AUTOMATED SYSTEM FOR AIR QUALITY IMPROVEMENT

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Abstract

Air pollution occurs when harmful or excessive quantities of substances are introduced into earth's atmosphere. Both human activity and natural processes can generate air pollution Sources of air pollution include gases like ammonia, carbon monoxide, nitrous oxides, particulates and biological molecules. It may cause diseases, allergies and also cause harm to other living organisms such as animals and food crops. In the project, we are detecting impurities using gas sensor MQ-135 and the quality improvement is done by different types of air filters. Impure air is input to the gas sensor MQ-135. The sensor is connected to the Arduino will help us in detecting the amount of impurities in the air. Arduino converts the input in digital form, we should set up the threshold of the environment. If the quality value of the air in the surrounding exceeds the threshold limit then we can be able to see the display on the LCD relay circuit to set in operation and automatically we can see the filtering device turn ON. The filtering devices give us the purified air as output.

Keywords: Self-Sustainable, 'E-SHWASA', filter unit

1. Introduction

Everywhere in the world water purifiers are used, but no one ever tried to understand the importance of air purifiers. Air purifiers are also important as well. Impure air may result in headache, respiratory problems and death sometimes. Hence, we came up with "Automated System for Air quality Improvement" with Air Quality Monitoring Device along with filter consisting of several layers.

2. Objective

The main objective of doing this project is to reduce the effect of air pollution on living beings. As we all know that air pollution is the introduction of chemicals and biological materials that cause harm or discomfort to humans or other living organisms, or cause damage to the natural environment and to the atmosphere. A substance in the air that can cause harm to humans and the environment is known as an air pollutant. Pollutants can be in the form of solid particles, liquid droplets, or gases. In addition, they may be natural or man-made.

According to USA Health Effect Institute (HEI) air pollution is the 3rd highest cause of death among all health risks. In India nearly 1.2 million people die till 2017 due to diseases like breathing problems, lung cancer COPD (Chronic Obstructive Pulmonary Disease), etc., As the quality of living and usage of electronics is picking up the atmosphere surrounding us should be more in quality. So, we decided to take up this project to overcome these rapid growing problems up to some extent.

can be classified as primary and secondary. Impure air may result in diseases in human beings like

- Respiratory diseases
- Cardiovascular damage
- Nervous system damage
- Emphysema
- Disruption of endocrine function etc; The effects of impure air on plants
- Necrotic lesions
- Stunted plant growth
- Chlorosis etc.

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In this project, we are detecting the air quality using an air quality sensor (MQ-135) which take air as input and detects its quality range. The air quality can be seen through LCD display unit where it shows the quality of air in ppm. If the range extends the threshold value the relay circuit connected to the filters will be operated and the filters start filtering. The exhaust fan is the last stage of filter will drive out the purified air. Here the filters will be continued to work until the quality of the air is improved.

3. Methodology

The overview of the "Automated system for Air Quality Improvement" can be explained by the block diagram which consists of several units

The project can be classified into two parts

- Monitoring part
- Filtering part

The main function involved in monitoring is air quality sensor and LCD. Monitoring part consists of various stages which involve operation of transducer interfaced with control unit and display

4.Proposed system

The figure 1 shows the block diagram of the proposed system that consists of various hardware devices which are mounted on the Arduino uno. The devices are gas sensor, Arduino UNO board, filter, relay, power supply, LCD.



Fig. 4.1 Block diagram of "Automated system for Air Quality Improvement"

5.Hardware description

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5.1Arduino microcontroller

ATmega328 microcontroller manufactured by Atmel belongs to the Mega AVR (Advanced Virtual RISC) series which processes the signals coming from the different components or any sensors. It is a chip mounted on the Arduino board. Arduino is an open source microcontroller from which there is no feedback present in the microcontroller. This Arduino board consists of 12C bus that can be able to transfer the data from Arduino board to the output devices. These Arduino boards are programmed over RS232 serial interface connections with ATMEGA Arduino microcontroller is from 7V and the max of 12V. The DC input current given to the Arduino is in the range of 40mA. It consists of different types of memories such as flash memory, EEPROM.

The length of the Arduino board is nearly about 68.64mm and the width of the microcontroller is about 53.44mm. The weight of the microcontroller is about 20g. We can use various types of microcontroller such as 8-bit AVI Atmel arm microcontroller and 32-bit Atmel arm microprocessor. From these different kinds of processors, we can use those processors for various engineering projects as well as industrial application, some of the examples of using the Arduino in the Arduino in the industrial applications are controlling the actuators and sensors.



up to 70A, one ISO relay up to 40A and one 2 pin flasher. Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal.

Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal. Relays were first used in long-distance telegraph circuits as signal repeaters: they refresh the signal coming in from one circuit by transmitting it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.



Fig:5.2 Relay module

5.3 Sensors

The MQ-135 gas sensor senses the gases like ammonia nitrogen, oxygen, alcohols, aromatic compounds, Page | 713 Copyright @ 2021 Authors

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sulphide and smoke. The MQ-135 sensor applies 2 (tin oxide) which has a higher resistance in the clean air as a gas- sensing material. When there is decrease in the quality in the air i.e. increase in the pollution in the air which is given as the input the resistance of the gas sensor decreases along with the decrease in the quality of the air.

The gas sensor layer of the sensor unit is made up of tin dioxide (SnO2), it has lower conductivity compare to clean hair and due to air pollution, the conductivity is increases. The air quality sensor detects ammonia, nitrogen oxide, smoke, CO2 and other harmful gases. The air quality sensor has a small potentiometer that permits the adjustment of the load resistance of the sensor circuit. The 5V power supply is used for air quality sensor. Even though this sensor is particularly for air quality detection it can sense some of the gases like ammonia, alcohol and benzene in terms of ppm. The detection range of a certain gas is measured in terms of PPM (parts per million). If you need to measure the gases in PPM the analog pin need to be used. The analog pin is TTL driven and works on 5V and so can be used with most common microcontrollers. Some of the detecting ranges of the gases using MQ-135 air quality sensor are given below.

- Ammonia (*NH*3) 10 to 300 ppm
- Benzene (*C*6*H*6) 10 to 1000 ppm
- Alcohol (*C2H50H*)- 10 to 300 ppm



Fig.5.3 Internal Circuit for MQ-135 sensor

The MQ-135 sensor applies SnO2 (tin oxide) which has a higher resistance in the clean air as a gas-sensing material. When there is increase in the pollution of the air then there will be change in the internal resistance of the gas sensor. Depending upon which the output of the gas sensor varies accordingly along with the quality of air.

5.4 LCD Display

It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.

LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as pre-set words, digits, and seven-segment displays, as in a digital clock. They use the same basic technology, except that arbitrary images are made from a matrix of small pixels, while other displays have larger elements. LCDs can either be normally on (positive) or off (negative), depending on the polarizer arrangement. For example, a character positive LCD with a backlight will have black lettering on a background that is the color of the backlight, and a character negative LCD will have a black background with the letters being of the same color as the

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backlight. Optical filters are added to white on blue LCDs to give them their characteristic appearance



Fig. 5.4 General picture of LCD

The LCD can be made in different sizes such as 8x1, 8x2, 10x2, 16x1, 16x2, 16x4etc. For example, take LCD 16x2 which means it can display 16 characters per line and there are 2 such lines. All these LCD's performs the same functions such as display characters, numbers, special characters ASCII characters etc. Hence their programming is also the same since they all comes with same 14 pins (0-13) or 16 pins (0 to 15).

5.5 Filters

A particulate air filter is a device composed of fibrous or porous materials which removes solid particulates such as dust, pollen, mould, and bacteria from the air. Filters containing an adsorbent or catalyst such as charcoal (carbon) may also remove odors and gaseous pollutants such as volatile organic compounds or ozone. Air filters are used in applications where air quality is important, notably in building ventilation systems and in engines.

Some buildings, as well as aircraft and other human-made environments (e.g., satellites and space shuttles) use foam, pleated paper, or spun fiberglass filter elements. Another method, air ionizers, use fibers or elements with a static electric charge, which attract dust particles. The air intakes of internal combustion engines and air compressors tend to use paper, foam, or cotton filters. Oil bath filters have fallen out of favor.

The technology of air intake filters of gas turbines has improved significantly in recent years, due to improvements in the aerodynamics and fluid dynamics of the air-compressor part of the gas turbines. As we are talking about the air filter the below mentioned types are the main type of filters that are being used in this project.

The different types of filters used for the air quality improvement are

- HEPA Filter
- \blacktriangleright Pre Filter
- ➢ Carbon Filter
- Negative ion generator
- Fan

5.5.1 HEPA FILTER

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High-efficiency particulate air (HEPA) also known as high-efficiency particulate absorbing and high-efficiency particulate arrestance, is an efficiency standard of air filter. Filters meeting the HEPA standard must satisfy certain levels of efficiency. Common standards require that a HEPA air filter must remove from the air that passes through at least 99.95% (European Standard) or 99.97% (ASME, U.S. DOE) of particles whose diameter is equal to 0.3 μ m with the filtration efficiency increasing for particle diameters both less than and greater than 0.3 μ m. See the Mechanism and Specifications sections for more information.

HEPA was commercialized in the 1950s, and the original term became a registered trademark and later a generic term for highly efficient filters. HEPA filters are used in



Fig.5. HEPA Filter

applications that require contamination control, such as the manufacturing of disk drives, medical devices, semiconductors, nuclear, food and pharmaceutical products, as well as in hospitals, homes and vehicles. The fibers are typically composed of fiberglass and possess diameters between 0.5 and 2.0 micrometers. Unlike electro statically charged air filters and other technologies that experience substantial loss of efficiency as they become dirty, exactly the opposite typically happens with HEPA filters. The dirtier a HEPA filter gets, the more efficient it can become HEPA filters are composed of a mat of randomly arranged fibers. Key factors affecting its functions are fiber diameter, filter thickness, and face velocity. The air space between HEPA filter acts like a sieve where particles smaller than the largest opening can pass through is incorrect and impractical. Unlike membrane filters at this pore size, where particles as wide as the largest opening or distance between fibers cannot pass in between them at all, HEPA filters are designed to target much smaller pollutants and particles.

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5.5.2 Pre filter

It is an essential feature to the air filter's because it prolongs the life of the main filter such as HEPA filter. Pre filters are perfect for capturing large debris such as hair, dust and some pollen. These are mainly used to capture the particles that are greater than the size 0.3μ m as we can see that HEPA filters capture particles from the 0.3μ m and lower. Regardless of the type the pre-filters are washable and reusable. These are mostly made of 'activated carbon' in order to captivate the larger particles.



Fig.5.5.2 Pre-Filter

5.5.3 Carbon filter

Carbon filtering is a method of filtering that uses a bed of activated carbon to remove impurities from a fluid using adsorption. Activated carbon has special properties that allow it to remove volatile organic compounds (VOCs), odors, and other gaseous pollutants from the air. It accomplishes this in a way that is different from other air purifiers like HEPA that only filter particle pollution from the air. Carbon air filters trap gas molecules on a bed of charcoal. They are designed to filter gases through a bed of activated carbon (also called activated charcoal) and are usually used to combat volatile organic compounds (VOCs) released from common household products. They are also often used to remove odors from the air, such as the smell of tobacco smoke. They cannot remove fine particles like mould, dust, or pollen from the air. It mainly works by Absorption.

Adsorption

Adsorption is the adhesion of atoms, ions or molecules from a gas, liquid or dissolved solid to a surface. This process creates a film of the adsorbate on the surface of the adsorbent. This process differs from absorption, in which a fluid (the absorbate) is dissolved by or permeates a liquid or solid (the absorbent), respectively. Similar to surface tension, adsorption is a consequence of surface energy. In a bulk material, all the bonding requirements (be they ionic, covalent or metallic) of the constituent atoms of the material are filled by other atoms in the material. However, atoms on the surface of the adsorbent are not wholly surrounded by other adsorbent atoms and therefore can attract adsorbates. The exact nature of the bonding depends on the details of the species involved, but the adsorption process is generally classified as physisorption (characteristic of weak Vander Waals forces) or chemisorptions (characteristic of covalent bonding). It may also occur due to electrostatic attraction.

5.5.4 Negtive ion filter

An air ionizer or negative ion generator is a device that uses high voltage to ionize (electrically charge) air molecules. Negative ions, or anions, are particles with one or more extra electrons, conferring a net negative charge to the particle. Cations are positive ions missing one or more electrons, resulting in a net positive

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charge. Some commercial air purifiers are designed to generate negative ions. Another type of air ionizer is the electrostatic discharge (ESD) ionizer (balanced ion generator) used to neutralize static charge. Air ionizers have been used to eliminate the occurrence of airborne bacterial infections and to reduce static electricity build-up in electronics. These are mainly composed of carbon bristles fibers.



Fig.5.5.4 Negative ion generator propagation

5.5.5 Fan

A fan filter unit (FFU) is a type of motorized air filtering equipment. It is used to supply purified air to clean rooms, laboratories, medical facilities or microenvironments by removing harmful airborne particles from re- circulating air. The units are installed within the system's ceiling or floor grid. Large clean rooms require a proportionally large number of FFUs, which in some cases may range from several hundred to several thousand. Units often contain their own pre-filter, HEPA filter and internally controllable fan air distribution.



Fig.5.5.6 Exhaust fan

6.Software description

6.1 Arduino IDE

Arduino Integrated Development Environment (IDE) is an open source electronics platform which is based on easy-to-use hardware and software. Arduino boards are able to read inputs- light on a sensor, a finger on a button, or a twitter message. It is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3^{rd} party cores, other vendor development boards.

6.2 Algorithm

Step 1: Initially the sensor will take the air

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Step 2: The sensor check the gas level, compared to threshold whether the gas level is below threshold or above threshold

Step 3: If the gas is less than threshold value arudino passes the signal to LCD, LCD display Gas No Detected in that time green LED on and red LED off state.

Step 4: If the gas is above the threshold value the Arduino sends the signal to LCD, LCD display Gas Detected in that time green LED off and red LED on state.



7. Schematic and Results

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Fig 7.1 Schematic



Fig 7.2 Schematic result

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GasSensor - Proteus 8 Professional - Schematic Capture

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Fig 7.3 Schematic result

8. Conclusion

In this paper, The 'Automated System for Air Quality Improvement' is specially designed for subways, public smoking areas, bus stops, offices etc. This project can be used to know the air quality and to remove dust, smoke and other harmful substances from the air. It is easy to install and also no need for adapter. The advantage of this project is the automated system as it detects the air quality and purifies it when polluted.

As it does not require any power source for its continuous operation, it will be working on rechargeable battery (12V) until the charge stored in it completely discharges. Once the battery is discharged completely it requires specific time for charging that can be provided through a solar panel.

In addition to this it is possible to detect and display the temperature and humidity content present in the atmosphere. With the help of temperature and humidity sensor it is also possible to provide the rain indication through buzzer.

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