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UDC

ARDUINO-BASED DEVICE MODELING: INDOOR AIR QUALITY OF SICT THE RESULTS OF EVALUATION STUDIES

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Abstract

As the level of air pollution increases, it starts to damage our environment. But whenever the topic of air pollution comes up, we talk about the environment. Outdoor air pollution also affects indoor air. In our research, we measured indoor air pollution in University using Arduino boards, gas, humidity, and temperature sensors. In this work, we proposed a cheap air quality monitoring system based on Arduino uno microcontroller. The Arduino is connected to 2 sensors and the measured data is displayed on the LCD screen. The sensors used are DHT11 for humidity and

temperature sensors and Mq-2 for carbon dioxide (CO_2). Our device is a device capable of taking measurements of real-time conditions. Air pollution in the school environment was measured with this simulated device and the results were obtained.

Keywords: indoor air pollution, sensors, baseplates and control systems

I INTRODUCTION

Air pollution in buildings without indoor air flow is 2-5 times higher than outdoor air pollution, and in some serious conditions, it is 100 times higher. Indoor air pollution (IAP) is ranked among the top five environmental public health risks by the Environmental Protection Agency (EPA) Science Advisory Board (Environmental Protection Agency 2019). The concentration effect mentioned above is more relevant for people who spend more than 90% of their usual time at home or in the office. Although the health effects of increasing concentrations of indoor air pollution have not been thoroughly studied, studies have shown that indoor air quality has a greater impact on lung dysfunction [1].

The definition of indoor air pollution generally includes air pollution, introduction and distribution of outdoor air particles, relative humidity and temperature fluctuations. Humidity and temperature cannot be ignored because these thermal comfort parameters affect the level of protection of the indoor environment and are the basis of several complaints related to poor air quality [5].

The World Health Organization (WHO) has conducted a study that estimates that about 8 million people die each year due to air pollution worldwide, of which 4.3 million die from indoor air pollution sources alone (World Health Organization 2015; Apte and Salvi 2016). Most deaths due to indoor air pollution occur in middle- and low-income countries, with 52,000 in Europe, 82,000 in the United States, and 212,000 in the Middle East [2].

II main section

In this research, DHT11 (Humidity and Temperature sensor) was used as the humidity and temperature sensor. Carbon dioxide and MQ-2 gas detectors were coded and used. My device is basically running at 75 % capacity, measuring and coding the same as 80–90 % of our respective devices.

Purpose of the study:

- Improving the air environment inside the school
- See what environment you study and work in
- Make it clear that indoor air pollution is also dangerous

In order to carry out this research on a real device, the following objectives were set. In this:

✓ Review theoretical research by reading International academic materials in English

✓ Collect the boards and sensors to be used

✓ Make a connection by simulating device

✓ Experiment in a university setting

✓ Take measurements of indoor air pollution

Device cost:

1. Arduino Uno board – 35 000 MNT
2. DHT11 sensor – 5 000 MNT

3. MQ-2 sensor – 5 000 MNT
4. Active buzzer – 5 000 MNT
5. Resister – 1 000 MNT
6. LCD display – 15 000 MNT
7. Pin wire – 2 000 MNT

Total cost – 68 000 MNT

III DEVICE MODELING

In our tests, we coded a variety of motherboards, gas sensors, humidity and temperature sensors. Below is the device code:

```
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27,16,2);

// Display data bytes
byte Degree[] = {
  B00111,
  B00101,
  B00111,
  B00000,
  B00000,
  B00000,
  B00000,
  B00000
};

#include <DHT.h>

#define DHTPIN 6     // The pin that connects to DHT11
#define DHTTYPE DHT11    // DHT 11

DHT dht(DHTPIN, DHTTYPE);


int Analog_Input = A0;
int lpg, co;
int DI = 12;
int RW = 11;
int DB[] = {3, 4, 5, 6, 7, 8, 9, 10};//
int Enable = 2;

void LcdCommandWrite(int value) {
// define all pins
int i = 0;
for (i=DB[0]; i <= DI; i++) // assign a value
{
   digitalWrite(i,value & 01);// For 1602 LCD, D7-D0 (not D0-D7) is used for
signal recognition; Here it is used for signal inversion.

   value >>= 1;
}
digitalWrite(Enable,LOW);
delayMicroseconds(1);
digitalWrite(Enable,HIGH);
delayMicroseconds(1);  // wait 1 sec
digitalWrite(Enable,LOW);
delayMicroseconds(1);  // wait 1 sec
}

void LcdDataWrite(int value) {
// start all pings
```

```
int i = 0;
digitalWrite(DI, HIGH);
digitalWrite(RW, LOW);
for (i=DB[0]; i <= DB[7]; i++) {
   digitalWrite(i,value & 01);
   value >>= 1;
}
digitalWrite(Enable,LOW);
delayMicroseconds(1);
digitalWrite(Enable,HIGH);
delayMicroseconds(1);
digitalWrite(Enable,LOW);
delayMicroseconds(1);  // wait 1 sec
}

void setup(){
  Serial.begin(9600);
  Serial.println("DHT11 test!");

  dht.begin();
  Serial.begin(9600);

  lcd.init();
  lcd.backlight();

  // Create special characters:
  lcd.createChar(0, Degree);

  int i = 0;
for (i=Enable; i <= DI; i++) {
   pinMode(i,OUTPUT);

}

}
void loop(){

  // The data is read and stored in the h (humidity) and t (temperature) varia-
bles.
  //Reading temperature or humidity takes about 250 milliseconds!
    delay(2000);  // Delay between sensor readings

float humidity = dht.readHumidity();
// Read the humidity
  float temperature = dht.readTemperature();  // The temperature is read in Celsius

  // Check if the read failed and exit early (try again).
  if (isnan(humidity) || isnan(temperature)) {
    Serial.println("Failed to readfrom DHT sensor!");
    return;
  }
  Serial.print("Humidity: ");
  Serial.print(humidity);
  Serial.print(" %\t");
  Serial.print("Temperature: ");
  Serial.print(temperature);
  Serial.println(" *C");

// set cursor to (0,0):
// Print from 0 to 9:


    lcd.setCursor(0, 0);
    lcd.println(" Now Temperature ");

    lcd.setCursor(0, 1);
```

```
    lcd.print("T:");
    lcd.print("C");

    lcd.setCursor(11, 1);
    lcd.print("H:");
    lcd.print("%");

  delay(1000); //Wait 1 sec

  int val;
val=analogRead(0);// The gas value is read from analog 0
co=analogRead(0);
Serial.print("CO2=");
Serial.println( val,DEC);// Print the value to the serial port

 lcd.print(" CO:");
 lcd.print(co);
 lcd.setCursor(0,1);

  delay(1000);
}
```

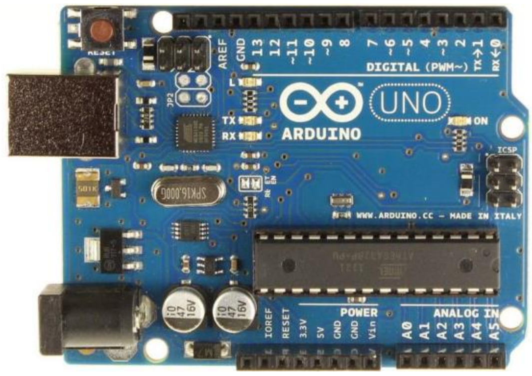

Figure 1 – Arduino board design

Explanation 1. The Arduino uno board is a popular microcontroller board based on the ATmega328P microcontroller chip. It has 14 digital I/O pins (6 of which can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header, and a reset button. It is one of the most widely used Arduino boards due to its versatility, ease of use, and wide availability [11].

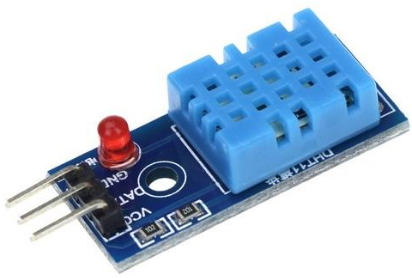

Figure 2 – DHT11 or humidity and temperature sensor

Explanation 2. The DHT11 is a basic, ultra-cheap digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the ambient air and output a digital signal to a data pin (no need for an analog input pin).

Figure 3 – MQ-2 or gas sensor

Explanation 3. The MQ-2 is Winsen's smoke and flammable gas detector. It can detect flammable gases in the range of 300 - 10000ppm. It's most common applications are highly sensitive household gas leak alarms and detectors for propane and smoke. It is also possible to code this gas meter to measure carbon dioxide [12].

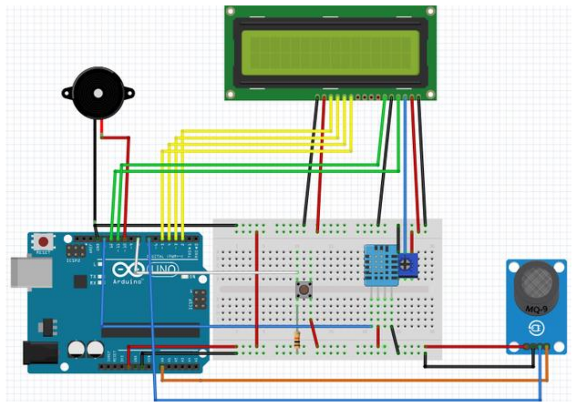

Figure 4 – Model made in the device simulation environment

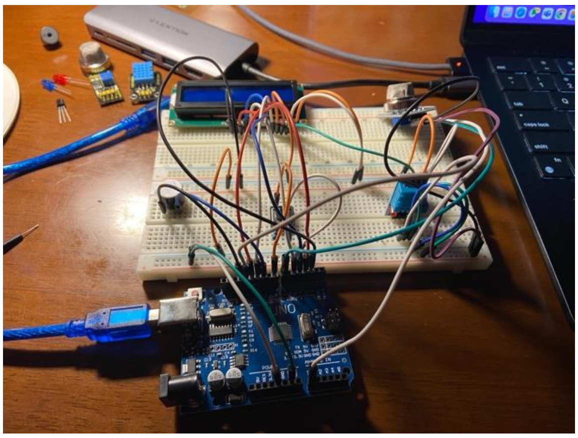

Figure 5 - The model of the connection made on the real device

IV RESEARCH METHODOLOGY

The object of the study was researched at the SICT of MUST. As for SICT, there are many students, and because of this, many students have to sit for long hours in small classes. Also, the glass parts for studying on each floor have a structure that cannot allow air circulation.

The following sensors and board were used in the study. In this:

1. Arduino uno board
2. Gas sensor
3. Temperature sensor

4. Humidity sensor

A. Methodology

We have created an air quality monitoring system that is cost effective and easy to use. using the active buzzer and restart button, we made the conversion, using the mq-2 sensor connected to the digital pin of the arduino uno as a carbon dioxide sensor, and the dht11 sensor as the key to get the humidity and temperature measurements.

We connected 2 sensors to arduino uno board with the aim of getting 4 types of data. The data read from the sensor will be processed by the arduino uno microprocessor and then the data will be displayed as numbers on the lcd screen.

The received results are analyzed according to the measured air quality thresholds. the stages of this study can be seen in figure 6.

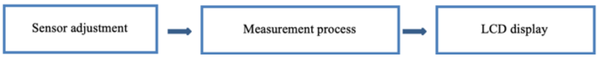

Figure 6 – Research stage

B. Average value and perception of measurement constant

The indoor temperature is 18-22\degc. In terms of humidity, however, absolute humidity is used to measure the weight of water vapor in a unit volume of air. The unit of absolute humidity is g.m-3, that is, the unit of grams of water vapor per cubic meter of air. If the humidity itself rises above 65 %, it will cause mold and more humidity to inhibit. But normal humidity should not be more than 55 %.

Natural gas contains carbon dioxide, a combustible mineral made up of methane, and excess amounts cause air pollution problems. If carbon dioxide is between 400 and 1,000 parts per million (or ppm), that's a normal rating per million of air. If it exceeds 1000, it is considered serious and dangerous. [4].

Formula to convert PPM to mg/m^3 [6]:

Concentration (ppm) = 24,45 x Concentration (mg/m3) ÷ Molecular weight (1)

C. Research results

Data collection was done in the school environment at 07:00 in the morning when students were not gathered and when children were most gathered. I also tried to get data samples from many locations here and there in the school.

Measurement locations:

Figure 7 – Sections A and B of the library

Figure 8 – Glass section for classrooms on the first and second floor

The results of air quality monitoring can be seen in table 1.

Table 1 – The results of air quality monitoring of SICT

Location	**Carbon dioxide (ppm)**		**Humidity g.m-3 (%)**		**Temperature (°C)**	
	No student	**Many students**	**No student**	**Many students**	**No students**	**Many students**
Library Section A	527	782	19%	39%	19.2°C	21.7°C
Library Section B	527	737	17%	39%	19.2°C	22.3°C
First floor glass section	**385**	**920**	**15%**	48%	19°C	24°C
Second floor glass section	**387**	**892**	27%	40%	17°C	23.7°C
Average	**456.5**	**832.75**	**19.5%**	**41.5%**	**18.6°C**	**22.92°C**

In terms of humidity, if it is more than 55 %, it is dangerous, but if it is too low, it is dry. In the locations where the measurements were taken, it is very dry when the students are not gathered, but after the gathering, the air inhaled by many people shows that the humidity increases in the closed environment. However, our carbon dioxide level is 920 ppm, which is a high level for the school. But in section A of the library, the range of 527–782 ppm shows that the humidity increases when many people breathe, which indicates that there is less air exchange when there are more students. But as a result of our measurements, the library room has a normal level of humidity and a high level of dryness.

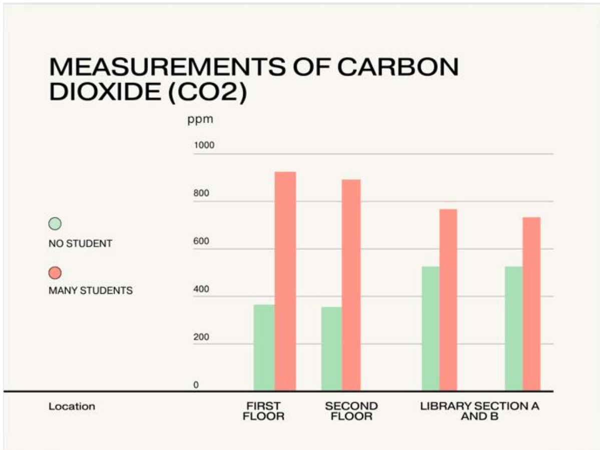

Figure 9 – Measurements of carbon dioxide

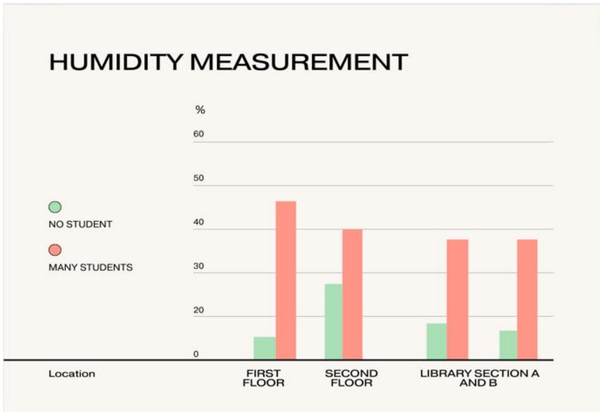

Figure 10 – Measurements in humidity

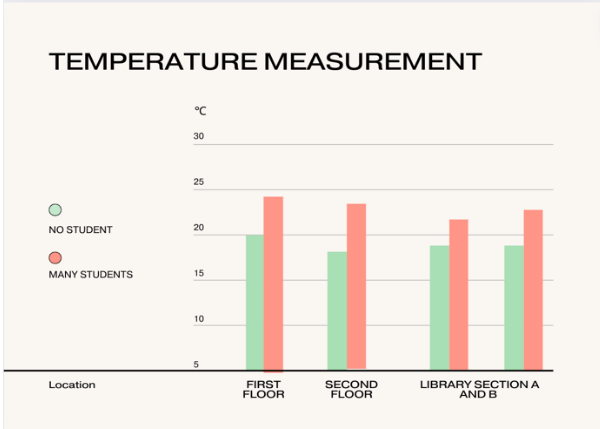

Figure 11 – Temperature measurement

CONCLUSION

As a result of this study, an inexpensive arduino-based air pollution measurement device was designed. it's an indoor air quality measurement system that uses an arduino uno as a microcontroller and sensors that can measure pollutants such as CO2 sensors, humidity sensors, and temperature sensors. This system is cost-effective and portable compared to existing fixed and expensive monitoring stations. it is also an easy-to-use, user- and researcher-friendly air quality detector whose performance is comparable to existing air pollution detectors. by measuring the indoor air where we live and work, It is convenient to improve the air and take measures against pollution.

According to the measurement results, if the humidity is more than 55 %, it is dangerous, but if it is too low, it is dry. In the locations where the measurements were taken, it is very dry when the students are not gathered, but after the gathering, the air inhaled by many people shows that the humidity increases in the closed environment. However, our carbon dioxide level is 920 ppm, which is a high level for the school. On the other hand, in section A of the library, the range of 527–782 ppm increases the risk of air pollution due to increased humidity due to increased breathing of many people. But as a result of our measurements, the library room has a normal level of humidity and a high level of dryness.

Therefore, it is advisable to clean the glass areas of the 1st and 2nd floors daily with wet cleaning and install air exchange equipment when students gather.

Our future plan is to add a WI-FI module to our ardiuno-based device and test it to turn it into an iot-level device. By making it an IOT-level device, the values obtained on the device can be fully viewed on the phone using a web interface and an application.

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УДК 004.415.25

АВТОМАТИЗИРОВАННАЯ СИСТЕМА РАЗВОЗА ТОВАРА СО СКЛАДА ПО ТОРГОВОМУ ЗАЛУ БЕСПИЛОТНОЙ ГРУЗОВОЙ ТЕЛЕЖКОЙ

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Реферат

В данной статье рассмотрена автоматизированная система развоза товара со склада по торговому залу беспилотной грузовой тележкой.

Рассмотрены перспективы автоматизации системы развоза товара со склада по торговому залу. Описаны преимущества и недостатки автоматизированной и неавтоматизированной систем. Представлены схема развоза товаров со склада по торговому залу, структура системы автоматического управления и устройство беспилотной грузовой тележки.

Ключевые слова: торговый зал, склад, беспилотная тележка, транспортировка, автоматизация, датчик, система управления, мобильный робот, роботизация.

AUTOMATED SYSTEM FOR DISTRIBUTION OF GOODS FROM THE WAREHOUSE AROUND THE SALES FLOOR BY AN UNMANNED TROLLEY

M. D. Tarasevich

Abstract

This article discusses an automated system for distributing goods from a warehouse to a sales floor using an unmanned cargo trolley.