Real-time snowboard training system

Daniel Spelmezan
Media Computing Group
RWTH Aachen University
52056 Aachen, Germany
spelmezan@cs.rwth-aachen.de

Jan Borchers
Media Computing Group
RWTH Aachen University
52056 Aachen, Germany
borchers@cs.rwth-aachen.de

CHI 2008, April 5 – April 10, 2008, Florence, Italy
ACM 1-xxxxxxxxxxxxxxxxx.

Abstract
We present a wireless prototype system for real-time snowboard training. This system can be used to detect common mistakes during snowboarding and to give students immediate feedback how to correct their mistakes. The project illustrates new ways to assist students during sports training and to enhance their learning experience on the slope.

Keywords
Snowboarding, wearable computing, wireless sensor system, improving sports performance, real-time feedback

ACM Classification Keywords
C.3 Special-purpose and application-based systems: Microprocessor/microcomputer applications, Real-time and embedded systems. H.5.2 User Interfaces: Auditory (non-speech) feedback, Haptic I/O

Introduction
Learning new sports techniques is often difficult and time consuming. Students need to practice for a long time until they can perform the necessary techniques of a sports domain correctly. In snowboarding, skiing, or surfing, students often receive feedback from their instructor only after they have performed an exercise. Instant feedback from an instructor is less feasible because of the spatial and temporal nature of these sports (Figure 1).

We present a prototype that uses sensors attached to the human body and inserted into the boots that detects mistakes during snowboarding. The system is intended to provide immediate audio and tactile feedback to alert users to incorrect movements and body positions.

Figure 1: Two beginners on the slope. The instructor cannot talk to the students to give them feedback on their mistakes.

Related work

In recent years, the interest in pervasive and ubiquitous computing for sports and fitness increased. Some of this interest stems from improving sports performance for elite athletes[1] or from providing incentives that motivate and support fitness in daily life[2]. Michahelles et al. [3] developed a wired system to collect data of a skier's movements for off-line analysis. Takahata et al. [5] and Kwon et al. [2] presented real-time systems for martial arts training. Kunze et al. [1] conducted an experiment to recognize tai chi movements. Paradiso et al. [4] presented a system for real-time monitoring of gait.

[1] http://www.sesame.ucl.ac.uk

[2] Workshop on Monitoring, Measuring and Motivating Exercise: Ubiquitous Computing to Support Physical Fitness, Ubicomp 2005

Interviews with snowboard instructors

We interviewed six snowboard instructors to understand how they teach and to gain more insight into the most common mistakes in snowboarding. The instructors confirmed our initial assumptions that they cannot observe all students at the same time on the slope and that it is often impossible to give a student instant feedback during an exercise. In summary, all of the interviewed instructors stated that our system could be useful for both instructors and students. They imagined using our system themselves to fine-tune their own movements as well as using the system in their own courses, allowing students to focus on a particular mistake.

Prototype and implementation

Figure 2 shows our wireless prototype system that senses the rider's motion and posture on the snowboard. We tried to address three common snowboarding mistakes that the instructors mentioned: Insufficient knee bending, incorrect weight distribution, and incorrect rotation of the upper body. Our system consists of one Bluetooth Arduino board[3], two Bluetooth Shake SK6 inertial sensor packs[4], two bend sensors and four force-sensitive resistors (FSR). We attached one bend sensor to the back of each knee to measure the amount of knee flexion during the ride. To measure the weight distribution on the snowboard we inserted in each boot one FSR under the heel and one FSR under the ball of the foot. We measured the body and snowboard rotation with the digital compass algorithm of the Shake devices that we attached to the upper body and to the shin with hook and loop fasteners. The system sampled data at 20 Hz.

[3] http://www.arduino.cc

[4] http://www.samh-engineering.com

We used a Nokia N70 mobile phone as host device to collect sensor data over the Bluetooth serial port profile.

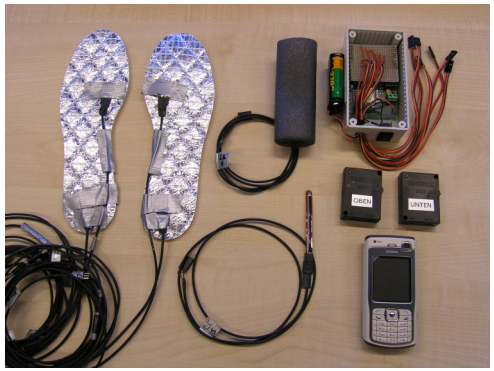

Figure 2: The wireless prototype to sense the rider's motions on the snowboard.

Pilot study

To test whether our system can sense the most common snowboarding mistakes mentioned above, we conducted a pilot study in an indoor wintersport resort with three snowboarders on advanced beginner level. We captured the subjects on video and simultaneously recorded the sensor data using the mobile device. The off-line analysis of the sensor recordings revealed that it is possible to detect insufficient knee bending and the weight distribution on the snowboard in real-time merely by using thresholds. The necessary software for real-time mistake detection can conveniently run either on the mobile phone or on the microprocessor of the Bluetooth Arduino board. We also found that acceleration during the ride influenced the compass measurements of the Shake devices, thus making it difficult to reliably detect incorrect rotation of the upper body.

Future work

We are currently improving our prototype system to make it more robust. We also plan to experiment with alternative sensors and their placement on the body, especially to improve detection of incorrect upper body rotation. We further want to compare different modalities to provide real-time feedback for snowboarders. Although audio feedback is straightforward and natural, the noisy environment may make it less useful. The tactile channel could be an alternative way to provide instructions. We ultimately want to investigate how to design patterns of tactile feedback that riders can easily interpret and react to and how real-time error detection and feedback affects the snowboarding and learning experience.

References

[1] Kunze, K. and Barry, M. and Heinz, E.A. and Lukowicz, P. and Majoe, D. and Gutknecht, J. Towards recognizing tai chi - An initial experiment using wearable sensors. Proc. IFAWC 2006.

[2] Kwon, D. Y. and Gross, M. Combining body sensors and visual sensors for motion training. Proc. ACE 2005, vol. 265, 94-101.

[3] Michahelles, F., Crameri, E., and Schiele, E. Design, implementation and testing of a wearable sensing system for professional downhill skiing in cooperation with trainers. Proc. IFAWC 2005.

[4] Paradiso, J. A., Morris, S. J., Benbasat, A. Y., and Asmussen, E. 2004. Interactive therapy with instrumented footwear. Proc. CHI 2004, Extended Abstracts, 1341-1343.

[5] Takahata, M., Shiraki, K., Sakane, Y., and Takebayashi, Y. 2004. Sound feedback for powerful karate training. Proc. NIME 2004, 13-18.