Challenges with Virtual Reality on Mobile Devices

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1 Introduction

The concept of virtual reality have been there for decades but recently with improvement in display and graphics technology it has picked a lot of momentum.

By 2018, the virtual reality (VR) market could reach $7 billion with "room to grow"[1]. The big question is if in this gold rush, can mobile devices take some share by replacing conventional head-mounted display (HMD) by providing similar VR experience?

Whilst both mobile and desktop compute devices could be considered akin to one another, mobile devices lend themselves particularly well to VR. They are light weight, require no external wiring and nowadays, most of us own one. However limited power budget, GPU power, bandwidth and sensor capabilities are current issues that need addressing. In this talk we discuss current VR capabilities on mobile as well as future goals.

2 Display Technology and Image Quality

Display technology has improved a lot over the years and many current generation handsets are now using OLED screens. OLED screens have a distinct advantage over LCD screens in that they provide a much better response rate of around 0.1ms compared to 16ms. Improving response time is a key requirement in improving the VR experience. OLED screens with low persistence and high frequencies can also aid in the reduction of motion blur, a common side effect of abrupt head motion whilst using a VR headset.

Current mobile devices have also increased the screen resolution, a QHD mobile will offer 1280 x 1440 resolution per eye in VR mode.

3 VR Rendering

Mobile provides limited bandwidth and graphics capabilities compared to desktop which can limit it's rendering performance. Moreover, mobile graphics which uses double or triple buffers for window surface can introduce latency of 32 ms ˜ 48 ms. This latency, the time swapbuffer is called to the actual time anything is drawn on the screen, is due to dependency on the vysnc for buffer updates.

One way this latency could be reduced is by using only one buffer that you can render while being scanned on the screen, but platform may not have such supporting APIs and moreover application can have tearing effect while display.

VR rendering also has a constant overhead of two eye rendering, lens correction and chromatic aberration. Use of different rendering APIs and rendering threads could be explored to reduce the GPU load. But any graphics APIs usage must be dependent on the underline mobile architecture.

Figure 1: *GearVR*

4 Head Tracking

Motion sensor accuracy and refresh rate are two important aspect to get the most accurate head orientation at a given time. The phone internal sensors are not as accurate as external sensors available, so one way is to use external sensors via micro usb connection from phone.

Moreover current sensors can only provide tilt and turn of your head but not translations, which limits a lot in VR experience. For example, one cannot lean down to inspect an object on the floor.

5 Power Management

Mobile phones will always try to conserve power by reducing it's central processing unit (CPU) and graphics processing unit (GPU) frequencies whenever possible. The downside of this is that you can't predict a constant VR performance. One way to fix this is to give the application developer some control over the clock frequencies to get predictable performance.

6 Conclusion

Evidently, it's early days for VR on mobile. But we have already seen huge improvement in VR experience in last few years. Increase in mobile screen resolution, better sensors for accurate position and powerful mobile GPUs are some of the reasons for this improvement.

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