SkiAR: Wearable Augmented Reality System for Sharing Personalized Content on Ski Resort Maps

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ABSTRACT
Winter sports like skiing and snowboarding are often group activities. Groups of skiers and snowboarders traditionally use folded paper maps or board-mounted larger-scale maps near ski lifts to aid decision making: which slope to take next, where to have lunch, or what hazards to avoid when going off-piste. To enrich those static maps with personal content (e.g., pictures, prior routes taken, or hazards encountered), we developed SkiAR, a wearable augmented reality system that allows groups of skiers and snowboarders to share such content in-situ on a printed resort map while on the slope.

Categories and Subject Descriptors
• Human-centered computing ~ Interaction devices • Human-centered computing ~ Ubiquitous and mobile devices

Keywords
Information sharing; skiing; augmented reality system; wearables.

1. INTRODUCTION
Skiing and snowboarding are undoubtedly highly social activities attracting millions of visitors to the mountains every year. Winter enthusiasts capture and share vast amount of pictures and videos during outdoor vacations. Recently, with an advent of portable GPS tracking devices and wearable sensors, it became possible to record one's own performance data on the slope and share it with others – to enrich an evening conversation or spice up a friendly competition while on the slope.

Such captured data can also help with the many decisions a group of skiers or snowboarders faces throughout a day: which piste to take next, what area to avoid when going off-piste, or how to catch up with friends for lunch or après-ski. Traditionally, folded papers maps or larger-scale board maps mounted along the slopes have supported skiers and snowboarders in these decisions by offering a basic navigational overview. However, such maps do not support any sharing of personal information (e.g., pictures taken, recorded GPS tracks) or customized context (e.g., relevant points of interests, hazards) that are often the basis for making such decisions. To aid decision making and support information sharing within groups of skiers and snowboarders we developed SkiAR, a wearable augmented reality (AR) system. Our first prototype consists of an AR application running on a smartphone (worn using a head-mounted phone holder) and a wrist-worn input device to control presentation and sharing.

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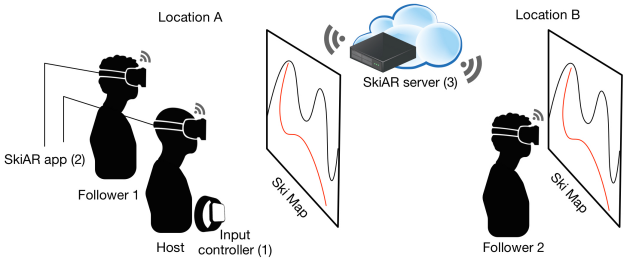

Figure 1. SkiAR system configuration. Generic watch image CC BY 3.0 Sherrinford on the Noun Project. Original goggles image CC BY 3.0 Boudewijn Mijnlieff on the Noun Project.

The *sharing of personal and contextual information* among members of a winter sports group is not only crucial for safety but also one of the ingredients of a positive skiing experience [1]. An empirical study by Fedosov and Langheinrich [1] with a group of backcountry skiers showed that the most important information they shared within a group were: (a) reference information necessary for descent (e.g., the time left until sunset, the operational hours of a ski lift at a particular location, conditions of the slope with detailed information about potential hazards during descent); (b) up-to-date location of skiers in a group and (c) personal media items (photos and videos). Consequently, our first prototype supports sharing four types of GPS-enriched content: pictures, tracks, points of interests (POIs), and hazards.

Previous research has looked at the skiing domain broadly from a technical perspective. Researchers described the emerging connectivity in the mountains [4] or built wearable computers to support on-slope communication [6] and navigation [5]. Jambon and Meillon [3] outlined a number of challenges while conducting experiments outdoors that involve complex hardware and software setups. We decided to use popular off-the-shelf devices that share a common software ecosystem, in our case iOS (using an iPhone and an Apple Watch), in order to approximate a future gadget for winter enthusiasts.

2. SKIAR SYSTEM
Ski goggles, a helmet, and gloves are typical attributes of any skiwear. We built our prototype with a vision of using ski goggles as an output display to provide additional information to skiers and snowboarders. Additionally, as suggested in the literature [2], using a smartphone on the slope is rather inconvenient. Therefore, we decided to use a wrist-worn controller in our setup to eliminate the trouble of having to take a phone out of a pocket. The SkiAR prototype *approximates* future technologies (as head-mounted *see-through* displays for active sports and *hands-free* input interfaces) with the help of a conventional smartphone and a

smartwatch. This allows us to test the interactive concept we envision.

2.1 System Configuration

The SkiAR system consists of: (1) an input device (watch) that handles user interactions; (2) an output device (head mounted mobile phone) running an application that mediates user interactions and provides an output interface, and (3) a server that handles content synchronization between multiple users in real time. Figure 1 shows the system configuration at a glance.

The SkiAR system supports two modes: *personal* and *sharing*. In personal mode, a user can review personal information: pictures taken previously, tracks run, hazards and POIs encountered. This information is only visible on the user's AR googles. The sharing mode supports sharing such information in a group. When in sharing mode, the SkiAR system supports two user roles: a *host* and one or more *followers* (see Figure 1). The host is responsible for creating a "group" before starting to ski and, subsequently, can share information with all followers in the group. Note, however, that *any* group member can request the host role and start sharing their content with others. The SkiAR server manages the group invitations and sharing sessions. We assume that all skiers have continuous Internet connectivity in the ski resort. In principle, followers do not have to be co-located with the host (Figure 1).

2.2 Output Interface and SkiAR App

The SkiAR app employs markerless tracking technique and uses printed maps of a ski resort as a tracking reference to overlay user's virtual content on top of it. Figure 2 shows the system's current user interface on a tablet. To achieve higher immersion, the SkiAR application supports the "stereoscopic" rendering of two screens next to each other. This allows users to insert their phone into a special type of AR goggles. As seen on the Figure 2, the system places photos, tracks, hazards, and POIs onto their corresponded physical locations on the ski map. The placement of these items is based on their embedded latitude and longitude information (e.g., EXIF information for pictures), using our custom-developed conversion algorithm that translates Geo-data into Cartesian map coordinates on the fly.

2.3 Input Interface

We use a smartwatch as the SkiAR input device. The watch is wirelessly connected to a smartphone in host mode. However, a more realistic input device may be a dedicated wristband controller. Figure 3 gives an example of the watch user interface in SkiAR. The user can control information presentation using a small set of swiping gestures. Figure 3a corresponds to the information presented to the user on Figure 2, where all available virtual objects can be seen in a single view. However, users can

Figure 2. SkiAR app running on a tablet computer

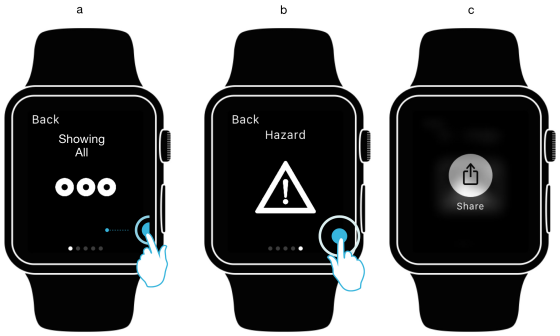

Figure 3. SkiAR input interface on a smartwatch. Generic watch image CC BY 3.0 m on the Noun Project.

filter and display only one type of objects at a time, e.g., only "Hazards" as indicated in Figure 3b. Additionally, it is possible to add new objects to the system using the watch interface (e.g., encountered in-situ hazards). In this mode, the system reads the current GPS position of a skier and registers a new item at this position. Finally, the *host* of a session can share any content category with other skiers in the group by applying a touch gesture while in the appropriate category and pressing "Share" (Figure 3c). The SkiAR system will then update the corresponding information for all *followers* automatically.

3. CONCLUSION

In this work, we presented the SkiAR system, a wearable augmented reality system for in-situ sharing of personalized information on ski resort maps. In future work, we plan to deploy the system "in the wild", evaluate its usefulness and usability and collect design requirements to better meet user needs. We hope that the SkiAR system could improve group decision making, interaction, communication, and, eventually, provide a safer environment for skiers and snowboarders.

4. ACKNOWLEDGMENTS

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5. REFERENCES

[1] Fedosov, A. and Langheinrich, M. From Start to Finish: Understanding Group Sharing Behavior in a Backcountry Skiing Community. *Proc. of MobileHCI '15 - Adjunct*, ACM Press (2015), 758–765.

[2] Fedosov, A., Niforatos, E., Alt, F., and Elhart, I. Supporting interactivity on a ski lift. *Proc. of UbiComp/ISWC '15 - Adjunct*, ACM Press (2015), 767–770.

[3] Jambon, F. and Meillon, B. User Experience Evaluation in the Wild. *CHI '09 Extended Abstracts on Human Factors in Computing Systems (CHI EA '09)*, ACM (2009), 4069–4074.

[4] Pfleging, B., Schmidt, A., and Michahelles, F. Ubiquitous Connectivity in the Mountains: Enhancing the Ski Experience. *IEEE Pervasive Computing 12*, 2 (2013), 5–9.

[5] Schmid, L., Holleczek, T., and Tröster, G. Ridersguide: The first real-time navigation system for ski slopes. In *Eingebettete Systeme*. Springer (2011), 71–80.

[6] Weilenmann, A. and Holmquist, L.E. Hummingbirds go skiing: using wearable computers to support social interaction. *Wearable Computers, 1999. Digest of Papers. The Third Intl. Symposium on*, IEEE (1999), 191–192.