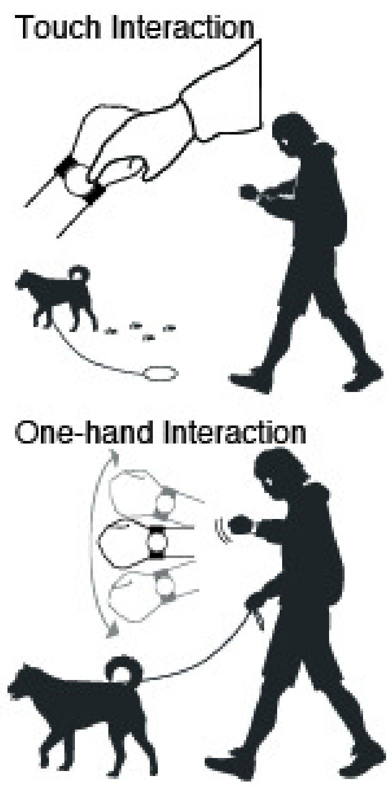

Figure 1: Touch interaction and one-hand interaction

Watch Spaces – A Spatial User Interface for Smart Watches

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ABSTRACT

We present a platform to prototype spatial user interfaces for smart watches relative to the user's body. We show the general feasibility and present 2 applications. The first application scenario enable users "pin" applications in the air around them and get back to them by moving the smart watch display at the same position again. The second application shows a zoom use case for maps or other larger displays/visualizations. The smart watch acts like a digital "magnifying glass" enabling the user to see details he cares about.

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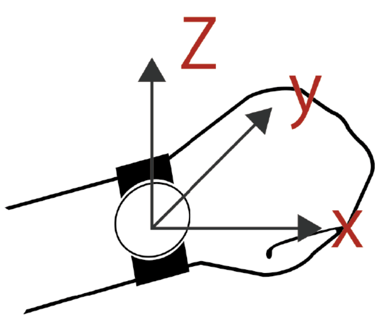

Figure 2: XYZ axis on the smartwatch

CCS CONCEPTS

• **Human-centered computing** → *HCI theory, concepts and models*; *Gestural input*.

KEYWORDS

Spatial Interactions; Smartwatch; Wearable; Extended Workspace; Gestures

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INTRODUCTION

Wearable devices together with Internet enable us to access any type of information anywhere. Yet, we often still use the two dimensional window metaphor for information interfaces. Even though early wearable computing work presented a lot of other paradigms [3]. In current smart watches as consumer products, interfaces with multi-touch, voice, and crown are used. Yet, mainly people use the touch screen.

However, touch interaction has the problem that the information of the position where the finger is placed is hidden by its nature and the range that can be input is basically limited to the size of the display.Therefore, it is very difficult to use a small screen-sized device closely attached to the body. There are research efforts to extend the interaction area from the watch to the arm or to the air on top of the watch[4, 5, 11].

Our approach is slightly different, we use the physical space relative to the user's body as a "Work Space" with the watch. The watch acts as a window into the virtual work space. The work space location and orientation is relative to the user's body, following early work on wearable spatial user interfaces [2]. Every time the user moves his hand to the same location relative to the body he will see the same information screen or application will open. Additionally, to the work space metaphor we also explore a "Digital Magnification Glass" concept, using the smart watch as a digital lense that can show more information about a visualization, map or other physical object.

The contributions of this paper are as follows: (1) We present a platform to prototype spatial user interfaces for smart watches and an initial implementation, (2) we provide two fully functional, proof-of-concept applications: A Spatial-Pin for watch applications and a digital magnification glass.

RELATED WORKS

Spatial Wearable Information Displays Our work is inspired by early mobile and wearable computing research,evaluating how to manage and display information in mobile scenarios with limited

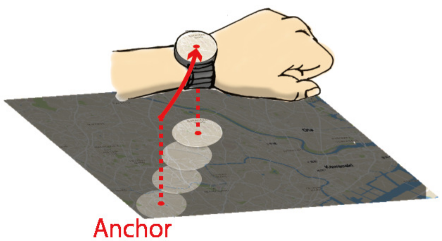

Figure 3: Extended Display & Anchor

Figure 4: Smart watch prototype equipped with IR Marker

screen estate [3]. We provide a spatial virtual display space relative to the user's body, the user can explore this space with the smart watch. Billinghurst et al. showed that body-spatialized displays provide benefits over head centered displays. They are easier to use and more intuitive as well as faster on search tasks [2]. Grubert et al. show a similar approach, yet focus on interactions on multiple devices devising methods to combine head- mounted display and smartwatch interfaces [8]. There are also a couple of other works focusing on extending/augmenting the smart watch display [9, 13]. Kening et al. show a smart watch extended to five displays [14]. Though closely related, we see our work complementary. We provide a platform for prototyping these type of interactions. Also, our concept implementation focus on a single device (smart watch) exploring the relative physical space around the user.

User Interaction Another larger group of researchers focusing on smartwatch interaction techniques to overcome the limited input space. Most of them implement novel wrist-worn sensors/devices [1][12]. Gesture input is one of the most socially acceptable methods[7]. Jun Gong, et al. suggest interactions with related to arm movements (mostly involving the elbow joint) [10]. They also evaluated hands-free interactions on the smart watch space [6]. This research supports our work as these types of interactions could be also used to interact with the Watch Spaces concept we introduce.

WATCH SPACES

In the following we present our general concept "Watch Spaces" as well as the underlying design ideas.

Concept

The Watch Spaces design is based on three key points we think are important for smart watch operations.

(1) One-hand only input: It should not be necessary to use 2 hands.
(2) Utilizing 3D physical space: We don't want to rely on finger movements for major interactions and want to use the whole 3D physical space.
(3) Virtual Extended Workspace & Anchor: User's should be able to access a large number of applications or tasks.

One-hand Input Currently,smart watches, often apply touch as a standard operation method. This means users need to use both hands to operate it. This is very limiting, especially if the user is on the go and carries bags etc. It is difficult to operate a smart watch in the case of holding something with the other hand (see Fig.1). Even if you reluctantly touch it, the interface is small, which cause many cases of miss-touch.

Figure 5: Tracking camera attached to the neck

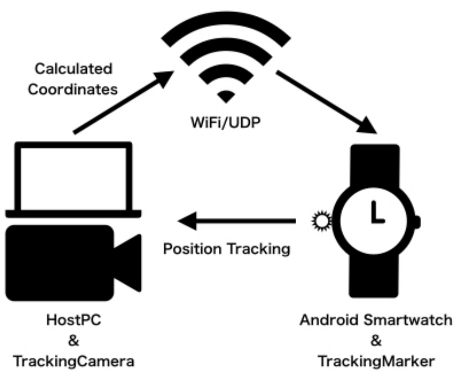

Figure 6: Configuration of system

Utilizing 3D physical space To make the input space more expressive (as we are limited to one hand), we design the interactions to use all 3 Dimensions of the physical space (see Fig.2). The user can use the smart watch to move closer to and away from the face. The user can move the wrist and the arm horizontally, and finally, the user can also move the arm up and down. The 3D movement can represent the switching, zooming, and more specific functions of an application.

Virtual Extended Workspace & Anchor As the display space of the watch is limited, we present the concept of an extended virtual 3D desktop for interaction around the user's body. The application "AppPin" described later uses a curved space around the user versus the "MapLense" uses a flat 2D space in front of the user (see Fig. **??**). Yet, the extended work-space can be defined by the application programmer using our concept.

We believe that the workspace extension should spatial based relative to the user. When accessing a large virtual workspace, the user defines an initial anchor (the starting point of the exploration). Due to proprioception, it should be easy for the user to find his way back to the starting point (Fig3). The anchor is necessary to synchronize the watch information with the larger map or visualization info for the "MapLense" use case.

Initial Prototype

Fig.4 and Fig.5 show the hardware implementation.And Fig.6 shows the system configuration. In this system, an Android smart watch with one infrared tracking blob attached is tracked by Leapmotion attached to the user's neck. We used Leapmotion to track bright pixels from the image obtained from the internal image API instead of the existing hand tracking function. Calculate the difference from the position of Blob obtained from the image of Leapmotion on Host PC and the position of Anchor. The position of Anchor can be set arbitrarily. The location information is sent to the smart watch via UDP. The smart watch displays the position and magnification of Extended Workspace corresponding to the received tracking position information.

The setup is easily replicable, we will share the demonstration code as open source.

Right now, we still need a leap motion on the body for tracking. For future, it's possible to remove this requirement, implementing inertial motion tracking with a body model and a nine-axis inertial motion sensor. Yet, we consider this future work. We wanted to present an easy to use and setup platform to prototype spatial smart watch interactions and are not so interested in product designs.

PROOF-OF CONCEPT APPLICATIONS

We present two proof of concept applications: AppPin and MapLense.

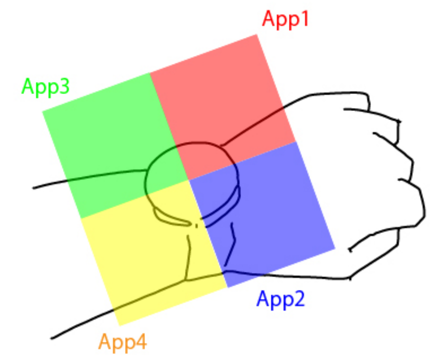

Figure 7: Concept of AppPin

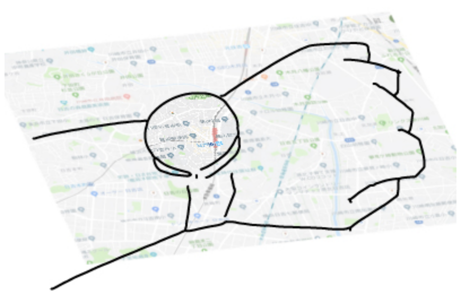

Figure 8: Concept of MapLense

AppPin

The Idea of is that a user can pin applications based on the relative position from his/her chest. The user can then switch back and forth between applications just by moving his arm again to the same position. In our proposed interaction, an anchor is always located in front of the chest established when the application is started.. With this interaction, it is possible to switch between displayed information and applications in an intuitive manner. For example, place the anchor point at the clock, then move the hand to the left side. The calendar will display on the left of the clock. and then if the user moves the hand to the right side, the weather forecast can be displayed on the right of the clock. Another Scenario includes the user using an arm scroll interaction to access scrolling text. This access is for hands-free access to information in some situations such as holding luggage by both hands. user is moving the arm up and down from the anchor point, it is possible to check a large amount of text. The access measure of information by swing is pre-designed by the user. Works in much the same way as general scrolling.

MapLense

Navigating and reading a map is often an important use case. In this application case the user utilizes the watch as a kind of lens or digital magnification glass. The smart watch can show more detailed information about a place, either giving the user the option to zoom in and out or get a different information overlay (maybe a population heat map or other types of data).

CONCLUSION

In this paper, we described a new method of spatial user interface for smart watches and presented a platform that implemented two prototype applications related to the concept. The major contribution is not so much the novelty of the concept, but a prototyping platform that let's developers and researchers explore interactions based on Watch Spaces as well as 2 proof-of-concept implementations.

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