Towards the Era of Wearable Computing?

Jagmohan Chauhan
UNSW & NICTA
Sydney, NSW, Australia
Jagmohan.Chauhan
@nicta.com.au

Anirban Mahanti
NICTA
Sydney, NSW, Australia
Anirban.Mahanti
@nicta.com.au

Mohamed Ali Kaafar
NICTA
Sydney, NSW, Australia
Dali.Kaafar
@nicta.com.au

ABSTRACT

With over 250 million devices to be sold, wearable devices revenue is forecasted to hit $2 billion by 2018. Wearables are expected to be the next generation of mobile devices. However, before we usher into the era of wearables, there are two key questions facing us: (a) What kind of issues are faced by the current generation of wearable devices before they provide good user experience and (b) Is today's Content Distribution Network ready for wearables? To answer these questions, we designed and implemented a profiler on Google Glass, which is used to study the Glass performance in terms of power consumption, device temperature and network traffic for a number of Glass applications across WiFi and BlueTooth interface. We also run a set of experiments to understand the main challenges faced by the content providers while serving content to Google Glass devices and alike.

Categories and Subject Descriptors

C.4 [**Computer Systems Organization**]: Performance of Systems

Keywords

Google Glass, Glass apps, Profiling

1. INTRODUCTION

Current estimates predict that more than 250 million smart wearables will be in use by 2018 [1]. Today's wearable market consists of smart-bands, smart-watches, and smart-glasses etc. Although, the wearable market has started to emerge, the culmination of wearable as a successful device in the mobile computing world is yet to happen. Hence, this seems to be the ripe time to do an early research on wearables and uncover the existing performance problems from the perspective of the device itself and the network which can affect user experience.

CoNEXT Student Workshop'14, December 2, 2014, Sydney, Australia.

http://dx.doi.org/10.1145/2680821.2680833.

We take a first look at the current capabilities of wearable devices taking Google Glass as a use case from two different perspectives. Specifically, we focus on two main aspects: (a) user experience and (b) content distribution network design. What kind of issues are faced by the existing devices when a user uses an app while worn and what kind of network support is needed by the content providers to support wearable systems are the two important questions we are trying to address in our current work. Google Glass [4] is a new entrant in the market of optical head mounted display devices(OHMD). A user can navigate, do live streaming, watch videos or browse the web using the touchpad or voice commands on Glass. Although, OHMD has been there for a while, Google Glass small form factor made ubiquitous computing practical. However, the same form factor can also be thought of as a physical limitation for the device. In order to keep the device small, Glass is equipped with a small battery [5]. A small battery influence the longevity of the device. The other challenge we expect to be on Glass is the heat. While running power intense applications on Glass, a significant amount of heat would be produced. This could spoil user experience and might be dangerous for the user's skin. Hence, an experimental study on the power consumption and temperature variation for different applications on Glass while user is wearing the device would be interesting. On the other side, it might be interesting to know which applications perform well on Glass and which does not.

On the other end of the spectrum, we envision content providers such as video on demand services or web content providers. To have a good user experience, not only the device but the network support for the device is an important factor. To this end, it is natural to ask questions such as: Are the today's websites designed to cater to the need of wearables or what factors are critical to support Video On Demand on wearables? As a first step to answer the previously asked questions, we created a profiler for Glass. The profiler measures power consumption, device temperature and network throughput for different Glass apps across different network interfaces. The profiler along with tools such as, tcpdump and top is used to study the network and system performance aspects of the two category of Glass apps listed in Table 1.

Application	Category
LiveStream	Live Streaming
Searching and Web-Browsing	Communication

Table 1: Glass Applications

The rest of the paper is organised as follows. Section 2 briefly introduces the profiler and methodology in use. We discuss a few early performance results in Section 3. Finally, we present the future work in Section 4.

2. PROFILER AND METHODOLOGY

The profiler is installed as a Glass app, which collects the performance metrics using the following ways: The power consumption and device temperature readings are read from corresponding system files, which are written by the operating system at regular intervals of time in Android. Profiler use traffic stats class from Android framework to get the application throughput.

The profiler records the measurements every second and writes them to a file. The measurements were taken while user was wearing the device and not connected to any external device. The battery of the device was fully charged. All the experiments were repeated 3 times.

3. EARLY RESULTS

LiveStream [2] application was used to stream a video live using Google Glass. Although, Glass is mainly designed for micro interactions, people have started to use Glass to make POV videos e.g. during surgery [3]. We streamed a 5 minute video on WiFi and BlueTooth. The power consumption is 2100 mW per second and 1950 mW per second on WiFi and BlueTooth respectively. Figure 1 shows the temperature variation of Google Glass with time for the LiveStream application in adaptive mode. The temperature rises significantly till 3 minutes and then gradually stabilizes thereafter. We found out that 55 degree celsius is the Glass temperature threshold after which it asks the user to stop an activity by displaying a message. Glass performs DVFS aggressively after crossing the threshold temperature. Hence, Glass starts operating in low frequency CPU and low voltage. This results in less power drainage from the system and slower temperature change but at the cost of degraded user experience (loss packets, latency). Live Streaming and streaming videos online are a few high resource intensive applications. *Our results suggest that Google Glasses do not seem to comply to user expectations in terms of good user experience for the streaming applications. Streaming applications are not suitable for longer duration of use on Glass with its current hardware configuration as it leads to high power consumption and temperature rise. High power consumption leads to low battery life and high temperature which can be dangerous to user skin.*

Under web browsing experiments, we measured 16 different websites to check the power consumption and heat generation pattern on Glass. From our analysis, we observed that websites such as, wsj.com (Wall Street Journal) needs 3 redirects before going to the main mobile webpage of the site. This increases the page time to load on Glass by 2 and 3 seconds on WiFi and BlueTooth respectively. Apart from time, redirection also leads to wastage of power. *Extra time to load and extra power dissipation due to redirections is not good for the quality of user experience on wearables. We think that the number of redirections should be minimized and better be avoided by better webpage design for such sites.*

In terms of power consumption and heat generation, youtube.com was found to be the most optimal website designed for Glass. Youtube.com use efficient network protocol named SPDY [6] and Webp [7] image format to deliver the content faster. *We suggest that similar to YouTube, using efficient network protocol and image formats can help other content providers to design more responsive and better websites. As an example, by converting all the JPEG images for Ted.com to Webp image format, we reduce the power consumption on Glass by 12 % with no change to the user experience.*

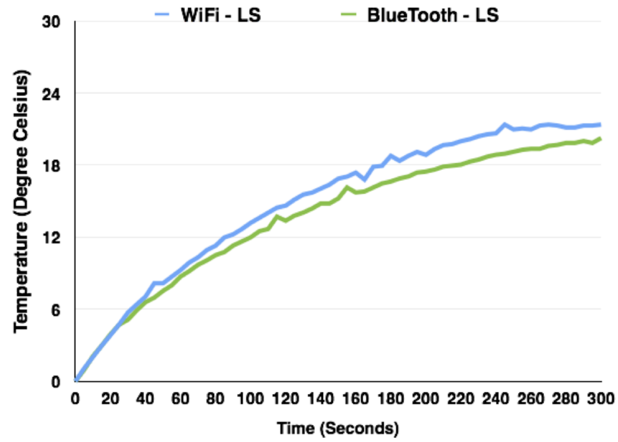

Figure 1: Temperature variation for LiveStream

4. FUTURE WORK

Inspired by the early results, we are extending our research to explore: (a) How other popular apps such as Social networking and Augmented Reality apps will perform on Glass, (b) What power saving techniques are employed on Glass other than DVFS, and (c) What techniques can be used to solve existing design issues in CDN for better wearable user experience. We hope that the insights provided by this work will be useful to the users of Glass, content providers in the network and other wearable products in general.

5. REFERENCES

[1] Forecast: 250 million smart wearables in use by 2018. `http://www.bizreport.com/2014/08/forecast-250-million-smart-wearables-in-use-by-2018.html`.

[2] Go live from your glass. `http://new.livestream.com/producer/glass`.

[3] Google glass enters the operating theatre. `http://www.dailymail.co.uk/health/article-2623372`.

[4] Google glass start. `https://www.google.com/glass/start/`.

[5] Google glass teardown. `http://www.techinsights.com/teardown.com/google-glass/`.

[6] Spdy: An experimental protocol for a faster web. `http://www.chromium.org/spdy/spdy-whitepaper`.

[7] webp: A new image format for the web. `https://developers.google.com/speed/webp/`.