Augmenting Reality Through Wearable Devices

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Abstract. Wearable devices such as smart watches, fitness bands, and other easily concealable sensors are become ever more ubiquitous in today's society. People are often checking their steps, heart rate, or text messages, with the same ease in which they would check the time only a few years ago. With all the data being collected and shared there is a new opportunity to leverage this information to better inform augmented reality. With wearable devices, there is the ability to create a fully personal augmented reality experience, tailored to the user's preferences, abilities and bio-metrics. This includes the ability to track things like heart rate and skin temperature, and inform runners when they are overheating, or suggest to sedentary workers that they perform exercise, and take the stairs, but when combined with rich interactive narrative, rules, and goals the feedback from these devices become an augmented reality game.

The ability for wearables to support augmented reality experiences is already in place. Users often already own the devices and they already interact with their own phones, or computers. It is possible to both leverage a single user's data, but also aggregate data across users and provide an even more immersive experience. This research discusses the use of wearable sensors in a framework of more complicated augmented experiences with design examples user analysis from a smart watch game for pedestrian safety (Crime Watch), and the wearable technology infrastructure that supports it.

Keywords: Smart watches · Wearable technology · Augmented reality · Ubiquitous computing · Gamification

1 Introduction

Wearable devices are increasingly becoming ubiquitous technologies. Large numbers of people are wearing smart watches and fitness bands. These are influencing how the users interact with the world. Sometimes this influence can be motivating. For example a fitness band can encourage more walking or exercise. Other times this can be a distraction, like a text message taking the users attention from a conversation. No matter how these devices are normally used, they can also be used as portals to augmented reality experiences. The ability for wearables to support augmented reality experiences is already in place. Users often already own the devices and they already interact with their own phones, or computers. It is possible to both leverage a single user's data, but also aggregate data across users and provide an even more immersive experience.

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This research discusses the use of wearable sensors in a framework of more complicated augmented experiences with design examples from a smart watch game for pedestrian safety (Crime Watch), and the wearable technology infrastructure that supports it.

2 Background

Smart watches are a relatively new phenomenon that is growing in popularity. Smart watches sync with smart phones (i.e. iPhone, Android) allowing wearers to engage with their phone's information without taking the phones out of their pockets. One popular use is controlling music in a car without having to go through the complicated process of taking out a phone, unlocking it, opening the music app, and selecting a song. This can all be done with a few clicks on the buttons on the side of the watch.

Sensors in Smart Watch AR are usually leveraged from a cell phone. This provides a certain limitation on the type of input that can be leveraged, unless the design incorporates both a phone and watch component. Allowing all available sensors in both devices to be used in applications. Table 1 shows the appropriate technologies for device based AR found in phones.

Table 1. Comparison of available AR sensor tech, modified from [1]

Technology	iBeacon	NFC	Markers
Hardware Requirements	Requires a handheld device that supports Bluetooth Low Energy.	Requires a handheld device that supports Near Field Communication (Not iOS)	Requires a device that has a camera installed.
Range	Up to 250 feet away and as close as a few inches.	A few inches away at most. The ability to touch handheld preferred.	Needs a direct line of sight, but could work across varied distances depending upon camera resolution.
App Requirements	Apps must know about specific beacons in advance and know what to do when those beacons are detected	App does not need to know about specific NFC chips though they can. Information can be stored and shared directly from the chip.	Apps may know about specific markers, but some standard format markers can contain information (QR Codes) and could use general purpose apps.
Setup Required by User	The user only needs to install the app and possibly enable	The user needs to install the app and enable NFC on	The user may have a general purpose app or might need

(*Continued*)

Table 1. (*Continued*)

Technology	iBeacon	NFC	Markers
	Bluetooth through the phones settings. This can be done through the app as well.	their phones. They will also need to physically touch sensors.	to install a specific app. No other functions need to be modified.
Setup Required by app developer	iBeacons need to be placed in specific locations by the developer. Finding the best location can be difficult.	NFC tags are placed in specific places. Generally easier to place than iBeacons, but may require specific information written to them.	Unique markers must be developed with visual variation.
Benefit	Can determine locations in and around buildings with high accuracy and no physical connection from the user. Can be used for long and short distances. Can be completely hidden	Can contain information. Can record information for user. Inexpensive Easily Hidden from view	Low cost solution Supports most devices
Issues	Higher cost than other solutions Proximity is directionless Requires Bluetooth on the device	Needs magnetic shielding on metal Short Range No iOS support	Needs line of sight Cannot be hidden Often considered unsightly

Additional sensors that can be leveraged on a cell phone are GPS, accelerometer, and compass sensors. Watches often also provide access to additional accelerometers, pulse sensors, buttons, galvanic skin response, and other sensors depending upon the device. Leveraging these sensors along with strong narrative and a gamification layer can provide an augmented experience without the use of traditional AR hardware.

3 Wearable Device Games

In the past there have been many attempts to make wearable device games. This includes games that leverage the Nintendo Game Boy Advance to add pedometer support. The gamified Striive device provided a FitBit style interface with an imbedded game.

Nintendo made a walking game that included sensors for both the player and their dog. All of these systems attempted to combine both movement and games. Newer devices such as watches have opened a new area of wearable device AR.

4 Technology Supporting Wearable Device AR

As the watch market matures there are now three leading types of watches, there are also many common sensors. These sensors find themselves in each type of watch or fitness sensor.

4.1 Common Wearable Sensors

The common sensors found in these devices are: Accelerometers, pedometers, pulse rate sensors, galvanic skin response sensors, and leveraged device sensors.

4.2 Major Wearable Categories

There are three major types of watches.

Apple Watch. The Apple Watch is developed by Apple and in only compatible with iPhone devices. The apple watch includes accelerometers, pulse rate sensor, and touch screen. These watches cost $300 and up and all work the same. Watches last about a day on single charge.

Android Wear. Android Wear is a category of smart watch designed by Google, but implemented by a large number of manufacturers. This means that the watches are often customized and it is not possible to know exactly what features will be available. Costs range from $80–$400 and up. Also, they come in both round and square screens. Watches last about a day on a single charge.

Pebble Watch. Pebble has three models of watch. One has a round screen. The other two are square, and are very similar except one is black and white, while the other has a color screen. They work equally well on both iPhone and Android phones. These watches range about $99 though prices vary. The screens are e-ink so the phones last almost a week on a single charge.

Fitness Bands. Fitness bands come in many shapes and sizes. The most capable of these bands currently is the Microsoft Band. This band includes skin temperature, pulse, galvanic skin response, and more. Costs are about $200.

5 Common Wearable Device Applications

The common applications on wearable devices are light in functionality. There are many reasons for this including the need to conserve battery power, the need to be unobtrusive to the users, and the small size of the screen. So, it may seem inconceivable

that augmented reality applications could run on such a device, but watches have been augmenting our reality for centuries, if only to provide the date and time to the wearer. Common applications extend this by providing real time weather, health, and other information to the user. Games for watches had traditionally been bland or simple remakes of Atari or other older games, but watch based AR is possible.

6 Crime Watch Case Study

In a recent study conducted by the National Complete Streets Coalition found that the top 4 most unsafe cities in the United State were in Florida, and the top city was Orlando with over 200 pedestrian deaths last year. Further, there have been over ten pedestrian deaths on Alafaya Trail in front of the University of Central Florida in the last seven years. Authorities have cited large six lane roads, fast moving traffic, and a large pedestrian population as causes of these problems. However, it is difficult to assess where these issues are occurring, and even harder to capture the focus of drivers on pedestrians when they are already focused on getting to where they are going and the huge number of vehicles that seem like a more prominent threat.

In an effort to help bring driver focus to pedestrians, and to identify problem intersections within the city, a smart watch based game that will increase awareness of drivers on pedestrians was designed. This project is an innovative approach to pedestrian safety, which could lead to many other types of games for pedestrian safety, as well as crowd sourced data collection.

The benefit to the University is that there is a real possibility that the game could lead to impactful change on campus and throughout the city. Safety on campus for both pedestrians and drivers is important. Even playing the mental game of finding people breaking traffic rules has an immediate change in a driver's mindfulness of their surroundings. With motivation added through games there will be an increased awareness in players.

6.1 Split Design

The design of Crime Watch is split between the phone and the wearable. Each side is used when most appropriate to the user. For reporting data the watch is used. For exploring the data the phone.

Watch Side. The watch side of Crime Watch runs on Pebble watches. The interface on the watch originally had a much more complex design, allowing the player to report multiple types of violations for both vehicles and pedestrians. It also allowed the player to view their statistics (Fig. 1).

Realizing that these extra options made running the game more difficult the design was changed to only allow for the reporting of generic pedestrian or automobile violation. When reporting the watch leverages the phones GPS and reports both the type of violation and its location.

Fig. 1. Crime watch running on a pebble watch

Mobile Device Side. The game provides a mobile app as an entry point that will describe the games narrative and engage the players in acting as a Dick Tracy style detective, helping to track a particular population that does not follow traffic laws. Tracking of this population will be done at traffic lights when the driver is stopped, through their smart watch. The watch app will harness GPS data from their phones and allow the driver to report pedestrians that are crossing inappropriately, cars that are running lights, and other common violations. On the phone app players will be able to see maps or areas others have reported, track their own reports, and will be given points for and achievements through a gamification layer in the app. More active players will be promoted to higher levels and will earn more points on a leader board though a rich gamification layer (Fig. 2).

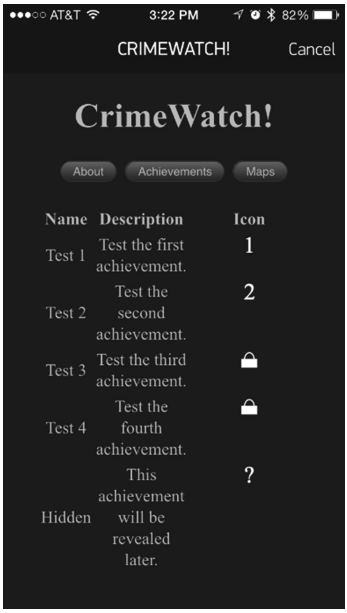

Fig. 2. Crime watch achievements

Gamification, or the act of adding gaming elements to real world situations, is a growing field with many recorded successes. Applying that to pedestrian safety is the logical next step. Smart watch research is in its infancy, but as we are on the precipice of Apple releasing their first watch in 2015, it is time to begin this type of research.

6.2 Leveraging the Crowd

More importantly, once drivers are asked to observe others committing traffic violations, and are engaged in the game they will begin to notice these violations even when they are not playing the game. They will spend more time thinking about the points they could earn in their current drive, then in the activities they would engage in when they arrive at their destination, and they will create a safer environment for pedestrians.

The results of players reporting traffic violations of both cars and pedestrians will be maps tracking various violations around intersections. These maps can then be used to determine issues with various intersections. For example, if cars are running the light, maybe the light isn't long enough, or if pedestrians are walking out in traffic, maybe there isn't enough time or clear visibility of all the traffic. Visits to these intersections combined with the types of reports collected can help shed some light into the urban design of the city.

7 Design Considerations for Wearable Device Applications

In the development of this application the following design considerations were developed.

- Battery Life: This is at a premium on watches. It is important to use as little battery as possible
- Attention: Watch applications can easily take attention from the user. There needs to be special attention paid to not taking too much attention.
- Appropriateness: Applications need to be appropriately scaled for use on small devices
- Distracted Driving: Watch use can also lead to distracted driving. Reducing text can help this.
- Distracting all the time: Watches can also be distracting in other settings.
- Small text on screen: Screens are small. If the text is also small it will be hard to read which can lead to more time spent looking at the watch than needed.
- Social interaction issues: Watches can distract the user and when the user looks at them they will look impatient because of centuries of watch use. This might not however be the case. Only ping the user when necessary.
- Fragmentation: Not all watch apps can run on all watches. With a small install base it is important to cast the widest net possible.
- Nothing complex: No applications should be complex on the watch. Shift complexity to the host device.

8 Conclusions

Most smart watch games are poorly converted Atari 2600 style arcade games, or passive play games similar to Farmville or Cookie Clicker. This will be one of the first games to actually leverage smart watch technology. The data collected can be used to identify problem intersections for both vehicles and pedestrians. Other variations of this game could find other dangerous urban design issues. Possibly more impactful, the same technology could be applied in other fields. For example, soldiers could identify possible IED locations, or crowd source enemy locations and armaments. These watches also include accelerometers; some even include heart rate and other sensors, and can be used as pedometers to track healthy activity in their wearers.

Reference

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