The German University in Cairo

Faculty of Media Engineering and Technology

(CSEN 701) Embedded Systems Architecture

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Project 43:

Fire Detection System: Employing Gas and Temperature Sensors for Fire Alarm

* Some modifications have been made to the project during this milestone. Kindly find them listed on page 4.
** The state chart is on page 5.

Project Description

"Fire Detection System: Employing Gas and Temperature Sensors for Fire Alarm" project seeks to build a reliable fire detection and alarm system. To enable the early detection of fire dangers, this system includes two sensors: a temperature sensor and a gas sensor. It will use the Raspberry Pi Pico and the Arduino RP2040 microcontrollers to create a dependable fire detection system. In order to improve coordination and data exchange, the project will also build a communication protocol between these microcontrollers. This system will also have a set of output devices, including a buzzer, a motor, and LED lights, to ensure complete and immediate fire alert capabilities.

Tasks Description

1. Sensing Subsystem:

A gas sensor and a temperature sensor are integrated to continually monitor the surroundings.
Data collection and preprocessing are used to collect and prepare sensor data for analysis.

2. Data Analysis and Decision Subsystem:

Algorithm implementation for analyzing sensor data for fire risk assessment.
When a fire hazard is discovered, decision-making procedures are used to activate alarms.

3. Alarm Subsystem:

The activation of a buzzer to convey an audible alert to people nearby.
Controlling a motor to open windows, doors, or ventilation systems in order to reduce the risk of a fire.
The LED lights in the alarm subsystem will be used to provide visual indicators, such as color changes or flashing patterns, to convey specific information about the fire alarm's status, severity, or specific actions taken by the system.

Communication Protocol

This project will use UART (Universal Asynchronous Receiver/Transmitter) communication over the TX (Transmit) and RX (Receive) pins.

Hardware Connections:

Connect the TX pin of one microcontroller (e.g., the Arduino RP2040) to the RX pin of the other microcontroller (e.g., the Raspberry Pi Pico).
Connect the RX pin of the first microcontroller to the TX pin of the second microcontroller.

The Flow

Arduino RP2040:

- This microcontroller is in charge of the Sensing Subsystem, as well as the Data Analysis and Decision Subsystem.
- It reads data from the gas and temperature sensors continuously.
- Analyses sensor data to determine the presence of a fire risk.
- If a fire hazard is recognized, it sends an alert message to the Raspberry Pi Pico through UART. This message could include information about the hazard's severity as well as any relevant sensor data.

Raspberry Pi Pico:

- This microcontroller is in charge of the Alarm and Communication Subsystems.
- The Arduino RP2040 sends an alert message to it through UART.
- When an alert message is received, it activates the alarm subsystem, which includes the buzzer, motor, and LED lights.
- The buzzer gives an audible alert, the motor initiates activities such as opening windows or doors for ventilation, and the LED lights can be used to show various states such as the severity of the fire hazard.
- To transmit different information, the Raspberry Pi Pico may vary the LED colors, blink patterns, or intensity.

Markey Survey

Input Devices (Analog Sensors):

1. Temperature sensor
2. Gas sensor

Output Devices:

1. Motor
2. Buzzer
3. LED lights

NB: There's a scarcity of the Arduino RP2040 in the market so in case we weren't able to find one, another Raspberry Pi Pico will be used! ☺

Modifications Done to the Project in Milestone 2:

1. Only 1 microcontroller has been used thus far – the Raspberry Pi Pico – to control the whole system.
2. Instead of the external temperature sensor, the microcontroller's internal temperature sensor is used.
3. The states the LED light has are ON (in red), indicating a fire has been detected, and OFF, indicating normal conditions.

Modifications Done to the Project in Milestone 3:

1. We used the 2 3.7V batteries and the h-bridge 5V output to power supply the Raspberry Pi Pico, instead of connecting it to the laptop.
2. We added a new LED to have two lights:
   - The red LED indicates whether or not the temperature sensor is sensing a temperature higher than 40 degrees Celsius.
   - The blue LED indicates whether or not the gas sensor detects if there is any smoke resulting from the fire.