SYSC3010 Computer Systems Development Project
FANS Final Report

Group L1-G8

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1 Project Description

1.1 Motivation

The motivation for the FANS project was to address the critical problem of preventable fire-related deaths in Canada. Fire safety was a fundamental concern for individuals, families, and communities nationwide. By leveraging modern technological advancements, the FANS system aimed to significantly enhance the effectiveness of fire alarm systems, reducing response times, and ultimately saving lives. The importance of this project could not be overstated, as it directly impacted the safety and well-being of Canadians.

1.2 Problem Statement

The need for the Fire Alarm Notification System (FANS) stemmed from the alarming number of preventable fire deaths in Canada, where 220 people died in fires each year, with at least one in seven of these deaths occurring in homes without working smoke alarms **??**. This critical problem underscored the shortcomings of traditional fire alarm systems, which often lacked advanced communication capabilities and real-time monitoring capabilities **??**. These limitations not only contributed to delayed response times but also to preventable deaths, underscoring the urgent need for an advanced fire alarm solution.

Traditional systems' shortcomings, coupled with the fact that smoke detection systems were sometimes unsafely disarmed by users to avoid false alarms—especially those installed close to kitchen spaces—further exacerbated the problem. The FANS project sought to address these issues by integrating smoke and temperature sensors with Internet of Things (IoT) technology. This approach not only aimed to cover scenarios where smoke may not reach the detecting device but also offered real-time notifications via SMS and email, thus notifying homeowners immediately in the event of an emergency.

By providing configurable thresholds for smoke and temperature alarms and adjustable timeouts that prevented the system from being deactivated in an unsafe manner, FANS aimed to use technological advances to significantly improve the effectiveness of fire detection systems. The ultimate goal of the project was to reduce response times, improve overall fire safety, and thereby mitigate fire disasters and protect the well-being of individuals, families, and communities across Canada **??**.

1.3 Overview of Solution

2 Final Solution

2.1 Deployment Diagram

2.2 Message Protocol Table

In the Fire Alarm Notification System (FANS), a variety of communication protocols are meticulously integrated to ensure seamless interaction among the system components and with the external cloud database, facilitating a robust and responsive fire alarm solution.

The system's core, the Smoke Detection System, communicates with its temperature and smoke sensors using the I2C and SPI protocols over the GPIO pins of a Raspberry Pi 4.

2.2.1 I2C Communication

The Raspberry Pi 4 utilizes the I2C protocol to communicate with an array of temperature and smoke sensors, monitoring environmental conditions to detect potential fire hazards. This is not visible in the sequence diagrams as they show the bigger picture of the communication of the nodes with the sensors.

Sender	Receiver	Message	Data Format	Protocol
Raspberry Pi 4	Temperature Sensor	`read_temp`	See section 6.2.1 of datasheet [2]	I2C
Raspberry Pi 4	Smoke Sensor (via ADC)	`read_smoke`	See figure 1.1 of datasheet [3]	SPI [3]

Table 1: Messages for I2C communication in FANS.

2.2.2 Local Area Network Communication

Nodes within the FANS (smoke detection, alarm, and notification systems) communicate over a local network using UDP packets, facilitating real-time alerts and system coordination.

The messages sent over UDP use numerical value to encode messages. The representation agreed upon is as follows:

Message	Value
Emergency	0
No Emergency	1

Table 2: Numerical representation of messages over UDP in FANS.

Sender	Receiver	Message	Data Format	Protocol
Smoke detection system	Notification system	Emergency	0	UDP
Smoke detection system	Alarm system	Emergency	0	UDP
Smoke detection system	Notification system	No emergency	1	UDP
Smoke detection system	Alarm system	No Emergency	1	UDP

Table 3: Messages for local area network communication in FANS.

2.2.3 Cloud Database Communication

Sender	Receiver	Message	Data Format	Protocol
Smoke Detection	Cloud DB	`put_sensor_data()`	See listing 1	HTTP (JSON)
GUI	Cloud DB	`update_threshold(new_threshold)`	See listing 2	HTTP (JSON)
Notification	Cloud DB	`query_contact_information()`	See listing 3	HTTP (JSON)
Haptic Alarm	Cloud DB	`emergency()`	See listing 4	HTTP (JSON)
GUI	Cloud DB	`get_sensor_data()`	See listing 5	HTTP (JSON)

Table 4: Messages for cloud database communication in FANS.

Listing 1: Update sensor data message.

```
{
  "method": "PUT",
  "path": "/sensor-data/temperature",
  "headers": {
    "Authorization": "Bearer YOUR_ACCESS_TOKEN",
    "Content-Type": "application/json"
  },
  "body": {
      "data": {
          "temperature": 21.2,
          "timestamp": "2024-03-13T08:37:22"
      }
  }
}
```

Listing 2: Threshold update message.

```
{
  "method": "PUT",
  "path": "/system/threshold",
  "headers": {
    "Authorization": "Bearer YOUR_ACCESS_TOKEN",
    "Content-Type": "application/json"
  },
  "body": {
    "newThreshold": 50
  }
}
```

Listing 3: Request for user contact information.

```
{
  "method": "GET",
  "path": "/user/contact",
  "headers": {
    "Authorization": "Bearer YOUR_ACCESS_TOKEN"
  }
}
```

Listing 4: Request for emergency flag.

```
{
  "method": "GET",
  "path": "/system/emergency",
  "headers": {
    "Authorization": "Bearer YOUR_ACCESS_TOKEN"
  }
}
```

Listing 5: Request for latest sensor data.

```
{
  "method": "GET",
  "path": "/sensor-data",
  "headers": {
    "Authorization": "Bearer YOUR_ACCESS_TOKEN"
  }
}
```

2.2.4 User Notification Communication

The notification system communicates with users through email, employing standard internet protocols to ensure timely and effective alerts.

Sender	Receiver	Message	Data Format	Protocol
Notification System	User Inbox	Emergency notification	See listing 6	SMTP (Email)

Table 5: Messages for user notification communication in FANS.

Listing 6: Email notification for detected emergency in FANS.

```
FROM: notification@example.com
TO: user@example.com
SUBJECT: Fire Alarm Notification

Dear [User's Name],

This is an emergency notification. Please exit the building.

Emergency detected: [Date, Time]

Stay safe!
```

2.3 Sequence Diagrams

3 Discussion of Final Design

4 Contributions

This section lists all of the contributions of each member on the FANS development team.

4.1 Code Contributions

Code file contributions listed in this table will use Unix file paths to describe which files were worked on by each contributor. The asterisk signifies the wildcard operator, so `alarm-system/*` captures all files within the alarm-system/ directory. All paths correspond to paths within the project repository on GitHub.

For a more granular view of contributions, where multiple authors have worked on the same file, please review the Git commit history.

Author	Code files
Grant Achuzia	• `docs/*` • `web-app/*` • `pico_alarm/*` • `README.md`
Saja Fawagreh	• `docs/*` • `notifier/*` • `notifier/tests/test_email_notification_system.py` • `README.md`
Javeria Sohail	• `docs/*` • `pico_alarm/*` • `haptic_alarm_test/*` • `README.md`
Matteo Golin	• `alarm-system/*` • `sensor-pi/*` • `web-app/main.py` • `web-app/templates/index.html` • `web-app/templates/settings.html` • `docs/*` • `notifier/templates/*` • `notifier/tests/test_email.py` • `notifier/messages.py` • `README.md`

Table 6: The individual code contributions of each FANS team member.

4.2 Report Contributions

Author	Report sections
Grant Achuzia	• TBD
Saja Fawagreh	• Message Protocols • Sequence Diagrams • Discussion of Final Design
Javeria Sohail	• Motivation • Problem Statement • Final Design Solution
Matteo Golin	• Contributions • Deployment Diagram • Project Extensions

Table 7: The individual final report contributions of each FANS team member.

References

[1] P. Matoušek, *Thick smoke on black background*. [Online]. Available: https://www.freeimages.com/photo/thick-smoke-on-black-background-1633270 (visited on 02/11/2024).

[2] “Mems pressure sensor: 260-1260 hpa absolute digital output barometer.” (), [Online]. Available: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiGq4Dy4_GEAxX1HNAFHSf-BRwQFnoECBcQAQ&url=https%3A%2F%2Fwww.st.com%2Fresource%2Fen%2Fdatasheet%2Flps25hb.pdf&usg=AOvVaw2FTksZHmMhimTAl6Qq3eFF&opi=89978449 (visited on 03/13/2024).

[3] “Mcp3004/3008.” (), [Online]. Available: https://ww1.microchip.com/downloads/aemDocuments/documents/MSLD/ProductDocuments/DataSheets/MCP3004-MCP3008-Data-Sheet-DS20001295.pdf (visited on 03/13/2024).

A GitHub Repository README