



IJITCE

ISSN 2347- 3657

International Journal of Information Technology & Computer Engineering

www.ijitce.com



Email : ijitce.editor@gmail.com or editor@ijitce.com

Internet of Things Devices for Atmospheric Pollution Detection

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ABSTRACT:

Air pollution is a major environmental and public health hazard due to the rise of industrialization and urbanization. In this project, we present an Internet of Things (IoT) system for detecting atmospheric pollution. The system can track the air quality in real-time using sensors such as the MQ2 gas sensor and the DHT11 temperature and humidity monitor. Providing data in parts per million (PPM), the MQ3 sensor detects dangerous gases including carbon monoxide (CO) and methane (CH₄), among others. Important variables in determining changes in air quality, the DHT11 sensor monitors both humidity and temperature. Internet of Things (IoT) integration allows for cloud-based pollution level monitoring and analysis from afar. To further guarantee prompt action and preventative actions, a buzzer is integrated to deliver an instant notification whenever pollution levels above a specified threshold. A safer and healthier environment is a result of this system's ability to help authorities, companies, and individuals make educated decisions about managing air quality.

EMBEDDED SYSTEMS

A computer system that is purpose-built to carry out a single or limited set of tasks, often under the restrictions of real-time computing, is known as an embedded system. As with other physical and mechanical components, it is often integrated into a whole device. A personal computer or other general-purpose computer, on the other hand, may be programmed to do a wide variety of functions. These days, many of the everyday items we use rely on embedded systems to function. Design engineers may improve the embedded system to decrease product size and cost while boosting reliability and performance since it is devoted to certain functions. Because of their mass production, certain embedded systems are able to take advantage of cost savings. From small, handheld gadgets like digital watches and MP3 players to massive, permanently installed systems like those managing nuclear power plants, traffic lights, and industrial controls are all examples of physically embedded systems. From simple systems using a single microcontroller chip to complex systems housing several modules, peripherals, and networks in a massive chassis or

enclosure, complexity may range greatly. The phrase "embedded system" lacks a precise definition because the majority of systems have programmability in some form. While they share some components with embedded systems, such as operating systems and microprocessors, handheld computers are not technically embedded systems as they enable the loading of multiple programs and the connection of peripherals. Computer hardware and software, either fixed in capability or programmable, particularly intended for a certain sort of application device—this is what's called an embedded system. Embedded systems may be found in a wide variety of objects, including but not limited to: vehicles, medical devices, cameras, home appliances, aircraft, vending machines, toys, and, of course, cellular phones and personal digital assistants. A programming interface is given to programmable embedded devices, and programming for embedded systems is a niche field in and of itself. Embedded Java and Windows XP Embedded are two examples of embedded-specific operating systems and language platforms. On the other hand, certain budget consumer goods include integrated application and operating system components, employ very cheap microprocessors, and have limited storage space. Instead of being loaded into RAM (random access memory), as applications on personal computers are, in this situation the program is written permanently into the system's memory.

CHARACTERISTIC OF EMBEDDED SYSTEM

- Speed (bytes/sec): Should be high speed
- Power (watts): Low power dissipation
- Size and weight: As far as possible small in size and low weight
- Accuracy (%error): Must be very accurate
- Adaptability: High adaptability and accessibility
- Reliability: Must be reliable over a long period of time

APPLICATIONS OF EMBEDDED SYSTEMS

Here, in the Embedded World, we are living. The smooth operation of the various embedded goods

that surround you is crucial to your day-to-day existence. In your living room, you have a TV, radio, and CD player; in your kitchen, you have a washing machine or microwave oven; and at your office, you have card readers, access controllers, and palm devices that let you do a lot. In addition to all of this, your automobile has a plethora of built-in controls that handle functions between the bumpers, most of which you probably don't give a second thought to.

- **Robotics:** industrial robots, machine tools, Robocop soccer robots
- **Automotive:** cars, trucks, trains
- **Aviation:** airplanes, helicopters
- **Home and Building Automation**
- **Aerospace:** rockets, satellites
- **Energy systems:** windmills, nuclear plants
- **Medical systems:** prostheses, revalidation machine.

MICROCONTROLLER VERSUS MICROPROCESSOR

When comparing microprocessors and microcontrollers, what are the key differences? Any general-purpose microprocessor, such as 8086, 80286, 80386, 80486, or a Pentium from Intel, or a 680X0 from Motorola, etc., is considered a microprocessor. In addition to lacking on-chip I/O ports, these microprocessors also lack random-access memory (RAM). Because of this, they are often called general-purpose microprocessors. Designing a working system around a general-purpose CPU like the 68040 or Pentium requires the addition of extra components like as RAM, ROM, I/O ports, and timers. Though these systems are more costly and cumbersome due to the inclusion of external RAM, ROM, and I/O ports, they provide the benefit of being versatile in that the designer may choose the quantity of RAM, ROM, and I/O ports required for the work at hand. Microcontrollers are an exception to this rule. On a single chip, you'll find a microprocessor, random access memory (RAM), read/write (ROM), input/output (I/O) ports, and a timer in a microcontroller. So, since the CPU, random access memory (RAM), read/write memory (ROM), input/output (I/O) ports, and timer are all integrated into a single chip, the designer is unable to include any more memory, I/O ports, or timer into the product. Because of its set quantity of on-chip ROM, RAM, and number of I/O ports, microcontrollers are perfect for many applications where space and cost are important considerations.

It is not necessary to have a 486 or even an 8086 CPU for many applications; for instance, a TV remote control. Typically, these programs will need some kind of input/output function in order to read signals and toggle bits.

INTRODUCTION

The earth's atmosphere contains a variety of materials, including potentially dangerous miasma and minute quantities of more uncommon compounds, and it is an essential part of our environment. The air we breathe must be free of dangerous toxins if all forms of life, health, and vitality are to flourish. Any change to the natural composition of Earth's atmosphere poses a significant risk to all forms of life on the planet. When dangerous compounds, such as miasma, are released into the air, they contaminate it and pose a threat not just to humans but also to other living things. Micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) or millionths of a millimeter are used to measure these contaminants. Discharges of dangerous miasmas or chemicals into the atmosphere are examples of prime impurities, whereas chemical interactions between prime impurities and other atmospheric components are examples of subsidiary impurities. Respiratory problems, coughing, and worsening of conditions like emphysema and breathing difficulties are some of the major impacts of air pollution on living things. In addition to reducing visibility, it causes almost seven million fatalities every year—equivalent to one in eight premature deaths globally. Among these, about 5,70,000 children under the age of five die from respiratory diseases caused by pollution, both inside and outdoors, with secondhand smoking being the leading cause. Asthma and other chronic lung illnesses are more common in children who live in polluted surroundings. Scientists from all around the globe have devised ways to monitor dangerous gases including sulfur dioxide (SO_2), carbon monoxide (CO), carbon dioxide (CO_2), and nitrogen oxides (NO_x) in order to document air pollution. An intelligent system to record atmospheric pollution is developed and created in detail in this work. Using a miasma sensor element in conjunction with an Arduino microcontroller and a Wi-Fi module, it also investigates the methodology's capacity to identify and quantify pollution levels. The major objective of this project is to create a flexible system for documenting air pollution levels that can measure, analyze, and save data on air quality to a remote server, all while keeping the most current information available online.

LITERATURE SURVEY

Monitoring and identifying individual vehicles' air pollution using intercommunication and the Internet of Things. The goal is to locate forest fires by directing sensor attention to the regions that have been impacted. A machine learning algorithm that can anticipate the presence of harmful gasses like carbon dioxide based on data collected from Internet of Things devices. Research on the monitoring of air pollution in real-time through the use of wireless sensors on public transportation vehicles. A device that measures and monitors air pollutants efficiently has a network that is both heterogeneous and homogenous. It is a connection-less dispensing ambulant atmospheric pollution recording approach called the General Packet Radio Service (GPRS) sensing element. With the development of connection-less communications and sensing element technologies, the models created for detecting atmospheric pollution are evolving daily. The Internet of Things (IoT) and related technologies are opening up new possibilities for the development of dynamic settings whereby machines and objects collaborate, exchange data, and generate novel forms of life. There has been a lot of progress in developing methods to monitor air pollution in today's technology world, and one of these methods can even record the quality of the air in your own house. Using a request-and-response protocol, this approach blends address-centric and data-centric protocols to record the home atmosphere quality. This design technique evaluates the quality of the interior and outside atmospheres and shows the reading on the screen through the detection of sensor elements. Unmanned Aerial Vehicle (UAV) research is another area of focus; these drones can document air pollution in areas with limited human access. A Pixhawk autopilot for unmanned aerial vehicle control and a Raspberry Pi for data collection on atmospheric pollution were components of this design's technique. The suggested approach is useful for analyzing the data collected on pollution. In order to identify air pollution in Sydney, a participatory sensing element approach was developed. The cars were equipped with sensing components, and data was collected and uploaded to the necessary repository using the ambulant program. The efficiency of the connection-less atmospheric pollution recording approach was enhanced by using the Recursive Converging Quartiles (RCQ) draft, which not only gathered data but also reduced redundant data by rejecting unnecessary values. Energy is conserved when connection-less connections and sensing element nodes are coupled to the server. Data is sent to the server by means of the nodes that comprise the collected sensing elements. A new design for atmospheric pollution detection was proposed as a result of technological advancements.

EXISTING SYSTEM

Manual sampling and laboratory analysis are the backbone of traditional air quality monitoring systems. However, these processes are laborious and don't offer data in real-time. Though they do exist, complex monitoring systems tend to be prohibitively expensive and difficult to use on a large scale. The majority of gas detection systems in use today rely on stationary sensors that can't be remotely monitored in real-time and don't have the ability to immediately notify when contamination levels increase. There is a lack of data accessibility for real-time decision-making since many current systems do not incorporate IoT connection. Health hazards would increase due to the substantial delay in responding to hazardous air quality situations in the absence of automated alarms.

PROPOSED MODEL

The suggested Internet of Things (IoT) atmospheric pollution detection system can monitor dangerous gas levels in real time and send out automatic alarms if they go too high. While the DHT11 monitors changes in temperature and humidity, the MQ3 monitors the air's concentration of dangerous gases in real time. For remote access and analysis, the data collected may be sent by the IoT module to cloud-based systems like ThingSpeak. There is a buzzer alarm built into the system that goes off as soon as the pollution levels go over a certain safe level, alerting everybody in the vicinity. For streamlined data transfer and efficient processing, choose a microcontroller like Arduino or NodeMCU. Air quality may be remotely monitored with this method using online dashboards or mobile apps; users can get real-time updates and analyze previous data for better pollution management and control.

BLOCK DIAGRAM

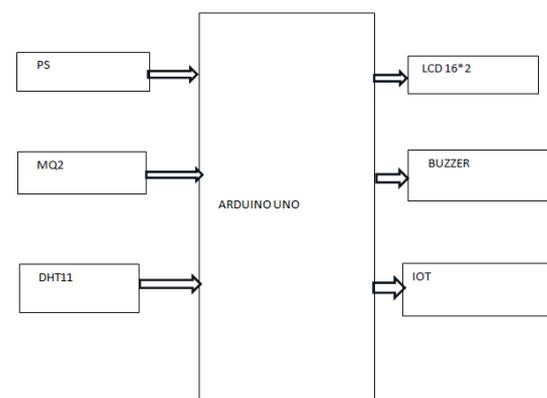


Figure 1: Block Diagram

Microcontroller:

A tiny controller, or microcontroller, as the name implies. Often used as a processing or controlling unit, they are similar to single-chip computers. For instance, microcontrollers that do decoding and other regulating operations are likely integrated into the control you are using. They find further use in vehicles, home appliances, microwaves, toys, and any other area requiring automation.

Arduino Uno Microcontroller:

One such microcontroller board is the Arduino Uno, which uses the Atmega328 (datasheet). It has a 16 MHz crystal oscillator, 6 analogue inputs, 14 digital input/output pins (6 of which may be used as PWM outputs), a power connector, an ICSP header, a reset button, and a USB connection. All you need is a USB cable, an AC-to-DC converter, or a battery to get it going; it comes with everything you need to support the microcontroller.

A key difference between the Uno and all previous boards is the absence of the FTDI USB-to-serial driver chip. Rather of that, it has an Atmega8U2 that has been configured to convert USB to serial. To celebrate the impending release of Arduino 1.0, the name "Uno"—which means "One" in Italian—has been chosen. The Uno and Arduino version 1.0 will serve as the foundational versions for future Arduino releases. For a comparison with prior generations, see the index of Arduino boards. The Uno is the newest in a series of USB Arduino boards and the standard model for the Arduino platform.

ARDUINO UNO BOARD:

One board that uses the Atmega328 microprocessor is the Arduino Uno. A 16 MHz ceramic resonator, 6 analog inputs, 14 digital I/O pins (including 6 PWM outputs), 1 USB port, 1 power connector, 1 ICSP header, and 1 reset button are all part of it. All you need is a USB cable, an AC-to-DC converter, or a battery to get it going; it comes with everything you need to support the microcontroller.

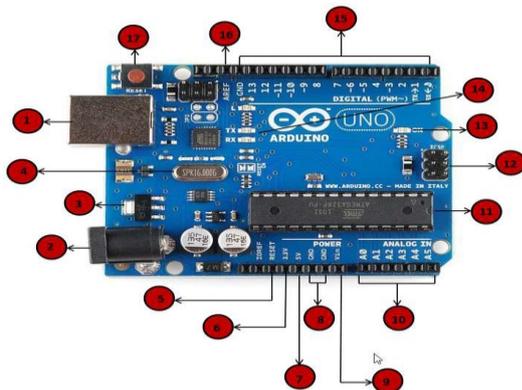


Figure 2: Arduino uno board

In contrast to all of its predecessors, the Uno does not have the FTDI USB-to-serial driver chip. As an alternative, it makes use of USB-to-serial converters coded into the Atmega16U2 (Atmega8U2 up to version R2).

HARDWARE COMPONENTS

POWER SUPPLY UNIT

The power supply for this system is shown below.

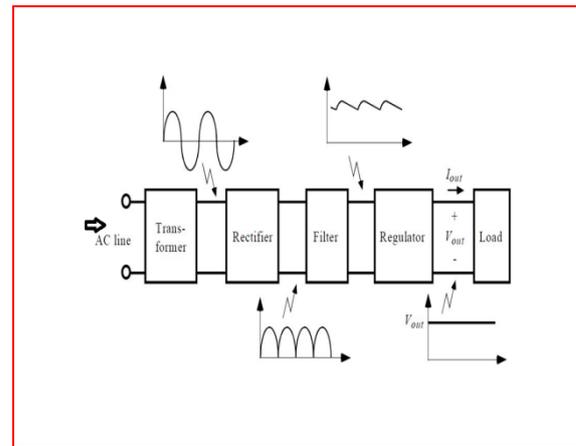


Figure 3: power supply

Diodes:

Only one path of electrical current may pass through a diode. Current may flow in either direction, as shown by the arrow in the circuit symbol. Originally termed valves, diodes are essentially an electrically enhanced version of the mechanical component.

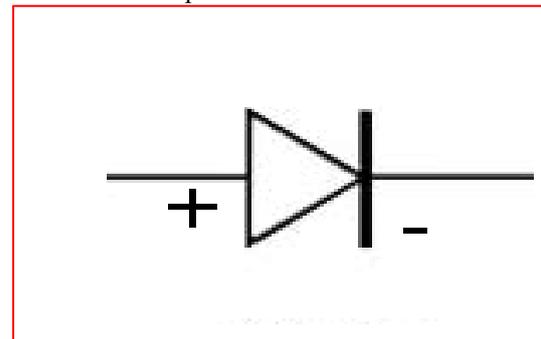


Figure 4: Diode Symbol

One kind of electrical component that restricts current flow is the diode. A voltage loss of around 0.7V will be the sole influence on the signal when the diode is "forward-biased" in this way. No current will flow through a diode that is "reverse-biased" when the current is applied in the other direction.

Rectifier

A rectifier's job is to change the phase of an alternating current (AC) waveform so that it appears as a direct current (DC) waveform. Both "half-wave" and "full-wave" rectifiers are used for rectification. Diodes are used in both devices to convert AC current into DC current. The Half-Wave Rectifiable

The graphic shows that the half-wave rectifier is the simplest rectifier type since it only employs one diode.

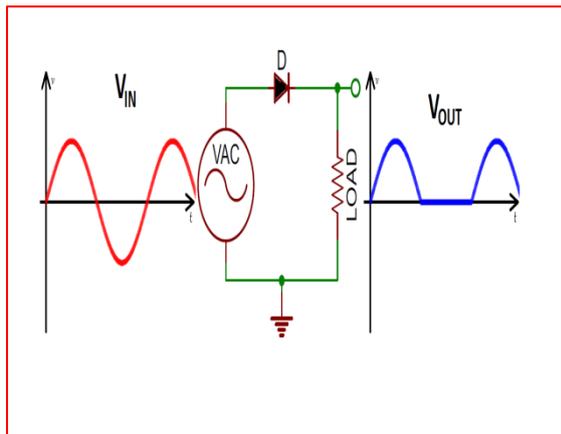


Figure 5: Half Wave Rectifier

LIQUID CRYSTAL DISPLAY

An array of color or monochrome pixels arranged in front of a light source or reflector makes up a liquid crystal display (LCD), a thin, flat display device. Two polarizing filters, with their polarity axes perpendicular to one other, and a column of liquid crystal molecules hanging between two transparent electrodes make up each pixel. Light would not be able to travel through them if the liquid crystals weren't interposed. To make light flow through two filters, the liquid crystal changes the polarization of the light entering the first filter.

A program's ability to communicate with the outside world depends on its input and output devices, which in turn rely on human communication. An LCD display is a typical accessory for controllers. 16X1, 16x2, and 20x2 LCDs are among the most popular types of displays that are often linked to the controllers. Which works out to sixteen characters on a single line. The first set has 16 characters on each line while the second set has 20 characters on each line. The use of "smart LCD" displays allows for the visual output of information by many microcontroller devices. Affordable, user-friendly, and capable of producing a readout utilizing the display's 5X7 dots plus cursor, LCD displays built on the LCD NT-C1611 module are a great choice.

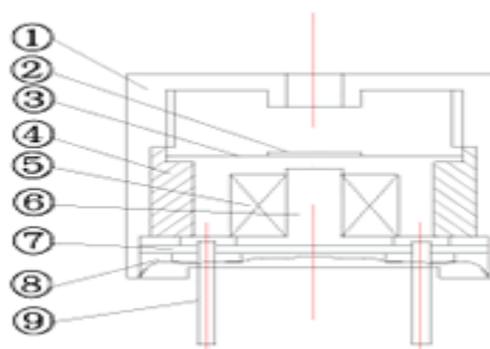
They use mathematical symbols and the usual ASCII set of characters. The display needs a +5V power and 10 I/O lines (RS, RW, D7, D6, D5, D4, D3, D2, D1, D0) for an 8-bit data bus. The only additional lines needed for a 4-bit data bus are the supply lines and six more (RS, RW, D7, D6, D5, D4). The data lines are tri-state and do not affect the microcontroller's function when the LCD display is disabled.



Figure 6: 2x16 LCD Display

BUZZER

In a magnetic transducer, the circuitry includes an iron core, a yoke plate, a wound coil, a permanent magnet, and a vibrating diaphragm that can be moved. The magnet's field gently draws the diaphragm up nearer the core's surface. A positive alternating current (AC) signal causes the diaphragm to move up and down, which in turn vibrates the air. This is achieved by the current passing through the excitation coil, which forms a fluctuating magnetic field. A resonator, which is composed of a cavity and one or more sound holes, may amplify vibrations in order to generate a loud sound.



ESP8266 Wi-Fi Module

This project revolves on this. Because the project relies on WIFI control of appliances, the module is a crucial part of it. One remarkable feature of this tiny board is the integrated MCU (Micro Controller Unit), which

allows for the control of I/O digital pins via a simple programming language that is almost pseudo-code like. Another benefit is that the ESP8266 Arduino compatible module is a low-cost Wi-Fi chip with full TCP/IP capability. The Chinese company Espressif Systems is situated in Shanghai and makes this gadget. In August 2014, this chip made its debut in the ESP-01 version module manufactured by the third-party company AiThinker. The MCU can establish basic TCP/IP connections and connect to WiFi networks with the help of this little module. He was His tiny size and cheap pricing (1.7–3.5\$) enticed a lot of hackers and geeks to look into it and utilize it for all sorts of projects. Because of its enormous success, Espressif now offers a wide variety of models with varying size and technological specs. Its replacement includes ESP32.

RELAYS:

Industrial controls, automotive systems, and home appliances all make extensive use of electrically controlled switches called relays. By using a relay, two independent voltage sources may be isolated from one another; in other words, a little quantity of voltage or current on one side can manage a big amount of current or voltage on the other side, and vice versa.

Inductor

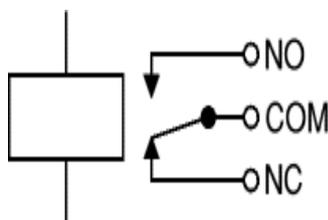


Fig7 : Circuit symbol of a relay

DRIVING A RELAY:

Two of the SPDT relay's five pins are used by the magnetic coil, one serves as the common terminal, and the other two are typically closed and normally connected. The coil is activated when a current passes across it. At the beginning, when the coil is deenergized, the usually closed pin and common terminal will be connected. A new connection will be formed between the common terminal and usually open pin when the coil is activated, breaking this connection. Therefore, the relay will be activated whenever the microcontroller sends an input signal to it. You may drive the loads connected between the common terminal and typically open pin while the relay is on.

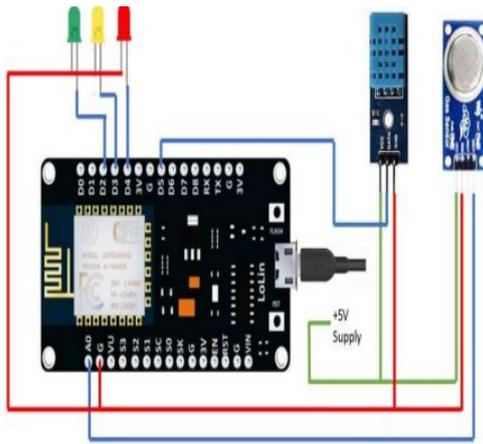
Consequently, the high-current loads are driven by the relay, which receives 5V from the microcontroller. This means the relay may be used as a means of isolation. The microcontroller and digital systems do not have enough current to operate the relay. In contrast to the 10 milliamps required to activate the relay's coil, the microcontroller's pin can only provide 1 or 2 milliamps. This is why the microcontroller and the relay are separated by a driver, like ULN2003, or a power transistor. By connecting ULN2003 to the relay and microcontroller, it is possible to activate many relays simultaneously.

SOFTWARES

The Arduino platform is an open-source, user-friendly hardware and software environment for prototyping. It is comprised of a programmable circuit board (also called a microcontroller) and an Integrated Development Environment (IDE) called Arduino that is pre-made for writing and uploading code to the physical board. The main characteristics are:

- Many sensors can send signals in digital or analog formats to Arduino boards, which may then be used to activate motors, control LEDs, establish connections to the cloud, and much more.
 - The Arduino IDE (also called "uploading software") allows you to command your board's operations by communicating with the microcontroller on the board.
 - A separate device, known as a programmer, is not required to load fresh code into an Arduino board, in contrast to most prior programmable circuit boards. The usage of a USB connection is all that is required.
 - The Arduino IDE employs a streamlined version of C++, which facilitates programming learning. Last but not least, Arduino offers a standardized form factor that simplifies the microcontroller's tasks.
- Now that we know what the Arduino UNO board is and how it works, we can go on to setting up the Arduino IDE. As soon as we figure this out, we can upload our software to the Arduino board.

RESULTS



Hardware Model

CONCLUSION

One practical and cost-effective method for detecting atmospheric pollution in real-time is to install an Internet of Things (IoT)-enabled air quality monitoring system that makes use of MQ3 and DHT11 sensors, as well as IoT connection and buzzer alarms. Quicker decision-making to avoid dangerous exposure is made possible by this system's rapid alarms and remote access, in contrast to traditional monitoring approaches. Continuous data collection and analysis made possible by cloud-based platform integration aids in the development of more effective environmental regulations and safety protocols. Predictive analytics powered by machine learning to foresee patterns in pollution and improve air quality control may be one of the next big things. In the quest for better health in the future, this technology is an important first step toward intelligent environmental monitoring.

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