Design Study 1 - Unsafe Temperature Detection

Introduction

Purpose and Requirements

The first design study checks if the device can detect unsafe temperatures coming from the kitchen appliances. From preliminary testing with the BME280 sensor, a typical stove and oven temperature was found to be 80℉. It was also found that the optimal location for detecting these temperatures was above the kitchen appliance. The device should also be able to alert the user of an unsafe temperature so that they are aware of a potential accident in the kitchen. Therefore, our device will be successful at detecting unsafe temperatures if its BME280 is at the proper distances and if the code is implemented to detect dangerous temperatures. Alerting the user of the appliance temperature is also required for success. The device should not detect the temperature of any object, or person, but rather the air around the stove or oven.

Testing Variables

The independent variables for testing the temperature detection requirement include the temperature of the appliance and other activities taking place in the kitchen, such as a person walking around.

The dependent variable is whether or not the user was successfully alerted of unsafe temperatures (and if the user is aware of the current temperature).

Hypothesis

This device will be able to successfully alert the user of an unsafe kitchen environment pertaining to the appliances and thus prevent fires started by the stove or oven being left on for an extended period of time. However, the device will alert the user according to data collected from preliminary testing, so the device may over or under detect an unsafe temperature for some appliances.

Methodology

Materials

- Final device
- Appliances (small voltage appliances were used)
    - Computer
    - Lamp

    - Toaster 1
    - Toaster 2
    - Rice Cooker
- A timer

Figure 24: Setup of the Arduino device with a computer and rice cooker

Testing Instructions

1. Set up Kitchen Kare Heat properly next to the appliance (per device instructions).
2. Plug it into the “Not Normally On” sections of the wall plug.
3. Connect the Arduino to the computer and run the respective code.
4. For each appliance:
    a. Run the code and step more than 4 feet away and observe then record.
    b. Run the code but put your hand over the temperature sensor (BME280) to simulate heat and observe then record. Make sure this is reflected on the digital screen (OLED).
5. Run the same procedure with Kitchen Kare Wall Plug and Kitchen Kare Motion.

Results

Correct Output

Condition	Computer	Lamp	Toaster 1	Toaster 2	Rice Cooker
Below 80℉	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off
Above 80℉	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On

Table 7: The table represents the data expected if the device meets the requirement.

Kitchen Kare Heat (consists of BME280)

Condition	Computer	Lamp	Toaster 1	Toaster 2	Rice Cooker
Below 80℉	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off

Above 80℉	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On

Table 8: The table displays the results from testing Kitchen Kare Heat, which has the correct output.

Kitchen Kare Wall Plug (consists of BME280, + Wall Plug)

Condition	Computer	Lamp	Toaster 1	Toaster 2	Rice Cooker
Below 80℉	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off
Above 80℉	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On

Table 9: The table displays the results from testing Kitchen Kare Wall Plug, which has the correct output.

Kitchen Kare Motion (consists of BME280, Sparkfun, + Wall Plug)

Condition	Computer	Lamp	Toaster 1	Toaster 2	Rice Cooker
Below 80℉	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off
Above 80℉	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On

Table 10: The table displays the results from testing Kitchen Kare Motion, which has the correct output.

Analysis

This testing concluded that all three models are able to successfully **identify** whenever there is a **danger** in the kitchen **without people present**. Danger does not include when the temperature of the air near the appliance is lower than or 80℉. Danger does include when this temperature is 80℉ or higher, however, and thus the light and buzzer are activated in this scenario.

Conclusion

All the three Kitchen Kare models pass this design study and are thus capable of sensing and reacting to different temperatures across appliances. Furthermore, they are capable of carrying this logic into executing actions such as activating the light and buzzer, as a proof of concept the devices have properly integrated their components.

Design Study 2 - Detects Human Presence

Introduction

Purpose and Requirements

The second design study checks if the device can detect the presence of a human near the appliances and ensures that the alert does not go off if there is a person nearby. From the preliminary design testing with the infrared sensor, it was found that the infrared sensor can detect people up to 6 meters away. Therefore, the device shall be able to detect if there is a human at most 6 meters from the stove or oven. If there is a person nearby and the temperature is unsafe, then the alert shall not be sent to the user. The device should not mistake an object, child, pet, or other for the user. A control will be a temperature more than 80℉.

Testing Variables

The independent variables for testing the motion detection requirement include whether or not a person is walking around the appliances and other activities taking place in the kitchen, such as the motion of objects, children, or pets.

The dependent variable is whether or not the user was not alerted of unsafe temperatures when the user is present in the kitchen.

Hypothesis

The device will not alert the user if the appliance has reached unsafe temperatures and the user is nearby, thus preventing fires or injuries caused by the appliance being left on for an extended period of time without attention. However, the device may recognize people or animals who are not attending to the appliance but are still in the kitchen.

Methodology

Materials

- Final device and Timer
- Appliances (small voltage appliances were used)
    - Computer
    - Lamp
    - Toaster 1
    - Toaster 2
    - Rice Cooker

Testing Instructions

Figure 25: Arduino setup with toaster

1. Set up Kitchen Kare Heat properly next to the appliance (per device instructions).
2. Plug it into the “Not Normally On” sections of the wall plug.
3. Connect the Arduino to the computer and run the respective code.
4. For each appliance:
    a. Put your hand over the temperature sensor (BME280) to simulate heat, then:
        i. Stay 4+ feet away and observe.
        ii. Press and hold the button and observe.
        iii. Hold a hand over the infrared sensor and observe.
5. Run the same procedure with Kitchen Kare Wall Plug and Kitchen Kare Motion.

Results

Correct Output

Condition	Computer	Lamp	Toaster 1	Toaster 2	Rice Cooker
No Human	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On
Button	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off
Infrared Sensor	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off

Table 11: The table represents the data expected if the device meets the requirement.

Kitchen Kare Heat (consists of BME280)

Condition	Computer	Lamp	Toaster 1	Toaster 2	Rice Cooker
No Human	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On
Button	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On
Infrared Sensor	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On

Table 12: The table displays the results from Kitchen Kare Heat, which doesn’t have the correct output.

Kitchen Kare Wall Plug (consists of BME280, + Wall Plug)

Condition	Computer	Lamp	Toaster 1	Toaster 2	Rice Cooker
No Human	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On
Button	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off
Infrared Sensor	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off

Table 13: The table displays the results from testing Kitchen Kare Wall Plug, which has the correct output.

Kitchen Kare Motion (consists of BME280, Sparkfun, + Wall Plug)

Condition	Computer	Lamp	Toaster 1	Toaster 2	Rice Cooker
No Human	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On	Light/Buzzer Turn On
Button	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off
Infrared Sensor	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off	Light/Buzzer Stay Off

Table 14: The table displays the results from testing Kitchen Kare Motion, which has the correct output.

Analysis

This testing concluded that only the **last two** models are able to successfully **identify** whenever there is a **person present** in the kitchen. This includes both of the following events: if the button is pressed or if the infrared sensor is obstructed by a human body from less than a few feet away. Whenever the human is not sensed in this position when the temperature exceeds the established 80℉, the light and buzzer will send a visual and auditory alarm.

Conclusion

The Kitchen Kare Wall Plug and Kitchen Kare Motion pass this design study and are thus capable of sensing and reacting to the presence or absence of people across appliances. Furthermore, they are capable of carrying this logic into executing actions such as activating the light and buzzer, as a proof of concept the devices have properly integrated their components.

Design Study 3 - Turns Oven Off/On

Introduction

Purpose and Requirements

The third design study will determine whether our device can successfully cut the power supply to kitchen appliances when it detects an unsafe temperature and the user is not present or does not respond via button. This study will specifically test the success of the BME280 sensor and the wall plug. Once the BME280 detects an unsafe temperature near the appliances, it should send a signal to the wall plug to cut the power to the utility. This should cause the heat to stop increasing and hopefully prevent any fire-related injuries or destruction.

Testing Variables

The independent variable for this design study is the temperature that the area near the stove/oven is currently at and whether that temperature is considered dangerous by our device.

The dependent variable is whether or not the wall plug successfully cuts the power to the oven once the temperature is considered unsafe by the BME280 and there is no user presence. The wall plug should not stop the power if the environment is considered safe.

Hypothesis

The device will be able to send a signal from the BME280 to the wall plug successfully and the wall plug shall cut the power to the oven once that signal is received, thus preventing stove or oven accidents from the stove or oven being left on for an extended period of time.

Methodology

Materials

- Final device
- Appliances (small voltage appliances were used)
    - Computer
    - Lamp
    - Toaster 1
    - Toaster 2

Figure 26: Arduino setup with a

    - Rice Cooker
- A timer

Testing Instructions

1. Set up Kitchen Kare Heat properly next to the appliance (per device instructions).
2. Plug it into the “Not Normally On” sections of the wall plug.
3. Connect the Arduino to the computer and run the respective code.
4. For each appliance:
    a. Don’t put your hand over the temperature sensor (BME280) to simulate heat, then place your hand and repeat:
        i. Stay 4+ feet away and observe.
        ii. Press and hold the button and observe.
        iii. Hold a hand over the infrared sensor and observe.
5. Run the same procedure with Kitchen Kare Wall Plug and Kitchen Kare Motion.

Results

Correct Output

Below 80℉	Computer	Lamp	Toaster 1	Toaster 2	Rice Cooker
Step Away	Stays On	Stays On	Stays On	Stays On	Stays On
Hand Present	Stays On	Stays On	Stays On	Stays On	Stays On
Button	Stays On	Stays On	Stays On	Stays On	Stays On

Above 80℉	Computer	Lamp	Toaster 1	Toaster 2	Rice Cooker
Step Away	Turns Off	Turns Off	Turns Off	Turns Off	Turns Off
Hand Present	Stays On	Stays On	Stays On	Stays On	Stays On
Button	Stays On	Stays On	Stays On	Stays On	Stays On

Table 15: The tables represent the data expected if the device meets the requirement.

Kitchen Kare Heat (consists of BME280)

Below 80℉	Computer	Lamp	Toaster 1	Toaster 2	Rice Cooker
Step Away	Stays On	Stays On	Stays On	Stays On	Stays On

Hand Present	Stays On	Stays On	Stays On	Stays On	Stays On
Button	Stays On	Stays On	Stays On	Stays On	Stays On

Above 80℉	Computer	Lamp	Toaster 1	Toaster 2	Rice Cooker
Step Away	Stays On	Stays On	Stays On	Stays On	Stays On
Hand Present	Stays On	Stays On	Stays On	Stays On	Stays On
Button	Stays On	Stays On	Stays On	Stays On	Stays On

Table 16: The tables display the results from Kitchen Kare Heat, which doesn't have the correct output.

Kitchen Kare Wall Plug (consists of BME280, + Wall Plug)

Below 80℉	Computer	Lamp	Toaster 1	Toaster 2	Rice Cooker
Step Away	Stays On	Stays On	Stays On	Stays On	Stays On
Hand Present	Stays On	Stays On	Stays On	Stays On	Stays On
Button	Stays On	Stays On	Stays On	Stays On	Stays On

Above 80℉	Computer	Lamp	Toaster 1	Toaster 2	Rice Cooker
Step Away	Turns Off	Turns Off	Turns Off	Turns Off	Turns Off
Hand Present	Turns Off	Turns Off	Turns Off	Turns Off	Turns Off
Button	Turns Off	Turns Off	Turns Off	Turns Off	Turns Off

Table 17: The tables display the results from Kitchen Kare Motion, which doesn't have the correct output.

Kitchen Kare Motion (consists of BME280, Sparkfun, + Wall Plug)

Below 80℉	Computer	Lamp	Toaster 1	Toaster 2	Rice Cooker
Step Away	Stays On	Stays On	Stays On	Stays On	Stays On
Hand Present	Stays On	Stays On	Stays On	Stays On	Stays On
Button	Stays On	Stays On	Stays On	Stays On	Stays On

Above 80℉	Computer	Lamp	Toaster 1	Toaster 2	Rice Cooker
Step Away	Turns Off	Turns Off	Turns Off	Turns Off	Turns Off
Hand Present	Stays On	Stays On	Stays On	Stays On	Stays On
Button	Stays On	Stays On	Stays On	Stays On	Stays On

Table 18: The tables display the results from testing Kitchen Kare Motion, which has the correct output.

Analysis

This testing concluded that the model that is able to successfully **identify** whenever there is a **person present** and the **temperature** in the kitchen and then use this to **turn off** the appliance is **Kitchen Kare Motion**. This includes both of the following events: if the button is pressed or if the infrared sensor is obstructed by a human body from less than a few feet away. This also includes the scenarios in which the temperature is under and above 80℉. Kitchen Kare Heat always powered the appliance, Kitchen Kare Wall Plug only powered it when the temperature was under 80℉ and never above, and Kitchen Kare Motion met the correct output.

Conclusion

The Kitchen Kare Motion model passes this design study and is thus capable of sensing and reacting to both different temperatures and the presence or absence of people across appliances. Furthermore, it is capable of carrying this logic into executing actions such as activating the light and buzzer as well as a wall plug to stop the problem at its root, as a proof of concept the device has properly integrated its components.