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DESIGN AND CONSTRUCTION OF PROTOTYPE VEHICLE GAS DETECTOR BASED ON ARDUINO UNO

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Abstract

Motor vehicle exhaust emissions, especially carbon monoxide (CO) and hydrocarbons (HC), are a major contributor to air pollution in areas with heavy traffic. Excess emissions can harm human health and damage the environment. Unfortunately, vehicle emission monitoring is still limited and simple devices that can be used directly by the public are not yet available. This study aims to design and build a prototype of a motor vehicle exhaust emission detection device based on Arduino Uno that is able to detect CO and HC levels in real time, provide a warning if the gas levels exceed the threshold, and display the detection results on an LCD screen. The study used a device engineering experiment (prototype) approach. The system was built with the main components of Arduino Uno as a controller, an MQ-7 sensor to detect CO gas, an MQ-135 sensor to detect HC gas, a 20x4 LCD to display the measurement results, and a buzzer as an alarm. If the gas concentration exceeds the predetermined threshold (CO > 3% and HC > 1000 ppm), the buzzer will sound as a warning and display the status "unsafe". Testing was carried out by exposing the device to two-wheeled vehicle exhaust gas to determine the accuracy and speed of the system's response. Test results indicate that the device can be applied to two-wheeled vehicles. The system provides fast and accurate warnings and is easy to use. With its simple, portable design and relatively low manufacturing cost, this device is expected to be an effective solution for monitoring exhaust emissions. It serves as a simple monitoring device that is useful for reducing the impact of vehicle emissions and as an effort to control air pollution.

Keywords: *Vehicle exhaust, carbon monoxide, hydrocarbons, Arduino, MQ-7 detector, MQ-135 detector*

1. Introduction

E Motor vehicle exhaust emissions are one of the main contributors to air pollution, especially in dense traffic areas. [1]. The main factor of these emissions is the content of carbon monoxide (CO) and hydrocarbon (HC) gases which are toxic and dangerous for human health and the environment. [2]. However, monitoring of vehicle exhaust emissions has not been able to be carried out optimally by the public, due to the limited availability of simple detection tools that can be used directly in the field.

Along with the development of technology, electronic device-based solutions are needed that are able to detect vehicle exhaust gases practically and accurately [3]. One alternative that can be used is designing a prototype detector using an Arduino Uno microcontroller as the main controller. This system is combined with an MQ-7 sensor to detect carbon monoxide (CO) and an MQ-135 sensor to detect hydrocarbons (HC), and is equipped with an LCD display and buzzer for information and warnings [4].

Several previous studies have discussed the use of gas sensors for air quality monitoring, but these have been limited to general environmental aspects. Research specifically on motor vehicle exhaust emission detection devices, specifically those with simple, portable designs that can be used by the public, has not been widely developed.

Based on the description, this study aims to design and build a prototype of a motor vehicle exhaust gas detection device based on Arduino Uno which is able to detect CO and HC gas levels, provide a warning if it exceeds the threshold, and display the detection results in real time via an LCD screen.

2. Literture Riview

Previous research conducted by Wahyu Ramadhan et al. entitled "Design and Construction of a Prototype Fire Detection Device Using Arduino Uno Equipped with Fire Extinguisher and SMS Gateway Notification" developed an Arduino Uno-based fire detection system equipped with a flame sensor and an MQ-2 sensor to detect fire and smoke. The system is capable of providing early warnings via a buzzer, LED, and sending automatic SMS notifications to the user's mobile phone. In fact, this tool is also integrated with a water pump to help extinguish fires directly [5].

However, this research still focuses on fire and smoke detection in the context of fires, not on motor vehicle exhaust emissions, which are also a serious air pollution problem. Furthermore, the parameters used are limited to smoke in general, not specifically for hazardous gases such as carbon monoxide (CO) and hydrocarbons (HC) produced by vehicle combustion processes.

2.1. Vehicle Exhaust Gas

Vehicle exhaust gas is the remaining result of the fuel combustion process in a motor vehicle engine which is released through the exhaust system [6]. The main components of this exhaust gas are carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NOx), and other particles. Excessive emissions can impact air pollution and human health, such as reducing air quality, causing respiratory problems, and worsening environmental conditions.

2.2. Arduino Uno

The Arduino Uno is an open-source ATmega328P-based microcontroller board widely used in various electronics applications and embedded systems. It has digital and analog inputs and outputs that can be programmed using the Arduino IDE software. Its advantages are that it is easy to use, inexpensive, and supports various additional sensors and modules, making it often used in prototyping detection and automation systems [7].

2.3. Carbon Monoxide and Hydrocarbons

Carbon monoxide (CO) is a colorless, odorless, poisonous gas produced by the incomplete combustion of fossil fuels in vehicle engines. This gas is dangerous because it binds to hemoglobin in the blood more strongly than oxygen, thus disrupting oxygen distribution in the humanbody[8].
Hydrocarbons (HC) are chemical compounds composed of carbon and hydrogen atoms, also produced by the incomplete combustion of fuel. Hydrocarbons in the air can trigger smog formation and are carcinogenic, endangering human health and polluting the environment [8].

2.4. MQ-7 Detector and MQ-135 Detector

The MQ-7 sensor is a gas sensor used to detect the presence of carbon monoxide (CO). This sensor works by changing the resistance of a sensitive material (SnO_2) when exposed to CO gas, then generating an electrical signal that can be processed by a microcontroller [9]. The MQ-135 sensor is a gas sensor used to detect various types of hazardous gases, such as ammonia (NH_3), benzene, alcohol, and hydrocarbon gases (HC). Similar to the MQ-7, this sensor also works based on changes in the resistance of sensitive materials to gas exposure, so it can be used for air quality monitoring and exhaust gas emission detection [9].

3. Research Methods

The type of research used is experimental research, which gives researchers the opportunity to control factors that influence measurement results, such as gas concentration levels, environmental conditions, and monitoring periods. The research stages used are Data Analysis, Design, Program Creation, Testing, and Implementation, with a diagram like the following:

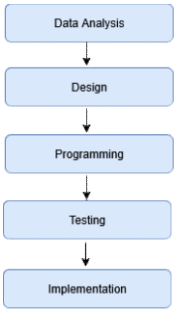


Fig 1: Research Stages

Data Analysis

During the analysis stage, researchers analyze the data collected in the previous stage, analyze the currently implemented system and formulate the problems to be investigated.

Design

At this stage, researchers design tools or systems based on alternative problem solving.

Programming

After collecting, analyzing and designing data, the researcher will build a program using the Java programming language.

Testing

The success rate of the previously designed program will be tested through a treatment analysis process using the method.

Implementation

Once the design is perfect, the application will be available to users.

3.1. System Design

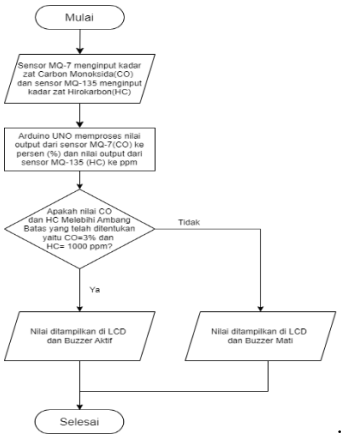


Fig 2: Proposed system design

The process is that the MQ-7 sensor detects CO levels and the MQ-135 sensor detects HC levels, then the data is processed by the Arduino Uno into percentages for CO and PPM for HC. The results are displayed on the LCD, if CO > 3% or HC > 1000 PPM then the buzzer sounds and the LCD displays the message "EXCEEDS THE THRESHOLD". If it is still ≤ the threshold, the buzzer is not active and the LCD displays the status "SAFE".

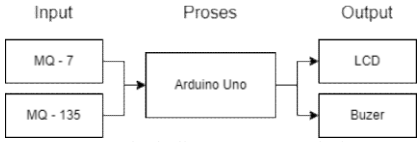


Fig 3: Block diagram system design

The MQ-7 detects carbon monoxide (CO) levels, while the MQ-135 measures hydrocarbon (HC) levels in motorcycle exhaust. Data from both sensors is processed by an Arduino UNO, then displayed on the LCD as CO percentage and HC levels. If the detected value exceeds the threshold, a buzzer sounds an alarm.

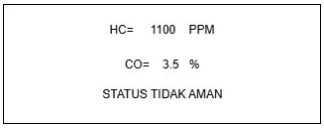


Fig 4: LCD System Design if it crosses the threshold

Description: The LCD image above shows the condition when the CO value reaches 3.5% which exceeds the 3% threshold and the HC value reaches 1100 PPM which exceeds the 1000 PPM threshold.

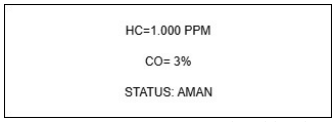


Fig 5: LCD System Design if safe

Description: The LCD image above shows a safe condition, namely when the CO value is 3% or less than the 3% threshold and the HC value is 1000 PPM or less than the 1000 PPM threshold.

4. Results and Discussion

4.1 Hardware

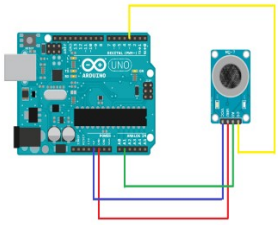


Fig 6: ADMEGA328P circuit to MQ-7 sensor

H The hardware flow can be explained that the Arduino Uno ATMEGA328P is connected to the MQ-7 sensor via several pins, namely the Arduino 5V pin is connected to the VCC pin on the MQ-7 sensor, the Arduino GND pin is connected to the sensor GND pin, the Arduino A1 pin is connected to the MQ-7 sensor AO pin to read analog values, and the Arduino D3 pin is connected to the MQ-7 sensor DO pin to read digital values.

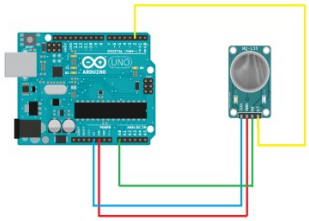


Fig 7: ADMEGA328P circuit to MQ-135 sensor

The hardware flow can be explained that the Arduino Uno ATMEGA328P is connected to the MQ-135 sensor via several pins, namely the Arduino 5V pin is connected to the VCC pin on the MQ-135 sensor, the Arduino GND pin is connected to the sensor GND pin, the Arduino AO pin is connected to the MQ-135 sensor AO pin to read analog values, and the Arduino D2 pin is connected to the MQ-135 sensor DO pin to read digital values.

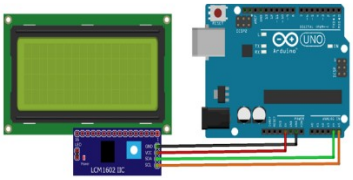


Fig 8: ADMEGA328P to LCD circuit

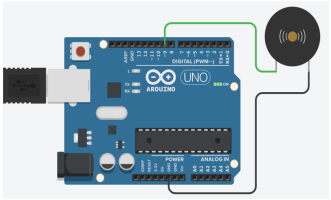


Fig 9: Arduino Uno ADMEGA328P Buzzer Circuit

4.2 Software

This software design is designed to detect CO and HC gas emissions using MQ-7 and MQ-135 sensors processed by Arduino Uno. The reading results are displayed on a 20x4 I2C LCD and followed by a buzzer or LED as a warning if the gas level exceeds the threshold. In the setup stage, Arduino initializes the pin and LCD, then in the main loop reads the sensor value, converts it to gas concentration, and displays the results. If detected exceeding the limit, the buzzer is active and the LCD displays a warning, while if safe the LCD displays a normal status. This system uses the LiquidCrystal_I2C library and can be further developed for wireless logging and monitoring.
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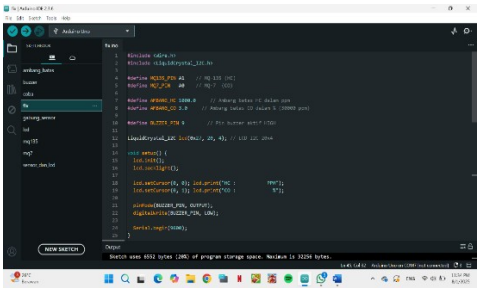


Fig 10: Software program code

4.3 Tool Design

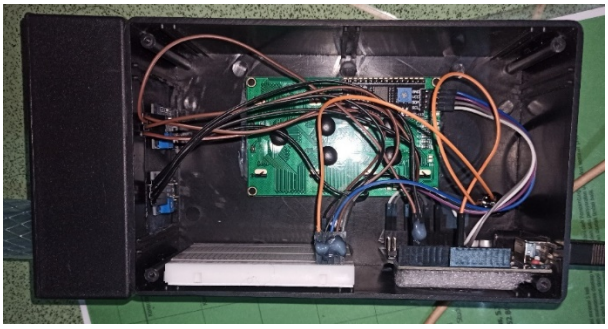


Fig 11: Tool Design

This device is designed to monitor vehicle exhaust emissions using an Arduino Uno. The MQ-7 and MQ-135 sensors measure CO and HC levels, and the results are displayed on a 20x4 LCD. If the gas exceeds the limit, a buzzer is activated as a warning. The system works automatically and is suitable for monitoring vehicle emissions.

4.4 Testing

1. *Black Box*

Black Box testing is a software evaluation method that focuses on application details, available functionality, and the suitability of functional flow to user needs. This testing does not involve reviewing or testing the program's source code [10].

Table I: Testing Black Box

No	Features tested	Input	Output	status
1	System initialization	Arduino dinyalakan	LCD displays initial message / system ready	✔ passed
2	CO sensor reading (MQ-7)	CO Gas Simulation (< 3%)	LCD displays low CO value, buzzer is off	✔ Passed
3	High CO sensor reading	High CO gas simulation (>3%)	LCD displays high CO value, buzzer is active	✔ Passed
4	HC sensor reading (MQ-135)	HC gas simulation (< 1000 ppm)	LCD displays high HC value, buzzer is active	✔ Passed
5	High HC sensor reading	HC gas simulation (> 1000 ppm)	LCD displays high HC value, buzzer is active	✔ Passed
6	Alarm response	High CO and HC at the same time	LCD displays two high values, buzzer is active	✔ Passed
7	System outage	Arduino dimatikan	System is down, showing no output	✔ Passed

2. Overall Tool Test Results

Table II: Safe Status Testing

Trials	Results	Information
The CO value shows that it is equal to or less than the predetermined threshold, namely 3%, and the HC value shows that it is equal to or less than the predetermined threshold, namely 1000 PPM.	Passed	The tool successfully displays the status information of the gas detection tool on the vehicle in a safe condition.
		

Table III: Unsafe Status Testing

Trials	Result	Information
The CO value shows more than the predetermined threshold of 3% and the HC value shows equal to or less than the predetermined threshold of 1000 PPM. / The CO value shows equal to or less than the predetermined threshold of 3% and the HC value shows exceeding the predetermined threshold of 1000 PPM.	Passed	The tool successfully displays the alert status information.
		

5. Conclusion

Based on the implementation and testing results, the following conclusions can be drawn:

1. The prototype device successfully identified vehicle exhaust emissions, namely carbon monoxide (CO) using the MQ-7 sensor and hydrocarbons (HC) using the MQ-135 sensor.
2. The use of white-box and black-box testing indicated that the system ran according to the program's logic flow and could respond to input conditions.

References

[1] Elsantika Meldacindya Nurmaya, Sigit Heru Murti, and Emilya Nurjani, "Kajian Pencemaran Lingkungan terhadap Kesehatan Masyarakat akibat Gas Buangan CO Kendaraan Bermotor di Kawasan Universitas Gadjah Mada," *Jurnal Paradigma*, vol. 1, no. 1, 2024, Accessed: Aug. 20, 2025. [Online]. Available: https://jurnal.ugm.ac.id/paradigma/article/view/91392

[2] H. W. Sudarwanto, I. W. Utami, R. Asmoro, and A. A. Wulandari, "Bahaya emisi gas buang kendaraan berbahan bakar bensin dan menumbuhkan lingkungan hijau di perkotaan," *SEMINAR NASIONAL & CALL FOR PAPER*, vol. 1, no. 1, 2020, Accessed: Aug. 20, 2025. [Online]. Available: https://ojs.udb.ac.id/HUBISINTEK/article/view/985

[3] Refi Widya, Melly Syahfitri, Taufiq Hidayat, Khalil Afif, and Sinekmehuli Br Perangin Angin, "Rancang Bangun Alat Ukur Emisi Gas Buang Kendaraan Bermotor Dengan Penampil Smartphone Android," *JISTI: Jurnal Ilmu Komputer, Sistem Informasi dan Teknologi Informasi*, vol. 1, no. 2, 2025, Accessed: Aug. 20, 2025. [Online]. Available: https://newjurnal.itbi.ac.id/index.php/JISTI/article/view/40

[4] D. Kurniawan, S. R. Sulistiyanti, and U. Murdika, "Sistem pemantau gas karbon monoksida (co) dan karbon dioksida (co2) menggunakan sensor mq7 dan mq-135 terintegrasi telegram," *Jurnal Informatika dan Teknik Elektro Terapan*, vol. 11, no. 2, Apr. 2023, doi: 10.23960/jitet.v11i2.2963.

[5] eguh Hidayat Iskandar Alam, Rendra Soekarta, and Wahyu Ramadhan, "Rancang Bangun Prototype Alat Pendeteksi Kebakaran Menggunakan Arduino Uno Dilengkapi Pemadam Dan Notifikasi Sms Gatewa," *INSECT*, vol. 5, no. 1, 2019, Accessed: Aug. 20, 2025. [Online]. Available: https://www.ejournal.um-sorong.ac.id/index.php/insect/article/view/1280/702

[6] U. M. Sugeng, R. Harfi,) Kuncoro, and A. Cipto, "Analisa perbandingan performa dan emisi gas buang menggunakan bahan bakar pertamax dan shell super pada kendaraan roda empat (kapasitas 1300 cc)," *PRESISI*, vol. 25, no. 1, 2023, Accessed: Aug. 20, 2025. [Online]. Available: https://ejournal.istn.ac.id/index.php/presisi/article/view/1457

[7] Andi Adriansyah and Oka Hidyatama, "Rancang bangun prototipe elevator menggunakan Microcontroller arduino atmega 328p," *Jurnal Teknologi Elektro, Universitas Mercu*, vol. 4, no. 3, Accessed: Aug. 20, 2025. [Online]. Available: DOI: http://dx.doi.org/10.22441/jte.v4i3.753

[8] D. Putri Agustina, N. Annisa, R. Riduan, and H. Prasetia, "Konsentrasi karbon monoksida dan nitrogen dioksida pada ruas jalan kuin utara dan kuin selatan kota banjarmasin concentration of carbon monoxide and nitrogen dioxide at road kuin utara and kuin selatan road, banjarmasin city," *urnal Tugas Akhir Mahasiswa Program Studi Teknik Lingkungan*, vol. 3, no. 1, 2021, Accessed: Aug. 20, 2025. [Online]. Available: DOI: https://doi.org/10.20527/jernih.v3i1.480

[9] E. Nebath, D. Pang, and J. O. Wuwung, "Rancang Bangun Alat Pengukur Gas Berbahaya CO Dan CO 2 di Lingkungan Industri," *65E-Journal Teknik Elektro dan Komputer*, vol. 3, no. 4, 2014, Accessed: Aug. 20, 2025. [Online]. Available: https://ejournal.unsrat.ac.id/v3/index.php/elekdankom/article/view/6012

[10] S. Anardani and A. R. Putera, "Analisis Pengujian Sistem Informasi Website E - Commerce Manies Group Menggunakan Metode Blackbox Function," *eminar Nasional Hasil Penelitian dan Pengabdian kepada Masyarakat UNIPMA*, 2019, Accessed: Jul. 19, 2025. [Online]. Available: https://prosiding.unipma.ac.id/index.php/SNHP/article/view/768/0