Peripheral interaction for sports – exploring two modalities for real-time feedback

Stina Nylander, Jakob Tholander, Alex Kent

Mobile Life @ SICS, Swedish Institute of Computer Science, Box 1263, 16429, Kista, Sweden

stny@sics.se, jakobth@dsv.su.se, alexkent@mac.com

Abstract. We believe that sports is a domain that would both provide valuable input to the area of peripheral interaction, as well as benefit from peripheral interaction itself. We present two pilot studies on peripheral interaction for cross-country skiing and golf using vibration feedback and audio feedback respectively. We believe the results of these initial studies are encouraging and aim to pursue the concept of peripheral interaction for the sports domain.
Keywords: Sports, real-time feedback, body movement.

1 Introduction

At her keynote speech at CHI 2010, Genevieve Bell pointed to sports as one of the domains that have been largely forgotten in Human-Computer Interaction (HCI) research, even though work is starting to emerge. We argue that HCI research in sports could contribute to the general problems involved in how to develop interaction models for a range of complex and variable settings where traditional hand-eye interaction is not sufficient, i.e. settings for peripheral interaction. Sports and physical activity provide challenging examples of such settings, and design principles and interaction techniques are potentially transferrable to other mobile domains, such as social and leisure activities in nature.

2 Peripheral interaction in sports

Our take on peripheral interaction comes from the sports domain, where interactive technology has been an integrated part for a long time. However, most technology either support data collection for post analysis such as GPS watches, heart rate monitors, or research prototypes like XC trainer [1], or provide visual interfaces (such as pulse watches) which can be rather difficult to handle during intense sports sessions. There are exceptions in HCI research, e.g. Spelmezan’s work on snowboarding [2] and Stienstra’s work on skating [3], but they are few. We have conducted initial experiments with tactile and audio feedback during sports to explore how we can design interaction that fits into the activity without breaking the experience or focus of the athletes. We argue that sports technology could benefit from peripheral interaction due to a number of characteristics of sports and physical activity in general:

- many sports involve the whole body and thus requires a mental focus on the activity and the bodily movement making it difficult for athletes to focus on visual user interfaces,
- it is common that sports use physical props such as ski poles, golf clubs, or in other ways occupy parts of the athletes body such as holding the reins during horseback riding or the handle bar of a bike, refraining athletes from holding devices for interaction,
- athletes, both elite and recreational athletes, strongly appreciate the experience of doing sports and prefer not to have their focus on that experience disturbed by technology [4, 5].

This list is in no way exhaustive, but gives some insight on how we see the relationship between sports and peripheral interaction.

3 Experimenting with two different modalities

To investigate how peripheral interaction could be used in sports we have explored two modalities for real-time feedback for two different sports: tactile feecback for cross-country skiing and audio feedback for golf.

3.1 Skiing and vibration feedback

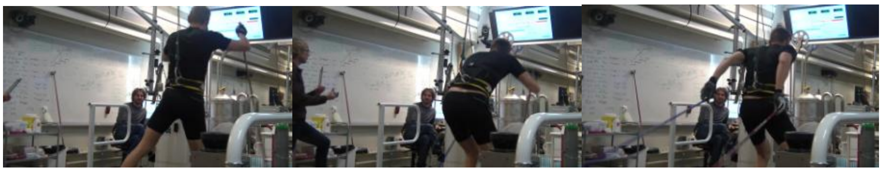

Figure 1: One of our skiers on the treadmill.

The study was carried out at the Swedish Winter Sports Research Centre in Östersund, Sweden. Four Swedish elite skiers participated, recruited by test leaders at the research centre.

The purpose was to explore how vibrational feedback is perceived *during* a sport activity, to what extent it integrates with or disrupt the experience, and how the perception of vibrations are affected by physical activity, and vice versa.

The skiers were equipped with a cell phone strapped around the chest, and skied on a treadmill using different skating techniques at various speeds and inclinations for approximately 30 minutes each, see figure 1.

Different vibration signals were remotely triggered in the phone attached to the skiers' chest. Signals varied in length and repetition. They were all were of the same strength (internal to the phone). Skiers were instructed to acknowledge and comment on the vibrations when they felt them. A post interview was carried out after the skiing session. The whole session was video and audio recorded.

Overall, the skiers were very positive to the idea of vibrational feedback on their skiing technique. They all said they clearly perceived the vibration, and did not describe the experience as intrusive or distracting. Several of them would have preferred a stronger more distinct vibration to make it easier to perceive while focusing on the skiing at higher level of fatigue.

As stated above, the vibration strength did not vary during the session, but the skiers expressed that they had experienced variations in strength. Possible reasons for this could be variations in tension in the upper body as well as variations in focus and concentration in different speeds and techniques, and different levels of fatigue. For instance, one of them said that *you need to be really focused to ski fast, so you block out a lot of stuff.* This suggest that the strength should possibly be increased as skiing intensity increases, but also, that the feedback should not attempt to involve to much information as it may disturb the focus of the skier, thus, potentially being contra-productive.

The skiers believed that vibration feedback on their skiing technique would be helpful during training sessions. In particular, they foresaw using it during high-intensity sessions where they would be especially focused on maintaining a correct technique despite a high-level of fatigue. Moreover, they reported that the skiing technique in general is more in focus at higher workloads since that is when loss of technique is most costly. Consequently, it would be in these situations that skiers would benefit mostly from interactive training support. During slower skiing, the technique is usually less critical so feedback would not be as valuable.

Examples in which they mostly themselves saw the usefulness of real-time feedback were technical details such as the transferring of weight from side to side, keeping the appropriate angles in hips or knees, to help keep specific technique training details in mind, and to be reminded of thinking about technical improvements that they could be working on.

The skiers also saw connections to video analysis, motion capture and other interactive tools that they use to analyze skiing technique. Such tools could be used to reveal important details that need improvement. Combined with real-time feedback mechanisms in the field, these could then be used to prompt skiers to think about those details and keep them constantly in mind during training sessions.

3.2 Golf and audio feedback

For golf we created a system where a sensor attached to the golf club (see figure 2) records accelerometer data which is mapped to real-time audio feedback. The system was implemented as an iphone app using pure data to generate the sound (see [6] for details on the system). Our aim with the feedback was rather to mirror the movement and support golfers in making their own interpretation of the swing than to provide a corrective system, inspired by the Interactional Empowerment philosophy [7].

Figure 2: Sensor attached to the golf club.

We have tested the system in three iterative sessions with experienced golfers to get feedback on the concept of real-time audio feedback on the swing. Typically during testing, users hit four or five golf balls and then been asked to comment on the experience and their understanding of the system, see the setting in figure 3. They tried different sounds and different timing of the feedback. The sessions were video recorded, and system sudio output was recorded in synch with the video.

Figure 3: The setting of our test sessions.

A few themes came up that are interesting for future development and tuning of the system, as well as providing input to the design of peripheral interaction in general:

Interpretation of discrete audio feedback – participants had some difficulty in perceiving real-time feedback since they were focused on swinging and did not have full attention on the feedback. The speculated in this having to do with our audio memory being less trained compared to our visual memory. It might also be the case that audio feedback on a discrete movement such as the golf swing requires more interpretation than a continuous movement such as running or cross-country skiing.

For a continuous movement, athletes can listen for a change in the audio, while for the golf swing they cannot do that.

Timing – from that, we of course came to discuss timing, and also from the second test session provided a mode of the system where the feedback was played directly after the swing instead of during it. We explored different delays to investigate how the timing helps users relate the feedback to the movement and how to make it feel connected to the movement.

Variation in the feedback – participants wanted larger differences in the audio feedback. In the current version of the system they reported that they could hear differences in the feedback between various types of shots, but the differences were quite small and difficult to notice.

In all, participants were positive to audio feedback and has many ideas on how to make it more useful as a golf training tool, for example allowing users to calibrate the system by saving successful shots, creating reversed feedback where the system is silent for good swings and gives audio feedback when the golfer deviates too much, or extending the system to give feedback already on the stance before the swing starts.

4 Discussion

We have presented initial results from a pilot study on the design of peripheral interaction in the form of real time vibrational and audio feedback in sport activities. Overall, this works targets design of services for movement based and bodily engaging settings in the wild. Our overall conclusion is that well designed real-time feedback can be provided for a variety of purposes without disrupting or disturbing the actual sporting experience. Moreover, even though the feedback we provided was relatively basic, the athletes saw usages that went beyond what we had foreseen when designing the study. This points to the possibility of using simple, easy to use devices when designing for a complex settings and activities.

References

1. Norström, C., Holst, A., Nylander, S., Tholander, J., Jonassson, A., Höök, K., Holmberg, H.-C.: Internet of Sports: a pilot case study from XC skiing. Submitted to Sports Engineering (2013)
2. Spelmezan, D. An Investigation into the Use of Tactile Instructions in Snowboarding. In Proceedings of MobileHCI. (2012) 417-426
3. Stienstra, J., Bruns Alonso, M., Wensveen, S., Kuenen, S. How to Design for Transformation of Behavior through Interactive Materiality. In Proceedings of NordiCHI. (2012) 21-30
4. Tholander, J., Johansson, C. Design qualities for Whole Body Interaction - Learning from Golf, Skateboarding and BodyBugging. In Proceedings of NordiCHI. (2010) 493-502
5. Höök, K. Transferring qualities from horseback riding to design. In Proceedings of NordiCHI. (2010) 226-235
6. Kent, A. A prototype sonification system for the golf swing. Master's Thesis, Department of System and Computer Science, Stockholm University (2013)

7. Höök, K., Ståhl, A., Sundström, P., Laaksolahti, J. Interactional Empowerment. In Proceedings of CHI. (2008) 647-656