İstanbul Bilgi University
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AIR QUALITY OBSERVING WITH IOT SENSORS

by

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LIST OF SYMBOLS/ABBREVIATIONS

IOT	**Internet Of Things**
WHO	**World Health Organization**
NOX	**Nitric Oxide**
TCP	**Transmission Control Protocol**
PM	**Particule Matter**
IP	**Internet Protocol**
CH4	**Methane**
HTTP	**Hyper Text Transfer Protocol**
VOC	**Volatile Organic Compound**
UHI	**Urban Health Initiative**
CO2	**Carbon Dioxide**
CO	**Carbon Monoxide**
SOX	**Sulfur oxide**
GSM	**Global System Mobile Communications**
GPS	**Global Positoning Syste**
MSP	**Managed Service Provider**
ADC	**Analog Digital Converter**
SMS	**Short Message Service**
LCD	**Liquid Crystal Display**
ARM	**Advanced RISC Machines**

ABSTRACT

As 2 electrical and electronics engineering senior students we are aware of the importance of air quality on human's health. Hence, we chose that project and we decided to make real such a project. According to World Health Organization estimates, 3 million people die from indoor pollution and 4.2 million people die from outdoor air pollution in 2016. In children under 5 years of age, one in 10 deaths is caused by air pollution. 93% of children under the age of 15 live in areas exceeding the PM 2.5 limit set by WHO. If Turkey is searched; The number of deaths due to air pollution is estimated by the OECD to be approximately 30,000. Due to air pollution caused by thermal power plants in Turkey every year there are 3,000 premature death. From smog hanging over cities to smoke inside the home, air pollution poses a major threat to health and climate. The combined effects of ambient (outdoor) and household air pollution cause about 7 million premature deaths every year, largely as a result of increased mortality from stroke, heart disease, chronic obstructive pulmonary disease, lung cancer and acute respiratory infections. More than 80% of people living in urban areas that monitor air pollution are exposed to air quality levels that exceed the WHO guideline level of 10µg/m_3, with low- and middle-income countries suffering from the highest exposures. The major outdoor pollution sources include vehicles, power generation, building heating systems, agriculture/waste incineration and industry. In addition, more than 3 billion people worldwide rely on polluting technologies and fuels (including biomass, coal and kerosene) for household cooking, heating and lighting, releasing smoke into the home and leaching pollutants outdoors.

Air quality is closely linked to earth's climate and ecosystems globally. Many of the drivers of air pollution (i.e. combustion of fossil fuels) are also sources of high CO_2 emissions. Some air pollutants such as ozone and black carbon are short-lived climate pollutants that greatly contribute to climate change and affect agricultural *productivity*. Policies to reduce air pollution, therefore, offer a "win-win" strategy for both climate and health, lowering the burden of disease attributable to air pollution, as well as contributing to the near- and long-term mitigation of climate change.[1]

In this project, we aim to provide people with reliable and accurate information. Because these data have a direct effect on human health. We will instantly assign the measured values to the database of our website and application. We will instantly assign

the measured values to the database of our website. Because of covid - 19 period, our university is closed like every university in Turkey and in the world. Therefore we met with our professor via online and together we decided to do some changings in our project. We have advanced the project in the light of our professor in our online meeting. Through that online discussion, we decided to create and design an application and also we would take the actual results about air quality. We decided to create and developed an application because our aim was that we would send these actual datas to our application. Apart from that, we decided to design a circuit diagram. At the end of the project, now; we are getting results from all devices at the same time. We have created and designed an application. We could transfer the actual results to our application and we created a circuit diagram.

1. INTRODUCTION

Firstly, we have drawn a road map in order to achieve our project. We have created a project draft and determined the necessary equipments. After that determination, we have bought some materials. These materials are:

- SDS011sensor; in order the measure the PM2.5 and PM10 rates in the air.
- MQ7 sensor; In order to measure the CO (Carbon Monoxide),
- DHT22 sensor; in order to measure the temperature and humidity,
- As LCD TouchScreen Display, we preferred 2.4 Inch Nextion HMI Touch TFT Lcd Display.
- As battery, we preferred 7.4 V 2S Lipo Batarya 1350 mAh 25C.
- As a microcontroller we chose ESP32. ESP 32 is a development board. We preferred ESP32 .Because, the bluetooth access with the internet is in the device. consumes less power from arduino and also you can program this board using the ESP32-WROOM-32 module just like an -Arduino. Thanks to its dual-core 160MHz processor, it supports not only high processing power, but also internal WiFi and Bluetooth connections. The card allows you to use the ESP32 module compatible with the breadboard and easily program it with the USB-UART converter (CP2102) on it. The chip first came to the attention of Western makers in August 2014 with the ESP-01 module, made by a third-party manufacturer Ai-Thinker. This small module allows microcontrollers to connect to a Wi-Fi network

and make simple TCP/IP connections using Hayes-style commands However, at first there was almost no English-language documentation on the chip and the commands it accepted. [4]

We have decided to make real that project for people to be sensitive about air quality and aipr pollution that has a very important impacgt on human health. Aim of that project is to provide users to access weather values that effect human health. The device that we produced in the porject aims to provide instant information to the users. We make our device in a small size and make the air pollution map of the locations that users choose always. The device we produced will be connected with the mobile phone and these datas can be reached instantly with the mobile application. That year, at the second semester of the education, because of covid - 19 period, our university is closed like every university in Turkey and in the world and we passed to online education as the university. Therefore we met with our professor via online and together we decided to do some changings in our project. We have advanced the project in the light of our professor in our online meeting. Through that online discussion, we decided to create and design an application and also we would take the actual results about air quality. We decided to create and design an application because our aim was that we would send these actual datas to our application. Apart from that, we decided to create a circuit diagram. At the end of the project, now; we are getting results from all devices at the same time. We have created and designed an application and also we could transfer the datas and these datas are accesible in our application right now and we created a circuit diagram.

2 .AIR QUALITY MEASUREMENT SYSTEM

2.1. TEMPERATURE AND HUMIDITY SENSOR

In order to measure the temperature and humidity, we bought a DHT22 sensor.

Description of DHT22 sensor:

DHT22 temperature and humidity sensor is an advanced sensor unit that outputs a calibrated digital signal. It is highly reliable and stable in long-term studies. Contains 8 bit microprocessor, provides fast and quality response. The unit, which measures temperature between -40 and 80 ° C with an error margin of +/- 1 ° C, can measure humidity with an error margin of +/- 5% RH between 0-100% RH. As the sensor measurement,

measurement results can be obtained in 2 second periods due to the datah collection period of the sensor. DHT22 is slightly larger in size than other DHT models. [16]

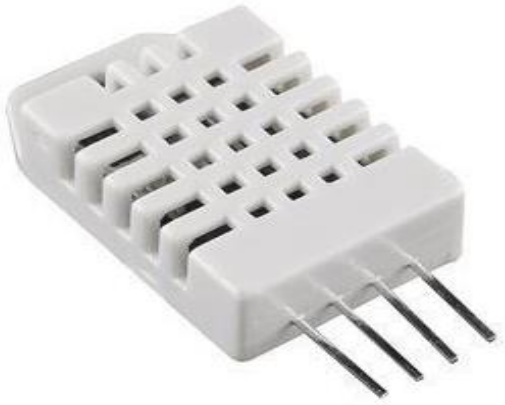

Figure 2.1: DHT22 Sensor

Another plus is the ability to present the ambient humidity to us. Moreover, as with analog sensors, we do not need to process incoming data mathematically. Our sensor gives us direct ambient humidity or temperature. This gives us significant convenience.

Specifications:

Operating Voltage:	3.3-5 VDC
Humidity Measurement:	0-100%RH
Temperature Measurement:	-40 - 80 °C
Humidity Sensitivity:	+/- %3 (Max %5) RH
Temperature Sensitivity:	< +/- 1°C
Size:	22x28x5 mm
Measurement period:	2s

Table 2.1:Specifications of DHT22

Temperature and its impact on the air quality

Temperature is a measure of how hot or cold something is; specifically, a measure of the average kinetic energy of the particles in an object, which is a type of energy associated with motion. But how hot is hot, and how cold is cold? The terms hot and cold are not very scientific terms. If we really want to specify how hot or cold something is, we must use temperature. For instance, how hot is melted iron? To answer that question, a

physical scientist would measure the temperature of the liquid metal. Using temperature instead of words, like hot or cold, reduces confusion.

Ever heard the phrase 'It's not the heat, it's the humidity'? People say this because humidity, which is the amount of water vapor in the air, can make hot temperatures even more unbearable than they already are. Humidity is actually a broad term, and we can describe different types of humidity in different ways.[6]

Humidity and its impact on the air quality

Humidity is an important thing to understand because it affects both weather and climate as well as global climate change. Humidity also affects indoor environments, so understanding it can help you determine the best place to store your books, clothing and other important items in your house.[10]

2.2 CARBON MONOXIDE SENSOR

In order to measure the CO (Carbon Monoxide) rate in the air ,we bought MQ7 sensor.

Description of MQ7 sensor:

MQ-7 is a Carbon Monoxide (CO) sensor, suitable for sensing Carbon Monoxide concentrations(PPM) in the air. The MQ-7 sensor can measure CO concentrations ranging from 20 to 2000ppm. This sensor has a high sensitivity and fast response time. The sensor's output is an analog resistance. The drive circuit is very simple , just a voltage divider; all you need to do is power the heater coil with 5V DC or AC , add a load resistance, and connect the output to an ADC or a simple OPAMP comparator. This sensor comes in a package similar to our MQ-3 alcohol sensor, and can be used with the rhydoLABZ breakout board.[7]

Specifications:

Operating Temperature:	-10 ° - 50 ° C
Operating Voltage:	5V
Drawn current:	150Ma

Table 2.2:Specifications of MQ7 Sensor

Figure 2.2: MQ7 Sensor

CO and it's impact on the air quality

Carbon monoxide is an odorless, colorless gas that often goes undetected, striking victims caught off guard or in their sleep.

More than 400 people in the U.S. die from unintentional carbon monoxide poisoning every year, according to the Centers for Disease Control and Prevention. More than 20,000 visit the emergency room, and more than 4,000 others are hospitalized.

This "invisible killer" is produced by burning fuel in cars or trucks, small engines, stoves, lanterns, grills, fireplaces, gas ranges, portable generators or furnaces. When the gas builds up in enclosed spaces, people or animals who breathe it can be poisoned. Ventilation does not guarantee safety.

2.3 DUST SENSOR

In order to measure the PM2.5 and PM10 value in the air, we bought SDS011 sensor.

Nova SDS011 detects 0.3-10 μm particles in the air by laser scanning technique. It has a digital output. In this way, you can easily integrate microcontroller into your projects and use it. Product content: Nova SDS011 sensor module, USB-UART adapter (CH340), connecting cable Nova SDS011 Features: Accurate and reliable results thanks to laser detection technology Fast response time, outputs in less than 10 sec when detects changes in the environment UART connection interface 0.3 μg / m ^ 3 high resolution Working

Principle: Particles in the scanning area are detected by laser scattering. The reflected light is returned to the unit and converted into electrical signal. The amount of analyzed particles is transmitted to the microcontroller / computer by serial communication.

Specifications:

Measuring Output	PM2.5 , PM10
Measuring Range	0.0-999.9 ug / m3
Supply Voltage	5V
Maximum work Current	100mA
Current in sleep state	2mA
Working temperature	-20-50 ° C
Response time	1s
Serial data output speed	1 time per second
Particle resolution	Less than 0.3μm
Error margin	10%
Dimensions	71 x 70 x 23mm

Table 2.3:Specifications of PM2.5 Sensor

Figure 2.3: SDS011sensor

We know when food is dirty or water is impure but when it comes to air we do not realize how polluted it is because we cannot see it. And we breathe in almost 3000 gallons of air every day. While larger pollutants are directly visible to the eye, particulate

matter, made up of very tiny solid and liquid particles is not. These suspended particulates are 25 to 100 times thinner than a human hair (which is why we can't see it) and can travel into the respiratory tract, penetrate deep into the lungs and even into the blood stream and cause severe health damage.[11]

PM2.5 particles and it's impact on the air quality

Particulate Matter- (PM) is a mixture of solid and liquid particles that are suspended in the air. These are categorized into coarse, fine and ultrafine. Coarse particles have a diameter of 2.5 micrometres to 10 micrometres (about 25 to 100 times thinner than a human hair), are relatively heavier and thus tend to settle. Dust, spores and pollen are some examples. PM2.5 refers to particles that have diameter less than 2.5 micrometres (more than 100 times thinner than a human hair) and remain suspended for longer.[9]

These particles are formed as a result of burning fuel and chemical reactions that take place in the atmosphere. Natural processes such as forest fires also contribute to PM2.5 in the air. These particles are also the primary reason for occurrence of smog.

Cardiovascular diseases, especially coronary heart disease, are the leading causes of death worldwide. The three most important causes of cardiovascular diseases are high cholesterol, high blood pressure and smoking. For this reason, in order to keep cholesterol and hypertension at normal levels, it is advised by doctors to avoid healthy eating, active lifestyle and smoking. However, recent medical studies have shown that cardiovascular diseases are associated with air pollution, especially fine particle (PM2.5) pollution. It is a mixture of air, gas, water vapor, dust and chemical compounds that we breathe. When we breathe, we take the particles that are in this mixture with the air we inhale into our body. It is filtered by the body's filter system to prevent large particles from reaching the lungs, but particulates smaller than 2.5 microns, especially those associated with petroleum fuels, such as exhaust fumes, may exceed the filter system. Particles of 10 microns or smaller, such as dust, pollen, mold, are called PM10 (particulate matter), and particles formed as a result of combustion are called particles of 2.5 microns or less, such as organic compounds, PM2.5. PM2.5 is about 3% the size of a human hair and can be detected by an electron microscope. The researchers believe that fine particles can accumulate in the blood vessels and cause inflammation in the blood vessels in and around.[8]

2.4 ESP32

Description of ESP32:

You can program this board using the ESP32-WROOM-32 module just like an - Arduino. Thanks to its dual-core 160MHz processor, it supports not only high processing power, but also internal WiFi and Bluetooth connections. The card allows you to use the ESP32 module compatible with the breadboard and easily program it with the USB-UART converter (CP2102) on it.

The chip first came to the attention of Western makers in August 2014 with the ESP-01 module, made by a third-party manufacturer Ai-Thinker. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands However, at first there was almost no English-language documentation on the chip and the commands it accepted.[2] The very low price and the fact that there were very few external components on the module, which suggested that it could eventually be very inexpensive in volume, attracted many hackers to explore the module, chip, and the software on it, as well as to translate the Chinese documentation.[3]

The ESP32 is an ESP32 with 1 MiB of built-in flash, allowing for single-chip devices capable of connecting to Wi-Fi.[4]

The successor to these microcontroller chips is the ESP32, released in 2016. [4]

Specifications:

• Processor: L106 32-bit RISC microprocessor core based on the Tensilica Xtensa Diamond Standard 106Micro running at 80 MHz[5]
• Memory:
○ 32 KiB instruction RAM
○ 32 KiB instruction cache RAM
○ 80 KiB user-data RAM
○ 16 KiB ETS system-data RAM
• External QSPI flash: up to 16 MiB is supported (512 KiB to 4 MiB typically included)
• IEEE 802.11 b/g/n Wi-Fi
○ Integrated TR switch, balun, LNA, power amplifier and matching network

○ WEP or WPA/WPA2 authentication, or open networks
• 16 GPIO pins
• SPI
• I²C (software implementation)[6]
• I²S interfaces with DMA (sharing pins with GPIO)
• UART on dedicated pins, plus a transmit-only UART can be enabled on GPIO2
• 10-bit ADC (successive approximation ADC)

Table 2.4:Specifications of Esp32

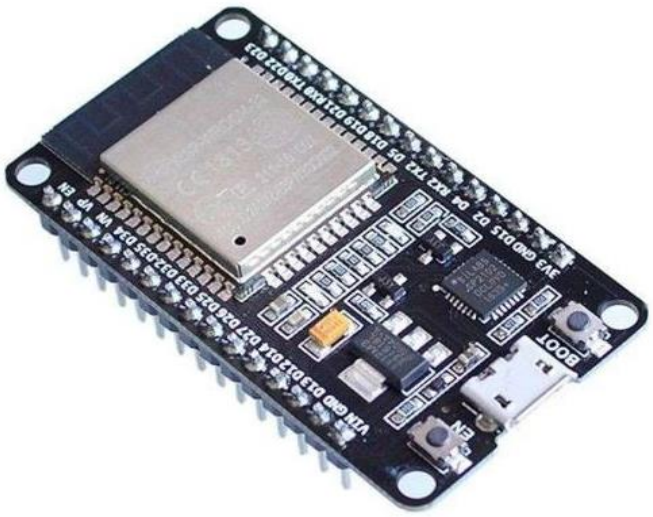

Figure 2.4: Esp 32

2.5 LIPO BATTERY

Description of LIPO BATTERY:

A lithium polymer battery, or more correctly lithium-ion polymer battery (abbreviated as LiPo, LIP, Li-poly, lithium-poly and others), is a rechargeable battery of lithium-ion technology using a polymer electrolyte instead of a liquid electrolyte. High conductivity semisolid (gel) polymers form this electrolyte. These batteries provide higher specific energy than other lithium battery types and are used in applications where weight is a critical feature, like mobile devices and radio-controlled aircraft.[18]

Specifications:

• Voltage: 7.4V
• Capacity: 1350mAh
• 25C (50C instantaneous, maximum 10sec)
• Weight: 85 g
• Dimensions: 63x32x14mm
• 2 Cells
• JST output socket and balancer charging socket are available.

Table 2.5 Specifications of Lipo Battery

Figure 2.5: Lipo Battery

2.6 LCD TOUCHSCREEN DISPLAY

Description of 2.4Inch Nextion HMI LCD Display:

This product consists of a series of TFT cards in the hardware part and - Nextion editor in the software part. The Nextion TFT card uses a single serial port for communication. So you don't have to deal with wiring. We observe that most engineers do not achieve satisfactory results despite spending a lot of time developing applications.

The Nextion editor features multi-use elements like buttons, text insertion feature, progress bar, scroll bar, instrumentation panel, and allows extensive interface designs. Move-and-drop feature reduces the time you spend for programming by 99%. Thanks to the WYSIWYG editor, it is very easy to design a GUI. It is easy to adapt HMI products of the Nextion family to your existing projects. All you have to do is add a UART. NX2432T024 is a powerful 2.4 " HMI product of the Nextion family. Features include: 2.4 'TFT, 320 x 240 resistive touch screen, 4M Flash, 2KByte RAM, 65k colors.

Specifications:

320 x 240 resolution
RGB 65K true colors
TFT 4 wire resistive touch panel display.
Easy to connect 4 pin interface to all TTL Serial Hosts 4M Flash for user code and data.
Micro-SD slot on the card for firmware updates.
Viewing Area: 36.72mm (U) × 48.96mm (G)
Brightness Adjustment: 0 ~ 180 nits, in 1% steps 5
V90mA power consumption

Table 2.6: Specifications of LCD Display

Figure 2.6: LCD Display Screen

3.THE PROJECT

We used esp32 in our project. Because, it enables less power consumption with and we can connect it to the wifi and bluetooh without a separate module. Firstly, we got our results by connecting our sensors to our project. we prefered SDS011sensor as a dust sensor. Because there are strictly results according to other dust sensors and can measure pm10 - pm2.5 values at the same time. We choose our other sensor as mq7 sensor in order to measyre the CO rate in the air. We selected DHT 22 sensor as temperature and humidity sensor. We choose to be cheap cost and give the right water results. We have started to record our data from firebase after we have completed the initial stage of our prohem. Firebase is the database. Our registration reason we used firebase to see the results we obtained in our project on the application and on the same time on the website. Moreover, we designed a simple applicatino to observe the results. As a display screen we preferred 2.4Inch Nextion HMI LCD Display. We have used this product in our project to instantly see the results in the same time. The screen design is required by using this product and to be a touch screen. Through this product, we can see our data on the screen instantly.

Figure 3.1: An image of the LCD Screen

3.1: Software of the Project:

```
#include <WiFi.h>
#include "FirebaseESP32.h"

#define FIREBASE_HOST "airpollution-80b0c.firebaseio.com" //Do not include https:// in FIREBASE_HOST
#define FIREBASE_AUTH "ZbAqCqFr3U4PaaIYXTJHIxffG4Yb3WVgqGvNajHM"
#define WIFI_SSID "HasanSelma"
#define WIFI_PASSWORD "37567061"


FirebaseData firebaseData;


String path = "";


#include "Nextion.h"

#define SENSOR 15 // MQ7 icin ESP32S ustunde GPIO15 (P15) pini
#include <SDS011.h>
float p10, p25;
int err;
SDS011 my_sds;
#ifdef ESP32
HardwareSerial port(2);
#endif

#include <DHT.h>
#define DHTPIN 4     // DHT22 icin ESP32S ustunde GPIO4 (P4) pini
#define DHTTYPE DHT22   // DHT 22  (AM2302), AM2321
DHT dht(DHTPIN, DHTTYPE);
```

```
int sensorValue = 0;  // MQ7 sensorunun verisini tutan degisken




void setup() {

  Serial.begin(9600);
 my_sds.begin(&port);
  dht.begin();

  initWifi();

}

void loop() {

   delay(2000); // Olcumler arasinda bekleme suresi.

 err = my_sds.read(&p25, &p10);
  if (!err)
  {
    Serial.print(" P2.5: " + String(p25));
    Serial.print(" P10:  " + String(p10));
  }

  // Sensor okumaları 250 ms civarinda surer ve 2 saniyeye kadar geriden gelebilir,
DHT22 oldukca yavas bir sensor.
  float h = dht.readHumidity();
  // Celcius cinsinden sicaklik degeri okuma (varsayilan)
  float t = dht.readTemperature();
  // Fahrenheit cinsinden sicaklık degeri okuma (isFahrenheit = true)
```

```
  float f = dht.readTemperature(true);

  // Sayi olarak deger okunamaması durumunda hata mesaji. (Donguden cikip tekrar
dener)
  if (isnan(h) || isnan(t) || isnan(f)) {
    Serial.println(F("DHT sensorunden okuma basarisiz!"));
    return;
  }

  // Fahrenheit cinsinden isi endeksi hesaplama (varsayilan)
  float hif = dht.computeHeatIndex(f, h);
  // Celsius cinsinden isi endeksi hesaplama (isFahreheit = false)
  float hic = dht.computeHeatIndex(t, h, false);

  Serial.print(F(" Nem: "));
  Serial.print(h);
  Serial.print(F("%  Sicaklık: "));
  Serial.print(t);
  Serial.print(F("°C "));
  Serial.print(f);
  Serial.print(F("°F  Isı indeksi: "));
  Serial.print(hic);
  Serial.print(F("°C "));
  Serial.print(hif);
  Serial.println(F("°F"));

  sensorValue = analogRead(SENSOR);
  Serial.print("CO degeri: ");
  Serial.print(sensorValue); // MQ7 karbon monoksit degeri



sendHumidityToNextion();
  sendTemperatureToNextion();
  sendSENSORToNextion();
```

```
  sendp10ToNextion();
  sendp25ToNextion();
 sendnemToNextion();


    Firebase.setDouble(firebaseData, path + "Pm10", p10);


    Firebase.setDouble(firebaseData, path + "Pm25", p25);


    Firebase.setDouble(firebaseData, path + "Nem", h);


    Firebase.setDouble(firebaseData, path + "Sicaklik", t);


    Firebase.setDouble(firebaseData, path + "CO", sensorValue);
}

void sendHumidityToNextion()
{
  String command = "humidity.txt=\""+String(dht.readHumidity())+"\"";
  Serial.print(command);
  endNextionCommand();
}

void sendTemperatureToNextion()
{
  String command = "temperature.txt=\""+String(dht.readTemperature(),1)+"\"";
  Serial.print(command);
  endNextionCommand();
}
void sendSENSORToNextion()
```

```
{
  String command = "SENSOR.txt=\""+String(SENSOR)+"\"";
  Serial.print(command);
  endNextionCommand();
}
void sendp10ToNextion()
{
  String command = "p10.txt=\""+String(p10)+"\"";
  Serial.print(command);
  endNextionCommand();
}
void sendp25ToNextion()
{
  String command = "p25.txt=\""+String(p25)+"\"";
  Serial.print(command);
  endNextionCommand();
}

void sendnemToNextion()
{
  String command = "humidity.txt=\""+String(dht.readHumidity())+"\"";
  Serial.print(command);
  endNextionCommand();
}
void endNextionCommand()
{
  Serial.write(0xff);
  Serial.write(0xff);
  Serial.write(0xff);
}



void initWifi(){
```

```
  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();

  Firebase.begin(FIREBASE_HOST, FIREBASE_AUTH);
  Firebase.reconnectWiFi(true);


  Firebase.setReadTimeout(firebaseData, 1000 * 60);

  Firebase.setwriteSizeLimit(firebaseData, "tiny");
}


// Return the minimum of two values a and b
#define minimum(a,b)     (((a) < (b)) ? (a) : (b))
```

3.2 CIRCUIT DIAGRAM

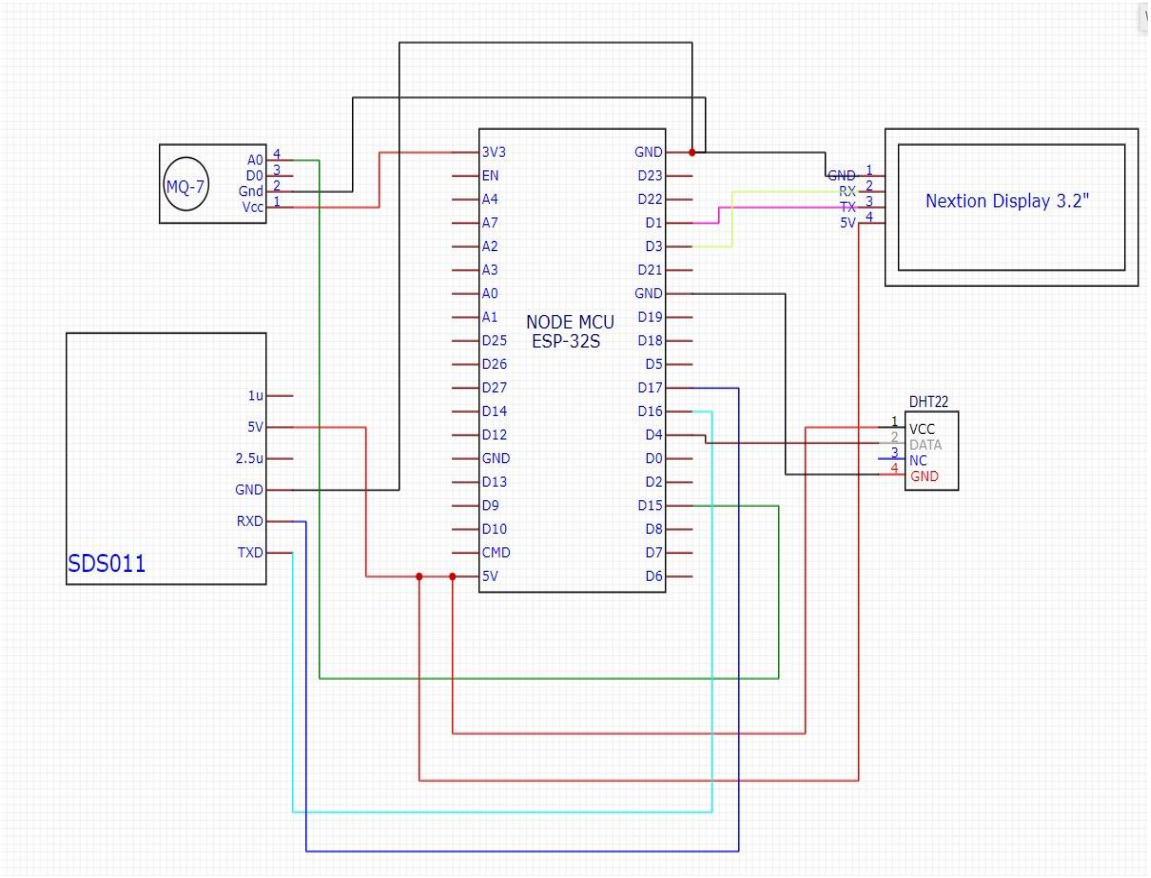

Figure 3.2: Circuit Diagram of the Project

3.3 FIREBASE

As database, we preferred Firebase.

Google Analytics Google Analytics is a cost-free app measurement solution that provides insights on app usage and user engagement. Develop Firebase Cloud Messaging Formerly known as Google Cloud Messaging (GCM), Firebase Cloud Messaging (FCM) is a cross-platform solution for messages and notifications for Android, iOS, and web applications, which as of 2016 can be used at no cost.[24] Firebase Authentication Firebase Authentication is a service that can authenticate users using only client-side code. It supports social login providers Facebook, GitHub, Twitter and Google as well as other service providers like Google Play Games, Apple, Yahoo, and Microsoft. Additionally, it includes a user management system whereby developers can enable user authentication with email and password login stored with Firebase.Firebase Realtime Database Firebase provides a real-time database and back-

end as a service. The service provides application developers an API that allows application data to be synchronized across clients and stored on Firebase's cloud. The company provides client libraries that enable integration with Android, iOS, JavaScript, Java, Objective-C, Swift and Node.js applications. The database is also accessible through a REST API and bindings for several JavaScript frameworks such as AngularJS, React, Ember.js and Backbone.js. The REST API uses the Server-Sent Events protocol, which is an API for creating HTTP connections for receiving push notifications from a server. Developers using the realtime database can secure their data by using the company's server-side-enforced security rules.[29] Cloud Firestore On January 31, 2019, Cloud Firestore was officially brought out of beta, making it an official product of the Firebase lineup.It is the successor to Firebase's original databasing system, Real-time Database, and allows for nested documents and fields rather than the tree-view provided in the Real-time Database. Firebase Storage Firebase Storage provides secure file uploads and downloads for Firebase apps, regardless of network quality, to be used for storing images, audio, video, or other user-generated content. It is backed by Google Cloud Storage.Firebase Hosting Firebase Hosting is a static and dynamic web hosting service that launched on May 13, 2014. It supports hosting static files such as CSS, HTML, JavaScript and other files, as well as support through Cloud Functions.The service delivers files over a content delivery network (CDN) through HTTP Secure (HTTPS) and Secure Sockets Layer encryption (SSL). Firebase partners with Fastly, a CDN, to provide the CDN backing Firebase Hosting. The company states that Firebase Hosting grew out of customer requests; developers were using Firebase for its real-time database but needed a placehosting.[19]

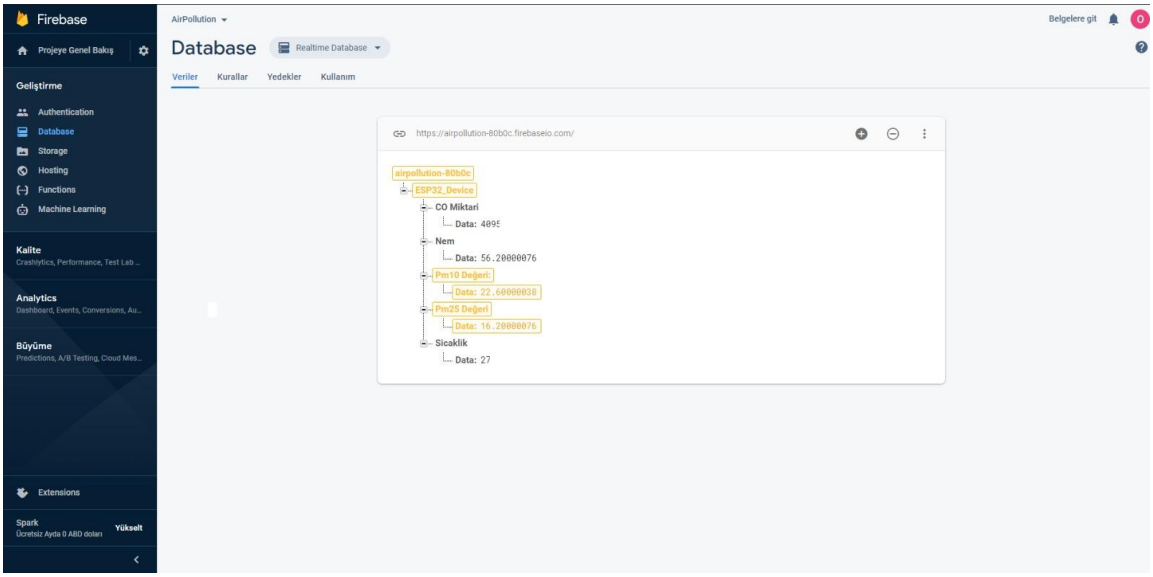

Figure 3.3: An image of Firebase

3.4 AIR QUALITY APPLICATION

We created and designed a mobile application. That application sends the datas instantly to the users. The user can access the air quality values in the user's location with this mobile application. While we are doing the air quality application, we used android studio. After some problems that we encounter, our application is not exactly ready. We decided to do more appropriate in the future stages and we are decided to make a more professional application. Our real objective to make people's attention that that that is making conscious consideration.

Figure 3.4: Application of Air quality

4. WEB BASED AIR QUALITY

After measuring the values that determine the air quality, we created and designed a website to transfer these values. The main parts of the internet site is prepared already. In homepage of the internet site, there are all districts of Istanbul. When we click on any district, the factors determining the air quality (temperature, humidity, pm2.5 and carbon monoxide) appear to a great extent and show us the measurements of these values clearly. Our target is to inform people in society with this knowledge and contribute their health.

Figure 4.1: Home page of the website

Figure 4.2: An image from the website

4.1 SOFTWARE OF THE WEBSITE

The homepage of the website was written with the following codes. We used html and php language while making the software.

```
<!DOCTYPE html>

<html>

<link href='style.css' rel='stylesheet'>

<head>

    <title>İstanbul Hava Kalitesi İzleme</title>

</head>

<body>

<h2>
```

```
<a href="detay.php"><img src="location.png" style="width:35px;height:35px;border:0"></a><div class="box">

        <iframe src="detay.php"  width = "450px" height = "450px"></iframe></

</a></h2>

</html>

</body>
```

The following codes are clicked on the district when a detailed review of the air quality can be made.

```
<!DOCTYPE html>

<html>

<body style="background-color:yellow;">

<head>

<title>Eyüp Detaylı Hava Kalite İzleme</title>

<style>

table, th, td {

  border: 1px solid black;

  padding: 5px;

}

table {

  border-spacing: 15px;

}
```

```
</style>
</head>
<body>
<h2>Eyüp İlçesi Hava Kalitesi</h2>
<br><br><br><br>
<table style="width:100%">
  <tr>
    <th>Sıcaklık</th>
    <th> &nbspNem   </th>
    <th>Pm2.5</th>
    <th> &nbspCO  </th>
  </tr>
  <tr>
    <td>  </td>
    <td>      </td>
    <td>  </td>
    <td>  </td>
  </tr>
 </table></body></html>
```

The following codes will provide a connection to the database and the values measured with our device will be transferred to the website.

```
<?php

$nem = $_GET['n'];

$sicaklik = $_GET['s'];

if (!$nem) {

  $nem = 0;}

if (!$sicaklik) {

  $sicaklik = 0;}

$db = new PDO("mysql:host=localhost;dbname="havakalitesi", "**kullaniciadi**",
"**sifre**"");

if($db)

{

        echo("baglanti basarili");

}

else

        echo("baglanti basarisiz");

$now = new DateTime();

$datenow = $now->format("Y-m-d H:i:s");

$insert = $db->query("INSERT INTO `bitirme` (`id`, `tarih`,`sicaklik`,`nem`) VALUES
(NULL, CURRENT_TIMESTAMP , "'.$sicaklik.'", "'.$nem.'")");

if ( $insert ){

    $last_id = $db->lastInsertId();
```

```
    print "insert islemi basarili";

}

$db = null;

N
```

5. AIR QUALITY OBSERVERS IN THE MARKET

PCE-PQC 23EU

Figure 5.1: PCE-PQC-23EU

Specifications:

Display : 4.3 "WVGA color touch screen, 480x272 pixels
Power Source : 110/240 VAC 50/60 Hz
Weight : 1 kg
Measuring Range : 0,3 - 25 µm [13]

PC200

Figure 5.2: PC200

Display : 2.8 inch color LCD, 320 x 240 pixels, with backlight

Power Source : Polymer Li-lon

Weight : 570 gr

Measuring Range : 0,3 – 6 μm [14]

AZ 7798

Figure 5.3: AZ 7798

Display : Large LCD Display

Power Source : 5V Adaptor

Weight : 1 kg

Measuring Range : 0,1 – 10 µm [15]

DEVICE/ SPECIFICATIONS	PCE-PQC 23EU	PC200	AZ7798	OUR DEVICE
Display	4.3 "WVGA color touch screen, 480x272 pixels	2.8 inch color LCD, 320 x 240 pixels with backlight	Large LCD Display	Touchscreen LCD display, website and application
Power Source	110/240 VAC 50/60 Hz	Polymer Li-lon	5V Adaptor	~7.4V lipo battery
Weight	1kg	570 gr	1kg	~765gr
Measuring Range	0,3 - 25 µm	0,3 – 6 µm	0,1 – 10 µm	~Not determined yet

Table 5.1: Comparison with other devices

6.ANALYSIS

6.1 APPROACH AND METHODOLOGY

Under the guidance of our advisor, we have taken some tasks and will continue to receive them, we have met and after that process we are going to continue to meet with our professor regularly and continuously and develop our project together.

We have made the task distribution among ourselves and we will try to present the project as complete as possible and even adding new features by helping each other's deficiencies.

IOT devices with low power consumption will be produced for data collection purposes. The IoT devices to be produced shall have a low power central processing unit like Arm and MSP. Temperature, humidity, carbon dioxide, carbon monoxide and the location of the sensors needed to be measured at certain intervals according to the characteristics of the IoT Lora network network or in the absence of IoT network, the data will be transferred to the system in the cloud periodically [2,3].

We used esp32 in our project. Because, it enables less power consumption with and we can connect it to the wifi and bluetooh without a separate module. Firstly, we got our results by connecting our sensors to our project. we prefered SDS011sensor as a dust sensor. Because there are strictly results according to other dust sensors and can measure pm10 - pm2.5 values at the same time. We choose our other sensor as mq7 sensor in order to measyre the CO rate in the air. We selected DHT 22 sensor as temperature and humidity sensor. We choose to be cheap cost and give the right water results. We have started to record our data from firebase after we have completed the initial stage of our prohem. Firebase is the database. Our registration reason we used firebase to see the results we obtained in our project on the application and on the same time on the website. Moreover, we designed a simple applicatino to observe the results. As a display screen we preferred 2.4Inch Nextion HMI LCD Display. We have used this product in our project to instantly see the results in the same time. The screen design is required by using this product and to be a touch screen. Through this product, we can see our data on the screen instantly.

6.2 NEXT STEPS

After the trial phase we will use a low power central processing unit like ARM and MSP. Because we need to keep the battery time longer.

We aim to connect the wifi module to the internet and send the measured values to the database of the website instantly. After the wifi module starts sending value to the internet, we will set up a special box for the device. The box is a closed box and we will have 2 fans in the box to be an input and an output. This is because the device must be protected outside. Therefore, a fan will be used to ensure the air circulation inside. If there is no internet in the environment, the data will be transferred to the database of our website via GSM module. If there is a problem with the GSM module, the measured values to prevent data loss in our device will have a memory unit. In order to see the location of the measured GPS module will also be included. Using GPS, the location information will be added to the actual time information. We need to provide serial communication and transfer data to the website and start measuring on campus. at the same time, we should be able to get the data on the website in a very clear way. Then, we will switch to the materials we will use and send the data to the website in a calibrated way. Other districts of İstanbul, will be added to the website later and through that, we will be able to watch these values in the website instantly. We will classify the data we receive and make the health status of people living in that region a statistical data. Once these are completed, we will work on the impact of the data we receive on human health. Our priority target for now; To understand the logic of the system, to communicate with our website and module and prepare ourselves for the original parts. because we won't be able to work through trial and error while working with those parts. That part was our normal plan for our senior design project. However;

After covid - 19 period, our project has changed and through that changings, future works are changed automatically. As future works, there will be a PCB design. The device will become smaller. There will be bluetooh and also WiFi accesibility. Through that, mobile and even non-mobile there will be accesible to the device. We have decided to make real that project for people to be sensitive about air quality and aipr pollution that has a very important impacgt on human health. Aim of that project is to provide users to access weather values that effect human health. The device that we produced in the porject aims to provide instant information to the users. We make our device in a small size and make the air pollution map of the locations that users choose always. The device we produced

will be connected with the mobile phone and these datas can be reached instantly with the mobile application and also from the website. Also, the website and the application will become more professional. There will be a map and through that map, we will observe the air quality and neccesery numbers by that map up to the streets all over the world.

6.3 EXPECTED RESULTS

- We are going to design a device that measures the air quality in 3 different campuses of İstanbul Bilgi University.
  (Dolapdere campus, Kuştepe campus and Santral campus.)
- In order to keep the power consumption low, it is planning to the data stored in the memory unit will be transmitted in certain time periods of the day.
- Daily weather quality values will be taken online or sms and will be added to the database of our website and application.
- The device will be wireless and will be powered by a battery.
- The device will go into sleep mode when it does not measure and therefore the battery will last for 1 year.
- There will be a map and through that map, we will observe the air quality and neccesery numbers by that map up to the streets all over the world.
- The device will become smaller.
- The application will becoma more professional.
- PCB design will be designed.
- There will be bluetooh and also WiFi accesibility
- We want to connect the device and the project with bluetoth, and to connect with the mobile phone in which the internet does not active. We aim to design the device in a small size by using 3DS max, that people can always move this device in their bags easily and effectively.

7. CONCLUSION

This documentation was all about the hava air quality monitoring with IoT sensors ”project. This project is designed for human health. This project has become a different dimension with the increase of air pollution all over the world. Especially in our country, in Turkey. Air pollution has a great impact on human health. So we know that; Air quality is very important. 2 As a senior student in electrical and electronics engineering, we are aware of the importance of air quality on human health. We decided to carry out such a project so that the people in the community can access the correct information. That year, at the second semester of the education, because of covid - 19 period, our university is closed like every university in Turkey and in the world and we passed to online education as the university. Therefore we met with our professor via online and together we decided to do some changings in our project. We have advanced the project in the light of our professor in our online meeting. Through that online discussion, we decided to create and design an application and also we would take the actual results about air quality. We decided to create and design an application because our aim was that we would send these actual datas to our application. Apart from that, we decided to create a circuit diagram. At the end of the project, now; we are getting results from all devices at the same time. We have created and designed an application and also we could transfer the datas and these datas are accesible in our application right now and we created a circuit diagram.

7.1 REALISTIC CONSTRAINTS

We have achieved the goals we set with our advisor to a large extent. When we look at the general situation, we can describe it as a success for us. However,
Our device could be smaller. The goal we set at the beginning of the year was to see and compare the air quality results from 3 different campuses of our school at the same time. However, due to the pandemic, we could not take our measurements by going to our campuses freely and comfortably. We have received the air quality values in the places we currently have. Pandemic was a serious restriction for us because the location was extremely critical for our project. The reason that at some points we changed our project to a certain extent was the pandemic.

7.1.1 SOCIAL, ENVIRONMENTAL AND ECONOMIC IMPACT

In our project, we investigate the effect of air quality on human health. Therefore, our project has a huge impact on the social and enviromental aspects. It will have a positive and indirect contribution to human health. Because the researches and statistics say that; According to World Health Organization estimates, 3 million people die from indoor pollution and 4.2 million people die from outdoor air pollution in 2016. In children under 5 years of age, one in 10 deaths is caused by air pollution. 93% of children under the age of 15 live in areas exceeding the PM2.5 limit set by WHO. If Turkey is searched; The number of deaths due to air pollution is estimated by the OECD to be approximately 30,000.

Due to air pollution caused by thermal power plants in Turkey every year there are 3,000 premature death. From smog hanging over cities to smoke inside the home, air pollution poses a major threat to health and climate. The combined effects of ambient (outdoor) and household air pollution cause about 7 million premature deaths every year, largely as a result of increased mortality from stroke, heart disease, chronic obstructive pulmonary disease, lung cancer and acute respiratory infections. More than 80% of people living in urban areas that monitor air pollution are exposed to air quality levels that exceed the WHO guideline level of 10μg/m_3, with low- and middle-income countries suffering from the highest exposures We hope that; through our senior project, we will make inform more people and they will realise the real danger and they will face with these realites. It is obviously seen that; air quality is really an important detail for people's health. Air pollution threats people's lifes really seriously.

Our project is actually not a cost-effective project because it is expensive and also our project is small in size and because of the high number of sensors and gasses taken for measuring the gases and molecules (CO2, VOC, CO, SOX, CH4, NOX, PM). As size, it should be smaller and also we stated about that problem in our future works part.

The largest restriction of our project is in the social meaning, it should be human to have this device to reach the real purpose of the project. Because, we are connected to more users as devices for we have air-quality measurement worldwide. If we can contact how many users about the project, that we have reached to the purpose. One of our objectives to make this project is to contribute to our state in international meaning.

7.1.2 COST ANALYSIS

EQUIPMENT	**COST(TL)**
DHT 22	**31,90TL**
DUST SENSOR	**244,15TL**
LIPO BATTERY	**112,10TL**
ESP32	**64,90TL**
LCD DISPLAY	**140,10TL**
MQ7	**13,90TL**
CABLES	**25,60TL**
BREADBOARD	**10,40TL**
ELECTRICITY COST	**~ 9TL**
TOTAL	**~ 649,05TL**
SALARY	**~ 3000TL**
TOTAL WORKING HOURS	**~ 210 HOURS**

Table 7.1: Cost Anaylsis

7.1.3 STANDARDS

Engineering standards are documents that specify characteristics and technical details that must be met by the products, systems and processes that the standards cover. The purpose of developing and adhering to standards is to ensure minimum performance, meet safety requirements, make sure that the product/system/process is consistent and repeatable, and provide for interfacing with other standard-compliant equipment (ensure compatibility). There are several good sources on engineering standards, including the IEEE Standards in Education and Standards Association portals; the website of ASTM International ; and the website of ANSI, the American National Standards Institute. Engineers who work on wireless communications, are likely to be very familiar with the IEEE 802 standards; these deal with local area networks and metropolitan area networks. Engineers who work on building design would consult the ASCE 7-05 standard on.

Standards of ESP32:

- Standards Certification: FCC / CE / TELEC
- Wireless standards: 802.11 b / g / n
- Frequency range: 2.4GHz-2.5GHz (2400M-2483.5M)
- Data interface: UART / HSPI / I2C / I2S / Ir Remote Contorl GPIO / PWM
- Operating voltage: 3.0 ~ 3.6V (recommendation 3.3V)
- Working Current: Average: 80mA
- Operating temperature: -40 ° ~ 125 [17]

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