# HAVEN: Hazardous Air and Vapor Environmental Notifier

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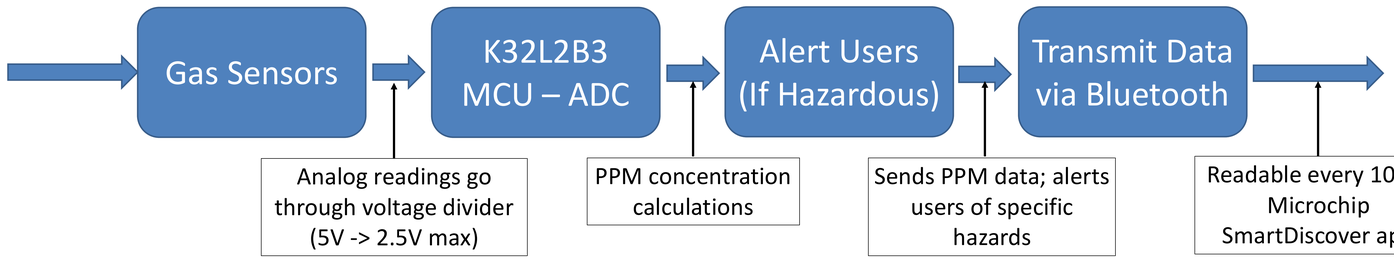
## Abstract

HAVEN (Hazardous Air and Vapor Environmental Notifier) is a compact, battery-powered air quality monitoring system designed to detect harmful gases and enhance environmental safety in residential homes. Equipped with six high-sensitivity gas sensors; carbon monoxide, ammonia, natural gas, ozone, nitrogen dioxide, and formaldehyde, the device continuously monitors air quality in real time. A low-power NXP microcontroller processes sensor data and transmits alerts via Bluetooth to paired smartphones. Visual and audible distress signals, including LED indicators and alarms, ensure awareness of hazardous conditions. Powered by readily available AA batteries and built with energy-efficient circuitry, HAVEN offers a reliable air quality monitoring solution, without the need for new infrastructure.

## Methods and Materials

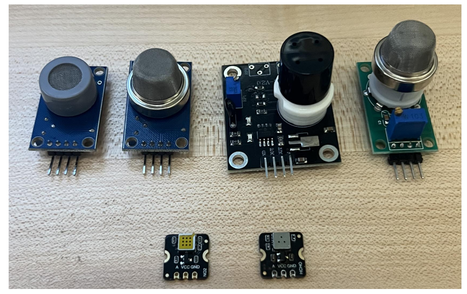



### Hardware

- Microcontroller Unit (MCU): NXP K32L2B3
  - 16-bit Analog to Digital Converter
  - Low Power UART
- Six Tin Dioxide Sensing Layer Gas Sensors
- Two LM2623 DC-DC Boost Converters (3.3V, 5V)
- Microchip RN4870 Bluetooth Module
- Distress LED and Audible Alarm
- Bluetooth Pair and Reset Button, Status LED

### Software

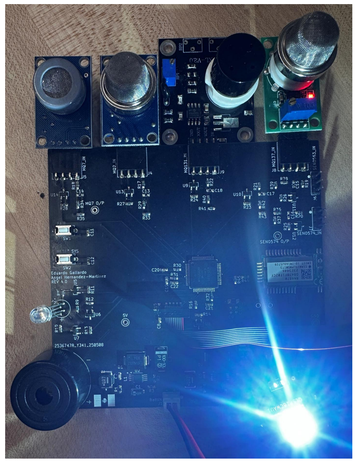
- MCU Programmed in C
  - µC/OS-III Real Time Operating System
- Task Scheduling for Gas Sensor Pre-Heat and Sampling
- PPM Conversion, Alerts and Bluetooth Communication via UART
- Low Battery Power Detection and Alert



## Background

Indoor air pollution is a serious health risk, especially in homes with older infrastructure where ventilation may be limited and gas leaks are more likely. Exposure to gases like carbon monoxide, ammonia, natural gas, ozone, nitrogen dioxide, and formaldehyde can lead to long-term health issues or immediate danger, like fires. Most consumer-grade air quality monitors only detect one or two gases and often miss less common but still hazardous compounds. More advanced systems that offer broader detection tend to be expensive, bulky, or require installation by professionals. HAVEN addresses this gap by offering a compact, battery-powered device that monitors six harmful gases in real time. With efficient embedded processing and wireless alerts, HAVEN makes comprehensive air quality monitoring accessible for everyday households.

## Results



- Alerts of high concentration of gas within the 60 second detection period as defined by the NFPA (National Fire and Protection Agency)
- Audible alarm is heard in adjacent rooms and follows NFPA standards
- Transmits what gas is in a hazardous concentration in room
  - Below on line 3 the ASCII message translates to
  - " ALERT: NATURAL GAS LEVELS HIGH "
- Able to connect to Bluetooth greater than 60 feet away
- Bluetooth pairing button enables Bluetooth as well as disables connection
- Reset button sets the state of HAVEN back to normal sampling mode after detection and alert of harmful gas
- Low power mode initiates after battery level is below 2V and continues until user replaces batteries

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3237352c 302c322c 31383837 2c302c30
2025-05-30 23:19:07 +0000
3237352c 302c322c 31383837 2c302c30
2025-05-30 23:19:05 +0000
414c4552 543a204e 41545552 414c2047 4153204c 4556454c 53204849 4748
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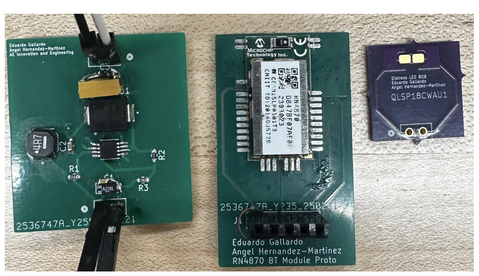


## Future Direction

Current Problems

- Detection of whether Bluetooth module is connected to a user
- Due to lack of calibration/testing tools, sensor readings aren't exact

Temporary Workarounds

- Board handles pairing mode as 'connected' so the board can send air quality information over Bluetooth
- We calibrate our sensors according to the given information found in their respected datasheets

Future Work

- Finer calibration of gas sensors
- Bluetooth connection between other HAVEN's
- Design better terminal app to read air quality index

## References

NFPA 72: National Fire Alarm and Signaling Code, National Fire Protection Association, Quincy, MA, USA, 2022. https://www.nfpa.org/codes-and-standards/nfpa-72-standard-development/72

R. Jalinder Jadhav, P. Radhakrishnan, D. Arun Jadhav, B. Ashreetha, J. Divya and S. Mukherjee, "Internet of Things Enabled Gas Leakage Detection Over Industrial Areas using Powerful MQ Series Sensor and Controller," *2024 International Conference on Inventive Computation Technologies (ICICT)*, Lalitpur, Nepal, 2024, pp. 1679-1686, doi: 10.1109/ICICT60155.2024.10544961.

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WWU

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