Arduino-Based Real Time Air Quality and Pollution Monitoring System

***Abstract*—Now-a-days air pollution is one of the most important concern of the world. Air pollution may evolve from anthropogenic or natural sources. Air pollutants of atmospheric substances like CO, CO_2, SO_2, NO_2, and O_3 suspended particulate matter (SPM), repairable suspended particulate matter (RSPM), and volatile organic compounds (VOCs) have a great effect on the people health. Most of the major cities in developing countries and most cities of the developed countries are suffering from it. Thus to develop a real time air quality and pollution monitoring system is critical. We have developed an arduino based air pollution detector which combined a small-sized, minimum-cost sensor to an arduino microcontroller unit. The advantages of the detector, have a reliable stability, rapid response recovery and long-life features. It is affordable, user-friendly, low-cost and minimum-power requirement hardware which is appropriate for mobile measurement, as well as comprehensible data collection. It has a processing software able to analyze, collected quality data with high precision. Simple instrument which can be commercially utilized.**

***Keywords*- Air pollution, ardunio, gas sensor, anthropogenic, atmosphere.**

I. INTRODUCTION

Air pollution is the presence of extra unwanted biological molecules, particulates or other harmful things into the earth atmosphere. It is a major cause of infections, allergies, and eventually reasons of death to some peoples. It also harms to other existing creatures like that animals as well as food crops, or the ecological or built environment [1-2]. They are also accountable for various kinds respiratory infections (like asthma), causes of different types of cancer in individuals, if they are unprotected to these toxins or chemicals for long period of time. For example, carbon monoxide (CO) is extremely poisonous to people as it may happen serious asphyxiation, headaches because of the composition of carboxy-hemoglobin and thus a reason of death if unprotected for a long time. The world health organization (WHO) in 2014 approximated that 7 million people deaths worldwide because of air pollution. The similar approximation roughly equaled by the International Energy Agency (IEA) also [3]. These chemicals or pollutants are also responsible for various environmental calamities like acid rain and depletion of ozone layer. Because of a number of anthropogenic actions, air pollution is on the growth and its controlling is of significant importance to alleviate particular actions to limit it [4].

In the past, the air quality measuring sensors were very big, non-portable and expensive. Presently, most air pollution sensors developed on five most common air pollutants viz. nitrous oxide, carbon monoxide, ozone, sulfur dioxide and particulate matter. In today's world, air pollution and quality monitoring are really vital as it has a great effect on human health. The developed air-quality measurement sensor can identify and observe the incidence of air pollution in the adjacent areas. It can be employed for both indoor and outdoor. With the help of future technological improvements, these sensors will become cheaper and more common, inexpensive, portable air-quality sensors which can be wearable by people to observe the local air quality [5-7].

II. MATERIALS AND METHODS

We have used Arduino UNO, MQ-135 air quality sensor, LCD display, breadboard, jumper wires, and potentiometer to develop an arduino based air pollution detector which combined a small-sized, minimum-cost sensor to an arduino microcontroller unit (Figure 1). The device is linked to a computer through a serial connection. From the sensor, the collected data through the arduino microcontroller. It will then be transmitted to the computer software, where it becomes documented and plotted in real-time. It is very small in size and can be hand-held measurement system that can detect numerous gas in real

time. It has microcontroller sensors for O_3, CO, CO_2, NO_2 etc. [5].

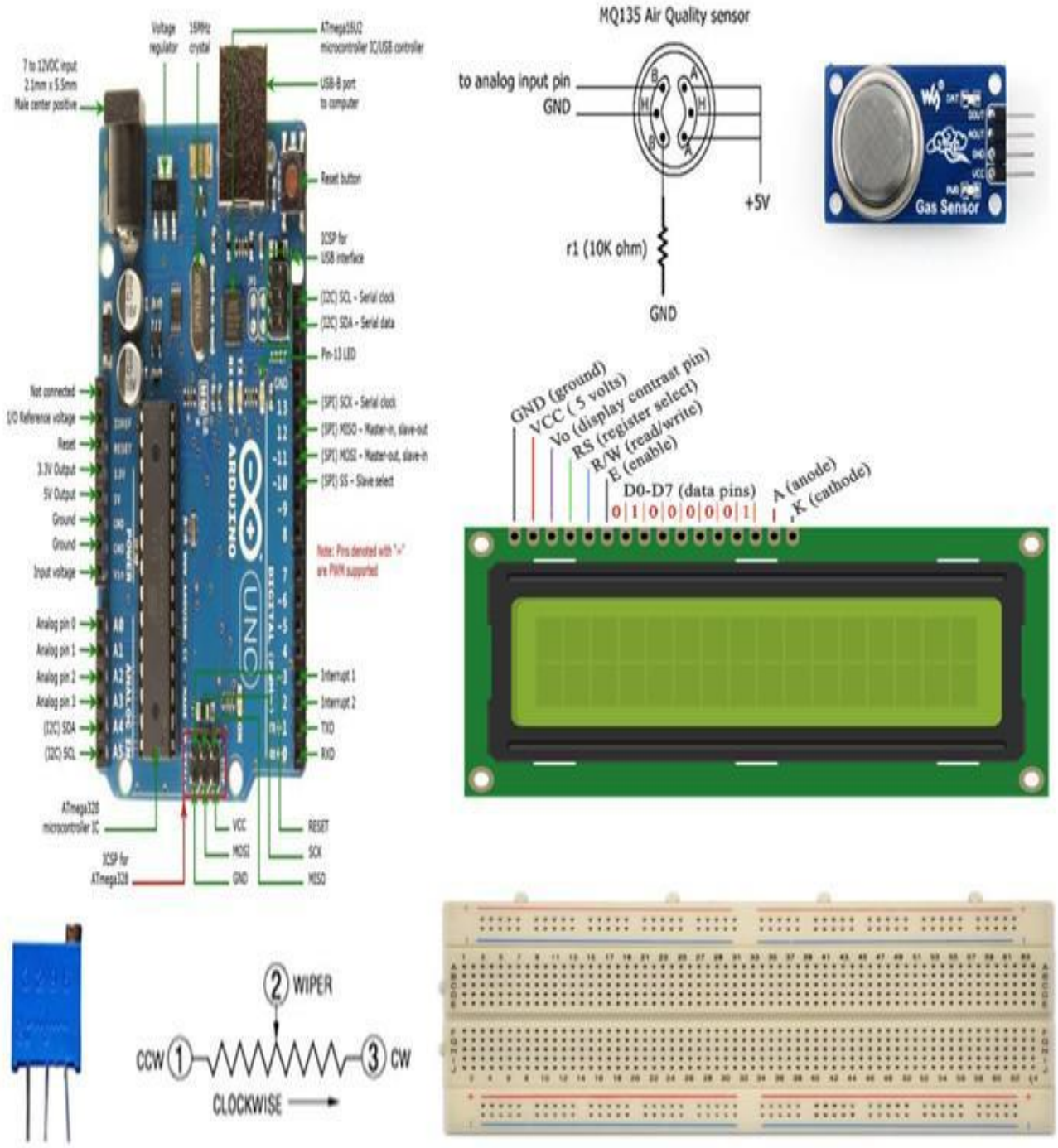

Fig 1: Parts of the air quality monitor system.

III. WORKING PRINCIPLE OF THE SYSTEM

The major chip of the system is LM393 and MQ135 are gas sensing analysis [8, 9, 10]. The Arduino or Genuino Uno is a modern microcontroller board based on the ATmega328P. It is simply related to a computer by a USB link or power. Connected to an AC-to-DC convertor or battery source to become commenced [10-11]. Using jumper wires the MQ135 gas sensor unit is linked to the arduino Uno board. The sensors analog pin is then related to the analog pin 0 and digital pin to digital 8 on the arduino board, while +5V and the GND (ground) pins on the sensor unit are linked to the 5V Vcc and GND (ground) pin correspondingly on the arduino board. Using USB connection, the arduino Uno board is then linked to a computer system. This part elaborates the hardware and software instruments and structural design of the detector.

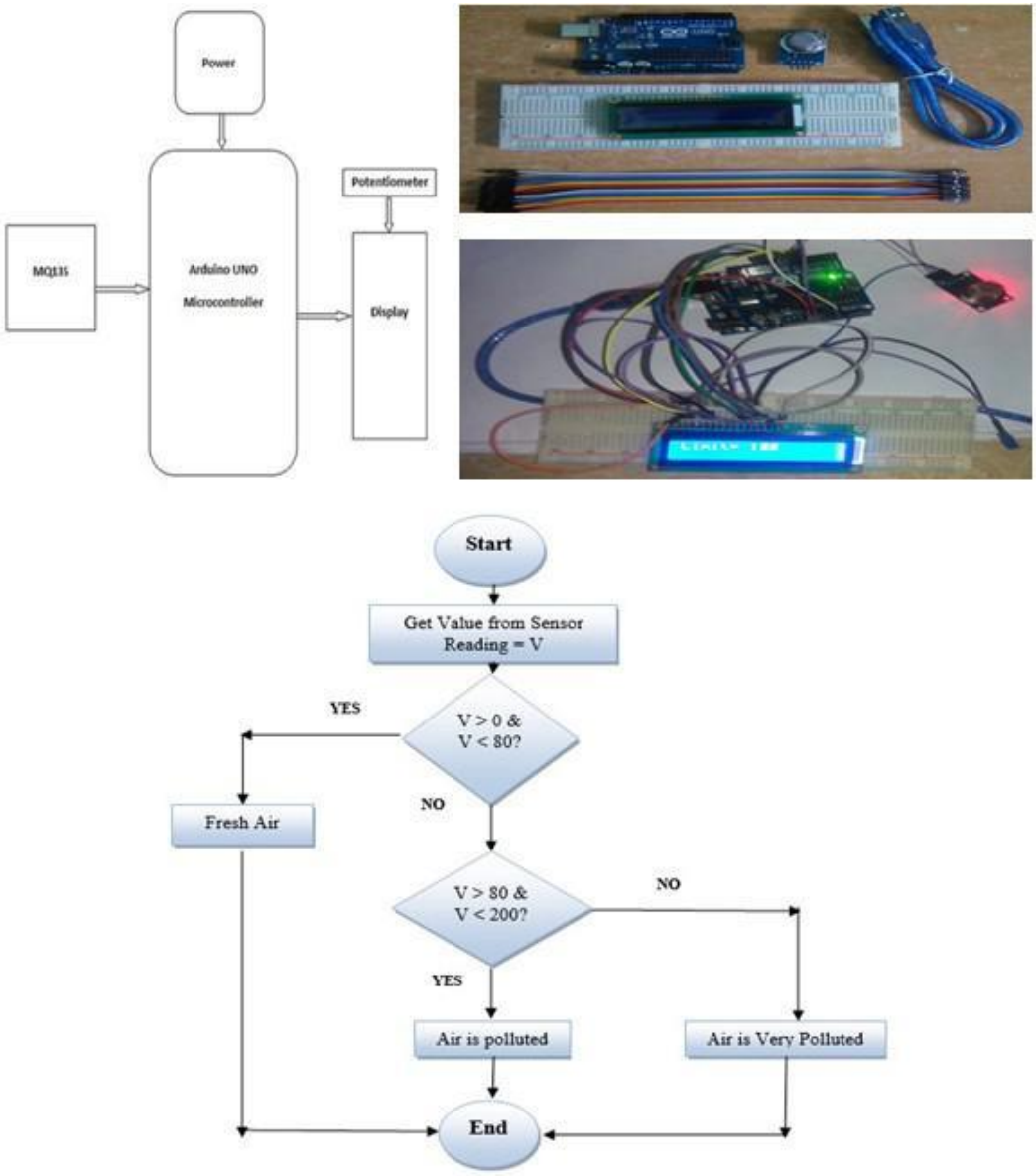

Fig 2: Block diagram, working principle and displaying the result.

A harmful gas recognition device for the people, the environment that is appropriate for. A wide variety of gases is detected in air quality sensor comprising NH_3, NO_2, benzene, alcohol, smoke, and CO_2. The collection of air pollutants like CO_2, CO, SO_2, etc. is greatly location-dependent [3, 6, 9, 12]. Very simple device, and monitoring circuit which is perfect for use in office or factory.

IV. SOFTWARE

We have also developed a customize software s for gathering data from the detector and mapping it in real-time [10, 13]. The software of arduino-based air pollution detector system comprises the coding of the arduino Uno board in its Integrated Development Environment (Arduino IDE). The serial connection between the sensor, the arduino, and the computer system that was formed using the serial library of the arduino. The attention of the gas measured hinge on upon the resistance of the gas sensor. Additionally, this depends on the sensor of the voltage of the analog output pin. The sensor revisits an analog voltage to the arduino [11, 14 -15].

V. DATA FROM THE DETECTOR AND CODE FOR THE ARDUNIO

To obtain real time air pollution data (in PPM), we have taken reading using our customized sensor-detector in different environmental pollutions. We have used cigarette smoke, mosquito coil burning smoke, motor vehicle smoke from street etc.

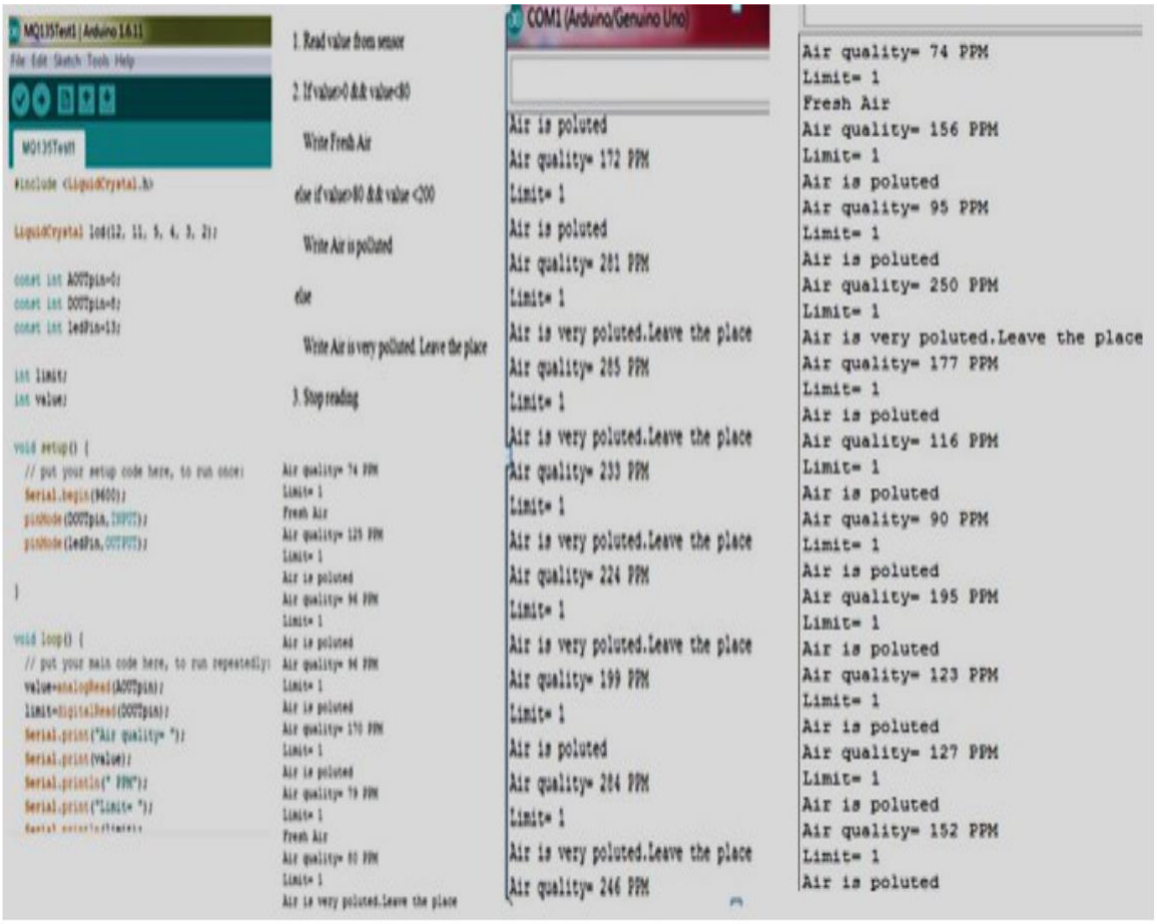

Fig 3: Arduino editor and coding Output Result for mosquito coil, motorcycle smoke and two types of cigarettes Marlboro and Hollywood

VI. RESULTS AND DISCUSSIONS

Arduino based air quality monitoring detector system design involves hardware and connection and finally the collection of data from the detector through code for the Ardunio. To obtain real time air pollution data (in PPM), we have taken reading using our customized sensor-detector in different environmental pollutions. We have used cigarette smoke, coil burning smoke, vehicle smoke from street etc. The following values depicts for mosquito coil within 1 meter. From this data analysis we can conclude that for mosquito coil it is safe to be far from the coil while burning atleast 2 or 3 meters.

Table 1: Data analysis for mosquito coil

Time(second)	Value(ppm)	Distance(meter)
02	74(Fresh air)	0.5
04	125(Polluted air)	0.3
06	96(Polluted air)	0.4
08	170(Polluted air)	0.2
10	79(Fresh air)	0.6
12	80(Fresh air)	0.55
14	70(Fresh air)	0.8

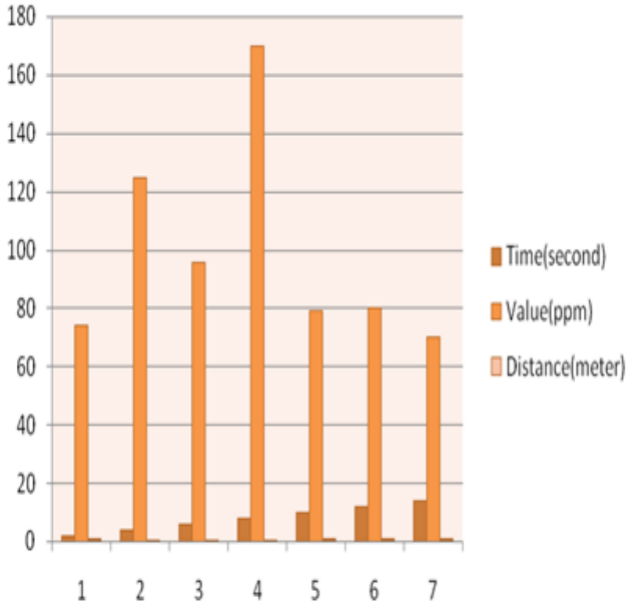

Fig 4: Graphical representation of mosquito coil smoke in detector.

For motorcycle smoke, we took values within 3 meters. From the values, we can say that the most polluted area is within 3 meters. So, it is safe to keep at least 5-meter distance from the motor cycle when running.

Table 2: Tabular representation of motorcycle smoke data

Time(second)	Value(ppm)	Distance(meter)
02	172(Polluted air)	3
04	281(Very Polluted air)	2.3
06	285(Very Polluted air)	2.2
08	233(Very Polluted air)	2.5
10	224(Very Polluted air)	2.1
12	199(Polluted air)	2.7
14	284(Very Polluted air)	1.9
16	246(Very Polluted air)	1.3

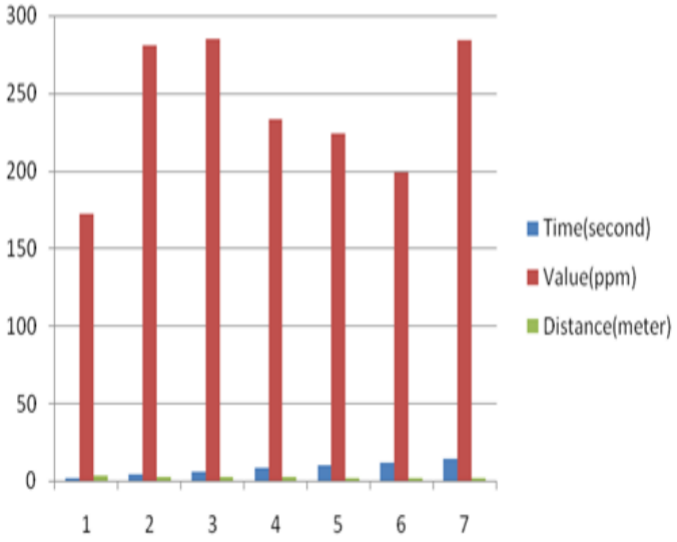

Fig 5: Graphical representation of motorcycle smoke data.

We have also calculated values for different types of cigarettes within 2-3 meters. From the values, we found that different cigarette pollution rate differs from each other but can be covered in a range of average values of 110-200 ppm. A cigarette can cause almost similar type pollution like motor vehicles.

Table 3: Tabular representations of cigarettes smoke data.

Time(second)	Value(ppm)	Distance(meter)
02	96 (Polluted air)	3
04	127 (Polluted air)	2.5
06	134 (Polluted air)	2.4
08	89 (Polluted air)	2.8
10	118 (Polluted air)	2.2
12	152 (Polluted air)	1.5
14	106 (Polluted air)	1.9
16	177 (Polluted air)	1.3
18	156 (Polluted air)	1.4
20	195 (Polluted air)	Less than 1

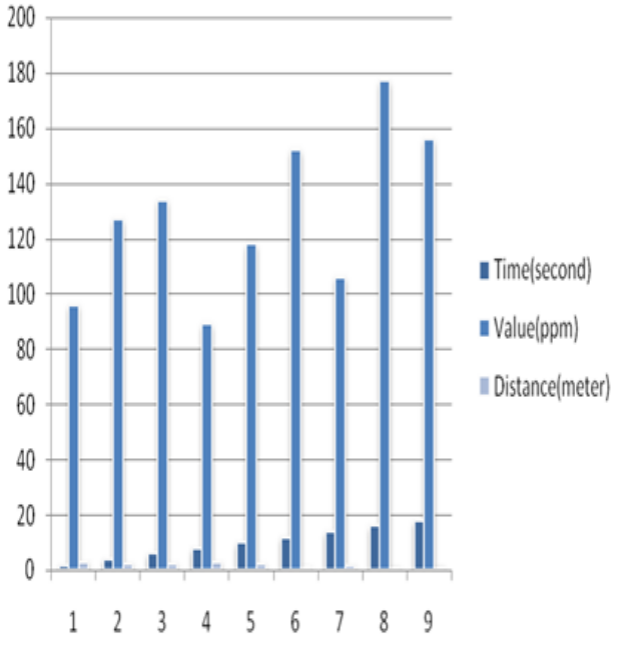

Fig 6: Tabular and graphical representation of cigarettes smoke data

We have defined the system of hardware and software that maps in real-time, also the data plotting software is illustrated the standard mechanism monitored by air quality monitoring. Finally, the data collection from the detector system is authenticated. This sensor-based system can easily be employed to monitor air quality.

VII.CONCLUSION

We have developed an Arduino based air pollution detector which is a very effective air pollution monitoring system. Based on the performance we can say that it is easy to use, and functionality is comparable to the expensive existing air pollution detectors. It is a microcontroller based portable system. It is efficient and user-friendly air quality detection system.

Conflict of Interest: The authors declare that they have no conflict of interest.

Ethical approval: This article does not contain any studies with animals performed by any of the authors.

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