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AUTOMATED DETECTION SYSTEM FOR AIR POLLUTION IN VEHICLES BY USING RASPBERRY PI AND GPS

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Abstract:

Every vehicle has its own emission of gases, but the problem occurs when the emission is beyond the standardized values. The primary reason for this breach of emission level being the incomplete combustion of fuel supplied to the engine which is due to the improper maintenance of vehicles. This emission from vehicles cannot be completely avoided, but it definitely can be controlled. The aim of the project is to monitor and control the pollutants in the vehicle by using the pollution control circuit. This pollution control circuit consists of various sensors like smoke sensor, temperature sensor and GSM, GPS kind of devices, and all of them are integrated and connected to a Controller. It is a real time work where a demo application has been made in which ARM 7 processor is used and a controller board is made where all these devices get integrated and work accordingly. The vehicle is controlled by this circuit. When a vehicle attains certain threshold pollution level then the engine gets automatically switched off and an SMS is generated and sent to the pre-defined number stored in the memory through the GSM module. The GPS module is used to locate the vehicle position where it is halted. This paper demonstrates an effective utilization of technology by which we save our environment by controlling the pollution of vehicles.

Introduction

The proposed project aims to tackle the pressing issue of urban air pollution by developing an Air Pollution Monitoring and Alerting System for Vehicles. This system integrates advanced sensors and communication technologies to provide real-time monitoring and alerts to drivers, thus mitigating the negative impact of vehicular emissions on public health.

Key components of the system include strategically placed MQ-2 smoke sensor, MQ-6 gas sensor, CO sensor, and CO2 sensor within the vehicle to detect pollutants emitted during combustion processes. These sensors continuously measure pollutant levels in the surrounding environment. Output devices of the system comprise a GSM module, a buzzer, and a 16x2 LCD display. Upon detection of abnormal pollutant values indicating high pollution levels, the system triggers an alert mechanism. It displays the abnormal sensor values in real-time on the LCD screen and activates the buzzer to audibly alert the driver to potential danger.

Additionally, the system incorporates a GPS module for accurate vehicle location tracking. In the event of an air quality anomaly, the system not only alerts the driver but also sends an SMS to specified emergency

contacts, including authorities and relevant stakeholders. The SMS includes the precise vehicle location obtained from the GPS module, facilitating quick response and intervention measures. Furthermore, the system integrates with the Thing Speak cloud platform to contribute valuable data for broader environmental monitoring and analysis. It sends data from all sensors to the cloud, enabling access, analysis, and visualization by researchers, policymakers, and the public. This data sharing fosters transparency, awareness, and informed decision-making regarding air quality management.

In conclusion, the proposed Air Pollution Monitoring and Alerting System for Vehicles combines sensor technology, communication devices, and cloud integration to empower drivers with real-time air quality information, thus facilitating collective efforts to combat air pollution for a healthier and sustainable future.

Literature Review

Sure, here is a condensed version of the text with key points converted into bullet points:

-Sensor Technologies: - Gas Sensors: MQ series sensors (e.g., MQ-2, MQ-6) detect CO and VOCs in vehicle emissions.

CO2 Sensors: Monitor combustion efficiency and carbon footprint of vehicles.

SMS Alerts: - GSM modules send SMS alerts to emergency services and stakeholders.

GPS Integration: -Enables precise location tracking for emergency response teams.

Challenges and Future Directions:

Location-Based Services: GPS modules assist in locating and assisting affected vehicles promptly.

Thing Speak and Cloud Platforms: Utilize platforms like Thing Speak for real-time data transmission and analysis.

Data Privacy and Security: Address concerns related to data privacy and security through robust protocols and encryption methods.

Existing System:

The current method of monitoring air pollution in vehicles relies heavily on periodic emissions testing conducted at specific inspection centers. These tests measure exhaust gas concentrations of pollutants like CO, hydrocarbons (HC), NOx, and particulate matter (PM). While effective for regulatory compliance, this approach lacks real-time monitoring capabilities and may miss transient pollution events during actual vehicle operation.

The existing systems face several challenges and limitations, including limited real-time monitoring capabilities, incomplete pollutant detection, reliance on periodic inspections, and minimal integration with vehicle systems for proactive pollution control. These challenges highlight the necessity for an advanced and integrated air pollution monitoring and alerting system tailored specifically for vehicles.

In summary, this overview outlines various approaches to air pollution monitoring in vehicles, ranging from traditional methods to modern systems like OBD, aftermarket devices, mobile apps, and data aggregation

platforms. It underscores the need for a more robust and proactive monitoring solution to address the limitations of current systems, paving the way for the development of innovative solutions like the proposed automated detection system using Raspberry Pi.

Proposed System:

Our proposed system for real-time air quality monitoring in vehicles integrates advanced sensors detecting pollutants from combustion. Components include MQ-2 and MQ-6 sensors for smoke and gas detection, CO and CO2 sensors for hazardous gas monitoring. It alerts drivers with a buzzer and LCD display, and sends SMS alerts via GSM to authorities. GPS tracking enables location-specific alerts. Data is transmitted to Thing Speak cloud for storage and analysis, accessible through a user-friendly dashboard. The system continuously monitors, analyzes, and alerts on air quality, promoting safer driving and contributing to environmental research.

METHODOLOGY:

Creating an automated detection system for air pollution in vehicles using Raspberry Pi and GPS involves several steps. Here's a basic methodology to get you started:

1.Understanding the Problem: Begin by understanding the requirements and constraints of the project. Define what parameters of air pollution you want to detect, such as carbon monoxide (CO), nitrogen oxides (NOx), particulate matter (PM), etc.

2. Gathering Hardware: Acquire the necessary hardware components: - Raspberry Pi (preferably Raspberry Pi 3 or higher) - GPS module compatible with Raspberry Pi- Air quality sensors (e.g., CO sensor, NOx sensor, PM sensor) - Wires, breadboard (if needed), and power supply

3.Setting up Raspberry Pi: Install the Raspbian operating system on the Raspberry Pi if not already done. Set up the Raspberry Pi to communicate with the GPS module and the air quality sensors.

4.Calibrating Sensors: Calibrate the air quality sensors to ensure accurate readings. This typically involves following the calibration procedure provided by the sensor manufacturer.

5.Coding: Write the necessary code to:- Read data from the GPS module to obtain the vehicle's coordinates (latitude and longitude).Read data from the air quality sensors to measure pollutant levels. Process the sensor data and determine the level of air pollution. Store the data along with the GPS coordinates in a suitable format (e.g., CSV file, database).

6.Data Fusion: Combine the GPS data with the air pollution data. This involves associating each air pollution measurement with the corresponding GPS coordinates.

7.Visualization: Develop a visualization interface to display the air pollution data overlaid on a map. This could be a web-based interface or a standalone application running on the Raspberry Pi.

8.Testing and Optimization: Test the system in real-world conditions to ensure its accuracy and reliability. Optimize the system as needed to improve performance and efficiency.

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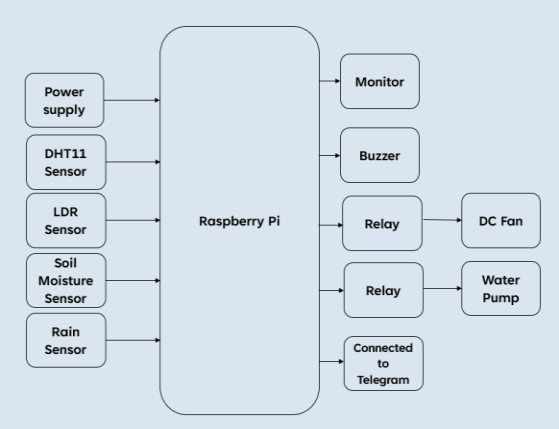
9.Deployment: Once the system is tested and optimized, deploy it in vehicles for real-world monitoring of air pollution.

10.Maintenance and Updates: Regularly maintain the system by checking sensor calibration, updating software, and addressing any issues that arise during operation.

Throughout the process, documentation is key. Keep detailed records of the hardware setup, calibration procedures, code implementation, and testing results. This will facilitate troubleshooting and future improvements to the system.

Block Diagram



The project utilizes sensors to gather environmental data like temperature, humidity, and soil moisture. This data is then fed into a Raspberry Pi, which processes it using machine learning algorithms. These algorithms analyze the data patterns to predict optimal conditions for plant growth. Based on these predictions, the Raspberry Pi controls various components such as fans, heaters, or irrigation systems to maintain the desired environmental parameters within the green house. This closed-loop system continuously monitors and adjusts the environment to ensure optimal conditions for plant growth.

Raspberry Pi

Raspberry Pi is a small, affordable, single-board computer developed by the Raspberry Pi Foundation.

It offers a wide range of functionalities, including general-purpose computing, programming, and DIY projects.

Equipped with GPIO pins, it allows for easy interfacing with external hardware components such as sensors and actuators.

Raspberry Pi has gained popularity for its versatility, making it a popular choice for educational, hobbyist, and industrial applications.

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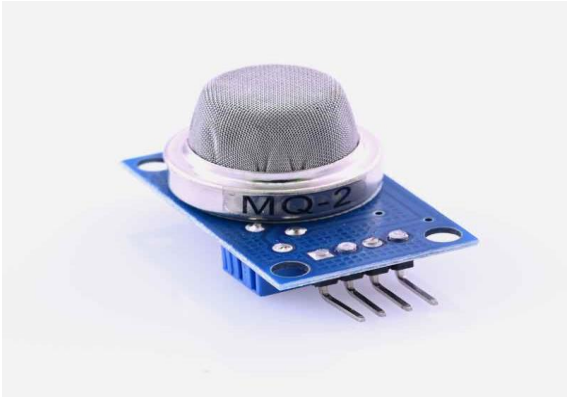
Buzzer

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric (piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke.

MQ-2 SENSOR:



The MQ-2 is a popular gas sensor module widely used in electronics and DIY projects for detecting and measuring various gases in the environment. It is specifically designed to sense the presence of gases such as methane (CH4), propane (C3H8), carbon monoxide (CO), hydrogen (H2), and smoke. The MQ-2 sensor operates on the principle of resistance change, where the electrical resistance of its sensing element varies in response to the concentration of the target gas. This change in resistance is then converted into a measurable electrical signal, making it suitable for integration into microcontroller-based systems. The

MQ-2 sensor is valued for its affordability and ease of use, making it a versatile choice for applications ranging from gas leakage detection in homes to air quality monitoring in industrial settings. It plays a crucial role in ensuring safety and environmental monitoring across various domains.

MQ-135 SENSOR:

The MQ-135 is a popular gas sensor module commonly used in electronic devices to detect the presence of various gases in the environment. It is especially renowned for its ability to monitor the concentration of harmful gases like carbon dioxide, ammonia, methane, and a range of volatile organic compounds. The sensor works on the principle of resistive conductivity, with its resistance varying in response to the gas concentration it is exposed to. When integrated into applications such as air quality monitors or safety alarms, the MQ-135 plays a crucial role in ensuring the health and well-being of individuals by providing real-time data on air quality and gas levels. This versatile sensor is widely utilized in industries, homes, and research settings to safeguard against potential gas hazards and maintain a healthy and safe living environment**.**

MQ-7 SENSOR:

The MQ-7 sensor is a type of gas sensor that is designed to detect the presence of carbon monoxide (CO) gas in the surrounding environment. It is a popular choice for applications where monitoring and alerting for carbon monoxide is necessary, such as in industrial settings, homes with gas heaters or stoves, and automotive systems. The MQ-7 sensor operates on the principle of chemo resistive detection, meaning that it changes its electrical resistance in response to the concentration of carbon monoxide gas. The MQ-7 sensor is compact, cost-effective, and widely used for CO gas detection due to its reliability .

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MQ-8 SENSOR:

The MQ-8 is a gas sensor module designed for the detection of hydrogen gas (H2) in the surrounding environment. Like other MQ series gas sensors, it operates on the principle of semiconductor gas sensing. The MQ-8 sensor consists of a sensitive layer of tin dioxide (SnO2) that reacts to the presence of hydrogen gas. When exposed to H2, the sensor's electrical resistance changes, which is then converted into a measurable voltage output. This voltage output is proportional to the concentration of hydrogen gas. The MQ-8 sensor is used in various applications where monitoring or detecting hydrogen gas is essential, such as in industrial settings where hydrogen is used, in laboratories, or in hydrogen fuel cell technology. It plays a crucial role in ensuring safety by detecting potential hydrogen leaks or monitoring hydrogen levels in different contexts.

POWER SUPPLY:

A 12V 1A (1 ampere) SMPS (Switched Mode Power Supply) is a type of power supply that converts AC voltage input into a regulated DC output voltage of 12 volts with a maximum current output of 1 ampere. It utilizes switching regulator technology to efficiently regulate voltage and provide stable power output. This type of SMPS is commonly used in various electronic devices, such as routers, LED strips, and small appliances, where a 12-volt power source is required.

LCD 16*2:

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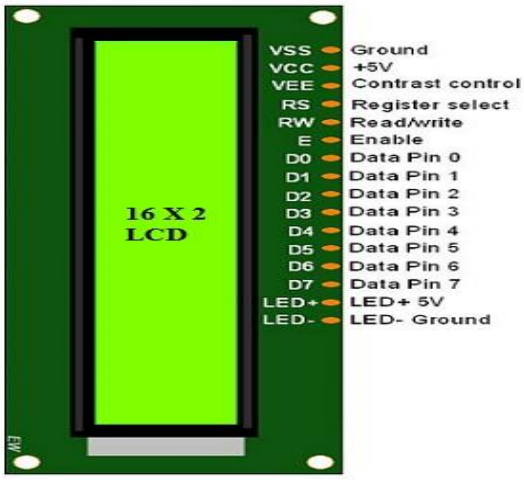

An LCD 16x2, also known as a 16x2 character LCD (Liquid Crystal Display), is a common type of alphanumeric display module widely used in various electronic devices and projects. The "16x2" notation refers to its physical size, which consists of 16 columns and 2 rows of characters, typically displaying a total of 32 characters at a time. These displays use liquid crystal technology to control the visibility of each character, which can be numbers, letters, or symbols.

MONITOR:

A monitor is a display device used to view images and videos from computers or electronic devices. It can also refer to medical devices tracking vital signs, environmental sensors measuring parameters like temperature, network tools observing network traffic, and surveillance systems displaying video footage from security cameras. Each type serves specific purposes, from visualizing data to ensuring health, safety,

and security in various contexts.

RELAY:

A relay is an electromechanical switch that uses an electromagnet to control the switching of one or more circuits. It consists of a coil, which when energized, creates a magnetic field that pulls a movable armature, connecting or disconnecting contacts to open or close the circuit. Relays are commonly used to control high-power devices or circuits with low-power signals, making them versatile components in industrial

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automation, home automation, automotive systems, and electronic circuits. They provide isolation between control and load circuits, protecting sensitive components and enabling safe and efficient operation.

GSM:

Global System for Mobile Communication (GSM) is a set of ETSI standards specifying the infrastructure for a digital cellular service. The standard is used in approx. 85 countries in the world including such locations as Europe, Japan and Australia[1]. When a mobile subscriber roams into a new location area (new VLR), the VLR automatically determines that it must update the HLR with the new location information, which it does using an SS7 Location Update Request Message. The Location Update Message is routed to the HLR through the SS7 network, based on the global title translation of the IMSI that is stored within the SCCP Called Party Address portion of the message. The HLR responds with a message that informs the VLR whether the subscriber should be provided service in the new location.

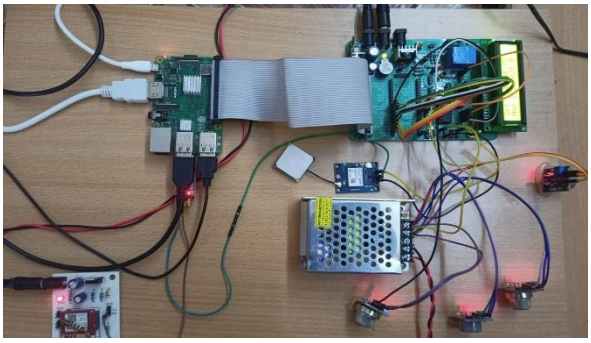
GPS:

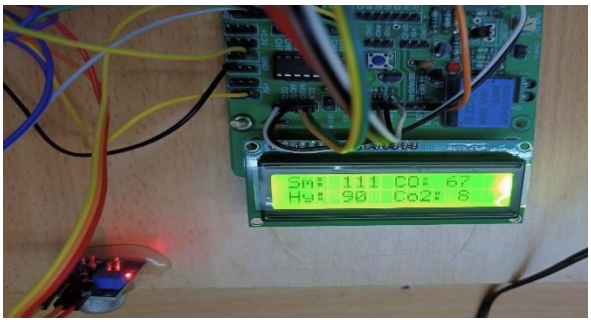
The Global Positioning System (GPS) is a satellite-based navigation system that sends and receives radio signals. A GPS receiver acquires these signals and provides you with information. Using GPS technology,

you can determine location, velocity, and time, 24 hours a day, in any weather conditions anywhere in the world—for free.

GPS, formally known as the NAVSTAR (Navigation Satellite Timing and Ranging). Global Positioning System originally was developed for the military. Because of its popular navigation capabilities and because you can access GPS technology using small, inexpensive equipment, the government made the system available for civilian use. The USA owns GPS technology and the Department of Defense maintains it.

RESULT:





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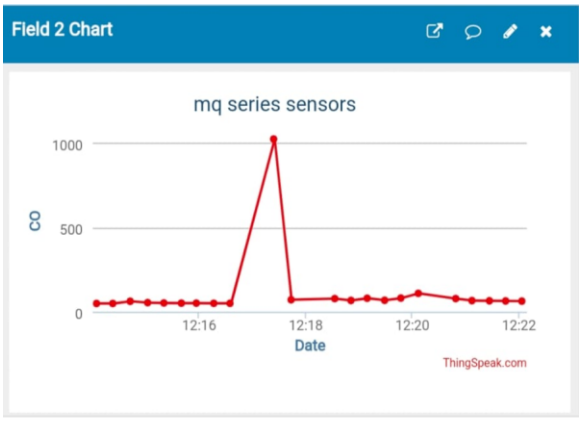

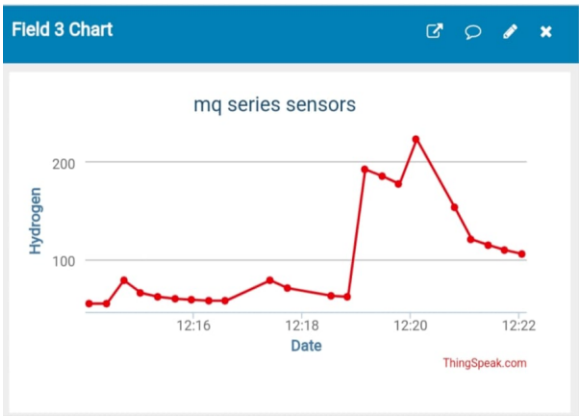

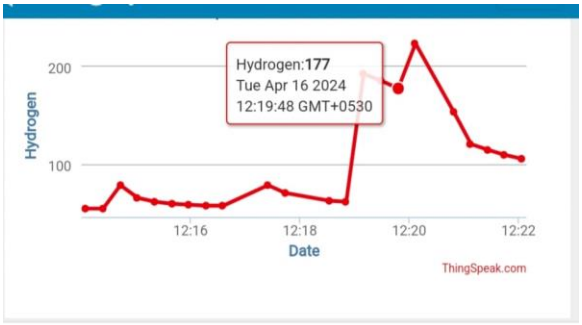

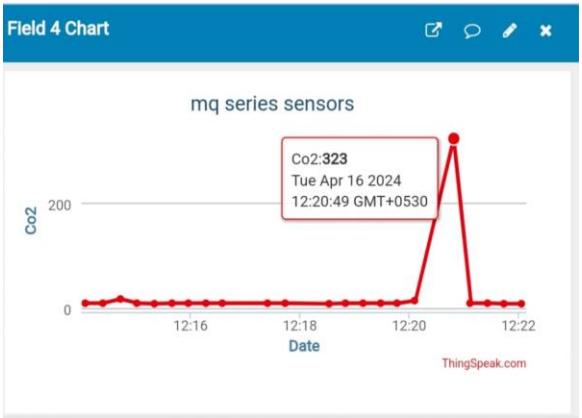

CONCLUSION:

The development of an air pollution monitoring and alerting system for vehicles marks a significant stride in bolstering environmental safety, health awareness, and informed decision-making within transportation settings. By seamlessly integrating specialized sensors, communication modules, and cloud connectivity, this system provides a holistic solution for real-time indoor air quality monitoring, anomaly detection, and prompt hazard alerts. With features such as sensor monitoring, alerting mechanisms, and user interaction interfaces, it ensures timely warnings, fosters user awareness, and enables data-driven insights. The anticipated impact spans across vehicle occupants, regulatory bodies, environmental agencies, and transportation companies, promising safer journeys, regulatory compliance, and heightened environmental consciousness. Continuous refinement, rigorous testing, and user training will be pivotal in upholding the system's reliability, accuracy, and long-term effectiveness, affirming its role as a vital innovation in mitigating environmental challenges and safeguarding public well-being in transportation.

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