# Smart Gardening

## Project Report (Nov 2017)

CS 321: Peripheral Lab

Batch P(Group 16)

## Batch Members


| | |
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# Contents

## Overview

Our Smart Garden project consists of a small prototype of garden that can be used in places where controlled environment is required for the plants like a greenhouse or for general use in homes. The outer body of the prototype is made of cardboard covered from 5 sides and open from the top where the controllable roof is present. The ideal position to place the garden should be a place with access to water(from a tap or pipe) and where maximum sunlight is available.

## Equipment used

Arduino Mega (1)

Xbee shield (1)

Raspberry Pi (1)

Digital Light Sensor (1)

DHT11 Temperature and Humidity Sensor (1)

Soil Moisture Sensor (1)

Solenoid Valves (2)

Relay Switch (2)

9V batteries (3)

Roller wheels (2)

Spray Nozzle (1)

Jumper wires

Roller Belt (cotton, 80cm)

Water Pipe (length 7m, diameter 0.8 cm)

Glue, Tapes, Scissors, Staplers  etc

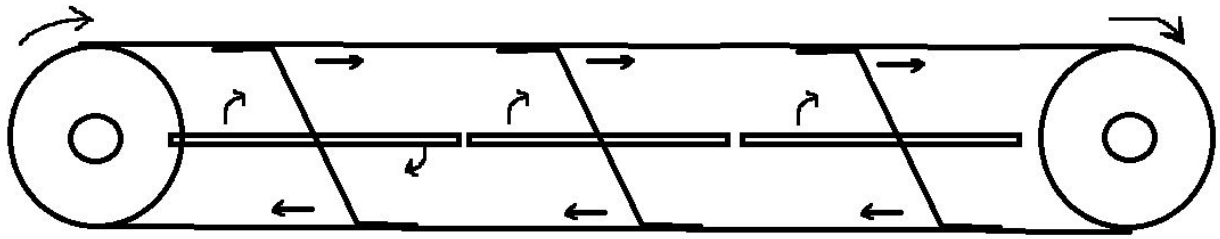
## Features of the project

1. **Automatic irrigation system** via drip irrigation through a pipe connected to water supply source at regular intervals.
2. **Sunlight** entering the garden **controlled** through automatic adjustment of the roof at regular intervals.
3. **Automatic humidity and temperature control** of the environment through a mist spraying mechanism at regular intervals.
4. **Manual control** of all the systems stated above including the time of watering plants, the time of spraying water, the angle of the roof and the interval of scanning the surroundings.
5. **MQTT** : Sensor values are sent over the internet **in real-time** and displayed on a user interface on [thingsboard.io](thingsboard.io)

## Working mechanisms

### Innovative feature : Sunlight control system

Sunlight falling on the plants is read through a Digital light sensor placed at the level of plants. The roof is movable from 0 through 90 degrees. 0 being fully closed and 90 being fully open.



Working of the sunlight control system

The movement is controlled by a belt and wheel mechanism (as shown in the image) where the wheel is controlled by a servo motor attached to the wheel which itself is connect to the arduino for controlling its movement. The detection of sunlight starts with the roof scanning through all the angles and noting the amount of sunlight falling on the sensor at intervals of 10 degrees. These value are sent to the arduino where modulo of their difference is taken with some predefined value set by the user. The minimum value which is then found is taken and the

corresponding angle is set as the angle of the roof. This scanning runs in intervals of 3hrs(can be changed by the user) and again the roof angle is adjusted.

### Other Features and their working

1. **Automatic Irrigation system**:
   The irrigation system starts with a soil moisture sensor placed in the soil taking the value of moisture present in the soil and sending the reading to an arduino where the reading is noted and checked for some constraints. If the conditions are satisfied, a signal is send to a solenoid valve which has pipes connected having water supply. When the signal arrives, the valve is opened and water is allowed to enter the garden. Here the plants are irrigated via drip irrigation method and acces water is drained through a pipe to the source tank. After some time, when the soil gets moist enough, a signal is again send to the valve which closes the water supply.

2. **Mist spraying mechanism**:
   Humidity and temperature is read through a temperature and humidity sensor placed in the corner of the box. The reading is sent to the arduino where it is checked to some conditions similar to the irrigation system and accordingly a signal is sent to the valve which opens the valve and water passes through a pipe which has a spraying nozzle attached to it which throws mist in the air surrounding the plants.

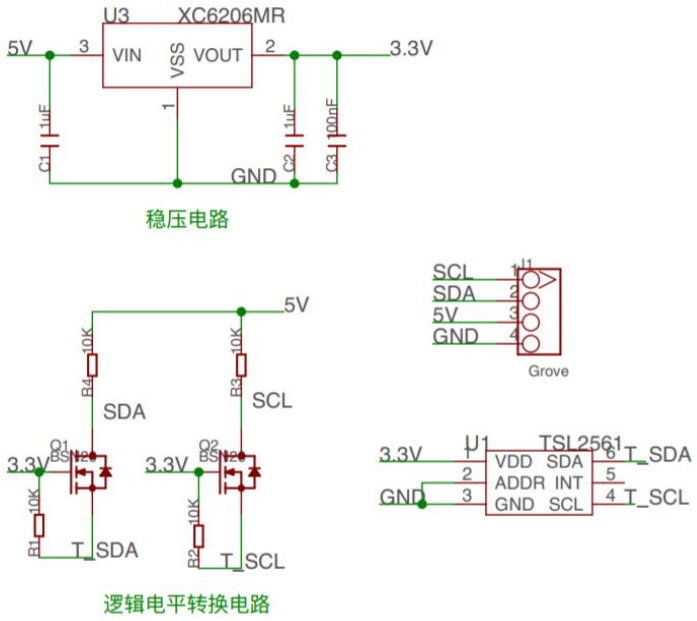
# Study of the sensors

## 1. Grove Digital Light Sensor

### Technical Specification

- Approximates Human eye Response
- Precisely Measures Illuminance in Diverse Lighting Conditions
- Temperature range: -30 to 80 *C
- Dynamic range (Lux): 0.1 to 40,000 Lux
- Voltage range: 2.7-3.6V
- Interface: I2C
- This board/chip uses I2C 7-bit addresses 0x39, 0x29, 0x49, selectable with jumpers

## Schematic diagram




Ref: [http://wiki.seeed.cc/Grove-Digital_Light_Sensor/](http://wiki.seeed.cc/Grove-Digital_Light_Sensor/)

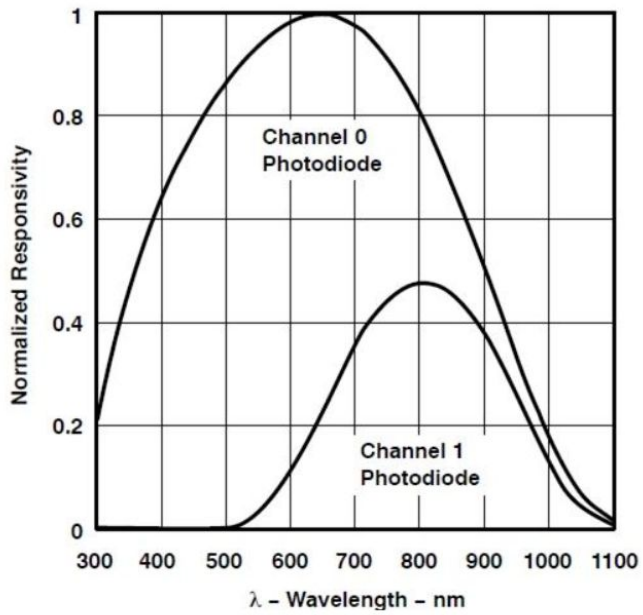
The TSL2561 is a second-generation ambient light sensor device. It contains two integrating analog-to-digital converters (ADC) that integrate currents from two photodiodes. Integration of both channels occurs simultaneously. Upon completion of the conversion cycle, the conversion result is transferred to the Channel 0 and Channel 1 data registers, respectively. The transfers are double-buffered to ensure that the integrity of the data is maintained. After the transfer, the device automatically begins the next integration cycle.

Communication to the device is accomplished through a standard, two-wire SMBus or I2C serial bus.

## Characteristics

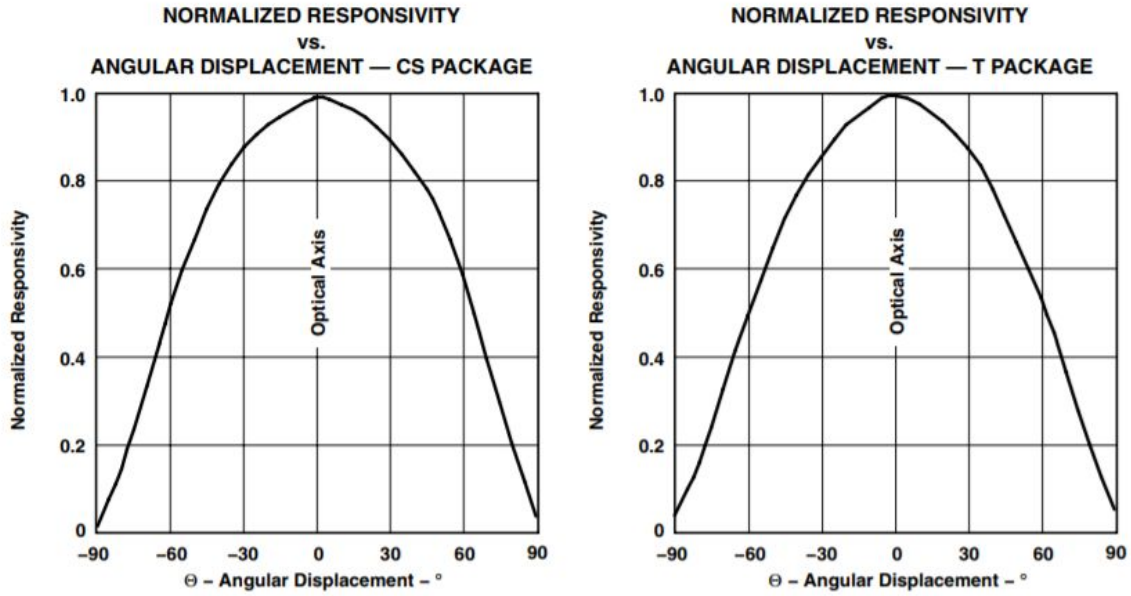
### Spectrum response curve -

- Spectrum Response Curve




The two channels of the digital light sensor have different response characteristic. We can choose its working mode by having both of them on or one of them off.

## Responsivity curve -




The digital light sensor we used was of the T package type.

*Reference for Info and Figures :*
https://raw.githubusercontent.com/SeeedDocument/Grove-Digital_Light_Sensor/master/res/TSL2561T.pdf

# 2. Soil Moisture Sensor

## Description

FC-28 Soil Moisture Sensor is a simple breakout for measuring the moisture in soil and similar materials. The two large exposed pads function as probes for the sensor, together acting as a variable resistor. The more water that is in the soil means the better the conductivity between the pads will be and will result in a lower resistance, and a higher AOUT.

## Features

- Digital Output Threshold Adjust Potentiometer
- Power and Digital Output Indicator LEDs
- Analog and Digital outputs
- Mounting hole for easy installation

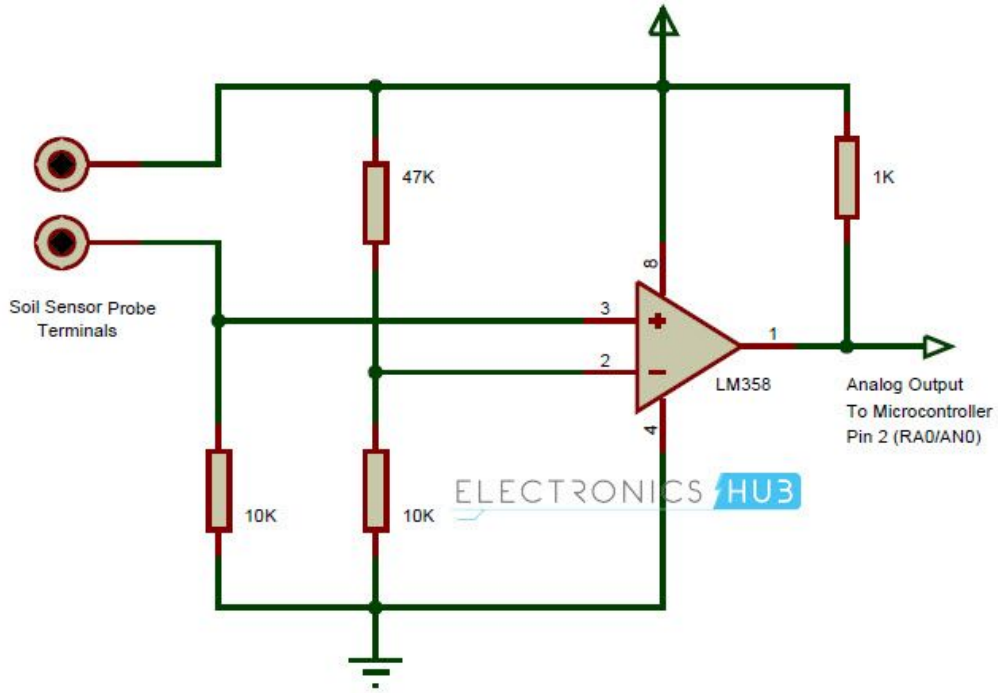
## Technical Specifications

- Operating voltage 3.3V-5V
- PCB size: 3.2cm x 1.4cm
- Power indicators: (red) and digital switching output indicator (green)
- Comparator Chip : LM393

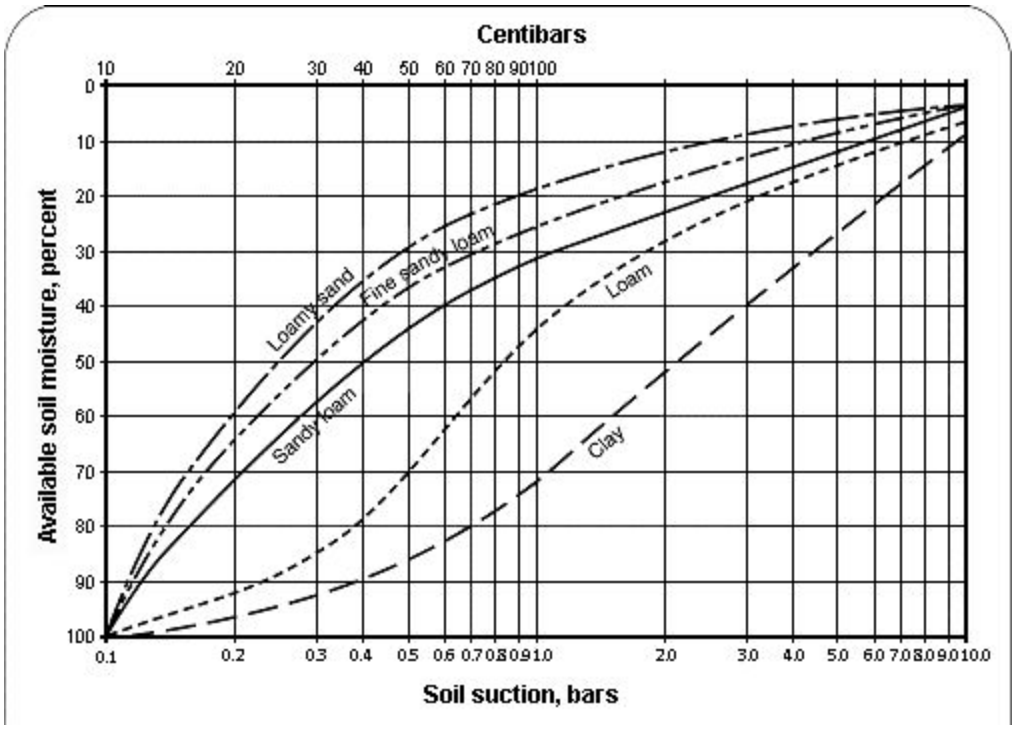
## Pinouts

1. VCC: .3.3V-5V
2. GND: 0V Ground Reference
3. DO: digital output (0 or 1)
4. AO: Analog output (0 – VCC)

## Driving circuit




## Characteristic Graph



This graph converts soil moisture tension readings to % available soil moisture for various soil textures.

From the observation of graphs reading, we can see the following relation

- 0-10 Centibars = Saturated soil
- 10-30 Centibars = Soil is adequately wet (except coarse sands, which are beginning to lose water)
- 30-60 Centibars = Usual range for irrigation (most soils)
- 60-100 Centibars = Usual range for irrigation in heavy clay
- 100-200 Centibars = Soil is becoming dangerously dry for maximum production.

Reference : http://www.ti.com/lit/ds/symlink/lm393-n.pdf

# 3. Temperature and Humidity sensor:

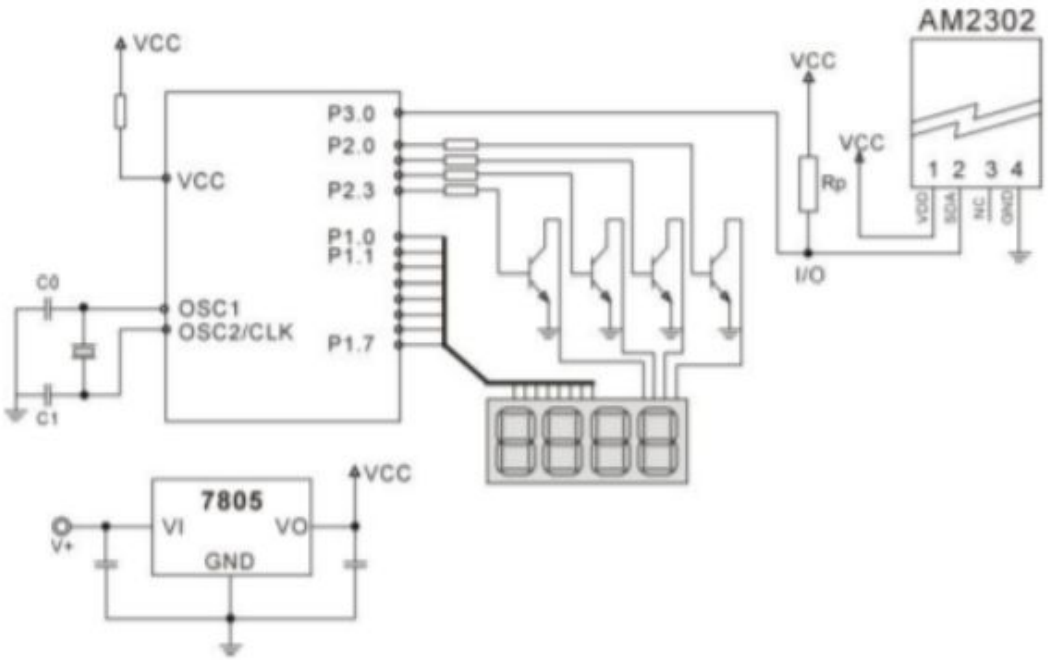
## Description

DHT series digital temperature and humidity sensor – full scale calibration, digital output – humidity measurement range: 20% to 9 0%RH (0-50 ° C temperature compensation); temperature measurement range: 0 to +50 ° C; humidity measurement accuracy: measurement accuracy of ± 5.0%RH temperature: ± 2 ° C response time: <5 seconds; low power consumption

## Technical Specifications

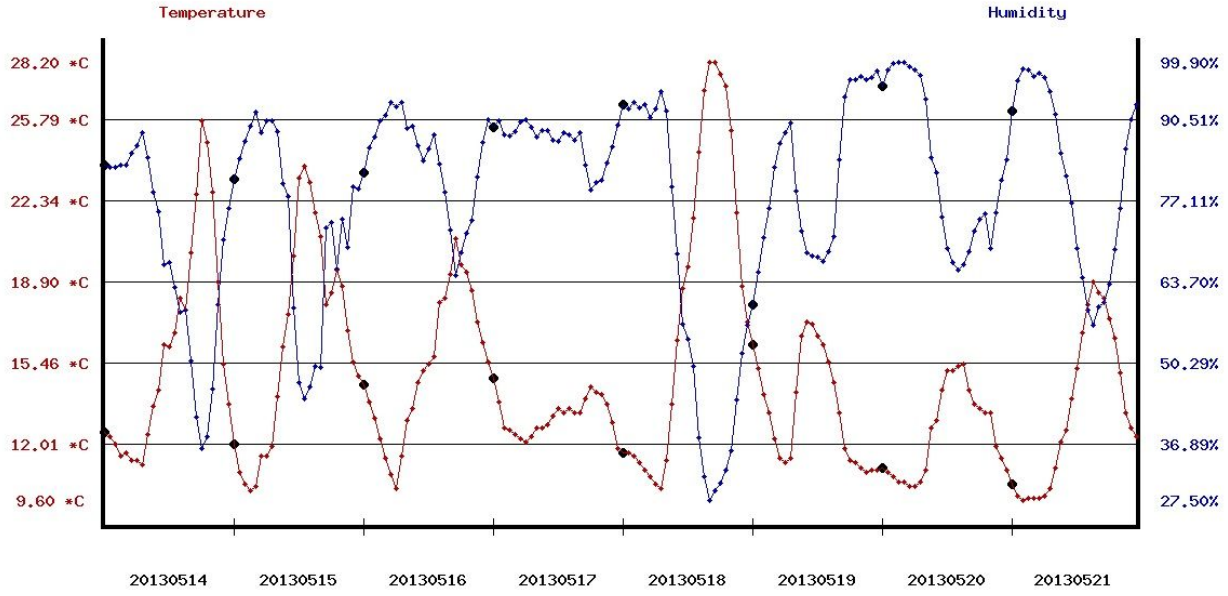
- Power supply voltage: 3.3~5.5V DC
- Output: the single bus digital signal
- Measuring range: 20-90%RH humidity, temperature 0~50°
- The measurement accuracy of +-5%RH: humidity, temperature +-2 °
- Resolution: 1%RH humidity, temperature 1 °
- Exchangeability: fully interchangeable, Long term stability: < ± 1%RH/

## Circuit Diagram:



## Characteristic graph:

The graph plots humidity and temperature noted by the sensor across time. Temperature readings are noted in celsius and relative humidity is noted in percentage.




| Parameter | Min. | Typical | Max. | Unit |
|---|---|---|---|---|
| Working voltage | 2.1 | 5 | 5.5 | VDC |
| Analog output voltage ( VCC=5V ) | 0 | Vout | 5 | V |
| Digital output voltage ( VCC=5V ) | 0 | - | 5 | V |
| Working current ( VCC=5V ) | - | 5 | - | mA |
| Threshold hysteresis ΔUth | - | VCC*0.09 | - | V |

## Specifications

| | |
|---|---|
| PCB size | 71.65mm X 24.00mm X 1.6mm |
| Working voltage | 3.3or 5V DC |
| Operating voltage | 3.3 or 5V DC |
| Compatible interfaces | 2.54 3-pin interface and 4-pin Grove interface[1][2] |

*Note 1 : D for digital output port, A for analog output port, S for analog/digital output port ( defined according to the switch), V and G for voltage at the common collector and ground respectively*

*Note 2 : When setting as analog output, output range is 0-3.3V or 0-5V according to the working voltage; when setting as digital output, output is 0/3.3V or 0/5V according to the working voltage.*

## Characteristics of Temperature and Humidity Sensor-

| Parameters | Conditions | Minimum | Typical | Maximum |
|---|---|---|---|---|
| **Humidity** | | | | |
| **Resolution** | | 1%RH | 1%RH | 1%RH |
| | | | 8 Bit | |
| **Repeatability** | | | ±1%RH | |
| **Accuracy** | 25℃ | | ±4%RH | |
| | 0-50℃ | | | ±5%RH |
| **Interchangeability** | Fully Interchangeable | | | |
| **Measurement Range** | 0℃ | 30%RH | | 90%RH |
| | 25℃ | 20%RH | | 90%RH |
| | 50℃ | 20%RH | | 80%RH |
| **Response Time (Seconds)** | 1/e(63%)25℃, 1m/s Air | 6 S | 10 S | 15 S |
| **Hysteresis** | | | ±1%RH | |
| **Long-Term Stability** | Typical | | ±1%RH/year | |
| **Temperature** | | | | |
| **Resolution** | | 1℃ | 1℃ | 1℃ |
| | | 8 Bit | 8 Bit | 8 Bit |
| **Repeatability** | | | ±1℃ | |
| **Accuracy** | | ±1℃ | | ±2℃ |
| **Measurement Range** | | 0℃ | | 50℃ |
| **Response Time (Seconds)** | 1/e(63%) | 6 S | | 30 S |

Reference : http://www.micropik.com/PDF/dht11.pdf

## Further developments in the project

1. We can add feedback to the roof panes to check if they are not loose or shifted.
2. Similar feedback mechanism can be added for Irrigation and Mist mechanisms **to check for leakages**
3. Weather prediction api can be used to detect the chances of rain and therefore control of roof accordingly.