Department of Computer Science
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Air Quality Monitoring System

Design with Microprocessors

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Contents

Chapter 1

Introduction

1.1 Purpose and Motivation

The Air Quality Monitoring System was developed as a part of the Design with Microprocessors laboratory. The motivation behind this project stems from the increasing concern over air quality and the need for an accessible and efficient monitoring solution. The system aims to provide real-time data on air quality parameters such as CO levels, gas concentrations, temperature and humidity, coupled with user-friendly recommendations and alerts.

1.2 Scope

The primary goal of the project is to create a portable and affordable solution for monitoring air quality. The system integrates multiple sensors and a microcontroller to gather data, which is then transmitted to a mobile device via Bluetooth. The inclusion of a fan allows for active ventilation in response to poor air quality. The project's scope encompasses both hardware and software components, ensuring a comprehensive solution.

1.3 Rationale

The decision to pursue this project was driven by the challenge of creating an affordable air quality monitoring system. The integration of various sensors and the real-time data transmission to a mobile device sets this project apart, providing users with a convenient tool to monitor and respond to their immediate environment.

Chapter 2

Bibliographic Study

The idea of an Air Quality Monitoring System is not something new in the technical field, but the way the ideas and principles are implemented can make the difference. So I will compare my project with a similar one already implemented and commercialized on specialized websites.

2.1 Existing solution

You can find the solution at the following link: https://shorturl.at/gN138

The above solution utilizes a similar combination of CO and gas sensors, coupled with temperature and humidity monitoring. Data is typically displayed on an in-built display, rather than sent to a smartphone via Bluetooth.

2.2 Comparison

Below you can see a table in which we compare our implementation with a similar and already existing one from a specialized website, the comparing criteria are the following: Power Consumption, Implementation Difficulty, Cost of Resources, Sensor Diversity, Real-time Alerts, User Adaptability, Modularity.

Criteria	Air Quality Monitoring System	Existing System
Power Consumption	Low	Moderate
Implementation Difficulty	Easy	Challenging
Cost of Resources	Moderate	High
Sensor Diversity	Comprehensive	Limited
Real-time Alerts	Yes	No
User Adaptability	High	Limited
Modularity	High	Limited

Comparison of Existing Solution and Air Quality Monitoring System

Chapter 3

Proposed solution and implementation

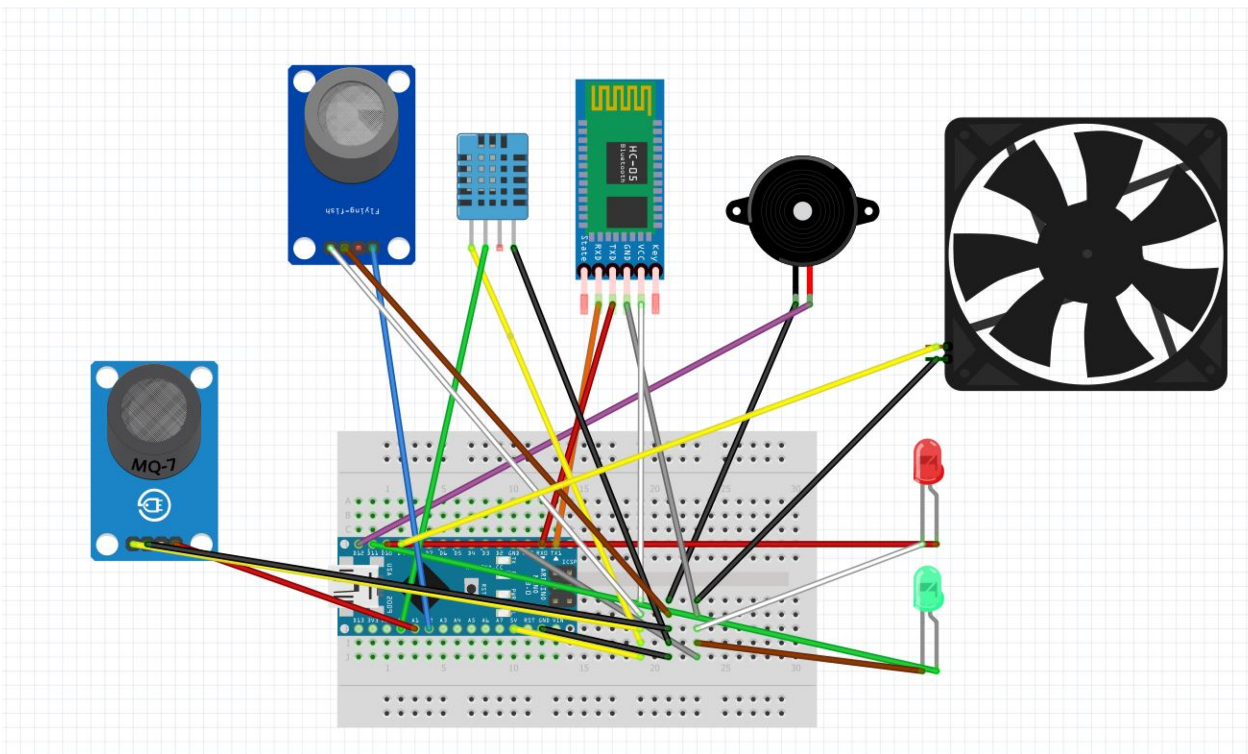
3.1 Overall Description

The Air Quality Monitoring System comprises **an Arduino Nano board, a breadboard, a MQ-7 CO sensor, a MQ-5 gas sensor, a DHT11 temperature and humidity sensor, a fan for ventilation, a Bluetooth HC-05 module, two LEDS(one green and one red), a buzzer, the needed wires and a plastic box**. These components work together to collect data, analyze air quality, and provide timely alerts and recommendations.

3.2 Implementation

3.2.1 Hardware

The circuit of the hardware parts and the connections can be seen below:



3.2.2 Software

The code incorporates various sensors and Bluetooth communication to monitor environmental conditions and detect potential hazards. It sets predefined thresholds for temperature, humidity, CO levels, and gas concentrations. If any parameter exceeds these safety limits, corresponding messages and alerts are sent over Bluetooth to a connected device.

In addition to visual and audible warnings (LEDs and a buzzer), the code introduces an extra safety feature. If the thresholds are exceeded, a fan is activated to improve the environmental conditions.

The program continuously reads data from the DHT, MQ-7 CO sensor, and MQ-5 gas sensor. The gathered data is then transmitted over Bluetooth, providing real-time updates. If conditions are within acceptable ranges, the system indicates normal operation, turning off the alerts, LEDs, buzzer, and the fan.

This comprehensive system enhances safety by actively responding to environmental changes, making it suitable for applications where maintaining specific environmental conditions is critical.

Chapter 4

Testing and Validation

4.1 Problems encountered

During the implementation of the Air Quality Monitoring System, several challenges emerged. One notable issue was the integration of sensor readings and Bluetooth communication. Ensuring seamless data transmission without compromising real-time monitoring required careful debugging and code optimization. Additionally, sensor calibration posed difficulties, particularly in fine-tuning the sensitivity of the gas and CO sensors to accurately reflect air quality.

4.2 Comparative Analysis in Changing Environments

To validate the system's robustness, I conducted tests in varying environmental conditions. The change in temperature, humidity, gas level or carbon dioxide level was noticed with ease by the implemented system.

4.3 Evolution of the project

The initial state of my project focused on individual sensor functionality and basic data display. Subsequent phases involved the incorporation of real-time alerts, Bluetooth communication, and the activation of a fan for improved air quality. This evolution necessitated adjustments in power consumption management and component layout. While the chassis and core sensor placement remained consistent, the addition of features prompted optimization for power efficiency. The final state showcases a more sophisticated and adaptive air quality monitoring system, successfully addressing the challenges encountered during development.

Chapter 5

Conclusions

5.1 Fulfillment of Purpose

The primary goal of my air quality monitoring system was effectively achieved. Through iterative adaptations and rigorous testing, I established a reliable and efficient solution for real-time air quality assessment. Challenges in sensor integration, Bluetooth communication, and calibration were successfully navigated, resulting in a robust implementation.

5.2 Adaptations and Tests

The project underwent extensive testing, including environmental variations to assess sensor responsiveness. Calibration trials ensured accurate gas and CO level readings. The introduction of real-time alerts and a fan for active response demonstrated the adaptability of the system to varying air quality conditions.

5.3 Ease of Adaptation

The modular design and user-friendly interface make my solution easy to adapt. The implementation of Bluetooth communication enhances accessibility, allowing users to monitor air quality remotely. The system's adaptability is a key feature, ensuring it can be seamlessly integrated into existing setups or expanded for more comprehensive applications.

5.4 Practical Improvements

Practically, my solution can be further improved by incorporating additional sensors for a more comprehensive air quality assessment. Integration with smart home systems and the development of a dedicated mobile application can enhance user interaction and accessibility. Future iterations could also focus on reducing power consumption to extend the system's operational lifespan on battery power.

Bibliography

Laboratory Guide - Design with Microprocessors [ISBN 978-606-737-337-0]

Arduino Website - https://www.arduino.cc/

https://www.geeksforgeeks.org/