Demo: WaDa - An Android Smart Watch App for Sensor Data Collection

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Abstract
Researchers, particularly in the area of ubiquitous and wearable computing, often spend significant amount of effort and time in developing devices and/or apps for data collection. Most of the apps and devices are customized with limited options, and they are usually non-generic or publicly unavailable. In this paper, we present WaDa, an easy to use app for sensor data collection from commercial off-the-shelf Android smart watches. It provides handy features such as user-defined labels, time synchronization, sensor selection, and data navigation. WaDa, freely available for research and academic purposes, facilitates prompt data collection without requiring expertise and effort for custom device/app development.

Author Keywords
Wearable Sensor; Data Collection; Android; Smart Watch

ACM Classification Keywords
[Human-centered computing; Ubiquitous and mobile computing; Ubiquitous and mobile computing systems and tools]

App Description
In this section, we briefly describe the main features of WaDa. The app and more details about it are available at [3].

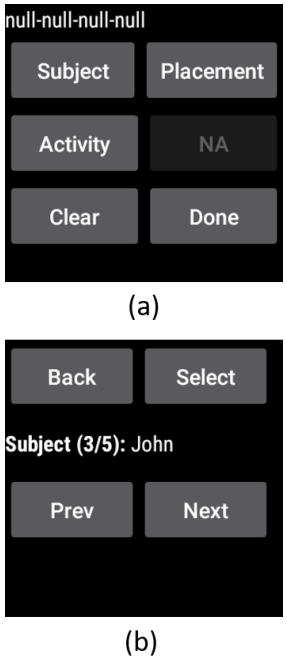


Figure 2: (a) List of tags and (b) Option navigation for a tag

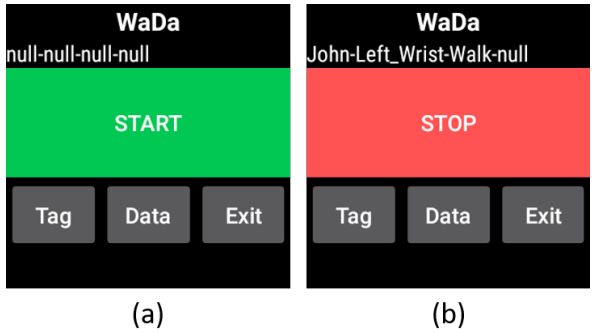


Figure 1: (a) Starting and (b) Stopping data collection in WaDa

Data Collection

WaDa runs on the watch, and it does not require a smart phone. This independence makes WaDa more convenient and less constrained compared to the watch apps that require a companion smart phone app. Data collection is started and stopped using a button available in the app (Figure 1). Once started, the app collects data in the background, and the 'STOP' option becomes available. Closing the app does not stop sensor data collection. The 'STOP' option is used explicitly to end data collection. The data is saved in the watch storage.

Data Labeling

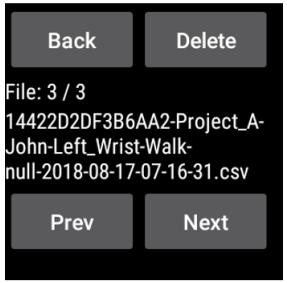
It is very important to label or tag the data, particularly for the ground truth purpose. Wada allows using multiple tags for the data. The tags can represent different ground truth information for the data like the code or name of the participant, the position of the device (e.g., left hand, right hand, waist), the activity for which the data is being collected and so on. Instead of fixed tags, WaDa allows up to four user-defined tags and any number of options for each of the tags. Figure 2(a) shows an example where WaDa has been configured for three tags (Subject, Placement, and Activity). WaDa provides easy mechanisms to navigate and select the options for the tags. Figure 2(b) shows the interface for a tag (Subject) with 5 options where the 'Prev' and the 'Next' buttons are available for navigating the options. Such an interface is available for each of the tags with a corresponding user-defined option list. Once the options are selected, they are displayed just above the 'START/STOP' button (Figure 1(b)). The tags are defined before starting data collection, and they are embedded in the name of the file that contains the sensor data. It is not necessary to define or select all the tags. Any tag that is not selected is marked as 'null'.

As mentioned earlier, the name of the tags and their options are not hard coded; rather they are defined by the users according to their preference and the need of the applications. It is very difficult to input text or other options in the watches due to their small form factor. We provide a companion desktop app to define the tags, the options for the tags, the sensors, and the sampling rates for the sensors. Figure 4 shows the interface from the desktop app used for these purposes. Up to four different tags can be defined, but there is no limit on the number of options for the tags. In Figure 4, we show an example where three tags and some options for each of the tags are defined. The push button is used to transfer the configuration to a watch while the watch and the laptop are connected via a USB cable. The configuration can be named, and then saved in the desktop.

Sensors and Sampling Rates

In WaDa, a user selects the sensors and their sampling rates. Different models of the Android smart watches have different set of sensors, and new sensors are often added to new models. Also, different applications need data from different set of sensors. Instead of providing an exhaustive

(a)



(b)

Figure 3: (a) The total file count and the option for deleting all the files (b) File Navigation with option for deleting individual file

list of all possible sensors, WaDa allows the users to create a list of sensors, and then select the sensors needed for the target application. By default three of the most widely used sensors (the Accelerometer, the Gyroscope, and the Magnetometer) are listed in the desktop app. To add a sensor to the list, a user provide the ID of the sensor, as defined by the Android platform [2]. For example, the ID of the Ambient Temperature Sensor is 13. A user can select any number of sensors from the list, and set the sampling rate for each of the sensors. Android has four predefined sampling rates: SENSOR_DELAY_UI, SENSOR_DELAY_NORMAL, SENSOR_DELAY_GAME, and SENSOR_DELAY_FASTEST [1]. Any of these four or a custom (in Hz) rate can be set for a sensor. The list of sensors, their sampling rates and availability (Y/N) can be checked in the watch as shown in Figure 5(a).

Data Navigation

The data collected in a session (between a start and a stop) is saved in a single file in the watch. The list of the files can be navigated in the app (Figure 3). The file name contains different information including the serial number of the watch, the name of the configuration file, the selected options of the tags (the labels) and the time when the data collection started. A user can delete an individual file or all the files from the watch when needed. The companion app is used to download the data or files from the watch to a desktop/laptop. The download option is available in the 'Data' panel in the desktop app (Figure 4). However, it is not shown here due to space limitation. Once the data files are downloaded to a desktop/laptop, they should be deleted from the watch to free storage.

Data Format

The data is saved in CSV (Comma Separated Values) format where each line in the file represents a sample from

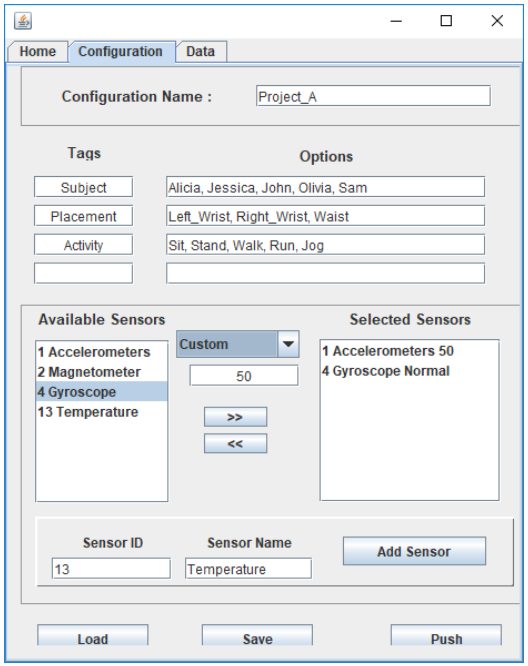


Figure 4: Companion desktop app for the configuration and the data download

a sensor, and includes the timestamp of the event in milliseconds (The Unix Epoch time), the ID of the the sensor, the accuracy of the sample, and the sensor readings. The format is like:

$$Timestamp, SensorID, Accuracy, [Values]$$

The number of readings or values for a sample depends on the sensor. Fore example, an accelerometer provides three values that are the acceleration along the X, Y and Z axes. On the other hand, an Ambient Temperature sensor

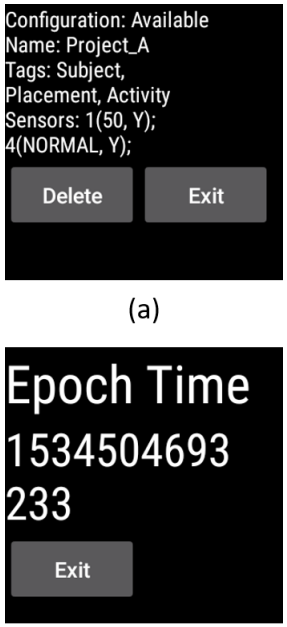


Figure 5: (a) Summary of the configuration and (b) The Unix Epoch time in the watch

provides a single value.

Time Synchronization

The timestamp of the sensor sample represents the time from the watch when the sensor is sampled. However, the time of the watch might not be synchronized with other devices (e.g., the camera used for the ground truth or other devices used together for data collection). It is important that the times from multiple devices are synchronized. WaDa displays the epoch time of the watch in milliseconds that is updated in every 100 ms (Figure 5(b)). This time can be recorded using a camera, and be used to synchronize the watch with other devices including the camera itself.

Discussion

Smart watches are designed to be used on the wrists. However, a watch, due to its small form factor, can be placed on different parts of the body (e.g., the waist, the chest, the legs, and the upper arms) using appropriate straps. So, WaDa can be used to collect data not only from the wrist, but also from other parts of the body. WaDa is easy to use, and it supports prompt data collection without requiring the time, the effort and the expertise needed for custom app/device development. WaDa is a generic app for data collection, and it has the potential to be used for many applications in different domains including ubiquitous computing, health care, elderly monitoring, and behavioral science. Earlier versions of the app have been used in some research works [5] [4], and for hands-on experiments in two undergraduate courses at the University of Virginia. Students with no or little prior experience of sensor data collection or using smart watches found it simple and easy to use. The app along with the detailed instructions and related information are available in a public repository [3] where future updates or changes to the app will also be made available.

Acknowledgement

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REFERENCES

1. 2018a. Android Sensor manger. (2018). `https://developer.android.com/reference/android/hardware/SensorManager`.
2. 2018b. Android Sensors. (2018). `https://developer.android.com/reference/android/hardware/Sensor`.
3. 2018. Wada App Repository. (2018). `https://github.com/abumondol/WaDa`.
4. Md Abu Sayeed Mondol, Ifat Afrin Emi, Sarah Masud Preum, and John A Stankovic. 2017. User authentication using wrist mounted inertial sensors. In *Information Processing in Sensor Networks (IPSN), 2017 16th ACM/IEEE International Conference on*. IEEE, 309–310.
5. Md Abu Sayeed Mondol and John A Stankovic. 2015. Harmony: A hand wash monitoring and reminder system using smart watches. In *12th EAI International Conference on Mobile and Ubiquitous Systems: Computing, Networking and Services*. 11–20.