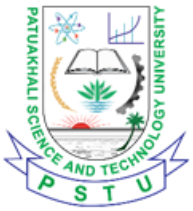
Faculty of Computer Science & Engineering

PROJECT REPORT ON

Early Flood Detection System Using Arduino



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EARLY FLOOD DETECTION SYSTEM USING ARDUINO

Abstract:

Over the past few years we can see there is an occurrence of floods at different parts of the world almost every year. The technical advancements in recent years have made it easier to get a solution for these natural disasters. One of such technologies which takes us much closer to the internet is the "Internet of Things". This project report consists of flood detection and avoidance system using the iot technology based on Arduino Uno. The sensors present in this are used to estimate the water levels, humidity, and temperature and send the real-time data to the Google Firebase (cloud database) and the users can access the data via internet. This model can be widely used to alarm the people before a flood occurs and necessary precautions could be taken.

Introduction:

First and foremost, Alhamdullilah and all praises to the almighty for the strengths and His blessing in the completion of this project. Special appreciation goes to our supervisor, Associate Professor MD. NAIMUR RAHMAN for his supervision and constant support. His invaluable help of constructive comments and suggestions during the project have contribute to the commence of this project .

In both developing and non-developing countries, flooding is the massive natural disaster that causes loss of human and animal life and property. Flood due to earthquakes in oceans, hurricanes, rainfall and other natural disasters occur in many parts of the globe every year. During rainfall, unmanaged drainage system in various geographical regions leads to floods and many lives are lost. If we have some system which can give us early alert regarding flood then we can save lives of people. A system which uses technology to detect the increase in water level and alert people beforehand so many people can be evacuated. Floods always occur unexpectedly and unpredictable. As today's technologies is grow up, it helps everyday life of people becomes easier. We have developed a **Flood Detector Warning System Prototype** named **"স্রোতস্বিনী"** that helps to monitor and give warning to people for facing the floods. By using one of the newest microcontroller technologies which is Arduino Uno, this system is developed. Combining hardware and software, this system needed some programming part for interfacing. The ultrasonic sensor is used to send the signal to microcontroller board for signal analyzing into output and then send an alert using ESP32 Wi-Fi Module via internet. Applying the concept of wireless connection for communication, nRF24L01 + 2.4GHz wireless modem are used. Users can monitor flood far from the monitored area by displaying the output of water level on LCD (Liquid Crystal Display) and computer monitoring.

Implementation method :

The main idea in our project is to integrate two platforms web based devices and IOT in order to realize a system that is dependable of easy to access at the same time. We use Arduino and different sensors in order to collect the data and used ESP32 Wi-Fi Module that upload the data to a real time database called Google Firebase (cloud database) and any internet connected device to use this data for monitoring purpose.

Hardware implementation:

Different hardware used in our projects are:

i) Arduino Uno.

ii) Ultrasonic sensor.

iii)ESP 32 Wi-Fi Module.

iv) Dht11(Temperature and humidity sensor).

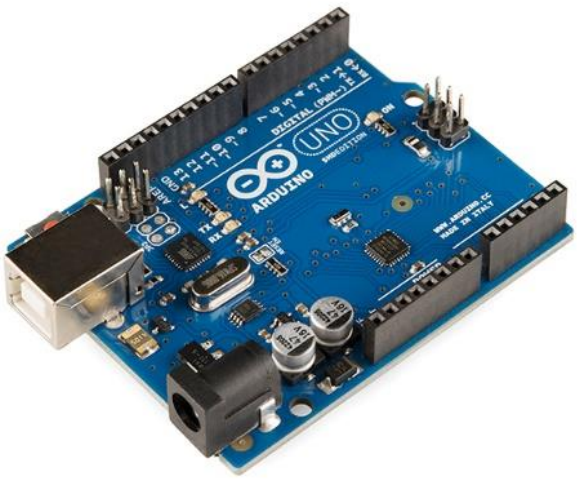
v) LCD Display.

Arduino Uno :

Arduino is an open source platform which is used to develop electronics project. It can be easily programmed, erased and reprogrammed at any instant of the time. There are many Arduino boards available in the market like Arduino UNO, Arduino Nano, Arduino Mega, Arduino lilypad etc. with having different specification according to their use.

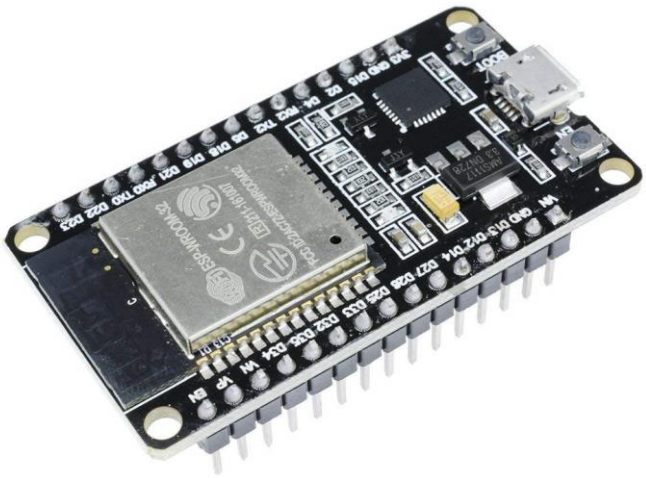
In this project we are going to use Arduino UNO to control home appliances automatically. It has ATmega328 microcontroller IC on it which runs on 16MHz clock speed. It is a powerful which can work on USART, I2C and SPI communication protocols. This board is usually programmed using software Arduino IDE using micro USB cable. ATmega328 comes with pre programmed onboard boot loader which makes it easier to upload the code without the help of the external hardware. It has vast application in making electronics projects or products. The C and C++ language is used to program the board which is very easy to learn and use. Arduino IDE makes it much easier to program. It separates the code in two parts i.e. void setup() and void loop(). The function void setup() runs only one time and used for mainly initiating some process whereas void loop() consists the part of the code which should be executed continuously.

This model consists of 6 analog input pins and 14 digital GPIO pins which can be used as input output 6 of which provides PWM output and analog using pinMode(), digitalWrite(), digitalRead() and analogRead() functions. 6 analog input channels are from pins A0 to A5 and provide 10 bit resolution. The board can be powered either from using USB cable which operates at 5 volts or by DC jack which operates between 7 to 20 volts. There is on board voltage regulator to generate 3.3 volts for operating low powered devices. Since the ATmega328 work on USART, SPI and I2C communication protocol, has 0 (Rx) and 1(Tx) pins for USART communication, SDA (A4) and SCL (A5) pin for I2C and SS (10), MOSI (11), MISO (12) and SCK (13) pins for SPI communication protocol.



ESP 32 Wi-Fi Module :

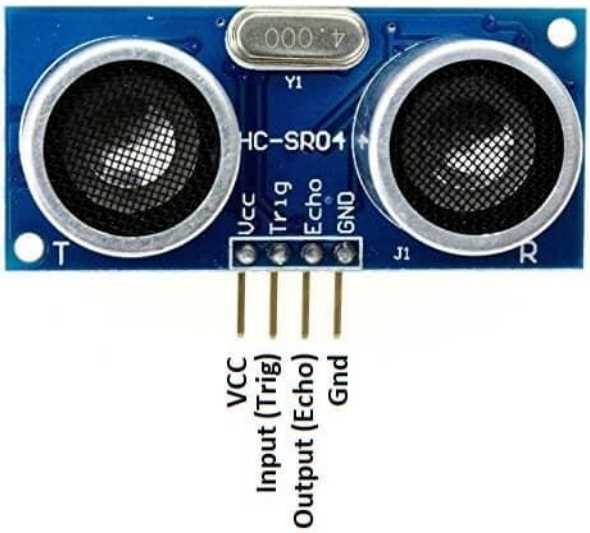
ESP32 is a series of low-cost, low-power system on a chip microcontrollers with integrated Wi-Fi and dual-mode Bluetooth. The ESP32 series employs either a Tensilica Xtensa LX6 microprocessor in both dual-core and single-core variations, Xtensa LX7 dual-core microprocessor or a single-core RISC-V microprocessor and includes built-in antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power-management modules. ESP32 is created and developed by Espressif Systems, a Shanghai-based Chinese company, and is manufactured by TSMC using their 40 nm process. It is a successor to the ESP8266 microcontroller.



HC-SR04 Ultrasonic Sensor :

HC-SR04 is an ultrasonic sensor which helps to measure distances in many places with no human contact. It works on the principle same as of RADAR and SONAR and provides an efficient way of measuring distances in a very precise way.

Theoretically it can measure distances up to 450 cm but practically it can measure distances from 2 cm to 80 cm with accuracy of 3 mm. It is operated at 5 volts, current less than 15mA and 40 Hertz frequency.



The HC-SR04 has one transmitter and one receiver installed on it. The distance is calculated with the basic speed, distance and time formula which we all studied in our school i.e,

Distance = Speed x Time

The transmitter of the HC-SR04 sensor transmits an ultrasonic wave in the air. If this wave is reflected by some object in the range of sensor then the reflected wave in the air is received by the receiver of the sensor. So to calculate the distance using above formula we should know the speed and time.

We know that the universal speed of the ultrasonic wave is around 330 m/s. The time is measured by the circuit build on the microcontroller. The echo pin gets high for the time period as which the time taken by the ultrasonic wave to return to the receiver. This way we can calculate the distance between the object and HC-SR04 ultrasonic sensor.

Interfacing HC-SR04 with Arduino UNO :

HC-SR04 ultrasonic senor can be used with all microcontrollers like Arduino, PIC, Raspberry Pi, etc. In this project we are going to interface HC-SR04 ultrasonic sensor with Arduino UNO. The HC-SR04 module has four pins: VCC, GND, Trig and Echo.

We power the HC-SR04 module with 5 volts and GND to the Arduino UNO. The trigger pin and Echo pin are the input and output pins so they have to be connected to the input and output pins of the Arduino UNO. So to measure the distance we first of all set trigger pin to “high” for 10 micro seconds and then set to “low”.

This will generate an ultrasonic wave of frequency of 40 kHz which goes to the object and reflects back to the receiver of the module. If the wave detects some object it immediately returns to the receiver part of the module and the echo pin gets “high” for the time period for which it returns back to the sensor. Now this time period multiplied with the speed of the wave which is 330 m/s gives us the distance between the HC-SR04 module and the object.

Dht11(Temperature and humidity sensor):

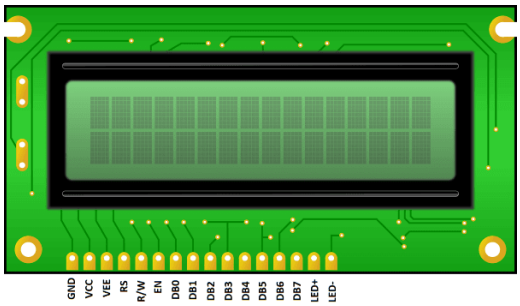
DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a highperformance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness.

16×2 LCD DISPLAY:

Interfacing 16 X 2 LCD with Arduino UNO is pretty easy. There are various type of LCDs available in the market but the one we are using in this project is 16×2 which means it has two rows and in each row we can display 16 characters.

This module has HD44780 driver from Hitachi on it which helps to interface and communicate with the microcontrollers. This LCD can work in 4 bit mode and 8 bit mode. In 4 bit mode only 4 data pins are required to establish connection between LCD and microcontroller whereas in 8 bit mode 8 data pins are required.

Here we are going to use it in 4 bit mode as it requires less number of wires and makes the circuit simplified. Let’s look at the pin description of 16×2 LCD.



PIN DESCRIPTION OF 16×2 LCD MODULE :

Pin on LCD	Description
VSS	Ground Pin
VCC	+5V power supply
VEE	Pin to change the contrast of LCD
RS	Register Select: Data Mode or Command Mode
RW	Read or Write Mode
E	Enable LCD
DB0-DB7	Data and command is fed using these pins
LED+	Anode of the backlight LED
LED-	Cathode of the backlight LED

This LCD does not has its own light so there is a LED behind the screen which acts as the backlight for the display. Interfacing this LCD with Arduino UNO is pretty easy as Arduino IDE provides a Liquid Crystal library which has many inbuilt function to make initialize and print anything on the display easier.

Software implementation :

For software part we have integrated our system with IOT we developed an web that is fully capable of monitoring the system environment. This is done using the data sent by the system. Using Google Firebase (cloud database) makes it convenient to use. Every detail related to the system can be viewed in Google Firebase. It can notify the user if there is any possibility of flood to occur. For e.g. certain rise in water flow increasing the overall water level of the dam/container (in our case) the application is versatile enough to let the user know about this and report it before hand in order to avoid any form of casualties. The application can also to be used to monitor sensor data in real time that is it can provide:

i) Distance from ultrasonic sensor to water.
ii) Total volume of water
iii) Temperature and humidity.

All these features provided by the application can be efficiently used by any individual to monitor the system. It is user friendly and avoids complication of different data used as the user is only provided with what really is important.

Working Principal:

i) The Arduino is the heart of the system all the sensors are connected to the Arduino and they operate in a synchronized manner.

ii) ESP 32 Wi-Fi Module is used to upload the data to the database (data is uploaded every 2/3 second).

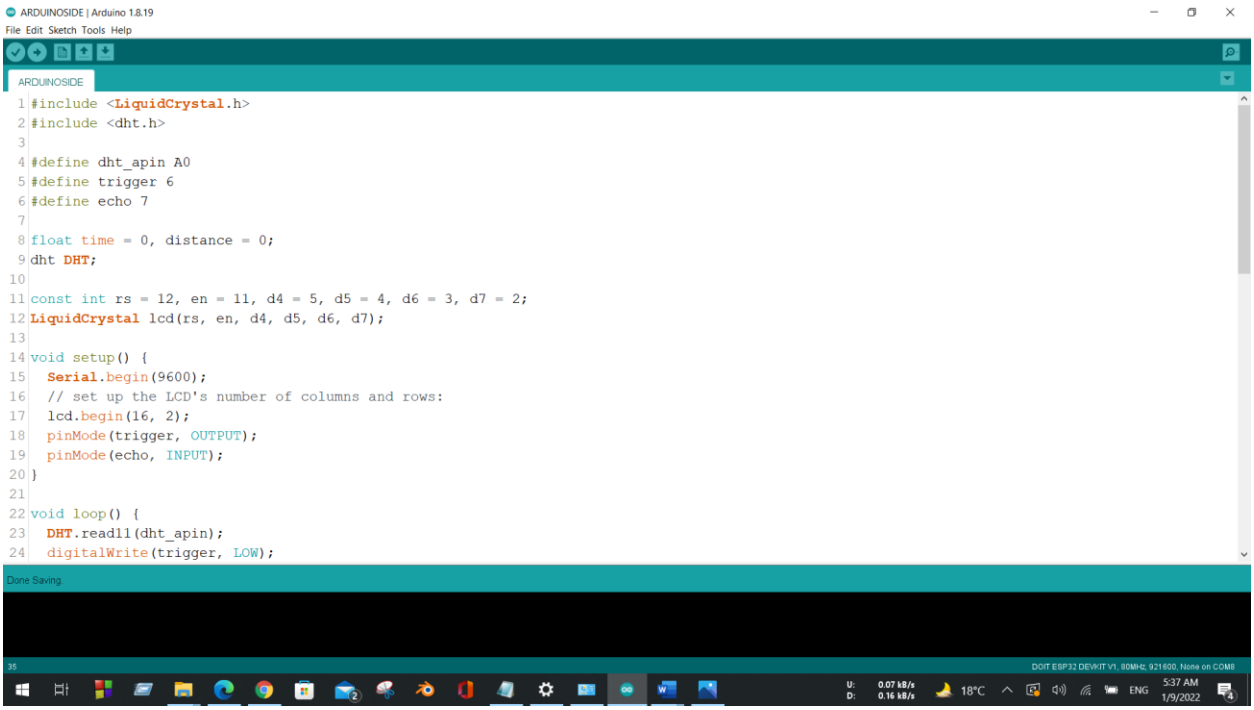
iii) Ultrasonic sensor is used to measure the amount of water or the distance from the sensor to the water level.

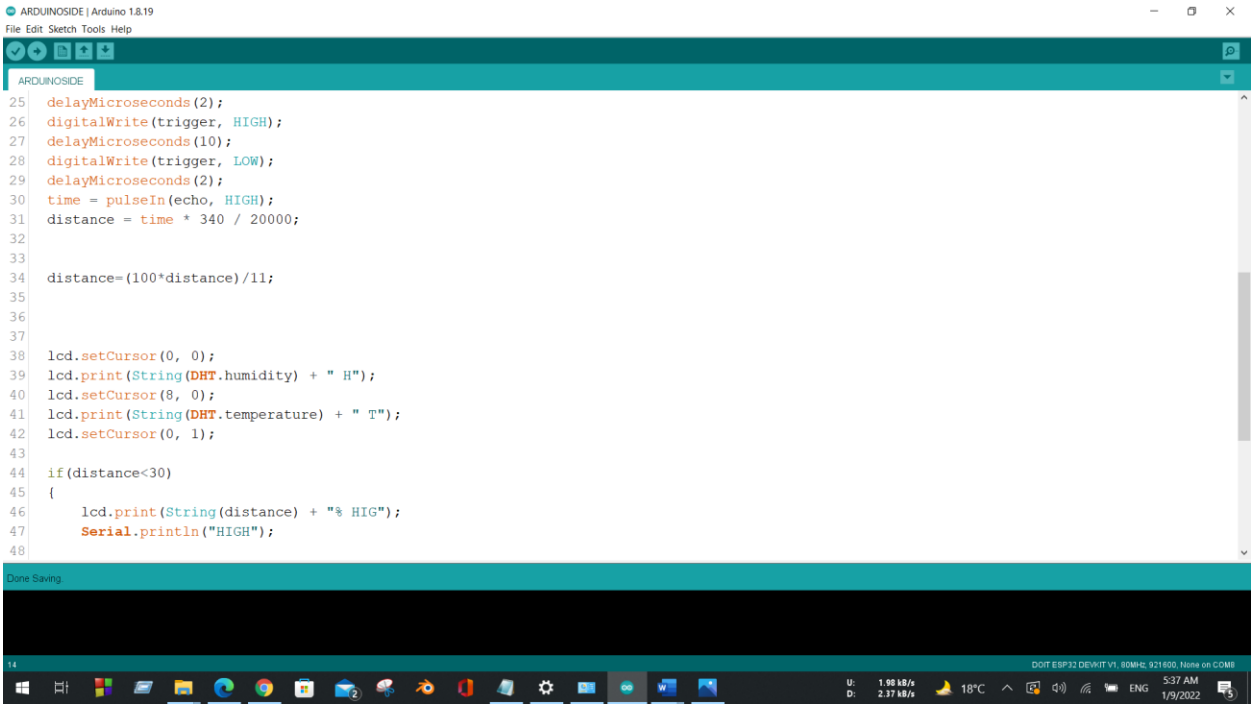
iv) DHT11 sensor for measuring temperature and humidity.

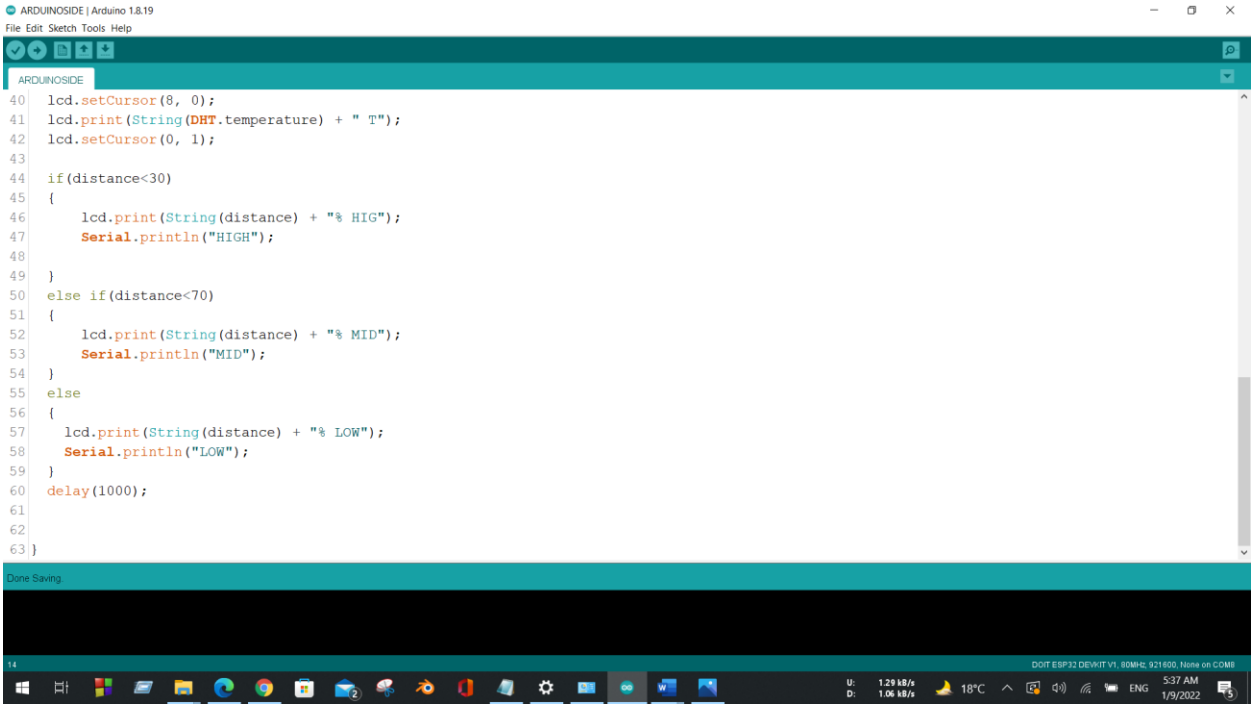
v) LCD for displaying the data.

Code used in the Project :

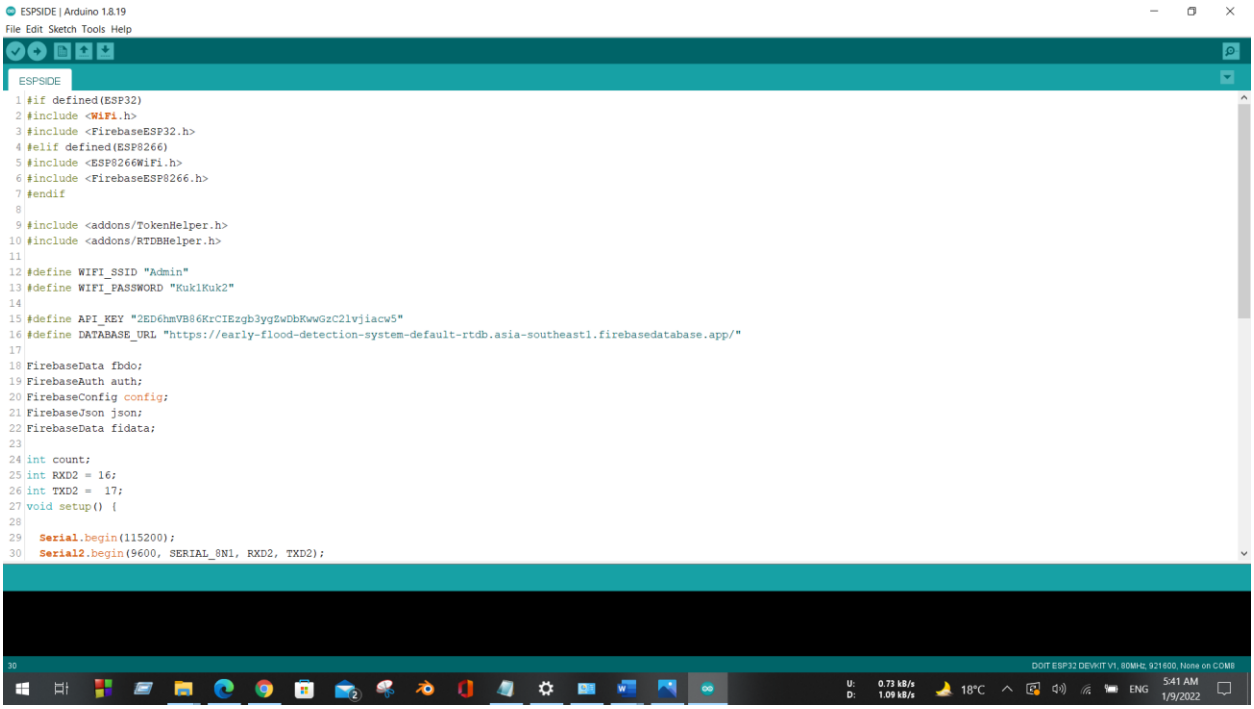
For ARDUINO UNO R3 :

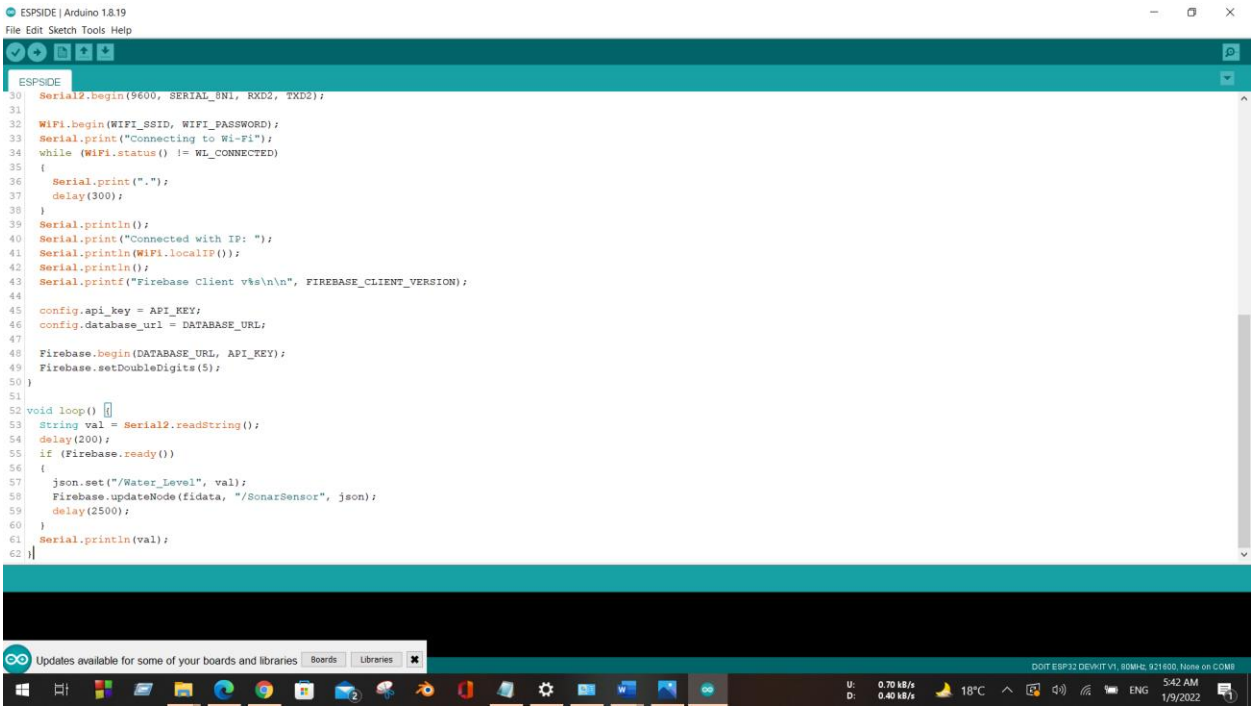



ARDUINOSIDE | Arduino 1.8.19
File Edit Sketch Tools Help
ARDUINOSIDE
25 delayMicroseconds(2);
26 digitalWrite(trigger, HIGH);
27 delayMicroseconds(10);
28 digitalWrite(trigger, LOW);
29 delayMicroseconds(2);
30 time = pulseIn(echo, HIGH);
31 distance = time * 340 / 20000;
32
33
34 distance=(100*distance)/11;
35
36
37
38 lcd.setCursor(0, 0);
39 lcd.print(String(DHT.humidity) + " H");
40 lcd.setCursor(8, 0);
41 lcd.print(String(DHT.temperature) + " T");
42 lcd.setCursor(0, 1);
43
44 if(distance<30)
45 {
46 lcd.print(String(distance) + "% HIG");
47 Serial.println("HIGH");
48
Done Saving.
14
DOIT ESP32 DEVKIT V1, 80MHz, 921600, None on COM8
U: 1.98 kB/s
D: 2.37 kB/s
18°C
ENG
5:37 AM
1/9/2022


ARDUINOSIDE | Arduino 1.8.19
File Edit Sketch Tools Help
ARDUINOSIDE
40 lcd.setCursor(8, 0);
41 lcd.print(String(DHT.temperature) + " T");
42 lcd.setCursor(0, 1);
43
44 if(distance<30)
45 {
46 lcd.print(String(distance) + "% HIG");
47 Serial.println("HIGH");
48
49 }
50 else if(distance<70)
51 {
52 lcd.print(String(distance) + "% MID");
53 Serial.println("MID");
54 }
55 else
56 {
57 lcd.print(String(distance) + "% LOW");
58 Serial.println("LOW");
59 }
60 delay(1000);
61
62
63 }
Done Saving.
14
DOIT ESP32 DEVKIT V1, 80MHz, 921600, None on COM8
U: 1.29 kB/s
D: 1.06 kB/s
18°C
ENG
5:37 AM
1/9/2022

For ESP 32 :


ESPSIDE | Arduino 1.8.19
File Edit Sketch Tools Help
ESPSIDE
#if defined(ESP32)
#include <WiFi.h>
#include <FirebaseESP32.h>
#elif defined(ESP8266)
#include <ESP8266WiFi.h>
#include <FirebaseESP8266.h>
#endif
#include <addons/TokenHelper.h>
#include <addons/RTDBHelper.h>
#define WIFI_SSID "Admin"
#define WIFI_PASSWORD "Kuk1Kuk2"
#define API_KEY "2ED6hmVB86KrCIEzgb3ygZwDbKwwGzC2lvjiacw5"
#define DATABASE_URL "https://early-flood-detection-system-default-rtdb.asia-southeast1.firebasedatabase.app/"
FirebaseData fbdo;
FirebaseAuth auth;
FirebaseConfig config;
FirebaseJson json;
FirebaseData fidata;
int count;
int RXD2 = 16;
int TXD2 = 17;
void setup() {
Serial.begin(115200);
Serial2.begin(9600, SERIAL_8N1, RXD2, TXD2);
DOIT ESP32 DEVKIT V1, 80MHz, 921600, None on COM8
U: 0.73 kB/s
D: 1.09 kB/s
18°C
ENG
5:41 AM
1/9/2022


ESPSIDE | Arduino 1.8.19
File Edit Sketch Tools Help
ESPSIDE
Serial2.begin(9600, SERIAL_8N1, RXD2, TXD2);
WiFi.begin(WIFI_SSID, WIFI_PASSWORD);
Serial.print("Connecting to Wi-Fi");
while (WiFi.status() != WL_CONNECTED)
{
Serial.print(".");
delay(300);
}
Serial.println();
Serial.print("Connected with IP: ");
Serial.println(WiFi.localIP());
Serial.println();
Serial.printf("Firebase Client v%s\n\n", FIREBASE_CLIENT_VERSION);
config.api_key = API_KEY;
config.database_url = DATABASE_URL;
Firebase.begin(DATABASE_URL, API_KEY);
Firebase.setDoubleDigits(5);
}
void loop() {
String val = Serial2.readString();
delay(200);
if (Firebase.ready())
{
json.set("/Water_Level", val);
Firebase.updateNode(fidata, "/SonarSensor", json);
delay(2500);
}
Serial.println(val);
}
Updates available for some of your boards and libraries
Boards
Libraries
DOIT ESP32 DEVKIT V1, 80MHz, 921600, None on COM8
U: 0.70 kB/s
D: 0.40 kB/s
18°C
ENG
5:42 AM
1/9/2022

Project Objectives:

There are some objectives that have to be achieved in this project and the objectives will act as a guideline in order to finish this project successfully.

i. To design a system which can reduce the impact and cost of the flood damage by providing warning, monitoring and detect of local flooding for people.
ii. To build a prototype system of flood detector using hardware and software provided.
iii. To understand the Arduino Uno applications and the basic concept of communication system.

Conclusion and Future Scope :

This project highlights the possibility to provide an alert system that will overcome the risk of flood. As the project is enabled with IOT technology and hence the sensor data can be monitored from anywhere in the world. More sensors can be integrated into the system in order to create more accurate and efficient flood detection system. It can also contribute to multiple government agencies or authority that ultimately help the society and mankind about the flood like hazardous natural disaster. It will monitor each and every aspect that can lead to flood. If the water level rises along with the speed, it will send an alert immediately. It also ensures increased accessibility in dealing and reverting to this catastrophic incident. In summary, it will help the community in taking quick decisions and planning against this disaster mankind about the flood like hazardous natural disaster. The Future scope of the project is , flood can also be related to the intensity of rainfall, which is the height of the water layer covering the ground in a period of time. Hence the development of a rainfall forecasting sensor eventually turn up to the early flood monitoring and detection, Scholarly studies are ongoing and can be implemented to our existing system in future.