ESCAPE ROOM

Introduction

The Escape Room is themed as a bomb defusal situation, and the challenges were designed around this theme. Each of the challenges leads to the next, and must be completed before the player can attempt the next challenge.

There are four challenges: Devmode, Frequency, Odd or Even, and Countdown.

The Devmode challenge is inspired by hidden advanced access modes in modern electronic devices. On solving the Devmode challenge, the player has access to the Frequency module. The Frequency module can be used to download a Password. Once the Odd or Even module is disabled, the countdown goes into a state in which the player can stop the countdown by playing a multiple round memory game. A multiple round memory game which increases in difficulty with each round.

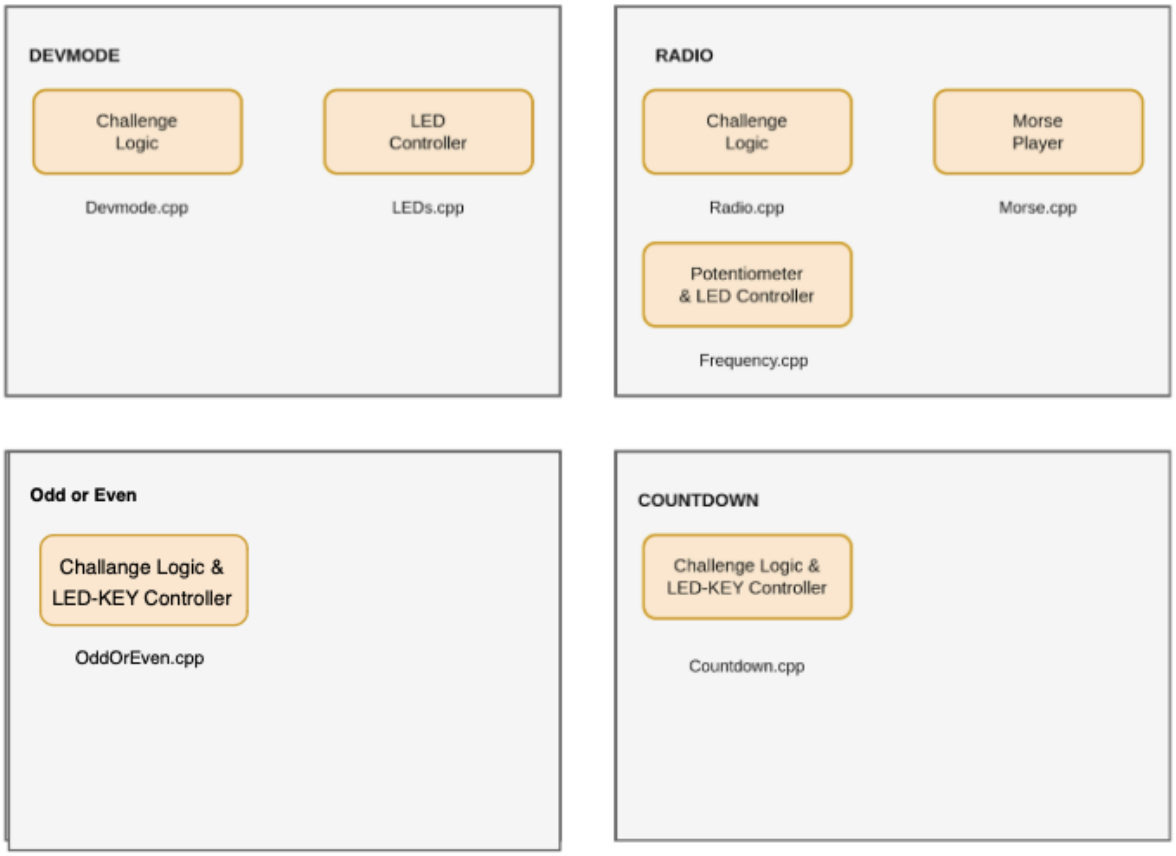
All the challenges have multiple rounds. The Devmode challenge implements increasing difficulty by setting a decreasing time limit in which each of the rounds must be solved. The Countdown challenge implements increasing difficulty by lengthening the sequence that needs to be memorised.

For exact details about how each of the challenges should be solved, please see the project description below.

Code Organisation

To allow parallel control over the peripherals, simple pseudo threads are used to run code. The threads are simple abstractions that use millis() to track time and run functions periodically.

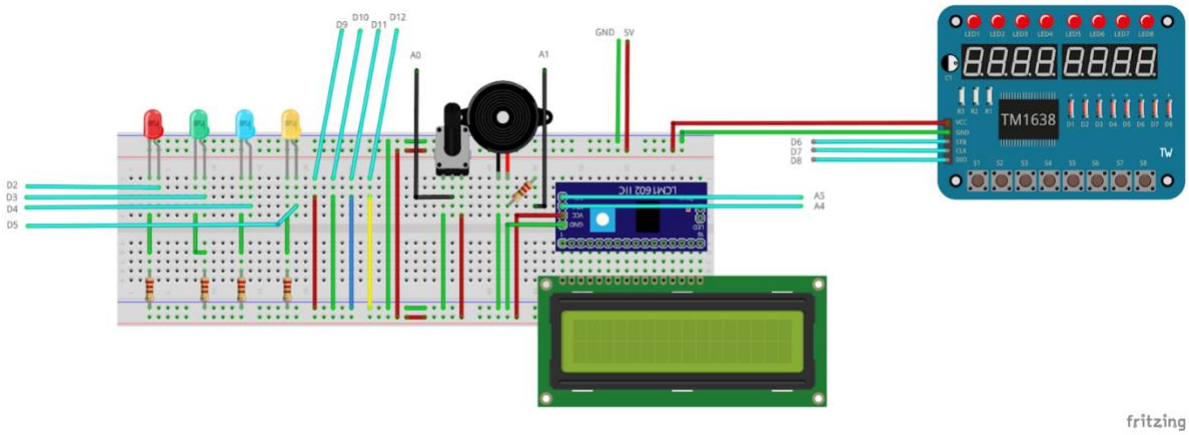
The Arduino Thread library was used for this: https://github.com/ivanseidel/ArduinoThread



A total of 8 Threads were used in this program. Their responsibilities, file of implementation, and the challenge they're affiliated to is described in the above diagram.

State machines and value persisting static variables were used to implement the complex logic for each of the challenges with much simpler code.

Hardware Description



The LEDs are used by Devmode challenges. The Potentiometer, and LCD are used by the Frequency challenge. Devmode challenge uses the 4 coloured wires connected to pins connected to D9, D10, D11, and D12 along with the LEDs. The LED&KEY module is used by the both the Odd or even and the Countdown challenge.

The pins to which each of the components are connected are labelled in the circuit diagram. The layout was designed to minimise the footprint and accommodate as many components as possible.

Libraries used:

- LCD Driver: https://github.com/johnrickman/LiquidCrystal_I2C
- LED&Key: https://github.com/gavinlyonsrepo/TM1638plus

Testing

Two mechanisms were implemented to aid testing.

1. Conditional serial prints

Functions with complex logic have Serial.print s enabling code inspection at run time. These print statements are guarded by #ifdefines so the logging may be enabled or disabled at a per file level at compile time.

2. Cheat codes

Cheat-codes that can be input from Serial were implemented. For example, sending ‘skip 2’ via Serial would mark the first and second challenges done and prepare the program for the third challenge.

Since all of the challenges are interconnected, this mechanism allowed testing any particular stage of the program without having to go through the preceding stages of the program.

The program was tested for any loopholes the player may use to cheat at the challenges. For example, the Frequency challenge’s frequency could be detected by sweeping the potentiometer from left to right. This was prevented by setting a minimum duration for which a frequency must be tuned for before the round is considered solved.

Erratic readings from the potentiometer were alleviated using weighted average for smoothing. A 100nF capacitor across the Ground and VCC pins of the Potentiometer might have been helpful too. To account for the erratic readings, a leeway of a few kilohertz was added to the frequency tuner in the Frequency challenge.

A leeway of a few hundred milliseconds was added to the Devmode challenge’s push button duration as humans can’t hold down buttons at millisecond precision.

Description of project

Scenario: You come across an active bomb in a building. There is not enough time to evacuate the area or for the bomb disposal squad to come over. The only way of escape is to defuse the bomb. Here is the manual you got from 911:

BOMB DEFUSAL MANUAL

Almost all bombs have a way to deactivate them. If your bomb has a timer, you need to stop the timer to deactivate the bomb. The bomb may present a series of challenges before it lets you stop the timer, however. This document will guide you through them.

Step 1: Activate Developer Mode

Like most devices today, bombs have a hidden Developer Mode. If you can activate the Developer Mode, you might be able to defuse the bomb. Look for four LEDs in the order RED, GREEN, BLUE, and YELLOW on the bomb, and take note of their state: ON, BLINK, OFF.

State \ LED	RED	GREEN	BLUE	YELLOW
ON	0	2	1	5
BLINK	1	1	1	2
OFF	1	0	2	3

Add the number corresponding to the state for all four LEDs, hold down the button on the bomb for those many seconds, and then let go.
For example, if RED: BLINK, GREEN: ON, BLUE: ON, YELLOW: OFF, hold the button for 1 + 2 + 1 + 3 = 7 seconds. If you hold the button for too long or too short, the bomb will explode. Be quick because the bomb will explode if you don’t do this fast enough.
Repeat till you see the Frequency module light up and display a frequency.

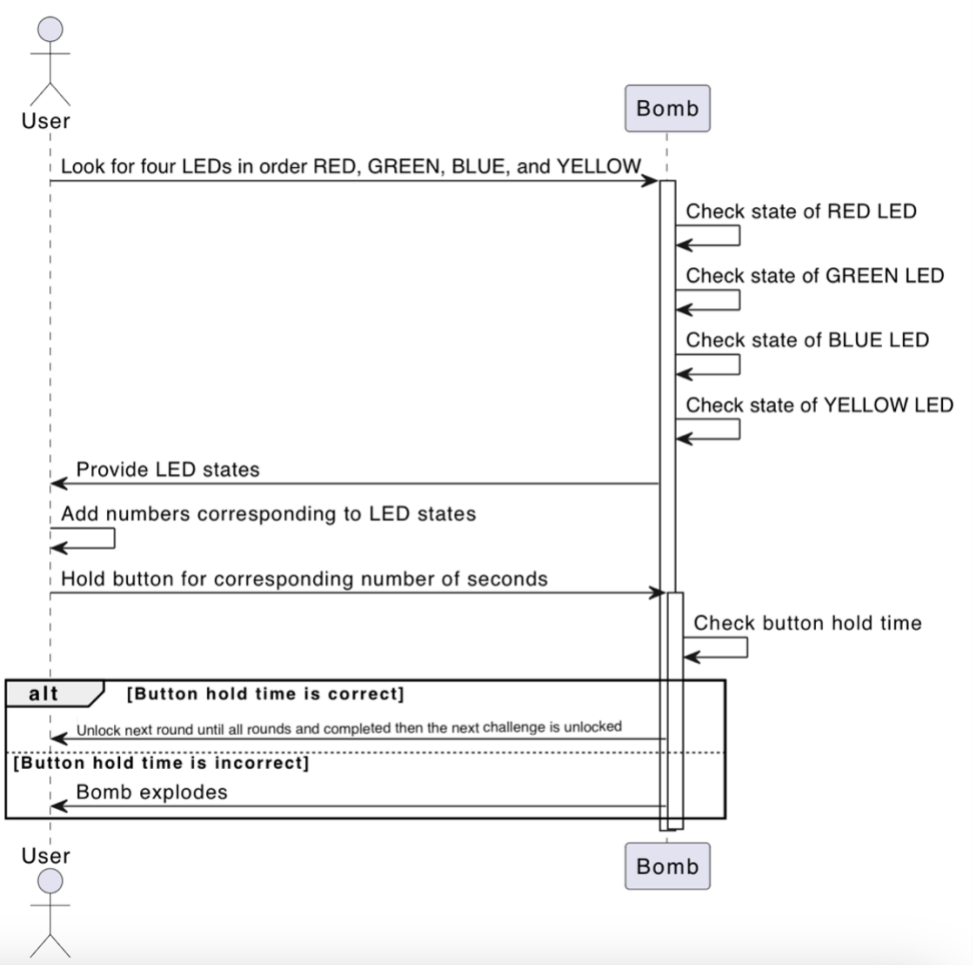


Figure 1: Sequence diagram for Challenge 1

Step 2: Download the Password

You can identify the Frequency Module on the bomb by looking for a dial and an accompanying LCD screen. You need to find the correct frequency (which is unknown) by moving the dial. This must be done several times, between 4 or 7 rounds to unlock the password. On the top part of the LCD display you can see the current round and the total rounds to complete. Also, you can see a measurement on how close you are to the correct frequency, the closer to zero, the closer you are to the frequency. If you get close enough to the target (less than 10), you will unlock the next round. After all frequencies are successfully found, an Alphanumeric code will be displayed on the screen. This is your Password.

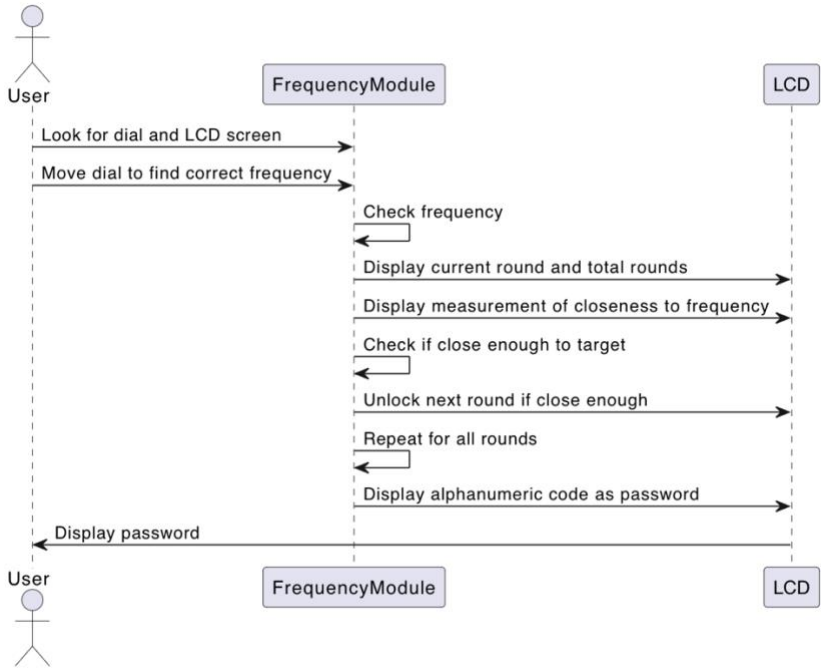


Figure 2: Sequence diagram for Challenge 2

Step 3: Odd or Even Challenge

Now, you encounter the Odd or Even Challenge. The bomb will present a sequence of randomly lit LEDs. The number of LEDs that light up will be either odd or even. Your task is to observe the sequence and press the button corresponding to the correct parity (odd or even).

- If the sequence contains an odd number of lit LEDs, press the button labeled "ODD" (Button 0).
- If the sequence contains an even number of lit LEDs, press the button labeled "EVEN" (Button 7).

Be careful to select the correct button, as an incorrect choice will result in the bomb exploding. Successfully completing this challenge will allow you to proceed to the next step in defusing the bomb.

Remember, you have a limited number of rounds to complete the challenge. The number of rounds will be randomly set between 3 and 7 at the beginning of the challenge. Pay close attention to the sequence and make the correct decision each time. If you successfully complete all the rounds, you will pass the challenge and move closer to defusing the bomb.

The clock is ticking, so stay focused and defuse the bomb before it's too late!

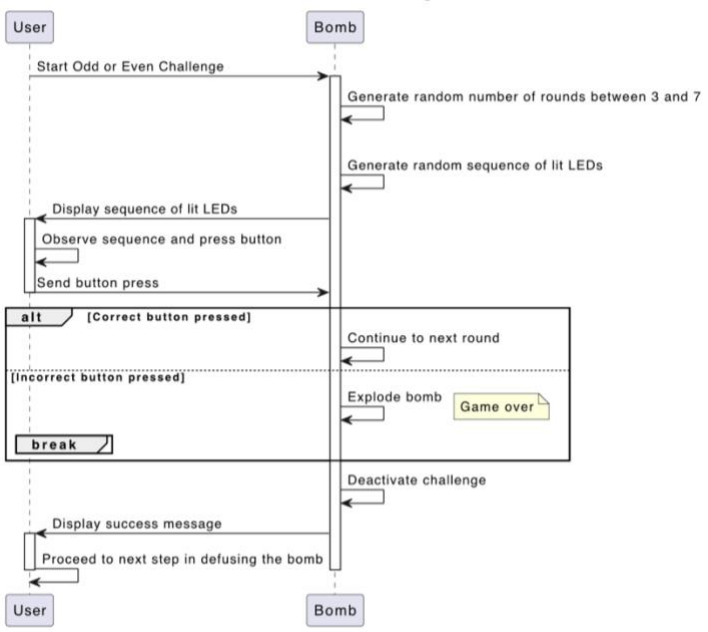


Figure 3: Sequence diagram for Challenge 3

Step 4: Stop the Countdown

The Countdown Timer typically has an LED display showing the countdown, a row of LEDs, and a row of Buttons.
After unlocking, wait for the LEDs to start blinking and note down the order. After the LEDs stop, press the buttons on the timer in the exact same order. If two or more LEDs light up simultaneously, do not enter that pattern and wait for the next pattern.
Repeat till the countdown stops.

Congratulations! You have successfully defused the bomb if you have stopped the Countdown. Add this skill to your Résumé and save this document for future use.

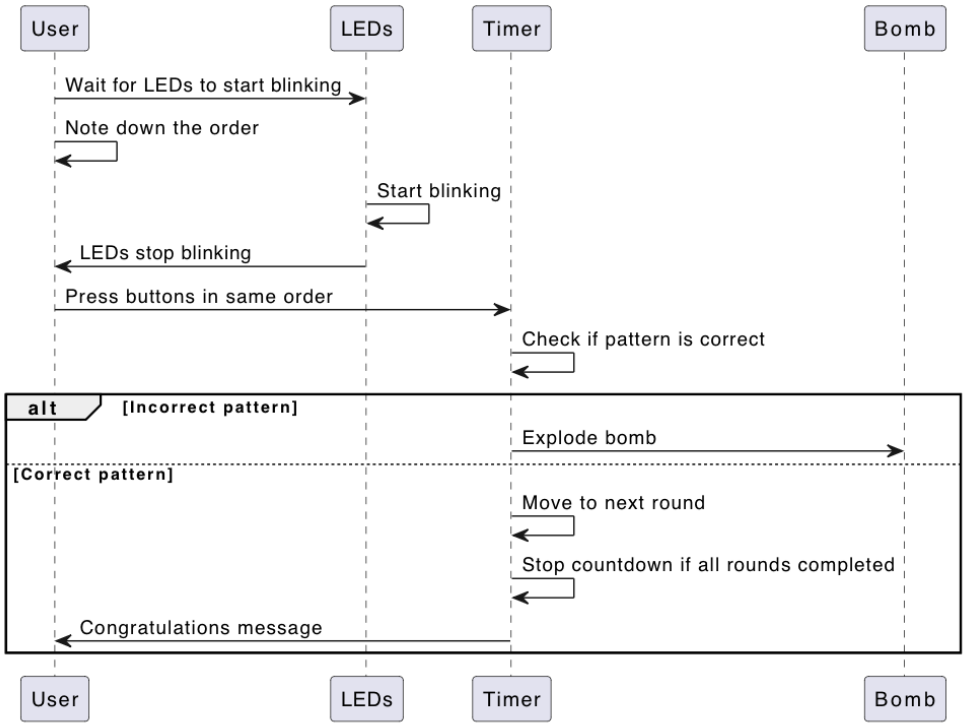


Figure 4: Sequence diagram for Challenge 4