4B25 Project Final Report - Human Fall Detector

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January 16, 2020

1 The problem solved

Falls are the second leading cause of accidental or unintentional injury deaths worldwide [3]. People may not be able to call for help after falling. So a device was developed to detect human fall and raise a warning after a fall is detected, which can be cleared by pressing the button, after which the device enters back into fall detecting mode.

2 Who cares if problem is solved

Older people have the highest risk of death or serious injury arising from a fall and the risk increases with age [3]. Anyone can have a fall, but older people are more vulnerable and likely to fall [4]. After falling, older people are more likely to lose conscience, so it is much harder for older people to call for help after falling. When people can't actively call for help, the importance of fall detector arises. Hence the older people care most if the problem is solved.

3 Current state of the art

Figure 1: Apple Watch fall alert[1]

Figure 2: Philips Lifeline[2]

There are several existing human fall detection devices available in the market, two of which are shown in Figure 1 and Figure 2, both of which have high consumer ratings according to Reference [2]. However, by the time of this report, the official price for Apple Watch Series 5 starts from £399 and even the Apple Watch Series 3 (released in 2017) still starts from £199, and the Philips Lifeline service starts from \$29.95 (around £23) per month and an activation fee of \$50 (around £38), which are quite expensive and not quite affordable for every family.

4 My approach to the problem

The detection flow chart is shown in Figure 3. Ideally, an independently running human fall detector should be able to have cellular and GPS connectivity, where cellular is used to send help message to a preset list of emergency contacts and GPS information can help locate who fell. However, under the timing and budget limit of this project, the connectivity part was implemented by the OLED, which was supplied in the toolkit, for indication of warning.

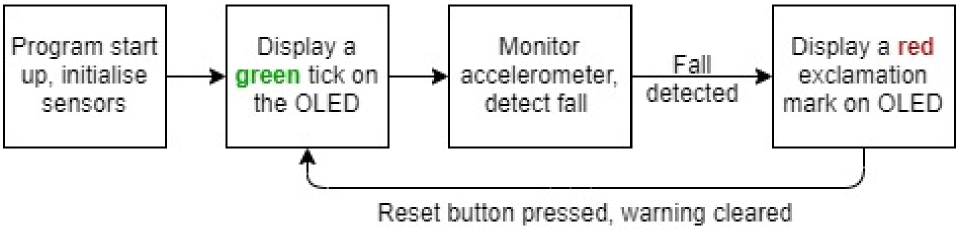

Figure 3: Human fall detector operation flow chart

5 Results

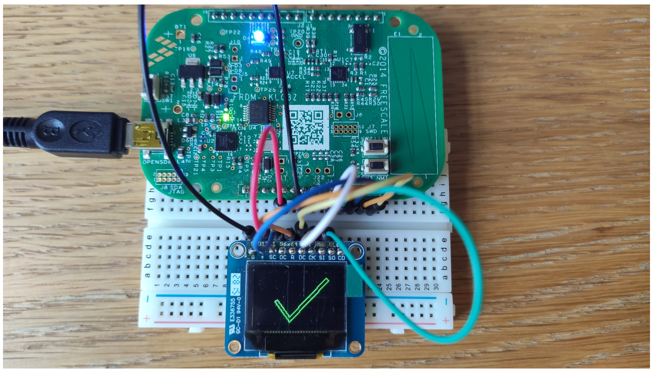

Figure 4: OLED displaying green tick

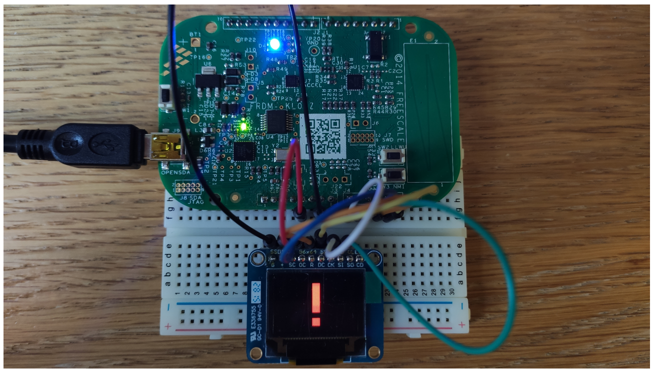

Figure 5: OLED displaying red exclamation mark

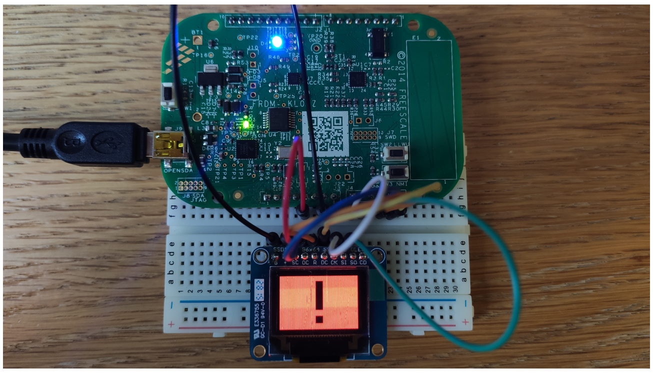

Figure 6: OLEDred-inverted

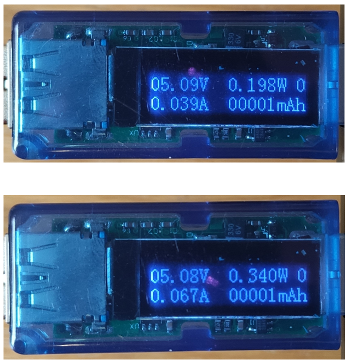

Figure 7: Power measurements

After the system powering up, the OLED displays a green tick (as shown in Figure 4) and enters the fall detection mode. When a fall is detected, to show the warning, the OLED displays a red exclamation mark and starts flickering, by switching between non-inverted and inverted exclamation marks (as shown in Figure 5 and Figure 6 respectively). To clear the warning, the user only needs to press the reset button, after which the OLED will display the green tick (as in Figure 4) and enter fall detection mode again.

The power consumption of the whole system was measured as shown in Figure 7. The top one in Figure 7 was the result measured when displaying the green tick (in Figure 4) and the red exclamation mark (in Figure 5), and the bottom one in Figure 7 was the result measured when displaying the inverted red exclamation mark (in Figure 6). Hence, for this implementation, the power consumption is 198mW in standby mode and toggles between 198mW and 340mW in warning mode, draining currents of 39mA and 67mA respectively. Given a battery having capacity of 1000mAh at 5V, this system can last an entire day at most (assuming always in detection mode), and 18 hours at least (assuming always in warning mode). So this system can achieve daytime monitoring, with recharging at night.

For real-world application of this device, the OLED can be replaced by a Wi-Fi module, a cheap one of which can be bought for as low as £5 with average current of as low as 80mA. The development board (KL03Z) with the accelerometer is priced at £17.5 and a Lithium polymer battery of 1000mAh can be bought for as low as £7.5 (e.g. `https://coolcomponents.co.uk/products/lithium-polymer-battery-1000mah`). Hence a total cost of £30 is achievable, which solves the budget problem. For commercialisation, large-scale manufacturing can further reduce the cost, by designing a development board that only needs the accelerometer and Wi-Fi module with the central processor, and large scale orders can reduce price of each component, making it a widely affordable fall detector.

References

[1] Use fall detection with Apple Watch, Apple Inc., `https://support.apple.com/en-us/HT208944` [Accessed 15 Jan. 2020].

[2] Best fall Detection Wearables in 2019, Wearable Technologies, `https://www.wearable-technologies.com/2019/07/the-5-best-fall-detection-wearables-in-2019/` [Accessed 15 Jan. 2020].

[3] Who.int. Falls. `https://www.who.int/news-room/fact-sheets/detail/falls` [Accessed 14 Nov. 2019].

[4] NHS. Falls. `https://www.nhs.uk/conditions/falls` [Accessed 14 Nov. 2019].