Indoor Exhaust System

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Test Plan:

Github repo link:

Project Description:

Our project is a simulation of an indoor exhaust system. We will use exhaust fans to remove harmful gases from the chamber and alert with a buzzer if the gases and/or temperature goes above a certain threshold.

Remote Node: Tiva TM4C1294XL

Control Node: Beagle bone green

The indoor exhaust system will be designed in a box that comprises of

Sensors:

1) Adafruit Temperature Si7021 Temperature and Humidity Sensor (I2C interface).
2) MQ7 gas sensor (detects CO value in ppm) sensor evaluation board that is used for detecting various gases in ppm level (ADC Interface).

Control outputs:

1) A set of four exhaust fans
2) A buzzer

   The sensors will be placed in a box and we are planning to check it with an incense stick or a lighter. The count of exhaust fans on and their speed can be varied according to the feedback from the sensor.

Requirements:

1) State machine on the remote node to alert in case of emergency or failure of sensors, switch the fans on and off according to feedback (closed loop state machine).
2) LEDs on the remote node to indicate the current mode of operation.

Use cases:

1) Default: The value of temperature and the gas sensor is within the normal range and the exhaust fan is off
2) Smoke detected: Turn on the fans according to the level
3) High Temperature detected: Turn exhaust fans on based on the level
4) Failure of smoke sensor: Send alert with the buzzer
5) Failure of Temperature sensor: Send alert with the buzzer

System Configuration:

1) Tiva board: Remote Node
2) Beagle bone green: Control Node

3) The alerting mechanisms by the beagle bone green to indicate:

We will be using two buzzers – One buzzer for TIVA board and One for Beagle bone green to indicate the operational status of the system. The exhaust fans (actuators) will be connected on the TIVA board.

- Default/Normal: The value of temperature and the gas sensor is within the normal range and the exhaust fan is off.

- Degraded mode: Status LEDs on the TIVA board – LED 4 is blinking

- Failure mode: Status LEDs on the TIVA board – LED 4 is on

- Temperature and Humidity sensor fails – LED 2 on the TIVA Board blinks
- Gas sensor fails – LED 3 on the TIVA Board blinks
- Message queue is full – LED1 on the TIVA Board is ON

Failure:

➢ Smoke detected: Turn on the fans according to the set thresholds
➢ High Temperature detected: Turn exhaust fans on based on the set thresholds
➢ Failure of smoke sensor: Send alert with the buzzer
➢ Failure of Temperature sensor: Send alert with the buzzer

Control-Remote Node connectivity:

➢ UART for connecting the remote node (TIVA Board) to the control node (Beagle bone green)
➢ A message queue for communicating the control/sensor information for the transmission of the temperature and gas sensor data and logs.

System Functionality:

Automatic startup:

Control Node startup

Remote Node startup

Remote Node sensing:

State diagram:

1) 0 fan on/off
2) 1 fan on/off
3) 2 fan on/off
4) 3 fan on/off
5) 4 fan on/off
6) Buzzer

 If the temperature and Humidity Sensor (Si7021) is disconnected, then the polling is done as it waits on acknowledgement for I2C and it stays in the degraded mode of operation and as soon as the sensor is connected back the data values is obtained.

If the Gas (MQ7) sensor is disconnected, then it continuously reads the ADC reading and by the time, the sensor remains disconnected the mode is in degraded mode of operation and once it is connected back, the sensor sends the reading.

The control algorithm – If the temperature goes above 20 degree Celsius then turn on one of the fan and if the temperature goes above 100 degrees – (alert condition): All the fans will be turned on and a buzzer will be turned on too. (Different threshold values will be set for different operations).

Failure and Fault detection Behavior:

 If the temperature and Humidity Sensor (Si7021) is disconnected, then the polling is done as it waits on acknowledgement for I2C and it stays in the degraded mode of operation and as soon as the sensor is connected back the data values is obtained.

If the Gas (MQ7) sensor is disconnected, then it continuously reads the ADC reading and by the time, the sensor remains disconnected the mode is in degraded mode of operation and once it is connected back, the sensor sends the reading.

Testing based on threshold values for temperature and gas: by activating the exhaust fans and buzzers.

If the control node cannot detect the Remote node then the control node will keep trying to get connected until it can get connected to the remote node.

If the sensor fails or the temperature and gas sensor values are beyond a threshold then the fans will be turned on accordingly as a feedback mechanism.

If the control node and the remote node connection fails then the buzzer on the control node side will turn on.

Logging:

The logging will be done on a logfile in the control node side. The data will be collected by the remote node and sent to the Beagle bone via UART. If the connection between the control node and remote node fails, then the real time data from the sensors will be saved on a logfile on remote node side and once the connection is retrieved then the temporary file will be sent to the beagle bone.

Architecture Description:

Software Diagram:
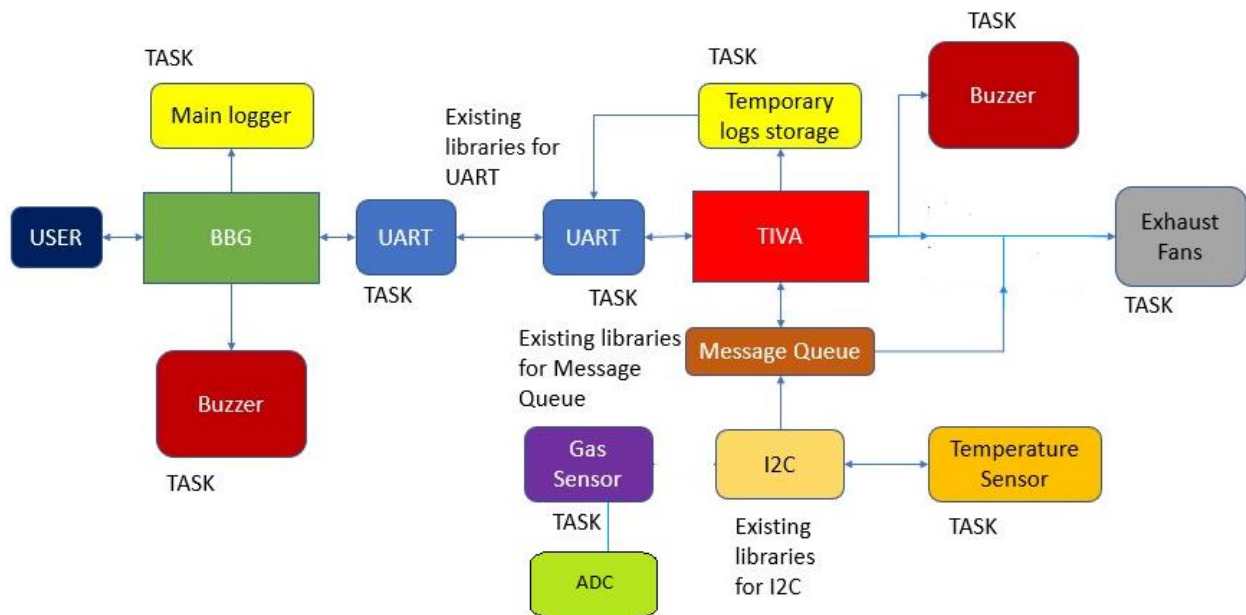
Closed loop Control:

1) 0 fan on/off
2) 1 fan on/off
3) 2 fan on/off
4) 3 fan on/off
5) 4 fan on/off
6) Buzzer on/off

Tasks for Remote Node:

1) Threshold task: To check the threshold values and accordingly turn on the buzzer and/or exhaust fans
2) Logger task: For collecting data and sending it over UART and back up data in case of connection failure
3) UART task: uart send and receive options
4) Temperature sensor task: To get the temperature values from the sensor using I2C interface
5) Gas sensor task: To get the gas readings from the sensor using I2C interface

Tasks for Control Node:

1) Threshold task: To turn on/off the buzzer and the fans based on threshold values
2) Logger task: To save the data in a log file
3) UART task: To send/receive data over UART
4) Gas Task: To get the CO value in ppm for the MQ7 Gas sensor.
5) Temperature and Humidity task: To get the readings from the temperature and the humidity (Si7021 sensor)

API Description:

Remote-Node:

1) void exit_handler(): To exit the handler
2) void uart_send(uint8_t* ptr, uint32_t size): To send the UART data
3) void uart_receive(uint8_t* ptr, uint32_t size): To receive the UART data
4) void queue_adder(queue_data_t* data_send): To add the data in the queue and send the message queue

5) void buzzer_control(void): To turn the buzzer on or off

6) void Fan_update(int8_t value): fans update based on the values – turn on or off

7) void i2c_init(void): To initialize the I2C

8) void gpio_init(void): To initialize the GPIO pins for the output devices

9) void uart_init(void): To initialize the uart and configure it

10) void UARTFxn(void* ptr): Task to send and receive data over UART from the remote node to the control node.

11) void loggerFxn(void* ptr): Task to log the data

12) void gasFxn(void* ptr): Task to send the gas data readings in ppm to the control node from the remote node
13) void thresholdFxn(void* ptr): Task to turn on/off the fans and the buzzer based on the set threshold values
14) void __error__(char* pcFilename, uint32_t ui32Line): Assert error() function FREERTOS

Control-Node:

fork() operation in main to separate the logger task and the GUI designed

1) void* logger(void* ptr): Logger function to log the data
2) void logfile_setup(void): To setup the logfile function
3) int32_t timer_init(void): To initialize the timer – periodic timer for 10 seconds
4) void system_end(int sig): To change the condition for system_end
5) void uart_init(void): uart initialization
6) void termios_init(void): To initialize the terminal for saving the current port settings and setting the conditions for uart using proper flags
.

Project Plan:

Using Excel Gantt:

AESD_PROJECT_2

Task Name	Apr 7							Apr 14							Apr 21							Apr 28					
	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
Procuring Sensors and Actuators				�																								
Remote Node Devlopment					▓	▓	▓																					
Interfacing Sensors									▓																			
Interfacing Actuators											▓																	
Control Node Development													▓	▓														
Communication Between Nodes																▓												
Fault Detection/Tolerance Behavior																		▓										
Handling error cases and Bugs																				▓								
Added Comments and Report																						▓						

1) Manual mode failure condition: When both the sensors are disconnected: Fail Condition:

```
time: 682 sec 56 msec    Manual         Failure         LOG_THRESHOLD    THRESHOLD CHECKED
time: 682 sec 56 msec    Manual         Failure         LOG_GAS          The CO value is 3 ppm
time: 683 sec 57 msec    Manual         Failure         LOG_THRESHOLD    THRESHOLD CHECKED
time: 683 sec 57 msec    Manual         Failure         LOG_GAS          The CO value is 3 ppm
time: 683 sec 302 msec   Manual         Failure         LOG_COMMAND      Command received: O
time: 684 sec 58 msec    Manual         Failure         LOG_THRESHOLD    THRESHOLD CHECKED
time: 684 sec 58 msec    Manual         Failure         LOG_GAS          The CO value is 3 ppm
time: 685 sec 59 msec    Manual         Failure         LOG_THRESHOLD    THRESHOLD CHECKED
time: 685 sec 59 msec    Manual         Failure         LOG_GAS          The CO value is 3 ppm
time: 685 sec 240 msec   Manual         Failure         LOG_COMMAND      Command received: P
time: 686 sec 60 msec    Manual         Failure         LOG_THRESHOLD    THRESHOLD CHECKED
time: 686 sec 60 msec    Manual         Failure         LOG_GAS          The CO value is 3 ppm
time: 687 sec 61 msec    Manual         Failure         LOG_THRESHOLD    THRESHOLD CHECKED
time: 687 sec 61 msec    Manual         Failure         LOG_GAS          The CO value is 3 ppm
time: 687 sec 828 msec   Manual         Failure         LOG_COMMAND      Command received: O
time: 688 sec 62 msec    Manual         Failure         LOG_THRESHOLD    THRESHOLD CHECKED
time: 688 sec 62 msec    Manual         Failure         LOG_GAS          The CO value is 3 ppm
time: 689 sec 63 msec    Manual         Failure         LOG_THRESHOLD    THRESHOLD CHECKED
time: 689 sec 63 msec    Manual         Failure         LOG_GAS          The CO value is 8 ppm
time: 689 sec 786 msec   Manual         Failure         LOG_COMMAND      Command received: A
time: 689 sec 786 msec   Manual         Failure         LOG_END.
root@arm:/#
```

2) Temperature and Humidity Sensor (Si7021) is connected and the Gas sensor is disconnected:

```
File Edit View Search Terminal Help
make[1]: Nothing to be done for 'build'.
make[1]: Leaving directory '/'
./control_node.elf log.txt
uart4 found

                         LOG_DATA='A'
                         GET_TEMPERATURE='B'
                         GET_HUMIDITY='C'
                         GET_GAS='D'
                         GET_THRESHOLD='E'
                         GET_FAN='F'
                         CHANGE_MODE='G'
                         CHANGE_TEMPERATURE_THRESHOLD='H'
                         CHANGE_HUMIDITY_THRESHOLD='I'
                         CHANGE_GAS_THRESHOLD='J'
                         BUZZER_ON='K'
                         BUZZER_OFF='L'
                         FORCE_CHANGE_FANS='M'
                         GET_BUZZER='N'
                         GET_FAILURE='O'
                         GET_MODE='P'
                         EXIT CONTROL NODE='X'
                         DISPLAY_COMMNANDS='?'
Timer Init
Enter next command:
B
Temperature: 24C° 75F° 297K°
Enter next command:
C
Humidity: 44%
Enter next command:
D
CO value: 3ppm
Enter next command:
Logs Received
Buzzer is off
Failure mode: Degraded
Remote mode: Automatic
Invalid Input
Logs Received
Buzzer is off
Failure mode: Degraded
Remote mode: Automatic
Invalid Input
Logs Received
Buzzer is off
Failure mode: Degraded
Remote mode: Automatic
Invalid Input
```

3) Mode Switched to Manual:


```
                         LOG_DATA='A'
                         GET_TEMPERATURE='B'
                         GET_HUMIDITY='C'
                         GET_GAS='D'
                         GET_THRESHOLD='E'
                         GET_FAN='F'
                         CHANGE_MODE='G'
                         CHANGE_TEMPERATURE_THRESHOLD='H'
                         CHANGE_HUMIDITY_THRESHOLD='I'
                         CHANGE_GAS_THRESHOLD='J'
                         BUZZER_ON='K'
                         BUZZER_OFF='L'
                         FORCE_CHANGE_FANS='M'
                         GET_BUZZER='N'
                         GET_FAILURE='O'
                         GET_MODE='P'
                         EXIT CONTROL NODE='X'
                         DISPLAY_COMMNANDS='?'
Timer Init
Enter next command:
K
Enter next command:
P
Remote mode: Manual
Enter next command:
Logs Received
Buzzer is off
Failure mode: Degraded
Remote mode: Manual
Invalid Input
O
Failure mode: Degraded
Enter next command:
Logs Received
Buzzer is off
Failure mode: Degraded
Remote mode: Manual
Invalid Input

5 fans are on
Enter next command:
N
Buzzer is off
Enter next command:
Logs Received
Buzzer is off
Failure mode: Degraded
Remote mode: Manual
Invalid Input
```

4) Degraded Manual mode log file:


```
root@arm: /

File  Edit  View  Search  Terminal  Help
time: 349 sec 827 msec  Manual          Degraded          LOG_COMMAND      Command received: A
time: 350 sec 13 msec   Manual          Degraded          LOG_THRESHOLD    THRESHOLD CHECKED
time: 350 sec 13 msec   Manual          Degraded          LOG_GAS          The CO value is 3 ppm
time: 350 sec 13 msec   Manual          Degraded          LOG_END.
time: 350 sec 120 msec  Manual          Degraded          LOG_COMMAND      Command received: O
time: 350 sec 122 msec  Manual          Degraded          LOG_COMMAND      Command received: P
time: 350 sec 124 msec  Manual          Degraded          LOG_COMMAND      Command received: N
time: 350 sec 768 msec  Manual          Degraded          LOG_TEMPERATURE  Temperature: 24C, 75F, 297K
time: 350 sec 786 msec  Manual          Degraded          LOG_HUMIDITY     Humidity: 22
time: 351 sec 13 msec   Manual          Degraded          LOG_THRESHOLD    THRESHOLD CHECKED
time: 351 sec 13 msec   Manual          Degraded          LOG_GAS          The CO value is 3 ppm
time: 351 sec 794 msec  Manual          Degraded          LOG_TEMPERATURE  Temperature: -6C, 22F, 267K
time: 351 sec 812 msec  Manual          Degraded          LOG_HUMIDITY     Humidity: 22
time: 352 sec 13 msec   Manual          Degraded          LOG_THRESHOLD    THRESHOLD CHECKED
time: 352 sec 13 msec   Manual          Degraded          LOG_GAS          The CO value is 3 ppm
time: 352 sec 820 msec  Manual          Degraded          LOG_TEMPERATURE  Temperature: 24C, 75F, 297K
time: 352 sec 838 msec  Manual          Degraded          LOG_HUMIDITY     Humidity: 22
time: 353 sec 13 msec   Manual          Degraded          LOG_THRESHOLD    THRESHOLD CHECKED
time: 353 sec 13 msec   Manual          Degraded          LOG_GAS          The CO value is 3 ppm
time: 353 sec 846 msec  Manual          Degraded          LOG_TEMPERATURE  Temperature: -6C, 22F, 267K
time: 353 sec 864 msec  Manual          Degraded          LOG_HUMIDITY     Humidity: 22
time: 354 sec 13 msec   Manual          Degraded          LOG_THRESHOLD    THRESHOLD CHECKED
time: 354 sec 13 msec   Manual          Degraded          LOG_GAS          The CO value is 3 ppm
time: 354 sec 872 msec  Manual          Degraded          LOG_TEMPERATURE  Temperature: 24C, 75F, 297K
time: 354 sec 890 msec  Manual          Degraded          LOG_HUMIDITY     Humidity: 22
time: 355 sec 13 msec   Manual          Degraded          LOG_THRESHOLD    THRESHOLD CHECKED
time: 355 sec 13 msec   Manual          Degraded          LOG_GAS          The CO value is 3 ppm
time: 355 sec 898 msec  Manual          Degraded          LOG_TEMPERATURE  Temperature: 24C, 75F, 297K
time: 355 sec 916 msec  Manual          Degraded          LOG_HUMIDITY     Humidity: 22
time: 356 sec 13 msec   Manual          Degraded          LOG_THRESHOLD    THRESHOLD CHECKED
time: 356 sec 13 msec   Manual          Degraded          LOG_GAS          The CO value is 3 ppm
time: 356 sec 924 msec  Manual          Degraded          LOG_TEMPERATURE  Temperature: 24C, 75F, 297K
time: 356 sec 942 msec  Manual          Degraded          LOG_HUMIDITY     Humidity: 22
time: 357 sec 13 msec   Manual          Degraded          LOG_THRESHOLD    THRESHOLD CHECKED
time: 357 sec 13 msec   Manual          Degraded          LOG_GAS          The CO value is 3 ppm
time: 357 sec 950 msec  Manual          Degraded          LOG_TEMPERATURE  Temperature: 24C, 75F, 297K
time: 357 sec 950 msec  Manual          Degraded          LOG_HUMIDITY     Humidity: 44
time: 358 sec 13 msec   Manual          Degraded          LOG_THRESHOLD    THRESHOLD CHECKED
time: 358 sec 13 msec   Manual          Degraded          LOG_GAS          The CO value is 3 ppm
time: 358 sec 958 msec  Manual          Degraded          LOG_TEMPERATURE  Temperature: 24C, 75F, 297K
time: 358 sec 976 msec  Manual          Degraded          LOG_HUMIDITY     Humidity: 44
time: 359 sec 13 msec   Manual          Degraded          LOG_THRESHOLD    THRESHOLD CHECKED
time: 359 sec 13 msec   Manual          Degraded          LOG_GAS          The CO value is 3 ppm
time: 359 sec 828 msec  Manual          Degraded          LOG_COMMAND      Command received: A
time: 359 sec 986 msec  Manual          Degraded          LOG_TEMPERATURE  Temperature: 24C, 75F, 297K
time: 360 sec 4 msec    Manual          Degraded          LOG_HUMIDITY     Humidity: 22
time: 360 sec 14 msec   Manual          Degraded          LOG_THRESHOLD    THRESHOLD CHECKED
time: 360 sec 14 msec   Manual          Degraded          LOG_GAS          The CO value is 3 ppm
time: 360 sec 14 msec   Manual          Degraded          LOG_END.
root@arm:/#
```

5) Automatic Degraded Mode Logfile:

```
                                                                              root@arm: /
 File  Edit  View  Search  Terminal  Help
time: 234 sec 378 msec   Automatic      Degraded              LOG_HUMIDITY     Humidity: 22
time: 235 sec 6 msec     Automatic      Degraded              LOG_THRESHOLD    THRESHOLD CHECKED
time: 235 sec 6 msec     Automatic      Degraded              LOG_GAS          The CO value is 3 ppm
time: 235 sec 386 msec   Automatic      Degraded              LOG_TEMPERATURE Temperature: 24C, 75F, 297K
time: 235 sec 404 msec   Automatic      Degraded              LOG_HUMIDITY     Humidity: 22
time: 236 sec 6 msec     Automatic      Degraded              LOG_THRESHOLD    THRESHOLD CHECKED
time: 236 sec 6 msec     Automatic      Degraded              LOG_GAS          The CO value is 3 ppm
time: 236 sec 279 msec   Automatic      Degraded              LOG_COMMAND      Command received: A
time: 236 sec 414 msec   Automatic      Degraded              LOG_TEMPERATURE Temperature: 24C, 75F, 297K
time: 236 sec 432 msec   Automatic      Degraded              LOG_HUMIDITY     Humidity: 22
time: 236 sec 432 msec   Automatic      Degraded              LOG_END.
time: 236 sec 583 msec   Automatic      Degraded              LOG_COMMAND      Command received: O
time: 236 sec 585 msec   Automatic      Degraded              LOG_COMMAND      Command received: P
time: 236 sec 586 msec   Automatic      Degraded              LOG_COMMAND      Command received: N
time: 237 sec 6 msec     Automatic      Degraded              LOG_THRESHOLD    THRESHOLD CHECKED
time: 237 sec 6 msec     Automatic      Degraded              LOG_GAS          The CO value is 3 ppm
time: 237 sec 432 msec   Automatic      Degraded              LOG_TEMPERATURE Temperature: -6C, 22F, 267K
time: 237 sec 434 msec   Automatic      Degraded              LOG_HUMIDITY     Humidity: 22
time: 238 sec 6 msec     Automatic      Degraded              LOG_THRESHOLD    THRESHOLD CHECKED
time: 238 sec 6 msec     Automatic      Degraded              LOG_GAS          The CO value is 3 ppm
time: 238 sec 442 msec   Automatic      Degraded              LOG_TEMPERATURE Temperature: -6C, 22F, 267K
time: 238 sec 460 msec   Automatic      Degraded              LOG_HUMIDITY     Humidity: 22
time: 239 sec 6 msec     Automatic      Degraded              LOG_THRESHOLD    THRESHOLD CHECKED
time: 239 sec 6 msec     Automatic      Degraded              LOG_GAS          The CO value is 3 ppm
time: 239 sec 468 msec   Automatic      Degraded              LOG_TEMPERATURE Temperature: 24C, 75F, 297K
time: 239 sec 486 msec   Automatic      Degraded              LOG_HUMIDITY     Humidity: 22
time: 240 sec 6 msec     Automatic      Degraded              LOG_THRESHOLD    THRESHOLD CHECKED
time: 240 sec 6 msec     Automatic      Degraded              LOG_GAS          The CO value is 3 ppm
time: 240 sec 486 msec   Automatic      Degraded              LOG_TEMPERATURE Temperature: -6C, 22F, 267K
time: 240 sec 488 msec   Automatic      Degraded              LOG_HUMIDITY     Humidity: 22
time: 241 sec 6 msec     Automatic      Degraded              LOG_THRESHOLD    THRESHOLD CHECKED
time: 241 sec 6 msec     Automatic      Degraded              LOG_GAS          The CO value is 3 ppm
time: 241 sec 496 msec   Automatic      Degraded              LOG_TEMPERATURE Temperature: 24C, 75F, 297K
time: 241 sec 514 msec   Automatic      Degraded              LOG_HUMIDITY     Humidity: 22
time: 242 sec 6 msec     Automatic      Degraded              LOG_THRESHOLD    THRESHOLD CHECKED
time: 242 sec 6 msec     Automatic      Degraded              LOG_GAS          The CO value is 3 ppm
time: 242 sec 522 msec   Automatic      Degraded              LOG_TEMPERATURE Temperature: -6C, 22F, 267K
time: 242 sec 540 msec   Automatic      Degraded              LOG_HUMIDITY     Humidity: 22
time: 243 sec 6 msec     Automatic      Degraded              LOG_THRESHOLD    THRESHOLD CHECKED
time: 243 sec 6 msec     Automatic      Degraded              LOG_GAS          The CO value is 3 ppm
time: 243 sec 548 msec   Automatic      Degraded              LOG_TEMPERATURE Temperature: -6C, 22F, 267K
time: 243 sec 566 msec   Automatic      Degraded              LOG_HUMIDITY     Humidity: 22
time: 244 sec 6 msec     Automatic      Degraded              LOG_THRESHOLD    THRESHOLD CHECKED
time: 244 sec 6 msec     Automatic      Degraded              LOG_GAS          The CO value is 3 ppm
time: 244 sec 574 msec   Automatic      Degraded              LOG_TEMPERATURE Temperature: 24C, 75F, 297K
time: 244 sec 592 msec   Automatic      Degraded              LOG_HUMIDITY     Humidity: 22
time: 245 sec 6 msec     Automatic      Degraded              LOG_THRESHOLD    THRESHOLD CHECKED
time: 245 sec 6 msec     Automatic      Degraded              LOG_GAS          The CO value is 3 ppm
time: 245 sec 600 msec   Automatic      Degraded              LOG_TEMPERATURE Temperature: 24C, 75F, 297K
time: 245 sec 618 msec   Automatic      Degraded              LOG_HUMIDITY     Humidity: 22
```

6) **Manual Normal Mode log file:**

7) Normal mode GUI BBG side:

```
root@arm: /

File  Edit  View  Search  Terminal  Help
                        GET_FAN='F'
                        CHANGE_MODE='G'
                        CHANGE_TEMPERATURE_THRESHOLD='H'
                        CHANGE_HUMIDITY_THRESHOLD='I'
                        CHANGE_GAS_THRESHOLD='J'
                        BUZZER_ON='K'
                        BUZZER_OFF='L'
                        FORCE_CHANGE_FANS='M'
                        GET_BUZZER='N'
                        GET_FAILURE='O'
                        GET_MODE='P'
                        EXIT CONTROL NODE='X'
                        DISPLAY_COMMNANDS='?'
Timer Init
Enter next command:
P
Remote mode: Manual
Enter next command:
O
Failure mode: Normal
Enter next command:
O
Failure mode: Normal
Enter next command:
Logs Received
Buzzer is on
Failure mode: Normal
Remote mode: Manual
Invalid Input
O
Failure mode: Normal
Enter next command:
A
Enter next command:
Logs Received
D
CO value: 60ppm
Enter next command:
Logs Received
Buzzer is off
Failure mode: (null)
Remote mode: Manual
Invalid Input
C
Humidity: 43%
Enter next command:
B
Temperature: 23C° 73F° 296K°
Enter next command:
```

Key Learnings:

The communication between two platforms Linux and Free Rtos

1) TIVA Board:

- ➢ Use of Free RTOS tasks and the configuration of the sensors (I2C and ADC)
- ➢ Proper use of semaphore to ensure synchronization for the UART communication
- ➢ Message Queue IPC send and receive functionality: Check if the queue is full or not using a variable to keep track
- ➢ Designing a robust GUI for communication between the two boards
- ➢ Addition of Manual, Automatic, Normal , Degraded and failure modes and the switching between them
- ➢ Configuration of the UART and UARTPrintf on the terminal and the send and receive to establish communication with the control node.
- ➢ The code runs into fault ISR when there is a segmentation fault
- ➢ An error function has to be added for error handling in the code which helps in analyzing that a run time error has occurred or not
- ➢ The sys clock has to be enabled with proper value and the baud rates should match (for the nodes)

2) BBG:

- ➢ Adding a Debian image on the sd card for UART communication
- ➢ Proper use of semaphore to ensure synchronization for the UART communication
- ➢ Designing a robust GUI for communication between the two boards
- ➢ Addition of Manual, Automatic, Normal , Degraded and failure modes and the switching between them
- ➢ Creating logfiles on the BBG and making a backup of the logfiles
- ➢ UART configuration (using termios.h) structure and handling error cases like:
  The log queue is full, Data lost, Log Type not found

- ➢ When a character gets stuck in a fd_uart file and the TIVA constantly reads that – the error condition – Log queue is full and the Data is lost might occur which is because a garbage character has been written in the file which is being read by the TIVA board – The solution to this issue is that the BBG needs to be reset
- ➢ The BBG and TIVA board have to be connected to a common ground potential in order to minimize the synchronization issues and prevent flipping of bits of data sent from BBG to TIVA board