mysql > select * from weathervalue(Table name)
```

Step 8: Write Python script for interfacing with MYSQL in my case Script given below

```
import serial  
import MySQLdb  
import time  
import datetime  
#establish connection to MySQL.  
#dbConn = MySQLdb.connect("localhost","database_username","password","database_name") or  
die ("could not connect to database")  
#dbConn = MySQLdb.connect("117.203.179.176","root","root","semc") or die ("could not connect to  
database")  
dbConn = MySQLdb.connect("localhost","peach","ece123","weathersystem") or die ("could not  
connect to database")  
#open a cursor to the database  
cursor = dbConn.cursor()  
device = '/dev/ttyACM0'  
print "Trying...",device  
arduino = serial.Serial(device,9600,timeout=5)
```

Connection Diagram: The connection diagram of the proposed system is shown below:





IV. CONCLUSION

Stone fruits like Plum, Peach, Pear, Apricot are found in the central plateau of East and West Khasi Hills and Jaintia Hills and have good commercial value. Now by implementing appropriate technology, stone fruits can also be grown in other parts of the state. Cultivation of fruits will surely play a vital role in the prosperity of Meghalaya as generally stated that the standard of living of the people can be judged by per capita production and consumption of fruits. Improved management of nutrients (nitrogen, phosphorous, potassium, and micronutrients) has a fundamental and critically important impact in responsible stewardship, and given sufficient scholarly investigation, may be amenable to much more precise delivery and consequent improvements in fruit and tree quality. Though the initial cost of establishment of an orchard is high, it is compensated by higher productivity or due to high value of produce. In the long term, the revolutionary technological innovations will dramatically change the way tree fruit is produced, handled, and utilized. A dynamic scientific base and aggressive implementation of technologies form the third essential component will be equally important in addressing the globalized marketplace and shaping the future of our stone fruit industry.

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