Engineering Capstone Project (OENG1167) PROJECTNAME

Oliver Patterson (S3723206),
Alec Harbis (S3661092),
Ahad Abdul (S3791936)

Supervisor:
Dr Katrina Neville

Date:
03/04/2022

RMIT School of
Engineering

Contents

1 Executive Summary

2 Introduction

3 Statement of problem

4 Background and literature review

4.1 General overview of wearable technology

4.2 Data Acquisition

4.2.1 Heart Rate

4.2.2 Temperature

4.2.3 Galvanic Skin Response

4.2.4 Sweat Rate

Sweat rate can be measured in multiple ways, counting drops using an amperometric system, impedence based measuring system[1], hydrogel, or microfluidic channel based system[2]. Some sweat sensors even analyse different componants in the sweat through conductivity and impedance measurements. One of the older methods of measuring sweat is described in [3] which uses two humidity sensors to measure the level of moisture generated by sweat. More modern patches use electrodes connected to microfluidic reservoirs to measure the speed and volume of sweat travelling through an area[1] [2] as these can be made smaller, more flexible, and significantly less intrusive.

4.3 Internal Data Transmission

Internal data transmission, we hereby define as the transmission of data between components of a system without the use of Over-The-Air (OTA) communication such as Bluetooth, WiFi, LoRa, etc. The main method of internal data transmission in traditional rigid electronics is through traditional printed PCBs. These materials are not very suitable for wearable electronics as they cannot endure large amounts of flexion without breaking. One novel technology which has been around for many years that attempts to solve this issue is Flexible Silicon Fibres (FSFs) [4]. These fibres present an alternative to the copper wires and traces of a traditional PCB and connect components together in a flexible, electronically functional way. One of the next major innovations in internal data transmission was the flexible PCB (FPCB) which could withstand high amounts of flexion, however as it is still a plastic foil, the FPCB can not undergo stretch which is required in many wearable applications. The next major innovation was the Stretchable PCB (SPCB). This, in one instance [5], involved embedding copper wires in an elastic flexible substrate in a two-dimensional spring such that stretch is possible in one axis without damaging the circuitry[6].

A good deal of sensors also use forms of one-wire communication such as the DHT11 temperature and humidity sensor[7] which uses a time-based coding of the signals in order to transfer data bi-directionally over one wire. Other projects also use signal multiplexing to send signals from a microcontroller to different LEDs [8].

One of the newer developments in data transmission through textiles is through the printing of conductive materials into the fabrics [9] This allows custom circuits to be attached to the clothing without adding any noticable thickness and can be used as a cosmetic addition to the clothing. Another approach to deposition of conductive materials onto a substrate such as textiles, silicon, glass, etc [10].

4.4 External Data Transmission

5 List of design/research questions

6 Methodology

6.1 Time Planning

6.2 Resource Planning

6.3 Design Method

6.4 Alternative Design

7 Risk assessment and ethical considerations

7.1 Risk Assessment

7.2 Ethical Considerations

8 References

[1] A. Steijlen, J. Bastemeijer, K. Jansen, P. French, and A. Bossche, "A novel sweat rate and conductivity sensor patch made with low-cost fabrication techniques," in *2020 IEEE SENSORS*, 2020, pp. 1–4. DOI: 10.1109/SENSORS47125.2020.9278850.

[2] M. A. Yokus, T. Agcayazi, M. Traenkle, A. Bozkurt, and M. A. Daniele, "Wearable sweat rate sensors," in *2020 IEEE SENSORS*, 2020, pp. 1–4. DOI: 10.1109/SENSORS47125.2020.9278818.

[3] P. Salvo, F. Di Francesco, D. Costanzo, C. Ferrari, M. G. Trivella, and D. De Rossi, "A wearable sensor for measuring sweat rate," *IEEE Sensors Journal*, vol. 10, no. 10, pp. 1557–1558, 2010. DOI: 10.1109/JSEN.2010.2046634.

[4] T. Healy, J. Donnelly, B. O'Neill, *et al.*, "Innovative packaging techniques for wearable applications using flexible silicon fibres," in *2004 Proceedings. 54th Electronic Components and Technology Conference (IEEE Cat. No.04CH37546)*, vol. 2, 2004, 1216–1219 Vol.2. DOI: 10.1109/ECTC.2004.1319066.

[5] "Stella project." (), [Online]. Available: http://www.stella-project.de/ (visited on 03/25/2022).

[6] R. Vieroth, T. Loher, M. Seckel, *et al.*, "Stretchable circuit board technology and application," in *2009 International Symposium on Wearable Computers*, 2009, pp. 33–36. DOI: 10.1109/ISWC.2009.13.

[7] D.-R. UK, *Dht11 humidity and temperature sensor*, 2010. [Online]. Available: https://www.circuitbasics.com/wp-content/uploads/2015/11/DHT11-Datasheet.pdf.

[8] A. Noda and H. Shinoda, "Frequency-division-multiplexed signal and power transfer for wearable devices networked via conductive embroideries on a cloth," in *2017 IEEE MTT-S International Microwave Symposium (IMS)*, 2017, pp. 537–540. DOI: 10.1109/MWSYM.2017.8058619.

[9] R. Guo, S. Yao, X. Sun, and J. Liu, "An improved liquid metal mask printing enabled fast fabrication of wearable electronics on fabrics [*]," in *2019 41st Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*, 2019, pp. 1761–1764. DOI: 10.1109/EMBC.2019.8857044.

[10] C. Cooper and B. Hughes, "Aerosol jet printing of electronics: An enabling technology for wearable devices," in *2020 Pan Pacific Microelectronics Symposium (Pan Pacific)*, 2020, pp. 1–11. DOI: 10.23919/PanPacific48324.2020.9059444.

[title=Appendix]