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SENSORS & INSTRUMENTATION

(ECE1005) – J COMPONENT

TOPIC: WEATHER STATION

Submitted by:

19BEC0428 - ANSHUMAN PHADKE

19BEC0552 - HRITIKA RATHI

19BEC0559 - SAKSHAM BHUTANI

19BEC0562 - ASHISH AKARSH

19BEC0564 - ARVIND N

Submitted to:

Prof. MUTHU RAJA S

Acknowledgement

We wish to express our sincere thanks and deep sense of gratitude to our project guide, **Professor.**
MUTHU RAJA S , for his consistent encouragement and valuable guidance offered to us in a pleasant manner throughout the course of the project work.

We also take this opportunity to thank all the faculty of the School of Electronics Engineering for their support and their wisdom imparted to us throughout the course.

We thank our parents, family, and friends for bearing with us throughout the course of our project and for the opportunity they provided us in undergoing this course in such a prestigious institution.

And lastly and most importantly, we would like to thanks Vellore Institute of Technology, Vellore, Tamil Nadu to provide us opportunities and facilities to carry out this project.

INTRODUCTION

Weather is an inevitable factor in every crop production. Knowing real-time weather conditions like temperature, precipitation, and humidity is the best way to protect crops from the harmful impact of adverse weather events as well as pests. In fact, accurate monitoring of weather data can greatly affect crop yield and overall farm productivity and profitability.

Weather monitoring is an important activity in farm management, especially prior to sowing, harvesting or some other activity crucial for successful crop establishment and yield.

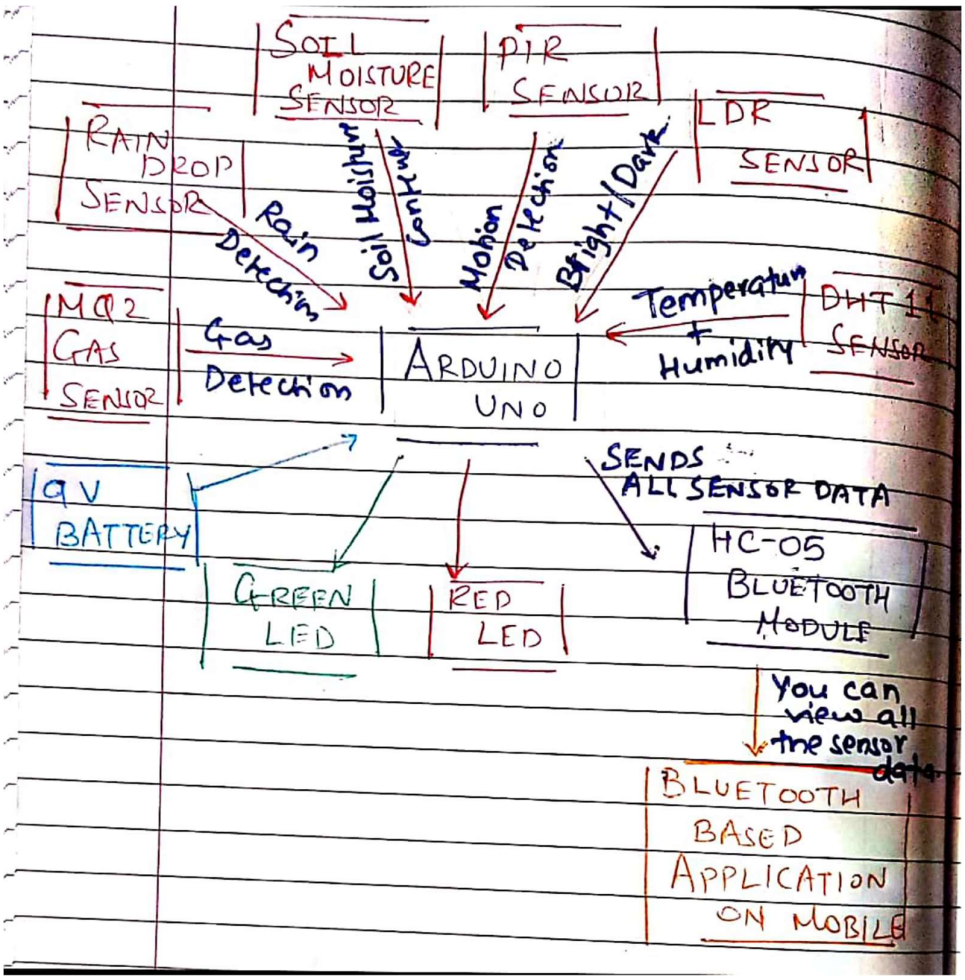
More than 75% of India's Population is engaged in Agriculture, yet the agriculture sector only holds 18% of share in India's GDP. Productivity of Agriculture has been increasing in India since Green Revolution, yet it has been very slow as compared to other countries. The main reason for this slow growth is lack of efficiency, which can only be provided with the help of Science. Agriculture directly depends on Weather and Atmospheric conditions of the area. Monitoring and taking steps according to Weather and Atmospheric conditions is very crucial. But monitoring the environment requires a lot of expensive machinery. So, our main aim was to monitor Weather and Atmospheric conditions of the area but without spending much money, so it is affordable for all

ABSTRACT

Since the beginning of agriculture, farmers have monitored weather conditions in order to prevent seed and later, yield losses. Initially, weather monitoring was very primitive, based on weather patterns on a particular location. Today, farmers have plenty of sources to obtain accurate weather forecasts, such as TV, internet, and various mobile applications. Nevertheless, farmers increasingly set their own weather stations in the field.

Modern agriculture offers diverse systems for precise monitoring of weather conditions. Farmers are therefore able to use the most sophisticated weather monitoring equipment. Such modern systems can measure both soil and environmental parameters related to evapotranspiration, plant growth, and development as well as irrigation schedule and insect pest and disease modelling.

BASIC LAYOUT:-



BLOCK DIAGRAM OF CIRCUIT

The model uses Solar panel; Solar panel uses photovoltaic cells joint together to convert heat energy from the Sun to electrical energy. The Arduino is embedded with ATMEGA328P Chip which interprets the code to perform various tasks. LDR Sensor uses photovoltaic cells for detection of light. DHT11 Temperature Sensors uses variable capacitors to measure Temperature and Humidity. Rain Drop Sensor and Soil Moisture Sensor use their Resistive Capacity to measure the amount of water. MQ2 Sensor uses an Electrochemical Sensor to measure the presence of different gases. The Bluetooth module (HC-05) works on 2.4GHz baseband transmission. It sends all the signals to the phone. The application converts these signals into readable signals. It takes all these signals , interprets it and send them via Bluetooth module to the respective devices or phones with application to show the results or information/details.

Combining all of this altogether we build our project – **WEATHER MONITORING SYSTEM** to ease up the daily work and per the requirements for farmers.

COMPONENTS USED:-

1. ARDUINO UNO BOARD

Arduino is a software company, project, and user community that designs and manufactures computer open-source hardware, open-source software, and microcontroller-based kits for building digital devices and interactive objects that can sense and control physical devices.

The project is based on microcontroller board designs, produced by several vendors, using various microcontrollers. These systems provide sets of digital and analog I/O pins that can interface to various expansion boards and other circuits. The boards feature serial communication interfaces, including Universal Serial Bus (USB) on some models, for loading programs from personal computers. For programming the microcontrollers, the Arduino project provides an integrated development environment (IDE) based on a programming language named *Processing*, which also supports the languages C and C++.

The first Arduino was introduced in 2005, aiming to provide a low cost, easy way for novices and professionals to create devices that interact with their environment using sensors and actuators. Common examples of such devices intended for beginner hobbyists include simple robots, thermostats, and motion detectors.\

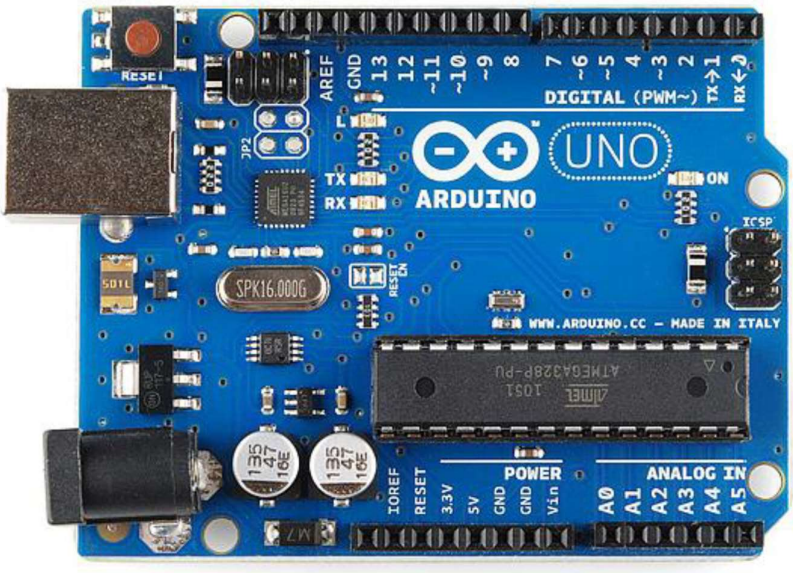


Fig. ARDUINO UNO BOARD

Arduino is a single-board microcontroller meant to make the application more accessible which are interactive objects and its surroundings. The hardware features with an open-source hardware board designed around an 8-bit Atmel AVR Microcontroller or a 32-bit Atmel ARM. Current models consists a USB interface, 6 analog input pins and 14 digital I/O pins that allows the user to attach various extension boards.

The Arduino Uno board is Microcontroller based on the ATmega328. It has 14 digital input/output pins in which 6 can be used as PWM outputs, a 16 MHz ceramic resonator, an ICSP header, a USB connection, 6 analog inputs, a power jack and a reset button. This contains all the required support needed for microcontroller. In order to get started, they are simply connected to a computer with a USB cable or with a AC-to-DC adapter or battery. Arduino Uno Board varies from all other boards and they will not use the FTDI USB-to-serial driver chip in them. It is featured by the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter

FEATURES OF ARDUINO UNO:-

• It is an easy USB interface. This allows interface with USB as this is like a serial device.

• The chip on the board plugs straight into your USB port and supports on your computer as a virtual serial port. The benefit of this setup is that serial communication is an extremely easy protocol which is time-tested, and USB makes connection with modern computers and makes it comfortable.

• It is easy-to-find the microcontroller brain which is the ATmega328 chip. It has a greater number of hardware features like timers, external and internal interrupts, PWM pins and multiple sleep modes.

• It is an open source design and there is an advantage of being open source is that it has a large community of people using and troubleshooting it. This makes it easy to help in debugging projects.

• It is a 16 MHz clock which is fast enough for most applications and does not speeds up the microcontroller.

• It is very convenient to manage power inside it and it had a feature of built-in voltage regulation. This can also be powered directly off a USB port without any external power. You can connect an external power source of 12v (maximum) and this regulates it to both 5v and 3.3v.

• 13 digital pins and 6 analog pins. This sort of pins allows you to connect hardware to your Arduino Uno board externally. These pins are used as a key for extending the computing capability of the Arduino Uno into the real world. Simply plug your electronic devices and sensors into the sockets that correspond to each of these pins and you are good to go.

• This has an ICSP connector for bypassing the USB port and interfacing the Arduino directly as a serial device. This port is necessary to re-boot your chip if it corrupts and can no longer used by your computer.

• It has a 32 KB of flash memory for storing your code.

• An on-board LED is attached to digital pin 13 to make fast the debugging of code and to make the debug process easy.

• Finally, it has a button to reset the program on the chip.

• Sound is output on digital pin 3 and/or 11. It can drive headphones directly or add a simple audio amplifier to drive a loudspeaker.

2. BREADBOARD

A breadboard is a solderless device for temporary prototype with electronics and test circuit designs. Most electronic components in electronic circuits can be interconnected by inserting their leads or terminals into the holes and then making connections through wires where appropriate. The breadboard has strips of metal underneath the board and connect the holes on the top of the board. The metal strips are laid out as shown below. Note that the top and bottom rows of holes are connected horizontally and split in the middle while the remaining holes are connected vertically. Note how all holes in the selected row are connected, so the holes in the selected column. The set of connected holes can be called a node. A modern solderless breadboard socket consists of a perforated block of plastic with numerous tin-plated phosphor bronze or nickel silver alloy spring clips under the perforations. The clips are often called *tie points* or *contact points*. The number of tie points is often given in the specification of the breadboard. The spacing between the clips (lead pitch) is typically 0.1 inches (2.54 mm). The edge of the board has male and female dovetail notches so boards can be clipped together to form a large breadboard.

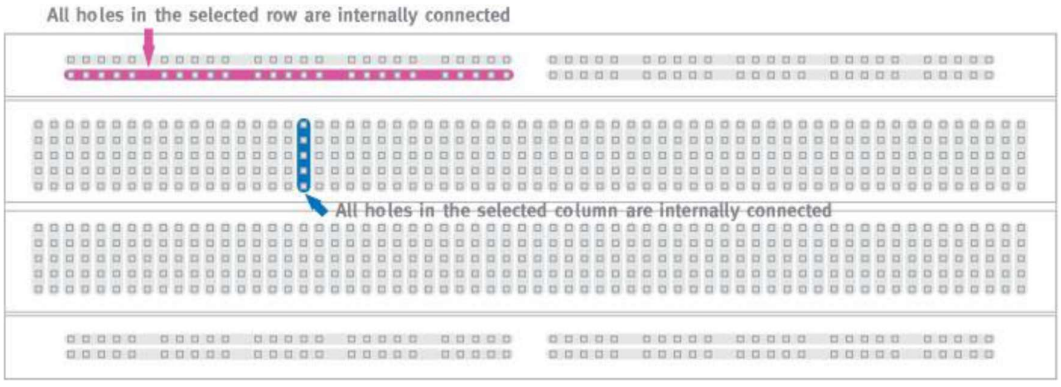


Fig. BREADBOARD

3. DHT11 (TEMPERATURE & HUMIDITY SENSOR)

Humidity is the measure of water vapour present in the air. The level of humidity in air affects various physical, chemical and biological processes. In industrial applications, humidity can affect the business cost of the products, health and safety of the employees. So, in semiconductor industries and control system industries measurement of humidity is very important. Humidity measurement determines the amount of moisture present in the gas that can be a mixture of water vapour, nitrogen, argon or pure gas etc… Humidity sensors are of two types based on their measurement units. They are a relative humidity sensor and Absolute humidity sensor. DHT11 is a digital temperature and humidity sensor.

DHT11 is a low-cost digital sensor for sensing temperature and humidity. This sensor can be easily interfaced with any micro-controller such as Arduino, Raspberry Pi etc… to measure humidity and temperature instantaneously. DHT11 humidity and temperature sensor is available as a sensor and as a module. The difference between this sensor and module is the pull-up resistor and a power-on LED. DHT11 is a relative humidity sensor. To measure the surrounding air this sensor uses a thermistor and a capacitive humidity sensor.

DHT11 sensor consists of a capacitive humidity sensing element and a thermistor for sensing temperature. The humidity sensing capacitor has two electrodes with a moisture holding substrate as a dielectric between them. Change in the capacitance value occurs with the change in humidity levels. The IC measure, process this changed resistance values and change them into digital form.

For measuring temperature this sensor uses a Negative Temperature coefficient thermistor, which causes a decrease in its resistance value with increase in temperature. To get larger resistance value even for the smallest change in temperature, this sensor is usually made up of semiconductor ceramics or polymers.

The temperature range of DHT11 is from 0 to 50 degree Celsius with a 2-degree accuracy. Humidity range of this sensor is from 20 to 80% with 5% accuracy. The sampling rate of this sensor is 1Hz .i.e. it gives one reading for every second. DHT11 is small in size with operating voltage from 3 to 5 volts. The maximum current used while measuring is 2.5mA.

DHT11 sensor has four pins- VCC, GND, Data Pin and a not connected pin. A pull-up resistor of 5k to 10k ohms is provided for communication between sensor and micro-controller.

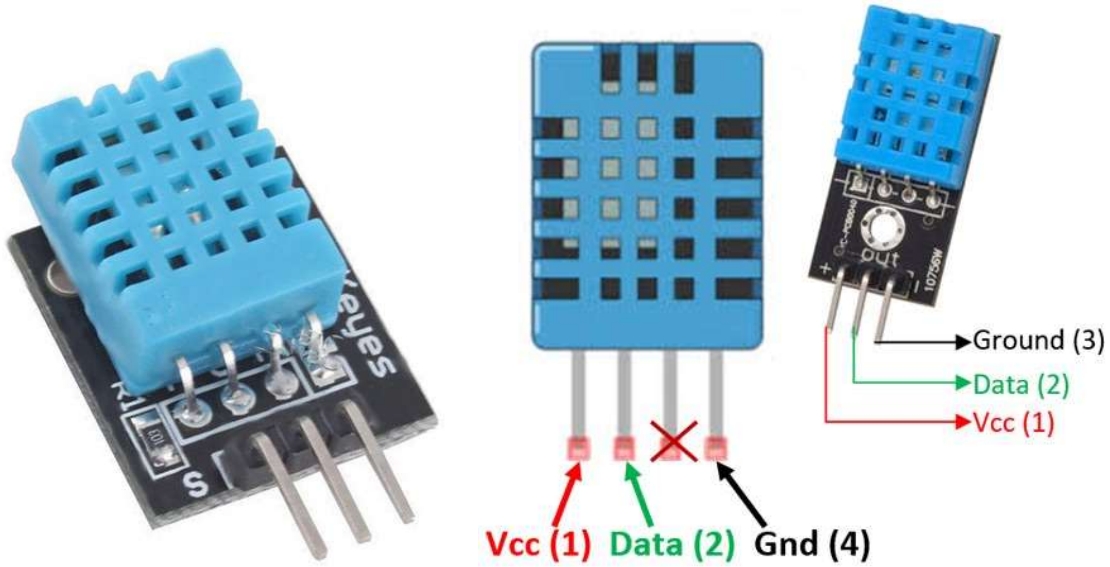


Fig. DHT11 – TEMPERATURE & HUMIDITY SENSOR

4. MQ2 (SMOKE AND GAS SENSOR)

The Grove - Gas Sensor(MQ2) module is useful for gas leakage detection (home and industry). It is suitable for detecting H2, LPG, CH4, CO, Alcohol, Smoke or Propane. Due to its high sensitivity and fast response time, measurement can be taken as soon as possible. The sensitivity of the sensor can be adjusted by potentiometer.

- Operating Voltage is +5V
- Can be used to Measure or detect LPG, Alcohol, Propane, Hydrogen, CO and even methane
- Analog output voltage: 0V to 5V
- Digital Output Voltage: 0V or 5V (TTL Logic)
- Preheat duration 20 seconds
- Can be used as a Digital or analog sensor
- The Sensitivity of Digital pin can be varied using the potentiometer

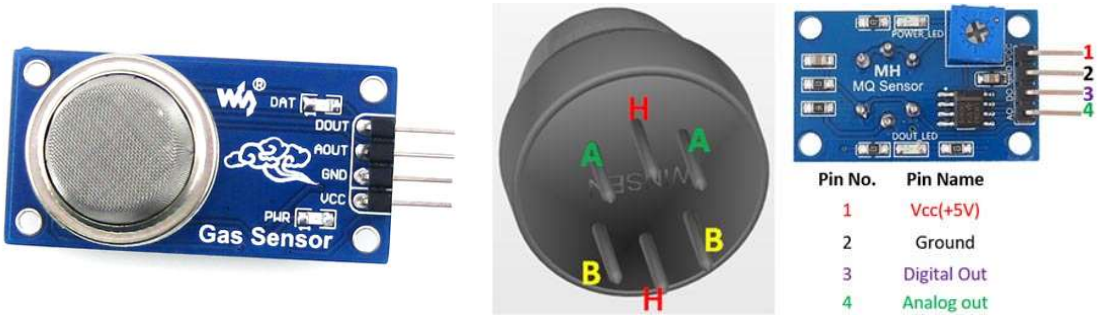


Fig. MQ2 –GAS SENSOR

5. RAIN DROP SENSOR

Raindrop Sensor is a tool used for sensing rain. It consists of two modules, a **rain board** that detects the rain and a **control module**, which compares the analog value, and converts it to a digital value. The raindrop sensors can be used in the automobile sector to control the windshield wipers automatically, in the agriculture sector to sense rain and it is also used in home automation systems.

- Working voltage 5V
- Output format: Digital switching output (0 and 1), and analog voltage output AO
- Potentiometer adjust the sensitivity
- Uses a wide voltage LM393 comparator
- Comparator output signal clean waveform is good, driving ability, over 15mA
- Anti-oxidation, anti-conductivity, with long use time
- With bolt holes for easy installation
- Small board PCB size: 3.2cm x 1.4cm

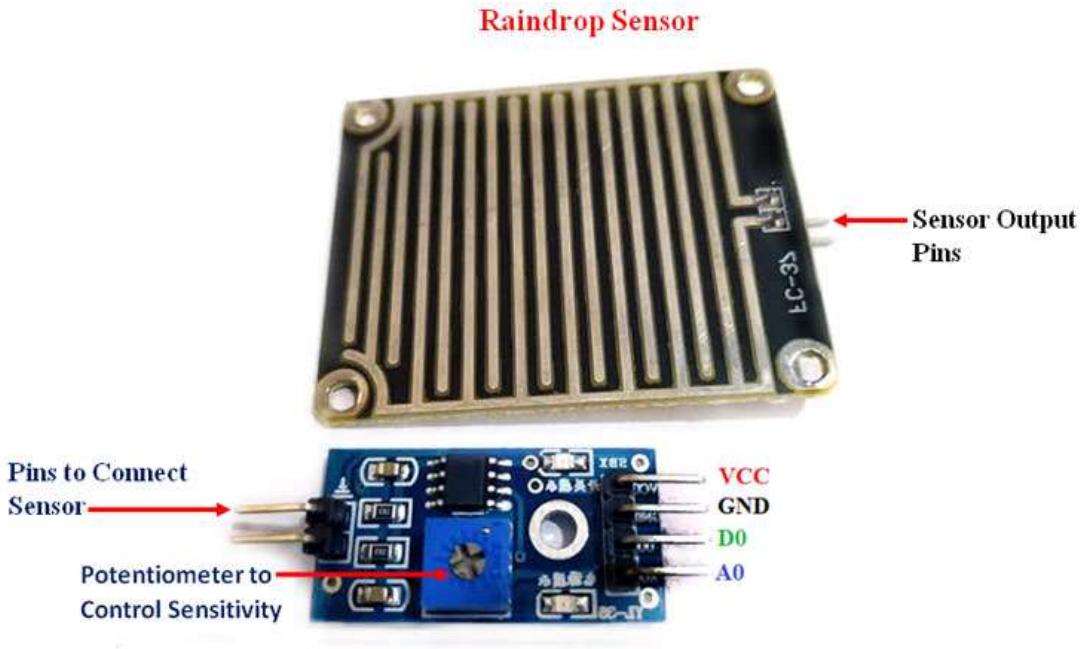


Fig. RAINDROP SENSOR

6. SOIL MOISTURE SENSOR

The moisture of the soil plays an essential role in the irrigation field as well as in gardens for plants. As nutrients in the soil provide the food to the plants for their growth. Supplying water to the plants is also essential to change the temperature of the plants. The temperature of the plant can be changed with water using the method like transpiration. And plant root systems are also developed better when rising within moist soil. Extreme soil moisture levels can guide to anaerobic situations that can encourage the plant's growth as well as soil pathogens. This article discusses an overview of the soil moisture sensor, working and it's applications.

The soil moisture sensor is one kind of sensor used to gauge the volumetric content of water within the soil. As the straight gravimetric dimension of soil moisture needs eliminating, drying, as well as sample weighting. These sensors measure the volumetric water content not directly with the help of some other rules of soil like dielectric constant, electrical resistance, otherwise interaction with neutrons, and replacement of the moisture content.

The relation among the calculated property as well as moisture of soil should be adjusted & may change based on ecological factors like temperature, type of soil, otherwise electric conductivity.

These sensors normally used to check volumetric water content, and another group of sensors calculates a new property of moisture within soils named water potential. Generally, these sensors are named as soil water potential sensors which include gypsum blocks and tensiometer.

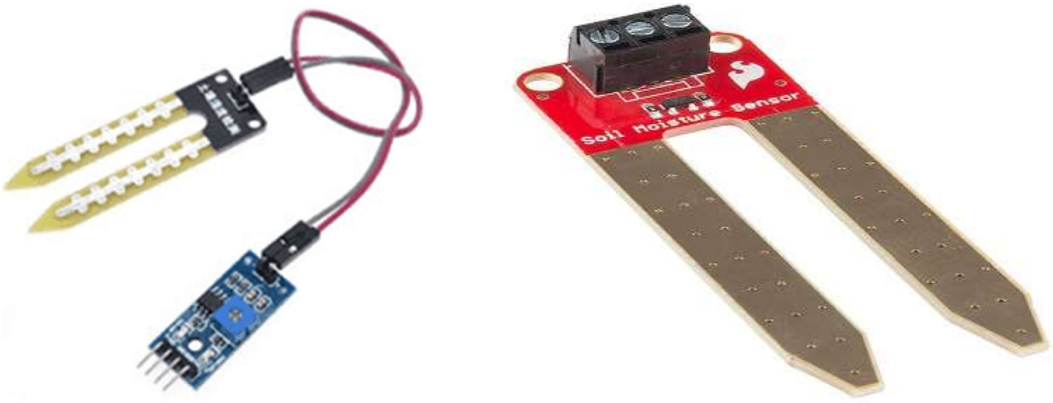


Fig. SOIL MOISTURE SENSOR

7. LDR (LIGHT INTENSITY SENSOR)

Light dependent resistors, LDRs or photoresistors are often used in electronic circuit designs where it is necessary to detect the presence or the level of light.

These electronic components can be described by a variety of names from light dependent resistor, LDR, photoresistor, or even photo cell, photocell or photoconductor.

Although other electronic components such as photodiodes or photo-transistor can also be used, LDRs or photo-resistors are a particularly convenient to use in many electronic circuit designs. They provide large change in resistance for changes in light level.

A photoresistor or light dependent resistor is an electronic component that is sensitive to light. When light falls upon it, then the resistance changes. Values of the resistance of the LDR may change over many orders of magnitude the value of the resistance falling as the level of light increases.

It is not uncommon for the values of resistance of an LDR or photoresistor to be several megohms in darkness and then to fall to a few hundred ohms in bright light. With such a wide variation in resistance, LDRs are easy to use and there are many LDR circuits available. The sensitivity of light dependent resistors or photoresistors also varies with the wavelength of the incident light.

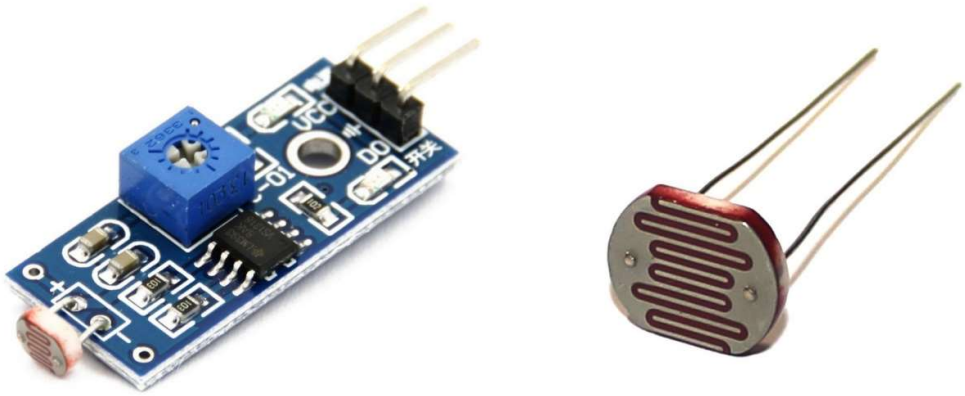


Fig. LDR

8. HC-05 (BLUETOOTH MODULE)

HC-05 is a Bluetooth module which is designed for wireless comunication. This module can be used in a master or slave configuration.

HC-05 Bluetooth Module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Its communication is via serial communication which makes an easy way to interface with controller or PC. HC-05 Bluetooth module provides switching mode between master and slave mode which means it able to use neither receiving nor transmitting data.

- Serial Bluetooth module for Arduino and other microcontrollers
- Operating Voltage: 4V to 6V (Typically +5V)
- Operating Current: 30mA
- Range: <100m
- Works with Serial communication (USART) and TTL compatible
- Follows IEEE 802.15.1 standardized protocol
- Uses Frequency-Hopping Spread spectrum (FHSS)
- Can operate in Master, Slave or Master/Slave mode
- Can be easily interfaced with Laptop or Mobile phones with Bluetooth
- Supported baud rate: 9600,19200,38400,57600,115200,230400,460800.

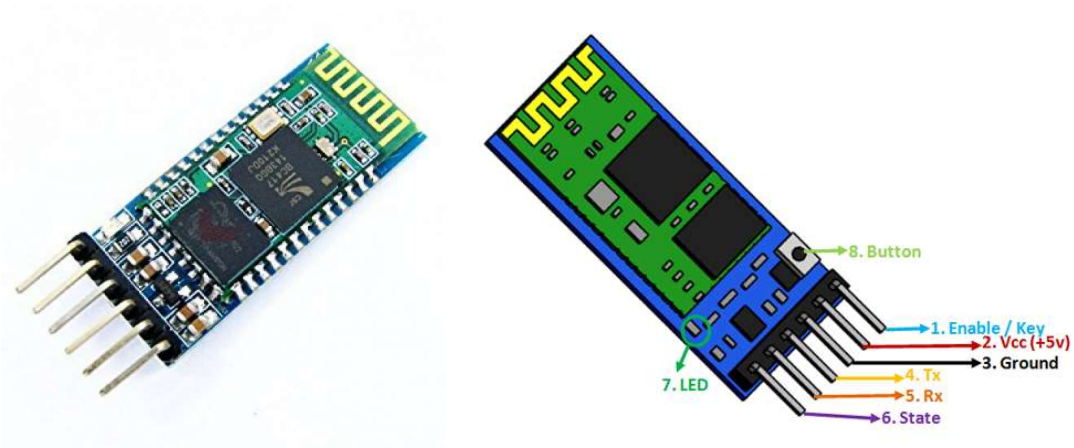


Fig. HC – 05 (BLUETOOTH MODULE)

9. PIR SENSOR

PIR sensors allow you to sense motion, almost always used to detect whether a human has moved in or out of the sensors range. They are small, inexpensive, low-power, easy to use and don't wear out. For that reason they are commonly found in appliances and gadgets used in homes or businesses. They are often referred to as PIR, "Passive Infrared", "Pyroelectric", or "IR motion" sensors.

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- **Size:** Rectangular
- **Output:** Digital pulse high (3V) when triggered (motion detected) digital low when idle (no motion detected). Pulse lengths are determined by resistors and capacitors on the PCB and differ from sensor to sensor.
- **Sensitivity range:** up to 20 feet (6 meters) 110° x 70° detection range
- **Power supply:** 5V-12V input voltage for most modules (they have a 3.3V regulator), but 5V is ideal in case the regulator has different specs

Fig. PIR SENSOR

10. OTHER COMPONENTS :- RESISTORS to limit the current. **LED's** for indication , and some **WIRES** and glue to connect and bind the circuit altogether.

WORKING PRINCIPLE

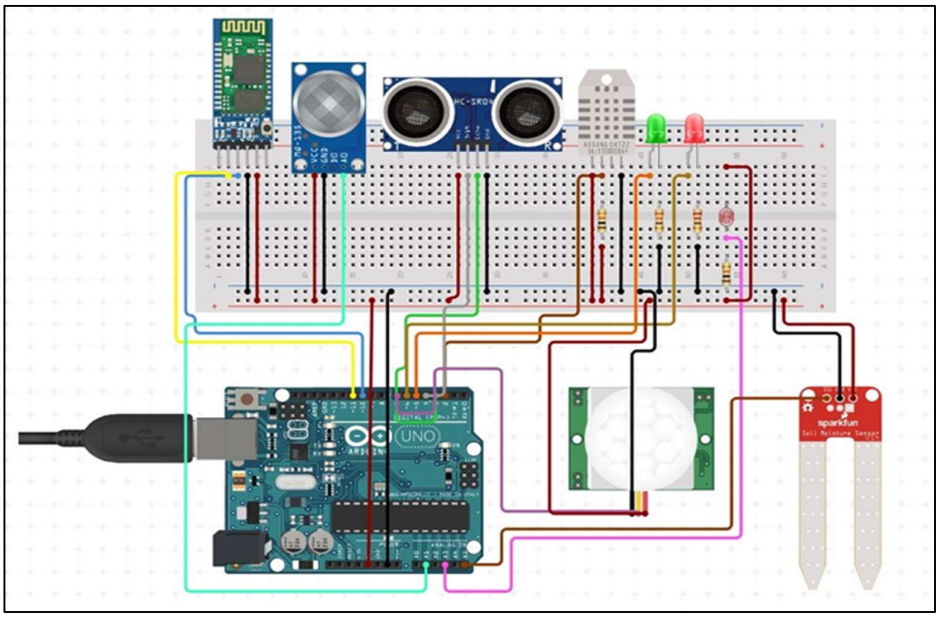
The Arduino is embedded with ATMEGA328P Chip which interprets the code to perform various tasks. LDR Sensor uses photovoltaic cells for detection of light. DHT11 Temperature Sensors uses variable capacitors to measure Temperature and Humidity. Rain Drop Sensor and Soil Moisture Sensor use their Resistive Capacity to measure the amount of water. MQ2 Sensor uses an Electrochemical Sensor to measure the presence of different gases. The Bluetooth module (HC-05) works on 2.4GHz baseband transmission. It sends all the signals to the phone. The application converts these signals into readable signals. Advanced Algorithms are used.

Arduino is the brain of this weather station. It takes all the information from the sensors, interprets it and then finally, sends the results via the Bluetooth Module. The data is interpreted in such a way that it is easy to understand, without need of any formal education. The language of the data can be changed according to the requirement of the farmer i.e. हिन्दी, English, Urdu etc. The data can be seen in any mobile phone with Bluetooth facilities. Live data is sent to the phone, it is also saved in the Arduino itself to be viewed later on. Arduino is programmed via Arduino IDE. Following data is received:

- Temperature (In *C)
- Humidity (In %)
- Air Quality (In ppm)
- Flammable Gas Detection (LPG, Alcohol & Methane)
- Rain Detection (No Rain/ Rain/ Heavy Rain)
- Soil Moisture (Dry Soil, Humid Soil, Water)
- Light intensity (In %)

  The application was developed using MIT's open source app developer (V-2). We have also prepared some Algorithms which give advance warnings to farmers about things like Strom, Heavy Rainfall etc.

CIRCUIT DIAGRAM



CODE

sensors_project_weather_station §

```
//Sensors Project-Weather Station For Farmers !
#include <SoftwareSerial.h>`

#define rxPin 0                    // define SoftwareSerial rx data pin
#define txPin 1                    // define SoftwareSerial tx data pin

SoftwareSerial blueTooth(txPin, rxPin);  // create instance of SoftwareSerial

int ledPin1=13;
int ledPin2=12;
int soilPin = A0;
int sensorValue;
int limit = 750;

#include <dht.h>
#define dht_apin A1 // Analog Pin sensor is connected to
 dht DHT;

const int trigPin = 7; // Trigger Pin of Ultrasonic Sensor
const int echoPin = 6; // Echo Pin of Ultrasonic Sensor
long duration;
int distance;

const int ldrPin = A2;

int smokePin = A3;
// Your threshold value
int sensorThres = 400;

const int capteur_D = 4;
int val_analogique;

#define pirPin 10
int calibrationTime = 30;
long unsigned int lowIn;
long unsigned int pause = 5000;
boolean lockLow = true;
boolean takeLowTime;
int PIRValue = 0;//Initializing the PIR Motion Sensor Value
```

sensors_project_weather_station §

```
void setup() {
  // put your setup code here, to run once:

   Serial.begin(9600);
   blueTooth.begin(9600);
   pinMode(pirPin,INPUT);
   pinMode(soilPin, INPUT);
   pinMode(trigPin, OUTPUT); // Sets the trigPin as an Output
   pinMode(echoPin, INPUT); // Sets the echoPin as an Input
   pinMode(ldrPin,INPUT);
   pinMode(smokePin, INPUT);
   pinMode(capteur_D, INPUT);
   pinMode(ledPin1,OUTPUT);
   pinMode(ledPin2,OUTPUT);
  Serial.println("\t\t\t  WELCOME TO OUR WEATHER  STATION!!  \t\t\t" );
}

void loop() {
  // put your main code here, to run repeatedly:

    if(Serial.available())
   {
    delay(1000);
    sensor2();
    delay(1000);
    sensor3();
    delay(1000);
    sensor5();
    delay(1000);
    sensor7();
    delay(1000);
    sensor1();
    delay(1000);
    Serial.println("Motion Detected!");
    sensor6();
    delay(1000);
     Serial.println("--------------------------------------------------------------------------------");
     Serial.println("\n");
    }
}
```

```
void sensor1(){
    if(digitalRead(pirPin) == HIGH) {
      if(lockLow) {
         PIRValue = 1;
         lockLow = false;
         Serial.println("      Motion detected    ");
         delay(100);
      }
      takeLowTime = true;
   }
   if(digitalRead(pirPin) == LOW) {
      if(takeLowTime){
         lowIn = millis();takeLowTime = false;
      }
      if(!lockLow && millis() - lowIn > pause) {
         PIRValue = 0;
         lockLow = true;
          blueTooth.write("Motion ended.");
         delay(100);
      }
   }
}


void sensor2(){
  sensorValue = analogRead(soilPin); //Reads the soil mositure values
   Serial.print("Soil Moisture Value Is: ");
   Serial.println(sensorValue);


  if (sensorValue>limit) {
  Serial.println("   Watering Needed!!  (GREEN LED) ");
  digitalWrite(ledPin1, HIGH);
  }
  else {
  digitalWrite(ledPin1, LOW);
  }

  delay(1000);
 }
```

```
void sensor3(){
 DHT.read11(dht_apin);
   //Reads The Humidity Of The Surrounding
    Serial.print("Current Humidity = ");
    Serial.print(DHT.humidity);
    Serial.println("%  ");
   //Reads The Temperature Of The Surrounding
   Serial.print("Temperature = ");
   Serial.print(DHT.temperature);
   Serial.println("oC  ");
 }



void sensor5(){
int ldrStatus = analogRead(ldrPin);
//To Detect The Amount Of Sunlight
  if (ldrStatus >=300) {

  Serial.print("Its BRIGHT !");
  Serial.println(ldrStatus);

} else {

     Serial.println("Its DARK ! ");
     Serial.println(ldrStatus);
}
}
```

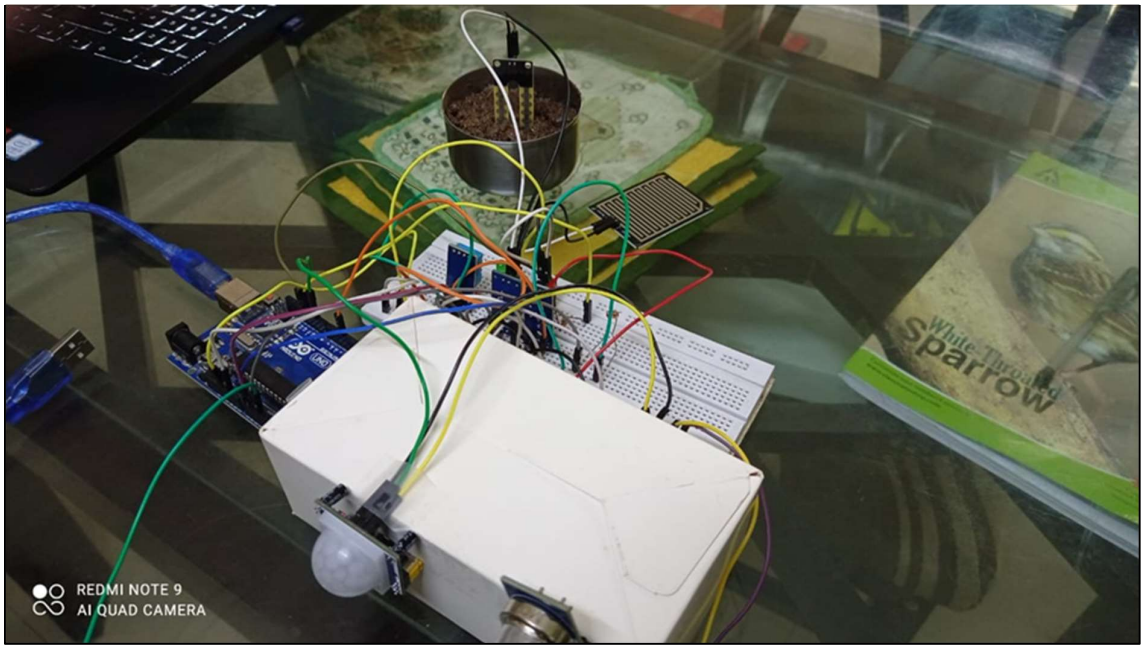
```
void sensor6(){
  //To detect any kind of hazardous gas
  int analogSensor = analogRead(smokePin);
  // Checks if it has reached the threshold value
  if (analogSensor > sensorThres)
  {
    digitalWrite(ledPin2,HIGH);

  }
  else
  {
    digitalWrite(ledPin2, LOW);

  }
  delay(100);
}

void sensor7()
{
if(digitalRead(capteur_D) == LOW)
  {
    Serial.println("Digital value : wet");
    delay(100);
  }
else
  {
    Serial.println("Digital value : dry");
    delay(100);
  }}
```

HARDWARE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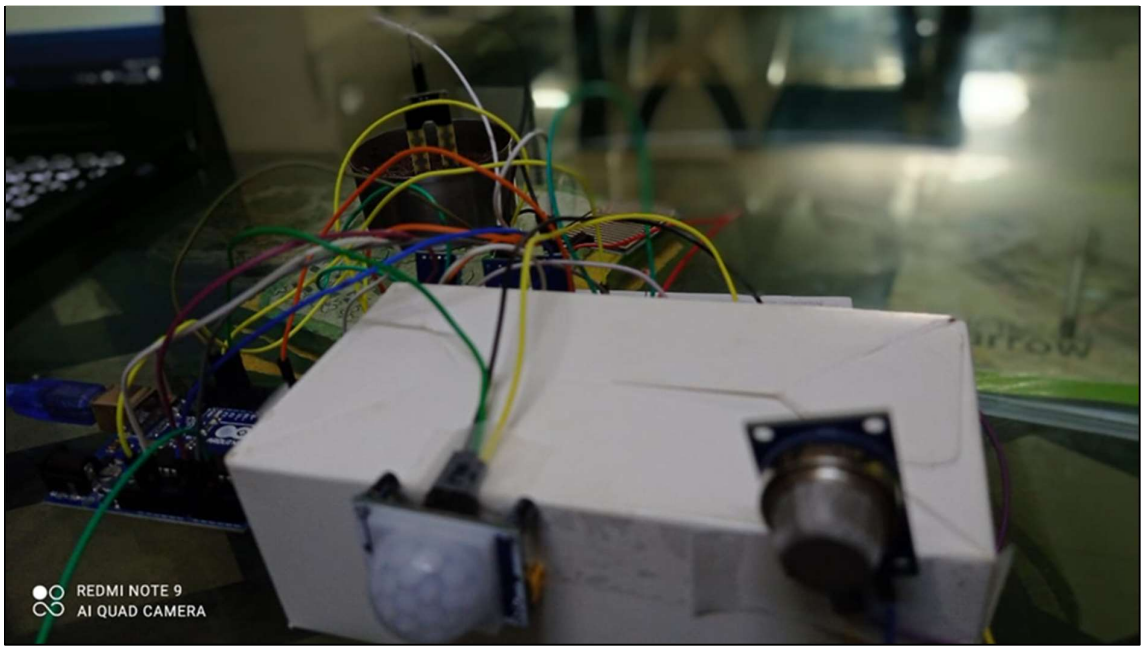
AI QUAD CAMERA
Sparrow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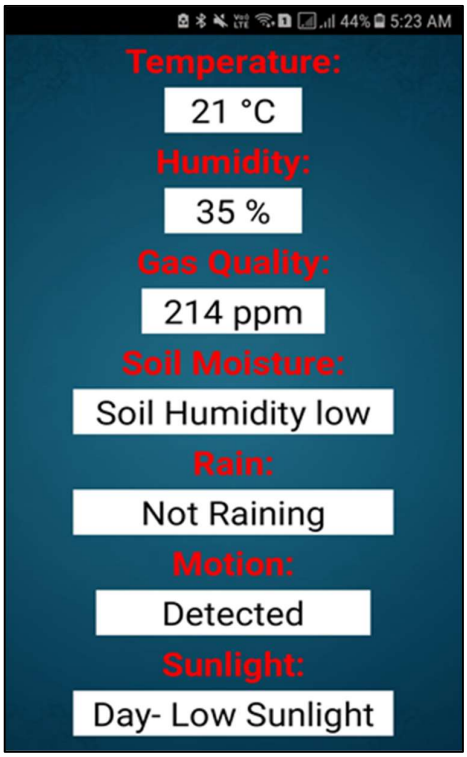
APP INTERFACE

A very minimal, efficient and effective app interface that provides all the necessary information in the simplest way possible. Interfaces also allows the user to choose the language they are comfortable with, considering the diverse background and mode of communication of the user.



VIDEO LINK

https://drive.google.com/file/d/1BuxuFKYgBrVo77YbMCGc7xq2EGdFA0Qa/view?usp=drivesdk

The above link shows the video of our working project.

APPLICATION

All of the parts of the device are easily available in hardware stores and online websites if one wants to make it domestically while the device can also be mass-produced if parts are to be bought at wholesale, which would also decrease the price substantially. Currently, the Weather Station uses Arduino Nano, if the product was to be mass-produced, the new PCB could be designed with integrated sensors which would reduce the price and will allow more number of sensors to be used.

Since we also worked on a new feature that allows the farmer to access all the data via the mobile application using Bluetooth, the ease of using the device has reduced considerably.

It tells the farmer about the temperature and humidity, so he can efficiently supply water to the plants and about the amount of sunlight present, by which the farmer can take the sensitivity of the crop into account. It tells the farmer the amount of water present inside the soil to protect the crop from overwatering or dehydration. It also successfully tells the farmer about air quality and also make him aware of any flammable substance. It tells the farmer about the presence of rainfall and the amount of rainfall, about the direction of wind and also makes the farmer more independent, as now he does not have to depend on any prediction, superstitions, or information by other people.

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