3.2 Performance

The general search of the Scanner's database was only limited by the speed of searching. According to the datasheet, the fingerprint scanner could take up to a second to search the database. This caused a significant delay in receiving a result. This would be difficult to resolve however without resorting to using another Scanner. All of the, time the Fingerprint scanner did exactly what the User expected. Achieving all goals set out in the Product Plan. A complete set up of the device can be viewed in Appendix B. Action 1 worked successfully. Th challenge however was to produce match-able files. There were 3 different files type, an image, a character file and a template. An error in the Datasheet [3] said that templates needed to be matched, however it was the case character files needed to be matched. This was resolved by trial and error, converting the files between different file types and matching files. An adjustment also allowed the program to continue if the fingerprints were not presented in the time. In which case the program simply went back to the option screen. Action 2 performed exactly the task expected. The only issue in this case being if the User did not press the keypad for a sufficient length of time, around 0.1s, it would not register the correct value. This could be improved by changing the delay values. More of a challenge would be to solve the multiple finger press, when more than 1 key is pressed simultaneously. This could be solved by not acknowledging the result it that case and asking for re-submission of a fingerprint. Actions 4, 5 and 6 were successfully set up as administrative options. They required the User already be registered as an administrator. Only Experimenter 1 and 2 were set as administrators however if a new person was registered, they could gain temporary administrative access. Action 4 could store a fingerprint if it was presented and wouldn't take one if it was not presented. The only issue here being that the memory location for the next fingerprint would be incremented, regardless of whether a fingerprint was taken or not. This could be resolved with modification [1]. The Challenger in getting this to work fully was tailoring the Command Package to vary so the memory location could be varied. How this was implemented can be seen in Appendix E, lines 456 to 487. This required two bytes to vary; the part of the package responsible for memory location and the Checksum. It also involved incrementing a value in SRAM to change the value for memory location. Action 5 was able to check how many Fingerprints were already stored in the memory. This was a useful feature which allowed the User to know if the database had been cleared recently of non-permanent identities. The device was capable of clearing memory locations. Although the user could enter more fingerprints not accessible by the Keyboard i.e. beyond location 15. This function allowed these also to be removed. The LCD was able to display every option the User could access, all of these can be viewed in Appendix C. There was also a possibility to return to the first option screen from the second, displayed on the second screen as 'return'.

3.2.1 Extensions

The project went beyond the plan set out by including extra capabilities. This included administrative setting where the device did not just recognize the specified user; it could add new fingerprints, remove old ones and check the memory usage. A final adaption was a function to check the memory manually.

3.3 Errors

Multiple factors could have contributed to the discrepancy between the stated failure rate and the observed failure rate. This included the position of the fingerprint over the sensor and distortion from dirt and grease on the surface of the scanner. These could warrant future investigation. A further unresolved issue could be the fact that the device uses a small area scanner that does not scan the whole fingerprint. This requires the same area of a finger to be presented every time. Previous investigation [5] has suggested that the area of the sensor is the most likely factor in misidentifying a correct finger. As this was a small area Scanner, its was likely affected by this.

3.3.1 Effect of Moisture and dust

The most productive investigation would likely be a check the effect of a dry and wet print to determine if there was a noticeable difference. Previous study [1] has indicated that it may be a significant detractor form the reliability of the Scanner.

4 Updates, Modifications and improvements

4.1 Updates

Additional functions that can be added to the Product could involve a third screen to get a few more options. One that would be relatively easy to implement would be toggling the alarm. This would be the equivalent of a feature that disabled the security. This would just require some coding that would only call the setup of Port B as an output port in certain situations. Another feature would be to add a pass-code override for the admin settings when a fingerprint is not recognized. This would be relatively easy to implement as the keypad is already set up and a simple routine could be called from the main screen which allows the admin settings to be accessed via a

[1] See 4.2 Modifications.

password. One possible area of improvement could be the time between the User selecting an action and an output being displayed in the screen. Some of this can't be completely avoided as it takes roughly one second, according to the datasheet, to carry out full search. Information on the screen whilst a search occurs could help the user to know how long they will be waiting for a result. This would be in the form of a load screen where a set of blocks would incrementally be displayed on the screen according to an estimate of progress.

4.2 Modifications

An issue with the current set up is that if the same finger is presented for storage, it will be stored in a new location. The result of which is several copies of the same fingerprint some situations. This uses up storage space for new fingerprints and lets someone have multiple ID's meaning they can't be uniquely identified by the device. A useful modification to the store function therefore would be a check to see if the print already existed in the database database before it was stored. A message could be displayed on the LCD to communicate the issue to the user.

4.3 Improvements

The main issue was the accuracy meaning that someone would either have to repeatedly present their fingerprint to reduce the chance of false rejection or they would have to only present certain fingers. A method could be that someone would have to take multiple prints for a verification. This would involve a loop that kept taking prints and comparing them. If a successful print was found it would exit the loop. A timer could be implemented to end the cycle once 5 seconds had elapsed without a successful attempt. This would reduce the chance of false rejection rate to 9% from 30% for the Fourth Finger, assuming 2 cycles could be implemented in the time. This is just a probabilistic estimate assuming the false positive rate is small enough to be ignored.

5 Conclusion

This project managed to complete the project to the point where the device could alert of a possible intruder via a buzzer as was set out. A slight variation was that we made it more of a user experience where they could interact with the device in several ways however it could also strictly be used as a security device.

References

[1] Lee S Son G Back S, Lee Y. Moisture-insensitive optical fingerprint scanner based on polarization resolved in-finger scattered light. *Optics Express*, 24(17), 2016.

[2] Biometrika. Basics of fingerprint recognition technology and biometric systems, 2017. Available from: http://www.biometrika.it/eng/wp_fingintro.html.

[3] Hangzhou Zhian Tec. Corp. Zhiantec zfm-206 series datasheet, 2011. http://wiki.seeed.cc/Grove-Fingerprint_Sensor/.

[4] Atmel Corporation. Atmega128 datasheet, 2011. Available from: http://www.atmel.com/images/doc2467.pdf.

[5] Maio D. Jain A. Prabhakar S. Maltoni, D. *Handbook of Fingerprint Recognition*. London: Springer London, 2 edition, 2009.

[6] Protostack. Hd44780 character lcd displays - part 1 - protostack, 2017. https://protostack.com.au/2010/03/character-lcd-displays-part-1/.