AQUAPONICS – DOCUMENTATION

16CN602 - FUNDAMENTALS OF EMBEDDED COMPUTING – PROJECT 1

CEN Mtech (Batch 2016-2018)

"The Earth is what we all have in common."

- Wendell E Berry
(American novelist, poet, environmental activist, cultural critic, farmer)

We would like to dedicate the project to our beloved pedagogy, ***Dr. K. P. Soman***, HoD, Department of Computational Engineering and Networking, Amrita School of Engineering, Coimbatore.

PREFACE

In this era of ‘flat earthers’ and communities who believe that global warming is a myth, the young generation must find ways inorder to sustain, maintain and protect our MOTHER EARTH, as a prelude to bringing Her back to all Her glory.

As a step to develop and inculcate this culture of taking care of our Omni Provider Earth, we, the students of the 1st year Mtech course, of the Department of CEN, Amrita School of Engineering, Coimbatore (batch 2016-2018), have delved into the world of **AQUAPONICS,** under the immense support, motivation and precise instruction of our beloved teacher, Mr. Sajith Varrier.

A project that lasted for a month, it is entirely the fruit of the whole class’ effort, even though divided into different teams, with the help and guidance of Sajith Sir. The report, has been compiled and presented, such that it covers the day to day modules of the project, challenges faced and the solutions obtained.

Lastly, we would like to thank The Almighty, for directing us in the right way, at each and every step.

Live, and Let Live

INDEX

DAY 1: 17-10-2016:

Inititation to take up the project of a "**PORTABLE AQUAPONICS SYSTEM**", that combines the areas of data science, embedded systems and sustainable development.

Expected duration of project: 2 weeks.

Teams: Class of 17, to be divided into 5 groups, taking up work in the four areas, namely
1. Sensors
2. Hardware and Circuit Implementation
3. Software (Programming)
4. Interface
5. Documentation

AQUAPONICS SYSTEM – BRIEF INTRODUCTION:

Basically, it is a self sustaining system, in which, aquaculture (fish, to be specific) as well as hydroponics (soil-less growing of plants) go hand in hand ie. the fish and the plants mutually support each other without any major external support. The crux of the system is that, the water containing ammonia (from the waste from the fish), is pumped into the plant bed, where it is converted into nitrites and then into nitrates by the microbial bacteria in the plant bed, and is used as plant food; thus the plants purify the water from the aquarium, which in turn, siphons back into the aquarium.

It is more intelligible from the given diagram (Figure 1). It clearly shows the combination of data science, embedded systems and sustainable development.

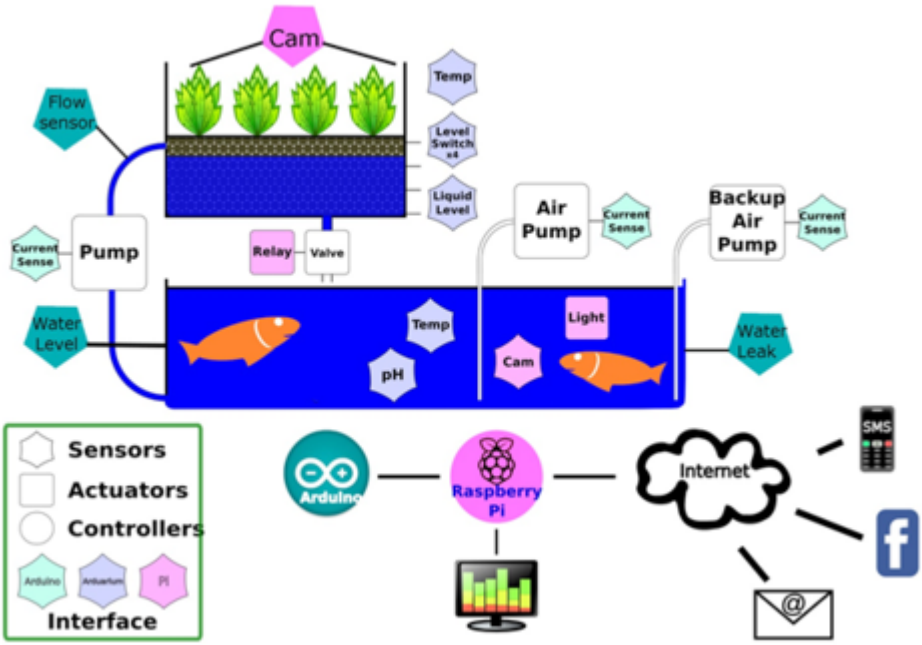

Figure 1. SCHEMATIC DIAGRAM OF THE WORKING OF AQUAPONICS SYSTEM

DAY 2: 18-10-2016

Teams decided :

1. Sensors – Anon George
Harikrishnan N B
Naveen
Shalini K

2. Hardware and Circuit Implementation – D. Aravind Reddy
Greeshma Riya B
Lakshmipriya
Raghul M

3. Software (Programming) – Anson Simon
Hiransha M
Nidhin
Nikhil Damodharan

4. Interface – Aravind Ravikumar
Hariharan
Sujith
Vivek Vinayan

5. Documentation - Vineetha Chacko

DAY 3 – 20-10-2016

PRESENTATION 1 on aquaponics system and the team members in each group – by **Nikhil**.
Teams approved. Chores assigned for each team, with final presentation on 24-10-2016.
Measurements of trolley framework calculated as below – by Raghul, Hiransha, Aravind Reddy.

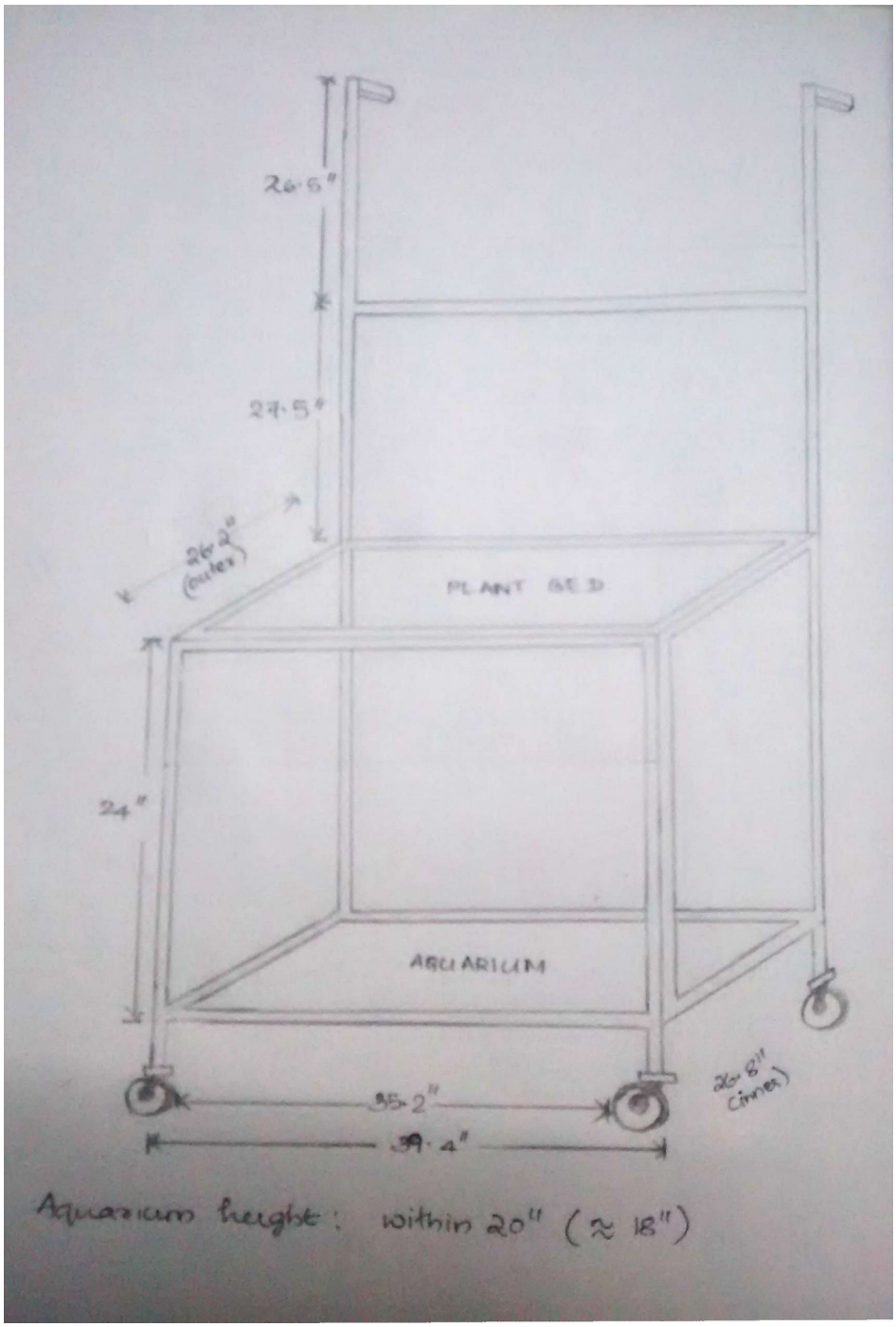

Figure 2. TROLLEY FRAMEWORK MEASUREMENTS

OVER THE WEEKEND (21ST,22ND ,23RD OCTOBER, 2016):

Plant bed container created, painted, and mounted on the trolley.

Figure 3. MOUNTED PLANT BED CONTAINER

Figure 4: INTERIOR OF PLANT BED –OUTFLOW OF PURIFIED WATER IS THROUGH THE 2 PIPES.

DAY 4: 24-10-2016

PRESENTATION 1: SENSORS – BY ANON GEORGE

Sensors used, based on operating range of voltage and current, and the evironment in which it is used:

1. pH of water in aquarium

pH to be maintained: 7.2 to 7.6 (for gold fish)

pH sensor:

As pH increases, concentration of H^+ ions increases, and hence more electricity flows.

PH probes measure the pH by mesuring the voltage of the solution in which it is dipped.

Figure 5. pH SENSOR

2. Light Dependant Resistor (LDR)

Helps maintain optimum light exposure for the plants, and turn the solar panel depensing on the direction of availability of light.

Has 2 cadmium sulphide photo conductive cells. As light intensity increases, resistance of cell decreases.

(Day and night sensors can also be employed at a later stage)

Figure 6. LDR

3. Water Temperature – DS18B20 Waterproof Digital Thermal Probe

Operating temperature range: -55° C to +125° C

Resolution = 9, 10, 11 or 12 bits corresponding to 0.5ºC, 0.25ºC, 0.125ºC, 0.6
respectively.

Figure 7. DS18B20 DIGITAL THERMAL PROBE

4. Water Flow – Water Flow Meter

Maximum operating current : 15 mA (DC 5V)
Voltage range : DC 5V ~ 18V
Flow rate : 1L/min
Pressure : 1.75 Mpa

Working: As the turbine inside rotates, a current is produced, which is calculated and noted. The reference range may be as below
high flow : +5V no flow: 0V

Figure 8a. WATER FLOW METER

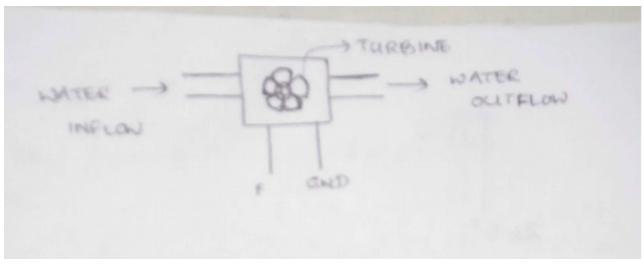

Figure 8b. WORKING – SCHEMATIC DIAGRAM

5. Water Flow – Water Flow Sensor

Working voltage : +5V
Load Current : maximum 1A

Figure 9a. WATER LEVEL SENSOR

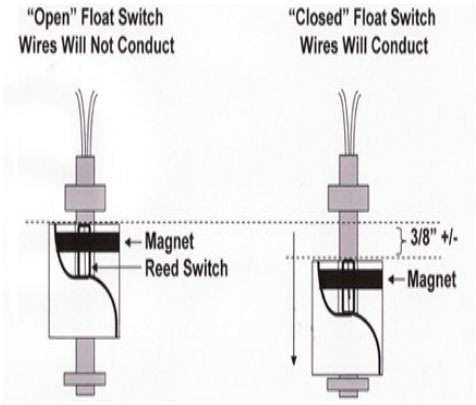

Figure 9b. WORKING OF WATER FLOW SENSOR

6. Water Leak – Water Leak Sensor

The cable works with the combination of two metal sensing wires protected by a fiber material.

Water is conductive and allows electricity through it.

When water comes in contact with the wires, and soaks through the fiber material, it acts as a switch, connecting the two metal wires together..

cable is a resistive based system, so the cable has specific ohms per foot, which allows the controller to determine a footage reading.

When a conductive fluid comes in contact with both wires it creates a short circuit between the sensing wire.

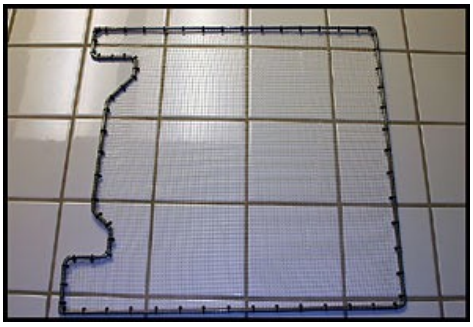

Figure 10a. WATER LEAK SENSOR

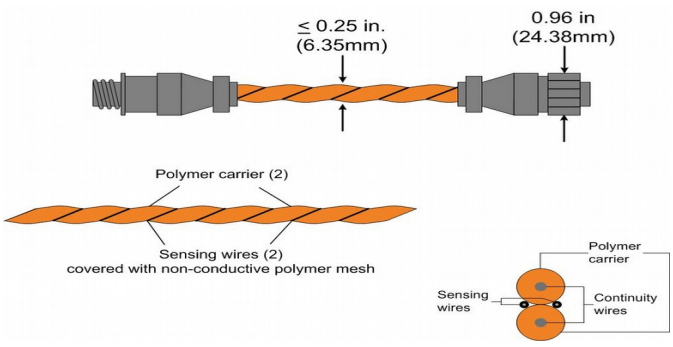

Figure 10b. WORKING – WATER LEAK SENSOR

7. Soil Moisture – Soil Moisture Sensor

Soil moisture sensors measure the volumetric water content in soil.

Measuring how strongly the soil resists the flow of electricity between two electrodes can be used to determine the soil moisture content

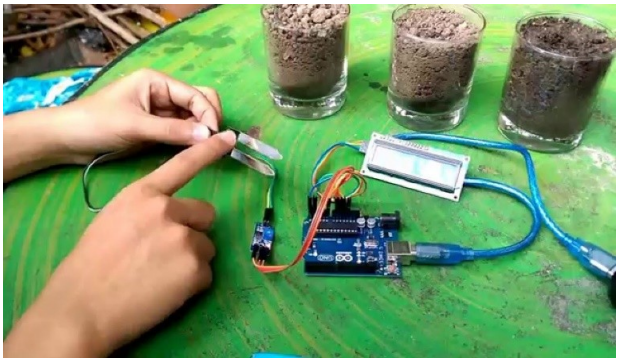

Figure 11. SOIL MOISTURE SENSOR

Suggestions made by Sir:

1. Minimum and maximum light required for the plants
2. Temperature required for fish
3. BoM (Bill of Materials)

PRESENTATION 2: INTERFACE – BY HARIHARAN

Web Interface used: **Python, via default framework 'FLASH',** that supports default admin module.
Predefined template is there.
In Windows,a batch file is created, which when run, a webpage is opened.
Back end : Flash, that uses MySQL, Python Front end : Bootstrapmade, that uses HTML, CSS and Java Script.

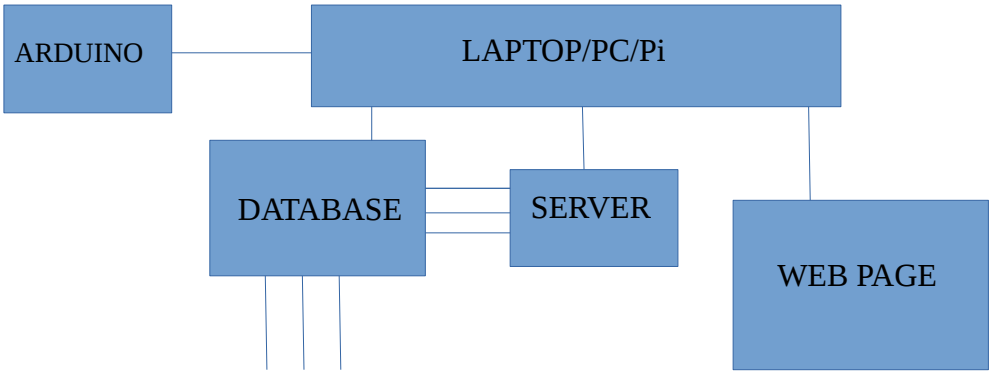

Figure 12. SCHEMATIC DIAGRAM OF INTERFACE WHEN CONNECTED FINALLY TO ALL MODULES

Suggestions made by Sir:

1. Read a textfile and display it on the webpage.
2. Data updated on server must also be updated on other clients.
3. Connect LDR and try to read data in server.

HARDWARE AND CIRCUIT IMPLEMENTATION

The hardware components required, such as valves, motors and oxygen pumps have to be decided.

1. Relays

Switch to control high power devices.

1. Arduino UNO
2. 5V Relay module 220v
3. AC light(example for this we can use another device such as motors, cars, transformers etc.,)

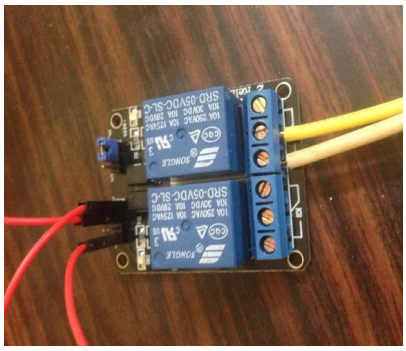

Figure 13a. 5V RELAY

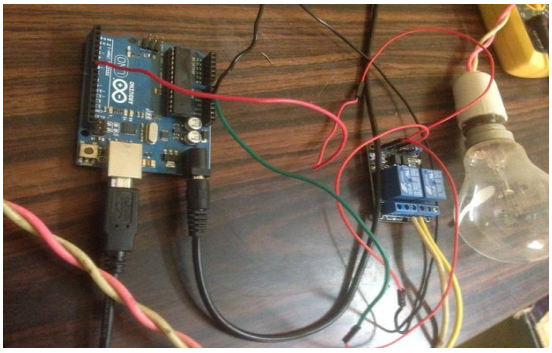

Figure 13b. COMPONENTS

PRACTICAL WORK DONE: (24th and 25th October, 2016)

1. Plumbing work done in plant bed container to allow water to seep in from the soil into the pipes, and hence, down to the aquarium.
2. Gravel filled, and water flow from plant bed to lower level is checked.
3. Overhead pipes fitted in plant bed for uniform water distribution. This is connected via T joint to a motor below, that pumps up water from the aquarium.
4. The pipes in the floor of the plant bed is also connected via T joint to allocate flow of purified water from plant bed to the aquarium below.

Status: Working of current set up has been checked and monitored.

SOFTWARE:

The Arduino microcontroller has to be programmed as per the components and requirements of the system.

26th OCTOBER to 1st NOVEMBER:

1. Fish tank made of wood, with an inner, layered, lining of plastic sheet placed in position, in the existing system structure.
Fish purchased and added.

2. Plants such as tomato and chilly shoots set in the plant bed

3. AC Motor is connected to check if the existing water flow system is working properly, by pumping water up to the plant bed.

4. Bell Siphon Construction: A bell siphon is used in aquaponics and hydroponics systems in order to regulate the flow of water. In a flow (also known as flood and drain) system water is pumped into the plant bed. At a specific point (usually 2 inches below the surface) the water drains via the bell siphon. When the water reaches the bottom you will hear the classic gurgle indicating the end of the drain phase. The process will then repeat itself over and over again. The bell siphon is a such an important part of any flow system that getting it right is crucial.

The bell siphon contruction is completed along with other plumbing work, with the materials purchased from the in-campus store, **Amrita Recycling Centre,** based on the given schematic diagram.

http://www.instructables.com/id/Make-a-Bell-Siphon/

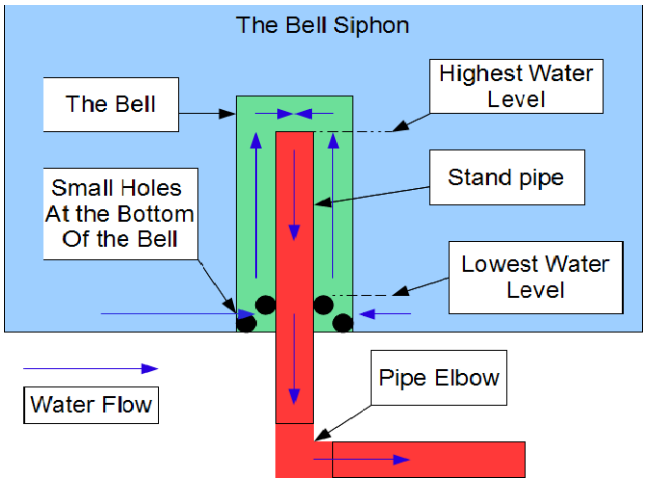

Figure 14a. Working of Bell Siphon – Schematic Diagram

Figure 14b. Bell Siphon constructed in the system.

Figure 14c. Water flowing down through the Bell Siphon into the fish tank

Figure 14d. AC Motor pumping water up into the overhead water distribution system via hose

Figure 14e. Aquaponics System

5. Soil Moisture Sensor: The working of the soil moisture sensor is studied and the corresponding sketch obtained.

The soil moisture sensor has 4 connections , $\mathbf{V_{cc}}$ which obtains **5V from the ARDUINO**, **GND,** connected to **ARDUINO GND** and **data line** connected to **analog pin of ARDUINO.** The 4th connection is to digital pins, which we dont use.

After these connection are made, the legs of the sensor are dipped in soil of different moisture levels, and the corresponding range of values is recorded from the Arduino IDE as follows:

Reading	Inference
>950	Dry Soil
750 – 950	Humid Soil
<750	Water

Table 1. Soil Moisture Sensor Reference values

The sketch to read soil moisture values is obtained depending on the above values, compiled and loaded into the **ARDUINO.**

The sketch runs succesfully, giving accurate soil moisture reading

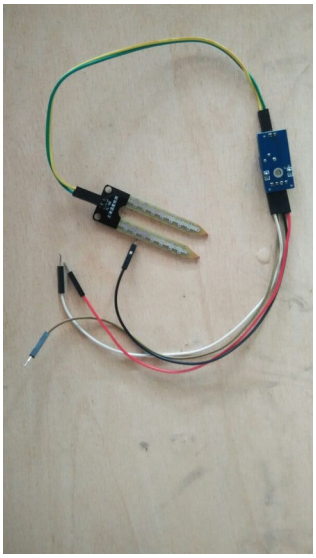

Figure 15a. Soil Moisture Sensor

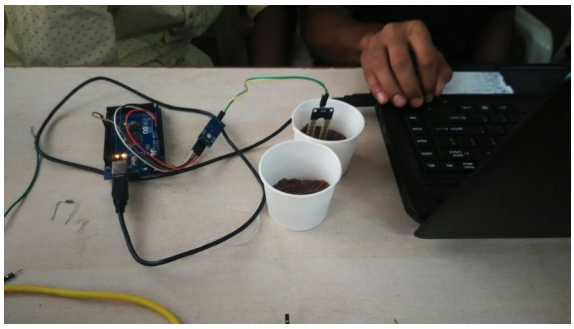

Figure 15b. Sensor connected to Arduino and different ranges of values checked for each moisture level.

Challenges faced:

1. Leak in the plant bed barrel. Problem resolved by welding the hole shut, with metal sheet.

2. Arduino program unable to load, due to faulty cable. Problem resolved by replacing the connecting cable.

3. AC Motor needs to be manually switched on or off. This is resolved by using a relay that acts as a switch to turn the motor on and off at regular intervals based on ARDUINO sketch.

DAY 5: 17-11-2016

Relay:

The working of the relay, which acts as the switch for the AC motor, is studied by connecting and lighting an AC bulb, at regular inervals.
The relay must be connected to a 12Vpower supply, and to the ARDUINO.
The sketch for blinking the bulb is compiled, loaded into the ARDUINO and run.

Reference: https://oscarliang.com/arduino-timer-and-interrupt-tutorial/

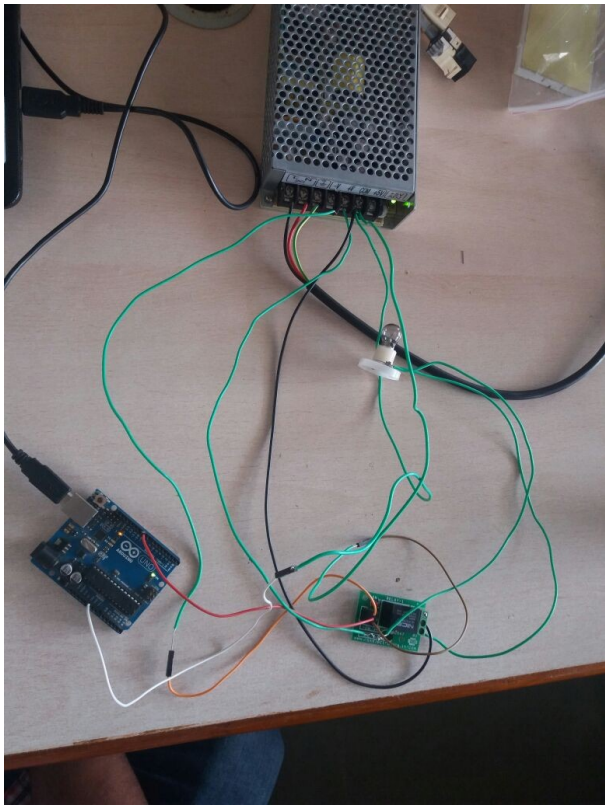

Figure 16. Relay connected to 12V power supply, and ARDUINO to blink the bulb.

Challenges faced:

When LCD display is connected to the relay, due to current variation (AC passing through relay), junk values are diplayed in the LCD or it becomes blank.

Suggestion by Sir:

Use an **Octocoupler –** it is a component that transfers electrical signals between two isolated circuits by using light. It prevents high voltages from affecting the system that is receiving the signal.

20th to 22nd NOVEMBER:

1. LDR: LDR or Light Detecting Resistor, which has 2 pins, has one pin connected, via a 10 kOhm resistor, to the **ARDUINO 5V V_{cc}** and the other pin to the **ARDUINO GND.**
The values are read from the ARDUINO analog pin connections from sensors.

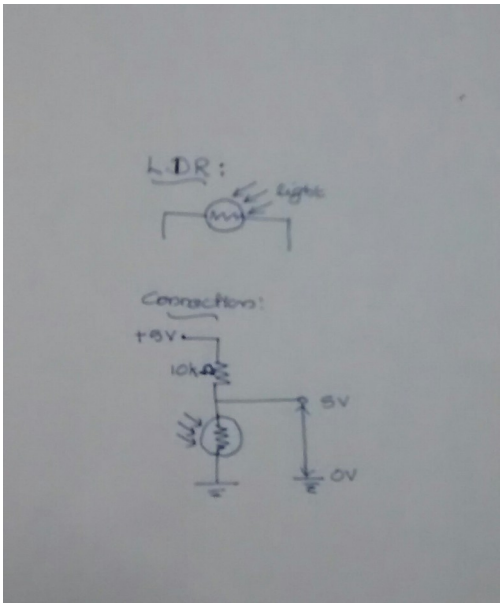

Figure 17. LDR Connection

2. Water Level Sensor:

It is connected to **5V ARDUINO V_{cc},** and to the **ARDUINO Analog Pins.** The values are read from the ARDUINO analog pin connections from sensors.

Precaution: Insulate the wires using sleeve, to prevent shorting when dipped in water

Figure 18. Water Level Sensor

3. 16 x 2 LCD (Liquid Crystal Display)

A 16x2 LCD is used to display the sensor values. It is connected to the **ARDUINO 5V V_{cc}** and also to the **ARDUINO GND.**

The **values are displayed** by connecting the display to the **digital pins** of the **ARDUINO.**

Increasing or decreasing the LCD display values is done using a pot, which has a pin that rotates to give different sensor values corresponding to the 0V to 5V range.

Challenges faced:

The connections between ARDUINO and LCD, and how to vary the LCD backlight, was confusing. This was resolved by referring to http://www.electroschematics.com/12135/arduino-lcd-enhancement/

Junk values displayed in the LCD, which has to be resolved using an **octocoupler**.

4. Soldering

The sensors which are properly functioning are soldered onto one cicuit board and the control system of the aquaponics system is hence integrated as one.

DAY 6 - 25th NOVEMBER:

An overview of the **power and control system** is given by **Anon George.**

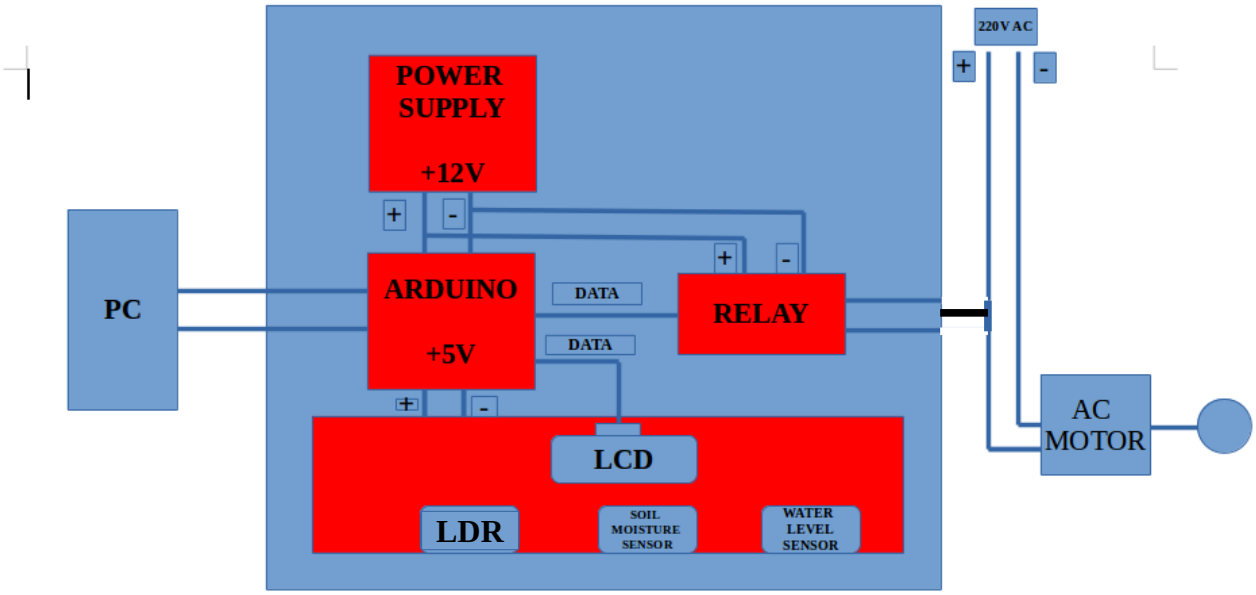

Figure 19. Aquaponics Power and Control System – Block Diagram

1. 12V Power Supply

It is used to power the ARDUINO as well as the Relay which controls the AC Motor.

2. Sensors:

All sensors are connected to the ARDUINO 5V and also grounded. Hence the sensor voltage varies between 0V and 5V.

All sensors are connected to analog pins of ARDUINO from which values are read.

Float voltage = Sensor value x (5V/1023). Hence the float voltage of all sensors used, varies between 0V and 5V corresponding to which the digital values vary between 0 and 1023.

3. LCD

It draws 5V from the ARDUINO and is connected to ARDUINO digital pins.

NOTE:

1. 12V's GND and **5V's GND** must be short as one, to the ARDUINO GND.

2. While connecting V_{in} of ARDUINO to the power supply, ARDUINO must be disconnected from laptop to avoid 2 power supplies.

FRONT END

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data-jump="prev"><i class="fa fa-angle-left fa-2x"></i></a>
                                                                        <a class="slider-control right" href="#"
data-jump="next"><i class="fa fa-angle-right fa-2x"></i></a>

                                                                    </div>
                                                                </div>
                                                            </div>

                                                            <div class="col-lg-6 ">
                                                                <div class="company mar-left10">
                                                                    <h4>Aquaponics - General Information</h4>
                                                                    <p>Aquaponics refers to any system that combines
conventional aquaculture (fishes) with hydroponics (cultivating plants in water) in a symbiotic environment. In normal aquaculture, excretions from
the animals being raised can accumulate in the water, increasing toxicity. In an aquaponic system, water from an aquaculture system is fed to a
hydroponic system where the by-products are broken down by Nitrifying bacteria initially into nitrites and subsequently into nitrates, which are
utilized by the plants as nutrients, and the water is then recirculated back to the aquaculture system.</p>
                                                                </div>
                                    </div>

                                                    </div>
                                    </div>

                                </div>

                        </div>
                </section>
                <!--/about-->

                <!-- spacer section:testimonial -->
                        <section id="testimonials-3" class="section" data-stellar-background-ratio="0.5">
                        <div class="container">
                                <div class="row">
                                                <div class="col-lg-12">
                                                        <div class="align-center">
                                                                <div class="testimonial pad-top40 pad-
bot40 clearfix">
                                                                        <h5>
                                                                                Aquaponics is
gardening and fish raising together in a way that takes advantage of the naturally symbiotic relationship between them. The plants around a lake aren't
just lush because of the water, but also the nutrients provided by the fish.
                                                                        </h5>
                                                                        <br/>
                                                                        <span
class="author">&amp;mdash; CEN 2016-18</a></span>
                                                                </div>

                                                            </div>
                                                        </div>
                                                </div>

                                        </div>

                        </section>

                        <!-- services -->
                        <section id="services" class="section pad-bot5 bg-white">
                        <div class="container">
                                        <div class="row mar-bot5">
                                                <div class="col-md-offset-2 col-md-8">
                                                        <div class="section-header">
                                                        <div class="wow bounceIn"data-animation-delay="7.8s">

                                                                <h2 class="section-heading animated"  >SENSORS</h2>
                                                                <h4>Various sensors used in aquaponics system</h4>

                                                        </div>
                                                        </div>
                                                </div>
                                        </div>
                                <div class="row mar-bot40">

                                        <div class="col-lg-4" >
                                                <div class="wow bounceIn">
                                                        <div class="align-center">
```

```
                                        <div class="wow rotateIn">
                                            <div class="service-col">
                                                <div class="service-icon">
                                                    <figure><img alt="" class="img-responsive" src="img/sens1.jpg" width="100%" height="350"/></figure>
                                                </div>
                                                <h2><a href="#">Moisture sensor</a></h2>
                                                <p>Soil moisture sensors measure the volumetric water content in soil.It measures how strongly the soil resists the flow of electricity between two electrodes can be used to determine the soil moisture content
</p>
                                            </div>
                                        </div>
                                    </div>
                                </div>

                                <div class="col-lg-4" >
                                    <div class="align-center">
                                        <div class="wow bounceIn">

                                            <div class="wow rotateIn">
                                                <div class="service-col">
                                                    <div class="service-icon">
                                                        <figure><img alt="" class="img-responsive" src="img/sens2.jpg" width="100%" height="350"/></figure>
                                                    </div>
                                                    <h2><a href="#">Water Level Sensor</a></h2>
                                                    <p>water level sensor measures liquid level in tanks, reservoirs, and in the environment, without any moving parts.The sensing probe element consists of a special wire cable which is capable of accurately sensing the surface level of nearly any fluid, including water, salt water, and oils. </p>
                                                </div>
                                            </div>
                                        </div>
                                    </div>
                                </div>

                                <div class="col-lg-4" >
                                    <div class="align-center">
                                        <div class="wow bounceIn">
                                            <div class="service-col">
                                                <div class="service-icon">
                                                    <figure><img alt="" class="img-responsive" src="img/sens3.jpg" width="100%" height="350"/></figure>
                                                </div>
                                                <h2><a href="#">LDR Sensor</a></h2>
                                                <p>Light Dependent Resistors are very useful especially in light/dark sensor circuits. Normally the resistance of an LDR is very high, sometimes as high as 1000 000 ohms, but when they are illuminated with light resistance drops dramatically.</p>
                                            </div>
                                        </div>
                                    </div>
                                </div>

                            </div>

                        </div>
                    </section>
                    <!--/services-->

                    <!-- spacer section:testimonial -->
                    <section id="testimonials" class="section" data-stellar-background-ratio="0.5">
                    <div class="container">
                        <div class="row">
                            <div class="col-lg-12">
                                <div class="align-center">
                                    <div class="testimonial pad-top40 pad-bot40 clearfix">
                                        <h5>
                                            Aquaponics systems have numerous benefits. The systems make gardening more productive and economical. Anyone interested in a cost effective and healthy gardening at home should consider having an aquaponics system at home
                                        </h5>
                                        <br/>
                                        <span
```

```
class="author">&mdash; CEN-2016-18</span>
                                        </div>

                                    </div>
                                </div>
                            </div>

                    </div>

                </section>
                <!-- /team -->
                <section id="team" class="section pad-bot5 bg-white">
                <div class="container">
                        <div class="row mar-bot5">
                            <div class="col-md-offset-2 col-md-8">
                                <div class="section-header">
                                <div class="wow bounceIn"data-animation-delay="7.8s">

                                    <h2 class="section-heading animated"  >TEAMS</h2>
                                    <h4>Four teams have worked for the success of Aquaponics
system</h4>

                                </div>
                                </div>
                            </div>
                        </div>
                    <div class="row mar-bot40">
                        <div class="col-lg-3" >
                            <div class="wow bounceIn">
                                <div class="align-center">

                                    <div class="wow rotateIn">
                                        <div class="service-col">

                                                <h2><a href="#">Sensor
team</a></h2>
                                                <p>Soil moisture sensors measure the
volumetric water content in soil.It measures how strongly the soil resists the flow of electricity between two electrodes can be used to determine the
soil moisture content
</p>
                                        </div>
                                    </div>
                                </div>
                            </div>
                        </div>

                        <div class="col-lg-3" >
                            <div class="align-center">
                                <div class="wow bounceIn">

                                    <div class="wow rotateIn">
                                        <div class="service-col">

                                                <h2><a href="#">Hardware
team</a></h2>
                                                <p>water level sensor measures liquid
level in tanks, reservoirs, and in the environment, without any moving parts.The sensing probe element consists of a special wire cable which is
capable of accurately sensing the surface level of nearly any fluid, including water, salt water, and oils. </p>
                                        </div>
                                    </div>
                                </div>
                            </div>
                        </div>

                        <div class="col-lg-3" >
                            <div class="align-center">
                                <div class="wow bounceIn">
                                    <div class="service-col">

                                            <h2><a href="#">Programing team</a></h2>
                                            <p>Light Dependent Resistors are very useful
especially in light/dark sensor circuits. Normally the resistance of an LDR is very high, sometimes as high as 1000 000 ohms, but when they are
illuminated with light resistance drops dramatically.</p>
                                    </div>
                                </div>
                            </div>
                        </div>
```

```
                    <div class="col-lg-3" >
                        <div class="align-center">
                            <div class="wow bounceIn">
                                <div class="service-col">

                                    <h2><a href="#">Interface team</a></h2>
                                    <p>Light Dependent Resistors are very useful especially in light/dark sensor circuits. Normally the resistance of an LDR is very high, sometimes as high as 1000 000 ohms, but when they are illuminated with light resistance drops dramatically.</p>
                                </div>
                            </div>
                        </div>
                    </div>
                </div>

            </div>
            </section>




            <!-- spacer section:stats -->
            <section id="parallax1" class="section pad-top40 pad-bot40 mar-bot20" data-stellar-background-ratio="0.5">
                <div class="container ">
    <div class="align-center pad-top40 pad-bot40">
      <h4 class="color-white pad-top50">Arduino </h4>
                        <p class="color-white">Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.</p><p class="color-white">The Arduino hardware and software was designed for artists, designers, hobbyists, hackers, newbies, and anyone interested in creating interactive objects or environments.</p>
    </div>
                </div>
            </section>
            <section id="line-pricing" class="line-section line-center">
                <div class="container pad-top50">
                    <div class="row mar-bot10 ">
                        <div class="col-md-offset-3 col-md-6">
                            <div class="section-header">
                                <div class="wow bounceIn">

                                    <h2 class="section-heading animated" data-animation="bounceInUp">Pricing Table</h2>
                                    <p>Neque porro quisquam est, qui dolorem ipsum quia dolor sit amet consectetur, adipisci velit, sed quia non numquam.</p>

                                </div>
                            </div>
                        </div>
                    </div>
                    <div class="line-wrap">
                        <div class="line-pricing-table">
                            <div class="pricing-table-wrap" data-scrollreveal="enter top over 0.5s after 0.3s">
                                <ul>
                                    <li class="line-head-row">
                                        Free
                                    </li>
                                    <li class="line-price-row">
                                        <p>
                                            <span class="symbol">$</span>

        <span>0</span>
                                        </p>
                                        <small>Ideal for beginners</small>
                                    </li>
                                    <li>
                                        1 theme included
                                    </li>
                                    <li>
                                        1 year of theme updates
                                    </li>
                                    <li>
```

```
                                                    20% off future purchases
                                                </li>
                                                <li class="line-btn-row">
                                                    <a href=""
class="line-btn light">Get Started</a>
                                                </li>
                                            </ul>
                                        </div>
                                        <div class="pricing-table-wrap" data-
scrollreveal="enter top over 0.5s after 0.5s">
                                            <ul class="line-highlight">
                                                <li class="line-head-row">
                                                    Premium
                                                </li>
                                                <li class="line-price-row">
                                                    <p>
                                                        <span
class="symbol">$</span>
                                                        <span>300</span>
                                                    </p>
                                                    <small>Per
user / month</small>
                                                </li>
                                                <li>
                                                    24 themes
included
                                                </li>
                                                <li>
                                                    Lifetime of
premium support
                                                </li>
                                                <li>
                                                    Access all new
themes
                                                </li>
                                                <li class="line-btn-row">
                                                    <a href=""
class="line-btn green">Get Started</a>
                                                </li>
                                            </ul>
                                        </div>
                                        <div class="pricing-table-wrap" data-
scrollreveal="enter top over 0.5s after 0.7s">
                                            <ul>
                                                <li class="line-head-row">
                                                    Standard
                                                </li>
                                                <li class="line-price-row">
                                                    <p>
                                                        <span
class="symbol">$</span>
                                                        <span>150</span>
                                                    </p>
                                                    <small>Per
user / month</small>
                                                </li>
                                                <li>
                                                    12 themes
included
                                                </li>
                                                <li>
                                                    1 year of theme
updates
                                                </li>
                                                <li>
                                                    Access all new
themes
                                                </li>
                                                <li class="line-btn-row">
                                                    <a href=""
class="line-btn light">Get Started</a>
                                                </li>
                                            </ul>
                                        </div>
```

```
                    </div>

                </div>
                    </section>
        <section id="footer" class="section footer">
                    <div class="container">
                            <div class="row animated opacity mar-bot0" data-andown="fadeIn" data-animation="animation">
                                    <div class="col-sm-12 align-center">
                <ul class="social-network social-circle">
                  <li><a href="#" class="icoRss" title="Rss"><i class="fa fa-rss"></i></a></li>
                  <li><a href="#" class="icoFacebook" title="Facebook"><i class="fa fa-facebook"></i></a></li>
                  <li><a href="#" class="icoTwitter" title="Twitter"><i class="fa fa-twitter"></i></a></li>
                  <li><a href="#" class="icoGoogle" title="Google +"><i class="fa fa-google-plus"></i></a></li>
                  <li><a href="#" class="icoLinkedin" title="Linkedin"><i class="fa fa-linkedin"></i></a></li>
                </ul>
                                    </div>
                            </div>

                            <div class="row align-center copyright">
                                    <div class="col-sm-12">
                                      <p>&copy; GREEN Theme</p>
                  <div class="credits">
                    <a href="https://bootstrapmade.com/">Bootstrap Themes</a> by <a href="https://bootstrapmade.com/">BootstrapMade</a>
                  </div>
                </div>
                            </div>
                    </div>

                </section>
                <a href="#header" class="scrollup"><i class="fa fa-chevron-up"></i></a>

                <script src="js/modernizr-2.6.2-respond-1.1.0.min.js"></script>
                <script src="js/jquery.js"></script>
                <script src="js/jquery.easing.1.3.js"></script>
    <script src="js/bootstrap.min.js"></script>
                <script src="https://maps.google.com/maps/api/js?sensor=true"></script>
                <script src="js/jquery.isotope.min.js"></script>
                <script src="js/jquery.nicescroll.min.js"></script>
                <script src="js/fancybox/jquery.fancybox.pack.js"></script>
                <script src="js/skrollr.min.js"></script>
                <script src="js/jquery.scrollTo-1.4.3.1-min.js"></script>
                <script src="js/jquery.localscroll-1.2.7-min.js"></script>
                <script src="js/stellar.js"></script>
                <script src="js/responsive-slider.js"></script>
                <script src="js/jquery.appear.js"></script>
                <script src="js/grid.js"></script>
    <script src="js/main.js"></script>
    <script src="js/wow.min.js"></script>
                <script>wow = new WOW({}).init();</script>
    <script src="contactform/contactform.js"></script>

</body>
</html>
```

ARDUINO SKETCH

1. SOIL MOISTURE

```
//Sensor code for soil moisture sensor:
void setup()
{
Serial.begin(9600);
}

void loop()
{
int soil_moisture=analogRead(A0);  // read from analog pin A0
Serial.print(soil_moisture);
Serial.print("\n");

if(soil_moisture>950)
{
 Serial.println("Dry soil");
}

if((soil_moisture>750)&&(soil_moisture<951))
{
 Serial.println("Humid soil");
}

if(soil_moisture<751)
{
 Serial.println("water");
}

//else Serial.println("nothing");
}
```

2. RELAY

```
const int relayPin = 6;      // the relay connected pin


int relayState = HIGH;
unsigned long previousMillis = 0;


unsigned long interval = 1000;

void setup() {
  // set the digital pin as output:
  pinMode(relayPin, OUTPUT);
}

void loop() {

  unsigned long currentMillis = millis();

  if (currentMillis - previousMillis >= interval) {

    previousMillis = currentMillis;

    if (relayState == HIGH) {
      relayState = LOW;
    } else {
      relayState = HIGH;
    }

    digitalWrite(relayPin, relayState);
  }
}
```

3. AC MOTOR CONTROL

```
void setup()
{
 pinMode(5, INPUT);
 pinMode(12, OUTPUT);
 Serial.begin(9600);
}
void loop()
{
 int a = analogRead(A0);
 float voltage = a * (5.0 / 1023.0);
 Serial.println(voltage);
 Serial.println(a);
 if (voltage <= 4.0)
   Serial.println("stop motor!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!");
 else
   Serial.println("switch on motor");
}
```

4. LCD DISPLAY

```
#include"LiquidCrystal.h"
const int lcdbacklight=13;
int c,a,a1,b1;
int s1,s2,s3;
const int Sen_LDR=A1;
const int Sen_Water1=A0;
const int Sen_moist=A3;
LiquidCrystal lcd(12, 11, 5, 4, 3, 2);
const int relayPin = 7;      // the relay connected pinint
int relayState = LOW;
unsigned long previousMillis = 0;
unsigned long interval = 6000;
unsigned long interval1 = 2000;
void setup()
{
  lcd.begin(16, 2);
  // Print a message to the LCD.
  lcd.print("  CEN AQUAPONICS");
  //delay(150);
  lcd.clear();
  pinMode(relayPin, OUTPUT);
  digitalWrite(relayPin, relayState);
 pinMode(lcdbacklight,OUTPUT);
}
void loop()
{
s1=Water_sensor();
s2=moist_sensor();
lcd_print(s1,s2);


  unsigned long currentMillis = millis();
lcd.clear();
  if (currentMillis - previousMillis >= interval)
  {


    previousMillis = currentMillis;
    lev:if((unsigned long)millis()-currentMillis<=interval1)

     {

     motorun();
      goto lev;
     }
    digitalWrite(relayPin,LOW);
}

}
```

```
void motorun()
{
  relayState=!(relayState);
digitalWrite(relayPin, relayState);
}



int Water_sensor()
{
   a=analogRead(Sen_Water1);
 float voltage1 = a * (5.0 / 1023.0);

  //waterlevelsensor at fish tank
  if (voltage1 >4.0){
 return 1;
  }
  else
  {
    return -1;
  }

}
int moist_sensor()
{
  c=analogRead(Sen_moist);
  if(c>950)
  {
    return 0;

}

else if((c>750)&&(c<951))
{
  return 1;
}



if(c<751){

return -1;
}

}
void ldr_Sensor()
{
  int lvalue=analogRead(Sen_LDR);
    if(lvalue<=700)
    analogWrite(lcdbacklight,255);
 else if (lvalue>=300 && lvalue<=700)
   analogWrite(lcdbacklight,150);
 else
   analogWrite(lcdbacklight,100);
}
int lcd_print(int a1,int b1)
{

  if(a1==0)
  {
    lcd.setCursor(2,0);
    lcd.print("low Water Level");
  }
  else if (a1==1)
  {
    lcd.setCursor(2,0);
    lcd.print("Normal Water Level");
  }
  if(b1==0)
{
  lcd.setCursor(2,1);
  lcd.print("Dry Soil");
}
else if(b1==1)
```

```
{
  lcd.setCursor(2,1);
  lcd.print("Humid Soil");
}
else
{
  lcd.setCursor(2,1);
  lcd.print("wet condition");
}
return -1;
}
```