Ubiquitous Sports Technologies Seminar Kick-Off WS2017/18
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Introduction to HCI in sports
Procedure
Presentation of topics
Q&A
Find group partners
Fields

• Dr. Florian Daiber
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  • Field: Run Tracker ++

• Frederic Kerber
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  • Field: UI Adaptations for Wearables based on current User State

• Felix Kosmalla
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  • http://umtl.cs.uni-saarland.de/people/felix-kosmalla.html
  • Field: Rock Climbing

• Frederik Wiehr
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  • http://umtl.cs.uni-saarland.de/people/frederik-wiehr.html
  • Field: Navigation in Long Distance Endurance Sports
Introduction
A Brief History of Computers in Sport

- **Biomechanical Modeling** since the mid 1960's, e.g. Pagenhoef 1969

- **Information and Documentation** since 1967 - 1st demonstration of sports documentation on an IBM computer in Graz, Austria

- Applications of computer technology in "Physical Education" since the mid 1980's, e.g. Sharp and Paliczka 1984, Donnelly 1987, Skinsley 1987
Ubiquitous & Wearable Computing in Sports
Ubiquitous Computing

Adapted from Mark Weiser

1) Mainframe
1 Computer
Many Users

2) PCs
1 Computer
1 User

3) Netbook, Smart Phone, Smart Card
1 User
Many Computers

4) Intelligent Objects
1 User
Many Computers

Sales/year

Time

Adapted from Mark Weiser
Wearable Computing
Wearable Computing

- Computers are „worn“ on the body
  - always on
  - easily accessible
  - connected to a network
- Other important properties:
  - extend the user’s interaction possibilities
  - use sensors to track the user and her environment
Thorp and Shannon (1961)

- Wearable timing device for roulette prediction
  - Audio Feedback
  - 4-Button Input
Taft (1972)

- Wearable computer for blackjack card counting
  - Belt Computer
  - Shoe Input
  - LED in Glasses as Output
MIThril (2000)
Wearable Computing today
Designing Wearables

• Wearable design involves human users from the very beginning

• The design process often starts with a corpus collection of human data
  • Collect as much (labeled) data as possible!

• Data collection is often challenging (e.g. synchronize different sensors)

• When collecting human data
  • Sufficient large number of participants
  • Controlled lab studies often not suitable
  • Ethical aspects (tracking location, medical data, etc.) need to be covered
Handling Wearable Data

- Data Labeling is cumbersome and time consuming
  - (Semi-) automatic labeling
- Data Analysis & Modeling
  - High-dimensional data usually require dimension reduction and/or feature selection
  - Start simple:
    - Simple measures can provide first valuable insights
    - More powerful techniques can be used later
Opportunities & Challenges

• Wearable Computing is a cool research topic!

• Wearable sensors to measure the Quantified Self.

• For the evaluation of wearable designs, a between-subjects experimental design is often mandatory

• Many research prototypes and some commercial products, but
  • not yet usable and widely accepted
  • only few fulfill Weiser’s definition of ubiquitous computing
Sports & Activity Tracking
Activity Recognition & Tracking

• Recognize and track user behavior with the goal to proactively assist users with their tasks

• Wearable systems are suitable for activity recognition in daily life

• Inertial Measurement Units (IMUs) mainly used for activity recognition

• Typical activity recognition consist of: pre-processing, segmentation, feature extraction, and classification

• Smartphones already support basic activity recognition

• However it is still a hard task to track many daily life activities, e.g. drinking
Activity Tracking Examples

- Simple (sports) activity tracking:
  - Steps (IMU)
  - Stairs (Barometer)
  - Sleep (IMU)
  - Sports Activities (heart rate)
In-the-wild Sports Research

• Wearables enable In-the-wild Sports Research!
• Equip athlete with loads of sensors and see what happens ;-)
• Study protocols differ from (over-)controlled lab settings
Ubiquitous Sports Technologies

Research Examples
RecoFit

• **Tracking Strength Training**

• Challenges:
  
  • Segmenting exercise from intermittent non-exercise periods
  
  • Recognizing which exercise is being performed
  
  • Counting repetitions

ClimbAX

ClimbAX: Skill assessment for climbing enthusiasts
In Proceedings of UbiComp '13, ACM, 235-244.
ClimbSense

- Climbing Route Recognition and Tracking

- Approach:
  - extract arm orientations during grabbing
  - convert these to a string of symbols
  - compare the strings with the training database

Fatigue Tracking in Running

- Classification of the perceived fatigue state of runners during running based on biomechanical and physiological data

- Feature selection and classification

- heart rate variability feature and two biomechanical features were best suited for classification of the perceived fatigue level.

- Resulting classifier was implemented on an embedded microcontroller.

FootStriker

• An EMS-based Foot Strike Assistant for Running
  • Reliably detects heel-striking.
  • Stimulate the calf muscles to actuate the foot angle.

• Main Findings
  • Participants avoided heel striking with EMS Actuation without any further instruction.
  • EMS Actuation significantly outperformed Traditional feedback.
  • EMS Alert was significantly less effective than EMS Actuation.

FootStriker

An EMS-based Foot Strike Assistant for Running

Mahmoud Hassan, Florian Daiber, Frederik Wiehr, Felix Kosmalla, Antonio Krüger

German Research Center for Artificial Intelligence (DFKI)
Saarland Informatics Campus
Germany
Wearable Sports Technologies

- Designing wearables for sports is challenging
  - Data collection
  - Data analyses
- Designing wearables for sports can be fun!
Procedure
Procedure
for this semester

START

Groups & Topics
find groups of 3-4 people and decide for topic

Brainstorming
meet with your supervisor for moderated brainstorming

Proposal
presentation of project proposals

Mid Presentations
present the current status of your project

Final Presentations
and deadline for final report

FINISH

today
06.11
20.11
8.1
TBA
Registration

- register in LSF / HISPOS within **the next 2 weeks**
- registration is already open
- if not registered, you won’t receive credit points for the seminar
- https://www.lsf.uni-saarland.de
- *deliverables via email to advisors*
Brainstorming

Meet with your group and your advisor to discuss.

- takes place on **6.11.2017, 2-4pm**
- during this session, we generate ideas and select the topic
- we provide a brainstorming methodology
- please read related work and bring initial ideas

The result of this session constitutes the basis for the project proposal.
Meet with your group and write a proposal for your project. This should include:

- short introduction of problem, motivation and goals
- milestones you want to reach
- equipment you need
- related work (scientific work and existing commercial systems)
- planned method of evaluation and testing
- the template from the seminar website is mandatory to use

Submit until 20.11.2017, 23:59, if necessary meet with your advisor for discussion.
Main Phase

Meet with your group to build the prototype.

- starts after submission of the proposal
- mid project presentation
- ends with final presentation

You are encouraged to help each other and regularly talk to your advisor.
Mid Project Presentations

Time  8.01.2017
      2pm
Duration  10min + 10min
         Discussion
Goal  Present the current state of the project and remaining work according to your project proposal.

Also, incorporate feedback of the discussion in your work.
Final Presentations

Time: TBA, March 2018

Duration: 20min + 10min Discussion

Goal: Introduce and demo your final and working prototype to all of us

Your work must be tested and empirically evaluated, and the results have to be presented.
Written Project Reports

Documents the work you have done during the main phase of the seminar.

Length: 4-6 pages (excluding figures / references).

Recommended structure:
- Introduction
- Related Work
- Implementation
- Evaluation
- Conclusion
- One paragraph per participant about the individual contribution (Who did what?)

The template from the seminar website is mandatory to use.

Submit at the day of the final presentation, 23:59.
Fields
Rock Climbing

Hangboard Training
• augmented
• collaborative
• over-a-distance
• ...

Interactive Training System
• projected obstacles
• user defined projections
• ...

... real-time system
UI Adaptations for Wearables based on current User State

e.g. derived by a user’s heart rate, running speed, the field of view, …
UI Adaptations for Wearables based on current User State

- Displaying Heart Rate Data on a Bicycle Helmet to Support Social Exertion Experiences
  Wouter Walmink, Danielle Wilde, and Florian 'Floyd' Mueller
  In: Proceedings of the 8th International Conference on Tangible, Embedded and Embodied Interaction (TEI '14). ACM. Pages 97-104.
  DOI: https://doi.org/10.1145/2540930.2540970

- Using Heart Rate to Control an Interactive Game
  Ville Nenonen, Aleksi Lindblad, Ville Häkkinen, Toni Laitinen, Mikko Jouhtio, and Perttu Hämäläinen
  DOI: https://doi.org/10.1145/1240624.1240752

- Heart Rate Control of Exercise Video Games
  Tadeusz Stach, T. C. Nicholas Graham, Jeffrey Yim, and Ryan E. Rhodes

- iHeartrate: A Heart Rate Controlled In-Flight Music Recommendation System
  Hao Liu, Jun Hu, and Matthias Rauterberg
  In: Proceedings of the 7th International Conference on Methods and Techniques in Behavioral Research (MB '10), 4 pages.
  DOI: https://doi.org/10.1145/1931344.1931370
• Use sensors to monitor training and race performance

• Goal
  • Track athletes’ biomechanical and physiological data during running
  • Classification of the various states (e.g. fatigue, running form)
  • Provide real-time feedback

Florian Daiber
Run Tracker++

• Corpus-Collection:
  • Continuously record data from runners during a free outdoor run. Enable a communication channel to communicate with the device (via Speech, Buttons, …)

• Build Interactive System

• Wearable to monitor training and race performance
  • Input: Buttons, Speech, EMG, …
  • Output: Subtle Notifications, Speech, EMS…
Run Tracker++

- **Embedded Classification of the Perceived Fatigue State of Runners: Towards a Body Sensor Network for Assessing the Fatigue State during Running**
  In Proceedings of BSN ’12, IEEE, 113-117.
  https://doi.org/10.1109/BSN.2012.4

- **FootStriker: An EMS-based Foot Strike Assistant for Running.**
  https://doi.org/10.1145/3053332

- **Run&Tap: Investigation of On-Body Tapping for Runners.**
  Nur Al huda Hamdan, Ravi Kanth Kosuru, Christian Corsten, and Jan Borchers.
  DOI: https://doi.org/10.1145/3132272.3134140
Navigation in Long Distance Endurance Sports

Frederik Wiehr
Navigation in Long Distance Endurance Sports

- **Route Generation and Planning**
  - Single- and Multiuser

- **Realtime Assistance**
  - e.g. Turn-by-Turn, different modalities

- **Logging** (Training Log) and **Sharing**
  - Route Visualization
  - Story Telling
Traditional
Digital Planning Tools

Frederik Wiehr
Digital Planning Tools
Frederik Wiehr

Navigation in Long Distance Endurance Sports
Haptic Sandwich
A shape changing handheld haptic navigation aid

ARTopos
Augmented Reality Topo Map Visualization for Collaborative Route Planning in the Mountains

Drawing your Path: Making Realtime GPS Art for a Creative Exploration in Long Distance Sports
FOLLOW THE PIONEERS: TOWARDS PERSONALIZED CROWD-SOURCED ROUTE GENERATION FOR MOUNTAINEERS

Scenario & Vision

• **User specifies**
  
  • pioneers: expert in a certain area
  
  • personal parameters: desired length and elevation, difficulty and risk, etc.

• **System recommends** routes, based on
  
  • segments of pioneers’ tracks
  
  • fitness and experience
  
  • personal parameters
Existing Hardware

- Recon Jet
- Epson AR Glasses
- MiBand
- Myo Armband
- Microsoft Band
- Arduino Stuff
- Mobile Phones
- OptiTrack

- Treadmill for running
- Climbing Wall
- Bike (stationary trainer)
- 3D Projectors
- Arduino
- Hololens
- HTC Vive
Existing DIY Tools

- Laser Cutter
- 3D Printer (Ultimaker 2)
- Arduino Kits / Sensors
- Soldering / Tools for Electronics
- ...

We are Hiring!

- Bachelor/Master Thesis
- Hiwi Jobs
- Tutors
- Depends on the performance in the seminar.

http://umtl.cs.uni-saarland.de/