Poster: A Profiling System for Android Wear

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ABSTRACT
In this poster paper, we describe the design and implementation of our system of profiling the behavior of Android Wear. The Android Wear device contains many kinds of sensors such as an accelerometer, a gyrometer, and a microphone. Therefore, profiling the use of these sensors in addition to the usage of CPU and memory is important to understand the global view of its behavior.

CCS Concepts
• H.1.2 [User/Machine Systems]: Human Information Processing.

Keywords
Wearables, Profiling, CPU

1. INTRODUCTION
Recently many wearable devices are becoming available in addition to smartphones. One of the advantages of wearable devices is unnecessary of inputting characters using fingers. Although they are expected to be widely used, there is a concern about their battery consumption. Liu et al.[1] examined the detailed profiling of Android Wear OS. However, their study is focused on the usage of CPU and I/O. Since wearable devices are equipped with many kinds of sensors such as an accelerometer, a gyrometer, and a microphone, we also need to investigate how these sensors consume energy while they are active. In our study, we have developed a tool to profile the usage of sensors on Android wear. This poster paper describes how the profiling system is designed and shows some results of profiling.

2. PROFILING
This section describes the design of our profiling system.

2.1 Android Wear
Android Wear is being one of the most popular wearable devices due to its easy portability and the cooperative operation with Smartphones. Its operating system, Android Wear OS, is based on the Linux kernel. Since there is some information about Android Wear OS, it is not a complete open-source software, which results in the difficulty of understanding its behavior. Furthermore, Android Wear OS has less functions that other Linux-based OS's. Therefore, we need to pay attention to the limitation of functions. Specifically, some commands are missing and the results differ from other OS's. In terms of hardware, Android Wear has less kinds of sensors, less CPU performance, and smaller size of display than smartphones do.

In addition to these disadvantages, the duration time of battery is not sufficient. Thus profiling Android Wear is important; understanding how CPU and memory are used helps prolonging the battery life. Since Android Wear has many kinds of sensors, profiling the activities of sensors is also desirable.

In this study, we create a profiling system of Android Wear which collects the power consumption of CPU, the usage of memory, and how a specific sensor affects the total performance. We use SONY SmartWatch 3 SWR50 for the preliminary experiment. It has a nine-axis inertial sensor consisting of an accelerometer, a gyro, and a magnetism sensor and a step counter, a GPS, and a microphone.

2.2 Creation of Profiling System
We use adb command to run a shell script on Android Wear from a Bluetooth-connected personal computer (PC) to avoid unnecessary overhead on Android Wear. The PC obtains the data from Android Wear and shows and displays the analyzed data. Figure 1 shows the flow of processing in our profiling system.

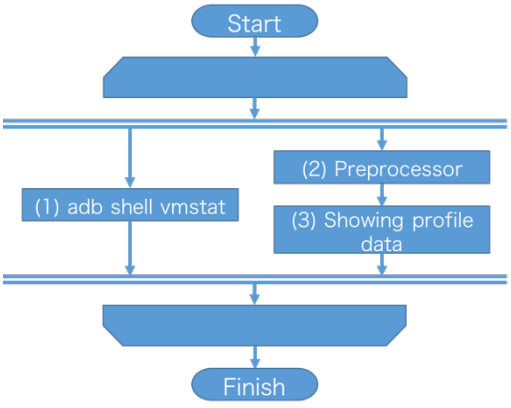

Figure 1. Flowchart of the profiling system.

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The sequence of profiling system is collecting the information for profiling on Android Wear by using vmstat command (1) and displaying the collected information (2)(3). (1) and (2)(3) occur concurrently and thus real-time profiling becomes possible. The details of (1), (2), and (3) are as follows:

1. adb shell vmstat

vmstat command returns the information regarding the system performance including CPU and memory. The CPU time consists of four classified time: the user-mode time us, the kernel-mode time sy, idle time id, the time of I/O waiting wa. We run the command every one second.

2. Preprocessor

Concurrently with the vmstat processing, preprocessing runs to prepare displaying the profiled result. Every time vmstat returns a result, the preprocessor starts. When vmstat returns an error, vmstat is rerun to obtain another correct result.

3. Showing profile data

When preprocessing is completed, the profiled data are displayed in a real-time fashion.

3. RESULTS

This section shows several obtained results.

3.1 Results of profiling

We examined how sensors were influential for the total performance using our profiling system. We created an application in which sensors continued running on Android Wear. We investigated five cases: with no sensor, with an accelerometer, with a microphone, with an accelerometer when the Android wear connects to the phone, and with three sensors (an accelerometer, a gyrometer and a magnetism sensor). Each case lasted 120 s. We carefully did not run anything other than a sensor while profiling was done. Figures 2-6 show a case with no sensor, with an accelerometer, with a microphone, with an accelerometer when the wear connects to the phone, and with three sensors, respectively. The horizontal and vertical axes represent the running time and the ratio of CPU usage, respectively. In the graph, us, sy, id, and wa are shown.

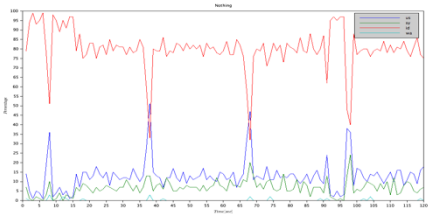

Figure 2. CPU profiling without using sensor.

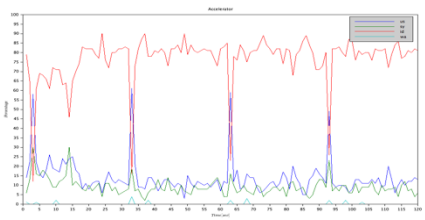

Figure 3. CPU profiling using an accelerometer.

3.2 Consideration

As seen in Figures 2-6, the value of 'us' has a peak every 30 seconds. This is considered to be the result of a periodic background activity. When a microphone is used, us and sy shows higher values than when an accelerometer is used. This suggests that using a microphone needs more in-kernel processing and background activities. As seen in Figure 4-6, the sy values are

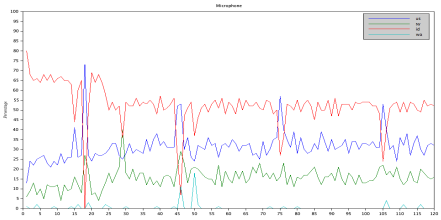

Figure 4. CPU profiling using a microphone.

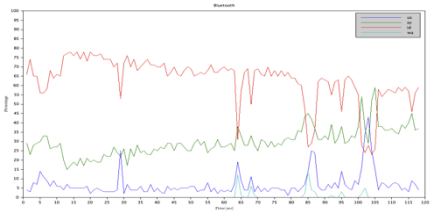

Figure 5. CPU profiling using an accelerometer when the Android wear connects to the phone using Bluetooth.

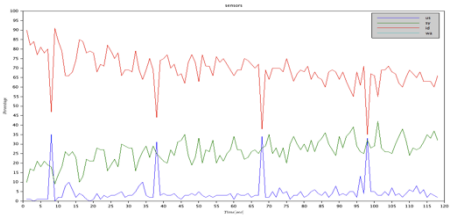

Figure 6. CPU profiling using an accelerometer, a gyrometer and a magnetism sensor.

higher than Figure 2, 3. These imply that the processing of a microphone requires a complicated and multi-threaded processing compared with other types of sensors. In addition, these infer that connecting to the phone and using some sensors need multi-threaded processing. Therefore, sy values are higher.

4. Conclusion

We proposed profiling system of Android Wear and examined how sensors were influential for performance.

In the future, we need to create a system to estimate battery consumption using result of our profiling system. Also we need to create proofing system on Android device and Android Wear as well as PC.

5. REFERENCES

[1] Liu, R. and Lin, F. X. 2016. Understanding the characteristics of Android Wear OS. In *Proceedings of Mobisys.* DOI= http://dx.doi.org/10.1145/2906388.2906398.