IoT Domestic Air Quality Monitoring

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Introduction

The importance of good air quality is paramount to the health of humans. Increasingly, people are spending more time indoors with some studies suggesting that we are spending up to 90% of our time in enclosed spaces such as homes, classrooms and offices. In a sense, it is more important to maintain clean air indoors than outdoors.

According to the WHO statistics, 3.8 million people die from exposure to domestic air pollutants annually. This is the largest environmental factor that affects mortality. It is clear that this is a serious health risk that needs to be addressed.

Modern technology has provided better sensing equipment to monitor gas levels in real-time in industrial setting. However, these technologies have been slow to trickle down to consumer use. There are few products on the market that provide real-time monitoring of air quality in homes.

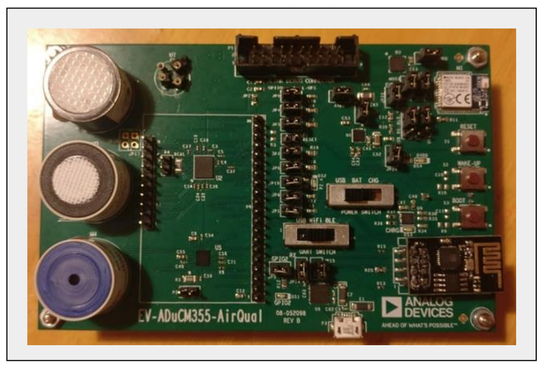
For all these reasons, it is clear that a simple-to-use, real-time air quality monitoring system is necessary for domestic use to prevent diseases and illness.

Project Outline

The purpose of this project is to make an air quality monitoring unit for domestic use. The device will detect the gas levels in the room and in particular, toxic gases, and report the readings to the user. A number of target gases are to be monitored and recorded.

The device is to be fully wireless. A rechargeable battery should provide the device with a reasonable use time between charges. A Wi-Fi or Bluetooth module will be incorporated into the device. The readings from the sensors will be pre-processed and reported to a website or app for the user to see.

The device created for this project is shown below.

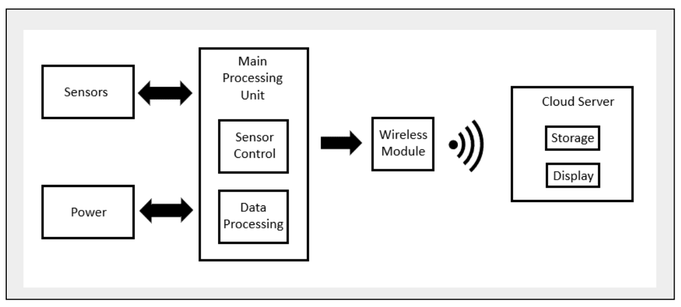


Device Created in this project

Design and Development

System Design

The diagram below shows a block diagram of the system.



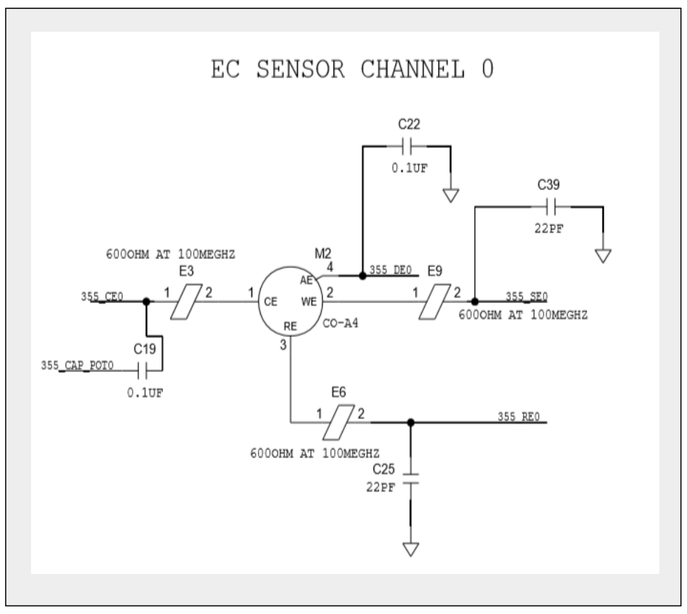
Block diagram for system design

For this project, the main processing block involves sensor control and data processing. The main processing unit receives measurements from the sensors. The data is processed and passed along to the wireless module. The wireless module sends the measurements to the cloud server where it is stored and displayed.

Hardware Design

The hardware for this project was custom built with the help of Analog Devices. The design is based around the ADuCM355 and the AD5940, two similar components, made by Analog Devices for electrochemical and biochemical measurements.

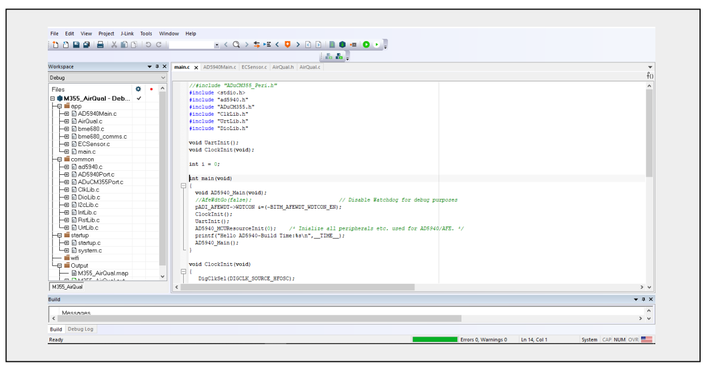
The hardware design for this project was designed in Cadence Allegro PCB designer. A piece of the design is shown below.



Electrochemical gas sensor channel circuit diagram

Software Design

The embedded software for this project was coded in IAR Embedded Workbench using the C language. A snippet of the workspace is shown below.



IAR Embedded Workbench

The software in this project interfaces with the sensors where it controls the sensors and takes measurements. The data is processed and sent to the WiFi module where it is forwarded to a cloud server for visualization.

WiFi and Cloud Storage

This project uses an ESP8266 WiFi module to send data from the device to a cloud server.

The cloud server used in this project is ThingSpeak. ThingSpeak is used to store and visualize the data. The user can log on to a website to monitor the air quality in their home.

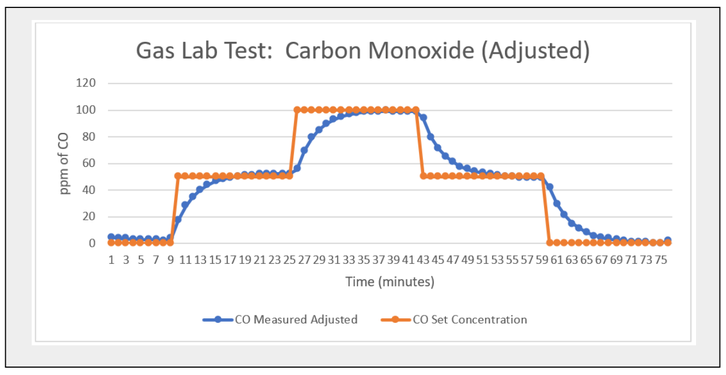
Sample Data Visualization from ThingSpeak

Result

This project has been successful in meeting the design criteria. The device has been shown to be functioning and can take measurements from the gas sensors, process the data and send it to the cloud for storage and visualization.

For practical results, the device was taken to a gas lab for testing. A set concentration of gas was pumped into a vessel containing the device and the gas sensors took measurements.

A sample of the data is shown below. The data was adjusted due to a processing error on the device which has since been resolved.



Electrochemical gas sensor channel circuit diagram

The gas levels measured correlate with the set gas levels. It takes time for the sensor to reach the expected level due to sensor delay and delay in the gas saturating the vessel.

The results show that the device is capable of accurately taking gas measurements.

Conclusion and Personal Reflection

The project was successful in reaching the aims and objectives and fulfilling the project outline. The project shows how it is possible to use industrial technology to make a domestic air quality monitor.

The device is capable of measuring sensor data to a high accuracy with low power consumption.

The device was successfully integrated between the device and the cloud server using a WiFi module. The cloud server is updated in real-time to reflect the sensor readings sent from the device.

The device created in this project is wireless and portable. It can operate fully wirelessly with a rechargeable battery and WiFi capabilities.

This project helped me to personally develop my professional engineering skills and in particular the university's graduate attributes. This project has demonstrated knowledge as shown in the development of the project, creativity from the design and research for the project, collaboration by working with others on this project and articulation from the creation of the accompanying report.

Acknowledgements

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