WearApp – Data Gathering in Emotion and Affect Experiments with Wearables

Mateusz Ficek and Paweł Jemioło
AGH University of Science and Technology,
al. A. Mickiewicza 30, 30-059 Krakow, Poland
mficek@student.agh.edu.pl, pawljmlo@agh.edu.pl

Abstract. Wearable devices have become increasingly popular due to low prices. Physiological data gathered using smartwatches and smartbands can be used for emotion and affect recognition with Artificial Intelligence (AI). Still, with a variety of available devices, there is no standard mobile software that enables researchers to experiment with them. In this paper, we present WearApp – a Flutter application that allows for simultaneous data acquisition from popular Bluetooth Low Energy and Bluetooth wearables. We validate the presented software in several scenarios, thus confirming it can be applied in different laboratory settings, including gathering data for emotion and affect recognition experiments. WearApp is an open-source solution for Android and iOS.

Keywords: Emotion and affect recognition · Data gathering · Wearables · Flutter · Application · Mobile · Android · iOS

1 Introduction

Wearable devices have become increasingly popular due to relatively low prices and growing availability. Sensors initially developed for specific purposes, i.e. healthcare, robotics or military, find their way into mainstream gadgets accessible to everyone. On a daily basis, humans can obtain data about their movement, heart rate, glucose level, electrodermal activity, and many others [5].

In the beginning, such devices were designed to inform users about basic statistics, e.g. number of steps made and calories burnt during the day. With progressing miniaturisation, more advanced sensors were introduced into wearables. For example, they allow for developing software able to measure idle time or determine sports activity with no direct human control.

Moreover, wearable devices are frequently used in emotion and affect recognition trials [5]. They are small and comfortable for participants; therefore, applying them in research may increase the ecological validity of scientific experiments reducing the *garbage in, garbage out* problem.

Enabling emotion and affect recognition is crucial to enhancing people's everyday life. There are numerous scenarios where it can be implemented, e.g. smart homes, personalised medicine and games that adapt to one's feelings.

In general, due to its complexity, emotion and affect recognition require using different physiological signals at the same time [5]. Thus, the researchers often apply more than one device for measuring various modalities. Obtaining required signals may be laborious, with separate applications designed for a specific wearable. Additionally, some of them do not provide access to raw data.

In this paper, we aim to present an open-source Flutter application for iOS and Android that may be used for flexible data gathering in experiments with multiple wearable devices simultaneously.

2 Background

When manufacturing wearables, some limitations need to be addressed. First, the modest size of such devices forces implementing energy-efficient solutions. The use of communication protocols, e.g. NFC or Bluetooth, is necessary to ensure constant data exchange between wearable and main device (in most cases a smartphone) and eliminate the need for high-capacity memory [3].

Modern wearables most often implement Bluetooth Low Energy (BLE) standard. Its major limitation is the data size that can be transferred in one moment. However, this constraint does not affect wearables since the data they send is on average 30 bytes [2]. The older protocol used in wearable gadgets is a classic Bluetooth. It uses considerably more battery when compared to BLE [6].

Data exchange differs in presented technologies. Most devices follow the universal Generic ATTribute Profile (GATT) standard [6]. It defines how two BLE devices exchange data. However, some manufacturers tend to use custom made Bluetooth communication. These custom communication need to be handled individually based on producers' specifications. On the other hand, GATT allows for creating a unified approach for a broad range of devices.

Communication with wearable devices requires a Bluetooth module, universally used in smartphones. Current smartphones operate with iOS or Android operating systems. Both of those platforms have their advantages, but they require separately built applications. It causes an increase in resources and development time. Rather than creating applications with platform-intended languages, developers may use multi-platform frameworks. Flutter is one of them and supports writing applications for Android, iOS, and the web.

As the wearables are frequently used for gathering data in emotion and affect recognition experiments, the researchers incorporate them in different ways – using native manufacturers' applications and custom made ones. See the paper by Alpers and Benta [1] for a comprehensive overview. However, there is still no standard open-source application for BLE and Bluetooth wearable devices that operates both on iOS and Android smartphones.

3 Presented approach

Based on our previous experiments within emotion and affect recognition [4], we pre-specified requirements for the presented application: adding support for the new device should be facile; it needs to operate on iOS and Android; both classic Bluetooth and BLE devices need to be supported; raw data from a specific device should be recorded and saved in CSV file immediately after receiving it.

WearApp was written in Flutter with support for Android and iOS. The application consists of 3 main screens presented in Figure 1. First screen (starting from left) represents available devices with highlighted connected gadgets. The second and third screens present BLE and Bluetooth data gathering views. The fourth one sums up the number of gathered samples.

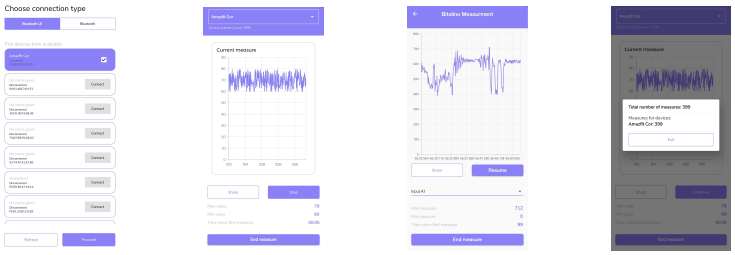

Fig. 1: Four screenshots of WearApp presenting device selection, data collection (BLE and classic Bluetooth) and measurement summary, from left respectively.

For BLE devices, WearApp, for now, supports heart rate values but can be easily expanded to handle more sensors. GATT services and characteristics work as a lookup table, so acquiring different data requires only reading information with a different ID. That can be achieved by extending `BLEManager` class.

After entering the app, the user is presented with a list of available devices. Pressing on one of them establish the connection with the selected equipment. Then, the user can proceed to the data gathering screen (*Proceed* button). Pressing *Resume* or *Continue* or *Stop* buttons toggle between working and paused states. *End measure* finishes acquisition from wearables.

As for BLE accessories, the user can connect to multiple devices at once. In the visualisation area, information about the selected accessory is presented. The data include battery level, last measured heart rate, a chart with the last 300 measures, maximum and minimum heart rate, and measurement duration. There is also a drop-down button that enables switching between accessories.

As for Bluetooth equipment, the software currently supports Bitalino device. WearApp can be easily expanded to handle more devices, as it only requires implementing connection protocol with new gadgets in the `BluetoothDevices` class and calling existing functions that visualise and save acquired data. Adding support for more BLE sensors in code is not mandated as it works out of the box thanks to implemented standards. As for visualisation, the user can switch between possible input charts for every simultaneously acquired input signal.

Collected data is instantly saved to a CSV file. After creating a new file in smartphone storage, each sample received from the device is converted and added at the end of a file. Every entry is converted to a row, including measurement ID, gathered data, and sample date. After the acquisition, the created document can be saved with a custom name, e.g. person ID and shared.

The code of this application, as well as Android installation files, are available on GitHub: https://github.com/mateuszFicek/wearapp.

4 Results

We tested the presented application in several different scenarios involving: acquiring connection between devices, connection stability, and reading and quality of gathered data.

The experiments were performed using the OnePlus 6T smartphone with wearable devices using a classic Bluetooth (Bitalino (r)evolution kit) and BLE technology (Polar H10, Scosche Rhythm+, and Xiaomi MiBand 5).

Based on 10 attempts for each wearable, only Bitalino had problems with the connection. Still, we achieved an 80% success rate in terms of this device and 100% for others. To verify the stability, each device gathered data for 300 to 1500 seconds, then the trial was paused, the screen was locked, and the acquisition was resumed. The test was passed for each device with pauses from 300 to 1,200 seconds. The quality of measurements was tested by acquiring data for 60, 300, 6,000, 12,000 and 18,000 seconds. Next, we compared the number of samples and maximum and minimum values between WearApp and CSV file. The collected data did not differ from those presented in the application in any case.

5 Conclusions and Future Work

In this paper, we present WearApp – an open-source Flutter application for iOS and Android that may be used for flexible data gathering in experiments with wearable devices. We tested the software with scenarios similar to real-world emotion and affect recognition experiments. Data collected using WearApp may be used in developing AI models in this area with supervised learning techniques.

In the future, we want to support more signals than cardiovascular ones in BLE apparatuses. Further improvements to the application could include automatic measurement management and voice control. Apart from that, we want to implement live data processing and include basic emotion and affect recognition algorithms directly in WearApp.

Funding Sources

Research project supported by program *Excellence initiative -– research university* for the University of Science and Technology.

References

1. Alpers, S., Benţa, K.I.: Sensegraph: Affect self-monitoring and tagging tool with wearable devices. In: 2021 International Conference on Computer Communications and Networks (ICCCN). pp. 1–6. IEEE (2021)
2. Carles Gomez, Joaquim Oller, J.P.: Overview and evaluation of bluetooth low energy: An emerging low-power wireless technology. Sensors (2012)
3. Dragomir, D., Gheorghe, L., Costea, S., Radovici, A.: A survey on secure communication protocols for iot systems. In: 2016 International Workshop on Secure Internet of Things (SIoT). pp. 47–62. IEEE (2016)
4. Kutt, K., Nalepa, G.J., Giżycka, B., Jemiolo, P., Adamczyk, M.: Bandreader-a mobile application for data acquisition from wearable devices in affective computing experiments. In: 2018 11th International Conference on Human System Interaction (HSI). pp. 42–48. IEEE (2018)
5. Saganowski, S., Dutkowiak, A., Dziadek, A., et al.: Emotion recognition using wearables: A systematic literature review-work-in-progress. In: 2020 IEEE International Conference on Pervasive Computing and Communications Workshops (PerCom Workshops). pp. 1–6. IEEE (2020)
6. Townsend, K., Cufí, C., Davidson, R., et al.: Getting started with Bluetooth low energy: tools and techniques for low-power networking. O'Reilly Media, Inc. (2014)