WatchAR: 6-DoF Tracked Watch for AR Interaction

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ABSTRACT

AR is about to change how people observe and interact with the world. Smart wearable devices are widely used, their input interfaces, like button, rotating bezel, and inertial sensors are good supplementary for interaction. Further 6-DoF information of these wearables will provide richer interaction modalities. We present WatchAR, an interaction system of 6-DoF trackable smartwatch for mobile AR. Three demos demonstrate different interactions: *Air Hit* shows a way to acquire 2D target with single hand; *Picker Input* shows how to select an item from a list efficiently; *Space Fighter* demonstrates the potential of WatchAR for interacting with a game.

Author Keywords: Wearable Devices; 6-DoF Tracking; Mobile AR

1 INTRODUCTION

The augmented reality (AR) technology is advancing quickly these days with the invention of several products like HoloLens 2, Magic Leap one. Most of them use hand gesture recognition to some extent for interaction. But hand gesture interaction lacks of haptic feedback and lacks accuracy when hand was occluded, effecting its interaction efficiency even more. Glove based hand tracking is precise but is cumbersome with a load of cables [1].

Although combining wearable with AR were explored by researchers [2, 3, 4, 5], the interaction possibilities related to 6-DoF information were not fully investigated.

We present WatchAR, an interaction system of 6-DoF trackable smartwatch for mobile AR. Our system is unique in two ways: Firstly, our system has a low tracking latency (<1 ms) and large tracking volume (HFOV 120°, VFOV 90°); secondly, we explore a wide range of interactions which are not fully explored.

2 TYPES OF INTERACTION

To begin with, we divide the interactions for WatchAR with the following variables. The first one being the placement of the content: whether the virtual content is anchored to the world or onto the smart watch. The second is handedness: whether an interaction involves single hand or both hands. The third one is motion gesture: pointing, aiming, tapping, swinging, raising hand are examples of motion gestures. It is important to point out that motion gestures require 6-DoF information of smartwatch, unlike 2D touch gestures. The last one is supplementary input and output: since smartwatch has buttons, touch screen and vibration motors on it, it's important to take them into considerations when designing interactions.

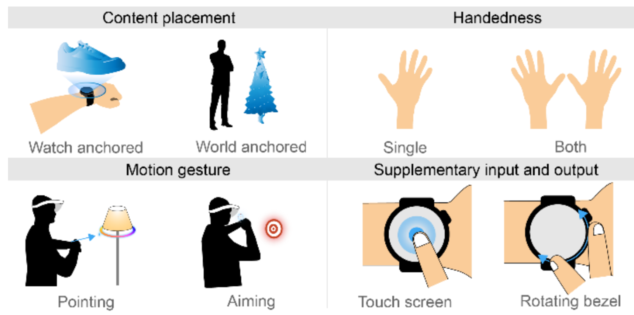

Figure 1: WatchAR Interaction Illustrations

3 TECHNICAL SETUP

To track the smart watch in 6-DoF, we put a fiducial marker group consisting of three markers on the side of the smart watch and one IR camera with two IR LEDs on the AR headset. The fiducial markers are covered with black IR filters so that the patterns are not visible to human eyes. The IR camera pointing downward can cover a tracking area of 120° (horizontal) × 90° (vertical). The tracking distance is over 0.7 meters.

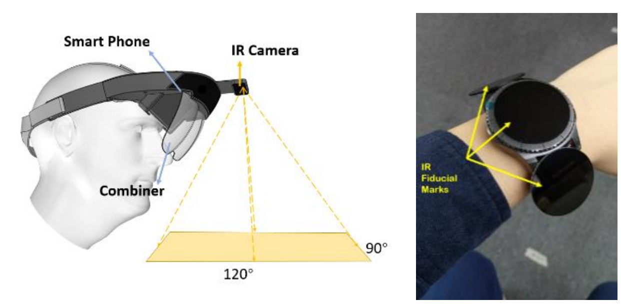

Figure 2: Left picture shows the tracking volume of the headset, right picture shows the IR fiducial markers on the smart watch.

We developed our own tracking algorithm and fiducial marker patterns [6]. The tracking latency is less than 1ms, which is sufficient for studying the interactions.

The smartwatch used in WatchAR prototype is a Samsung Gear Watch S3. The AR headset used in

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WatchAR prototype is a prototype AR headset with a Samsung S8 as the display source and computation provider. The AR headset has a FOV of 60° (horizontal) × 55° (vertical) with a resolution of 1440×1480 per eye.

4 Demos

Three demos would be demonstrated.

4.1 Air Hit: Single Handed Target Acquisition

Figure 3: *Air Hit* shot through the lens. Left picture shows the two-row layout, right picture shows the buttons placing far away from the user.

Unlike ray casting, we used an "air hit" gesture for 2D target acquisition. User can lift up his/her arm in the air and move it to different locations to hover at different targets. User can then confirm a selection by performing a "hit" gesture. In this demo, different notes of sound would be played upon different button hits. The button moves kinetically during interaction which appears like there is a spring attached to it.

We include three variables: ORIENTATION, POSITION and ARRANGEMENT. ORIENTATION: the UI plane is horizontal or vertical. POSITION: the UI plane is placed at the arm area or in front of user. The first one enables direct interaction while the latter one doesn't require user to bend his/her neck. ARRANGEMENT: the buttons are arranged in one or two rows.

4.2 Picker Input: Efficient 1D Selection

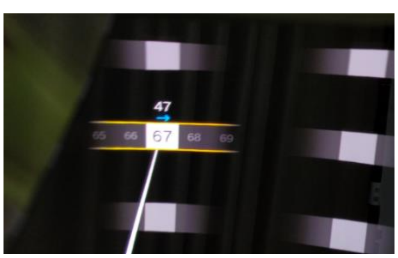

Figure 4: *Picker Input* demo, shot through the lens

Picker [7] is a commonly used UI widget on mobile platforms to select an item from a list. In this demo, user can point at a picker and rotate the rotating bezel on the smart watch to select the desired item quickly. We implemente a "speed up" feature: a signal would be sent by the smartwatch when the bezel is rotated by one detent (there are 24 detents in total 360 degrees). If two signals are received within a very short interval (<100ms), it means that user want to speed up. The picker would then move more steps (e.g. five steps) instead of one per signal. This could speed up the process when user want to move a lot of steps (e.g. from 1 to 90).

4.3 Space Fighter: Pointing Gesture for Gaming

Figure 5: *Space Fighter*, shot through the lens.

We explore whether WatchAR can be used for fast paced interactions like in a shooting game. In this demo, player pilots a space ship and dodges the enemy by moving it. The space ship would fire at the enemy automatically when the enemy is within 15 degrees of the pointing range of the spaceship.

5 Conclusion

We have presented WatchAR, an efficient and intuitive interaction system of 6-DoF trackable smartwatch for mobile AR. We explored different interaction possibilities by presenting three unique demos. In future work, we will explore other interaction modalities, look for ways to reduce fatigue, explore single handed input as well as further miniaturize the prototype.

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