Ubiquitous Sports Technologies
Seminar Kick-Off WS2017/18

Organizers

- **Dr. Florian Daiber**
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Agenda

of today

- 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**

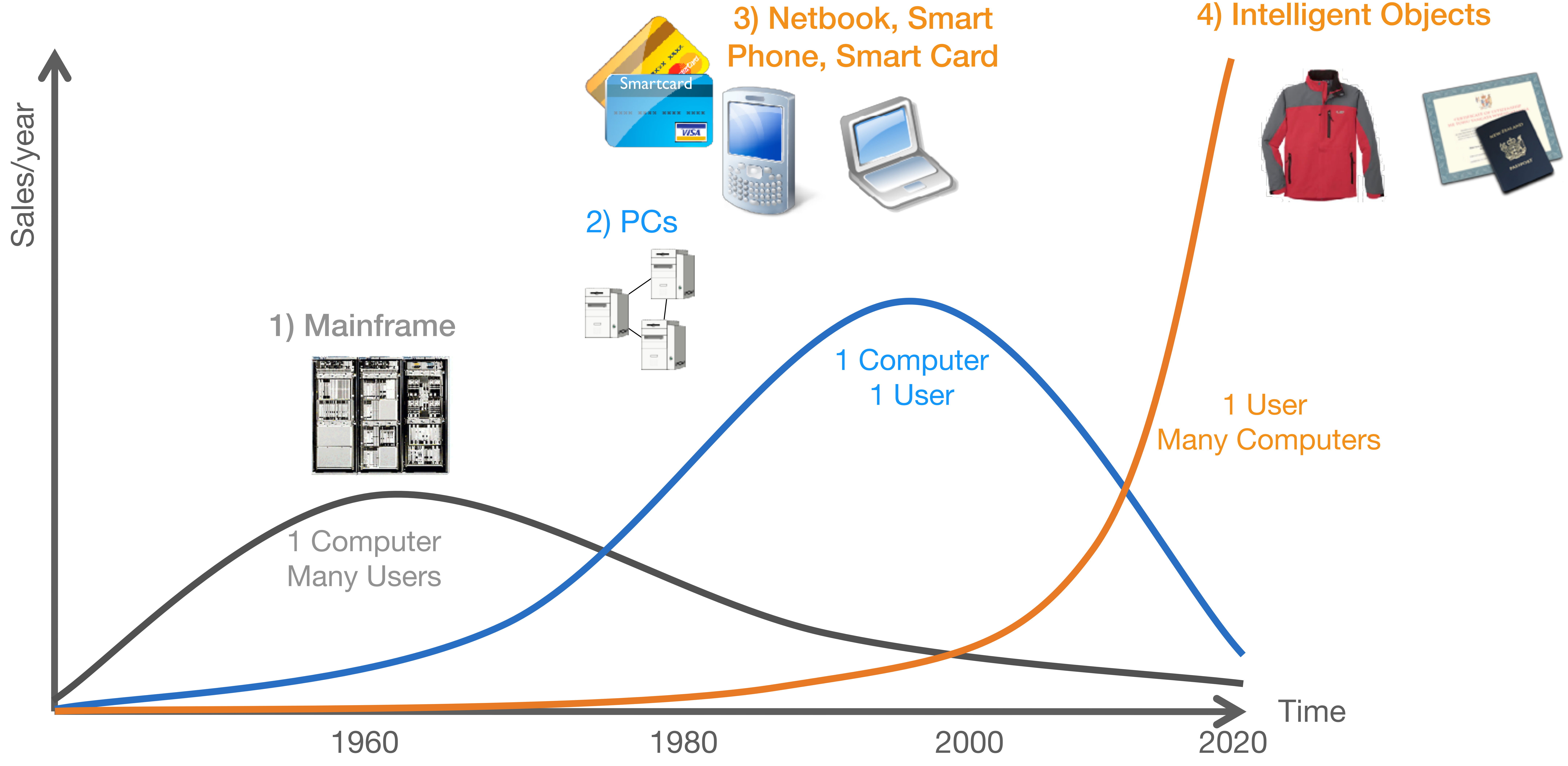
Introduction

A Brief History of Computers in Sport

- **Biomecanical 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

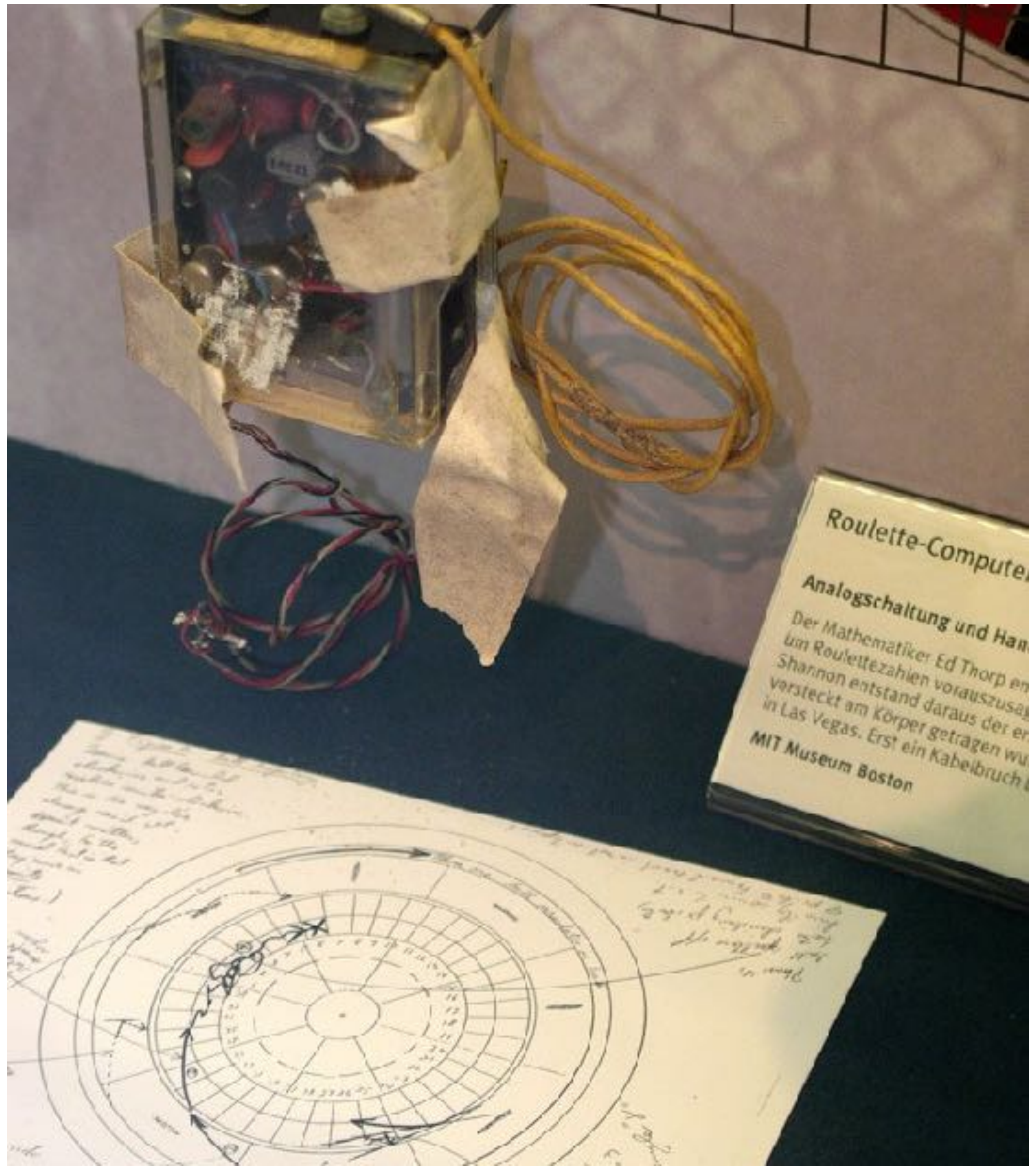
Wearable Computing

Wearable Computing

- Computers are „worn“ on the body
  - always on
  - easily accessible
  - connected to a network
- Other important properties:
  - extend the user’s interaction possibilies
  - use sensors the track the user and her enviroment

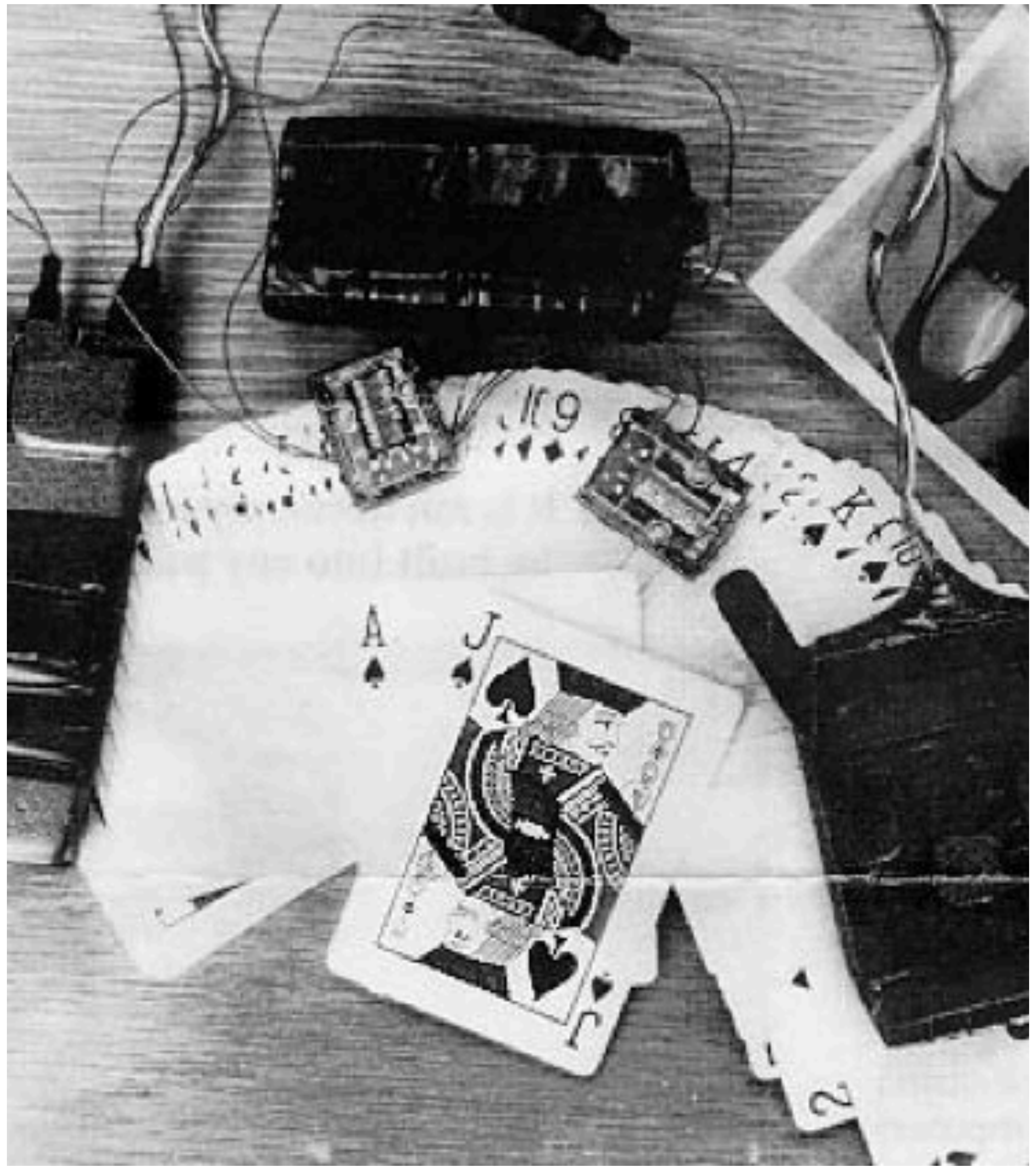
Thorp and Shannon (1961)

- Wearable timing device for roulette prediction
  - Audio Feedback
  - 4-Button Input

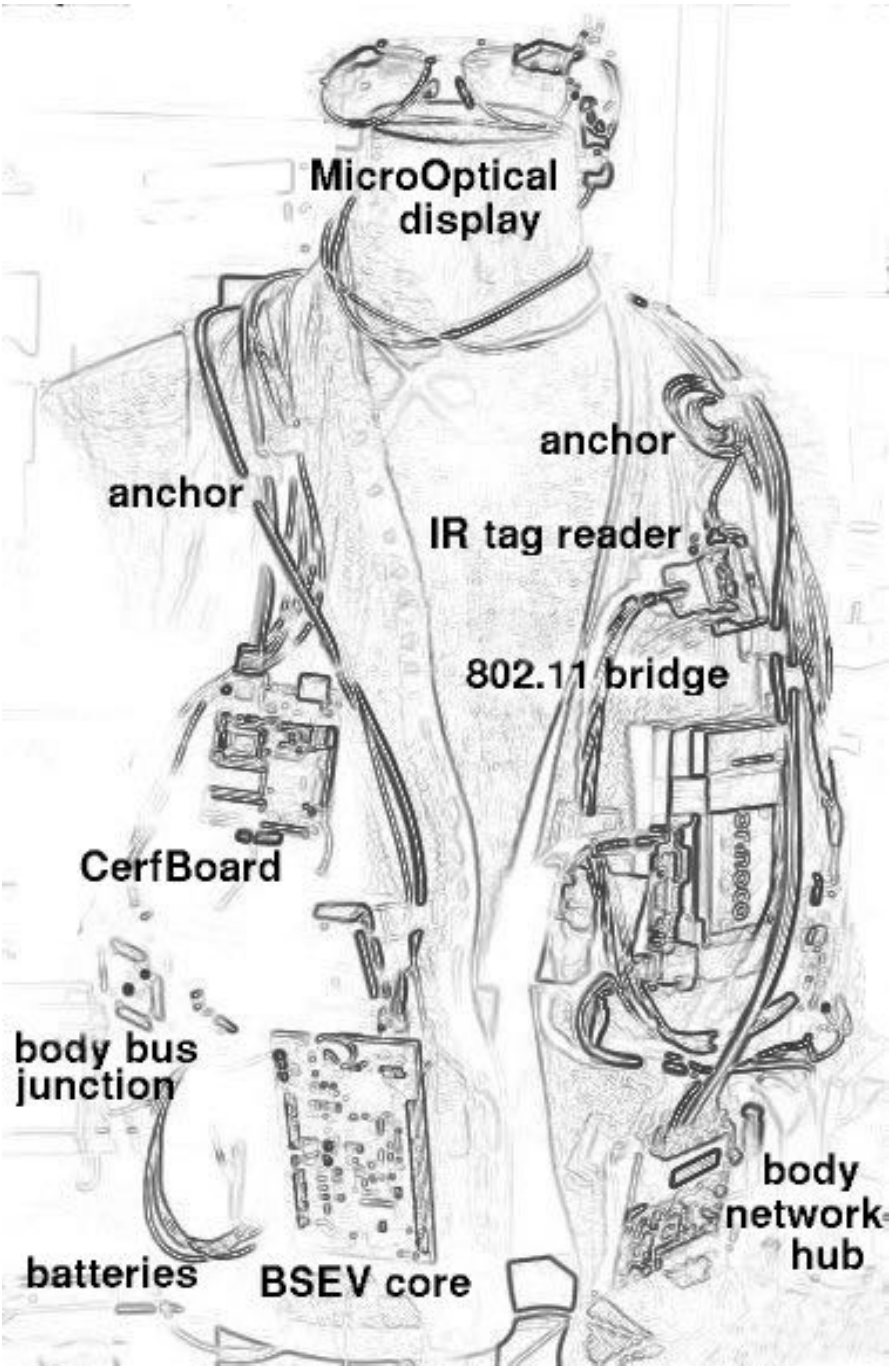


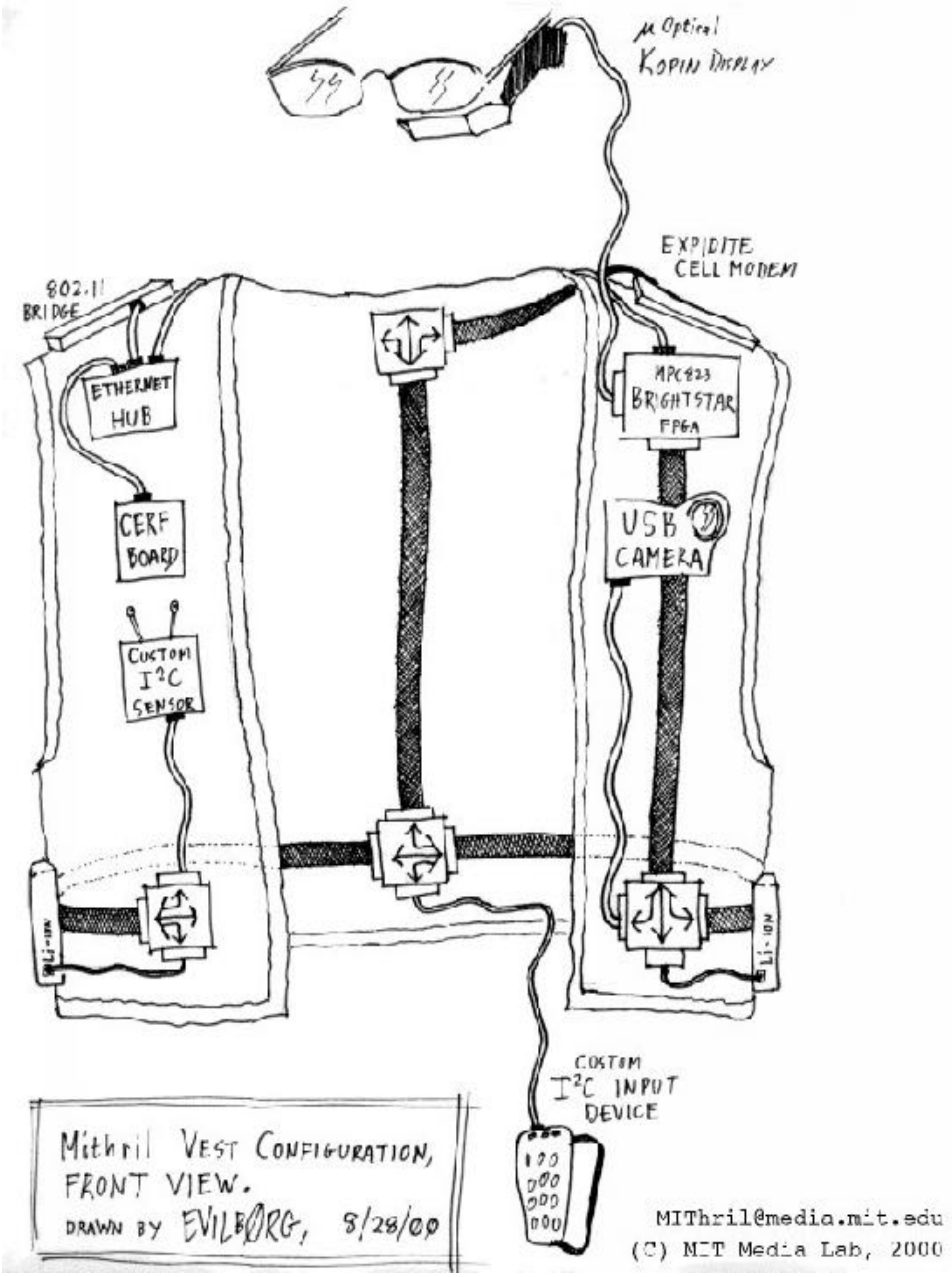
Taft (1972)

- Wearable computer for blackjack card counting
  - Belt Computer
  - Shoe Input
  - LED in Glasses as Output

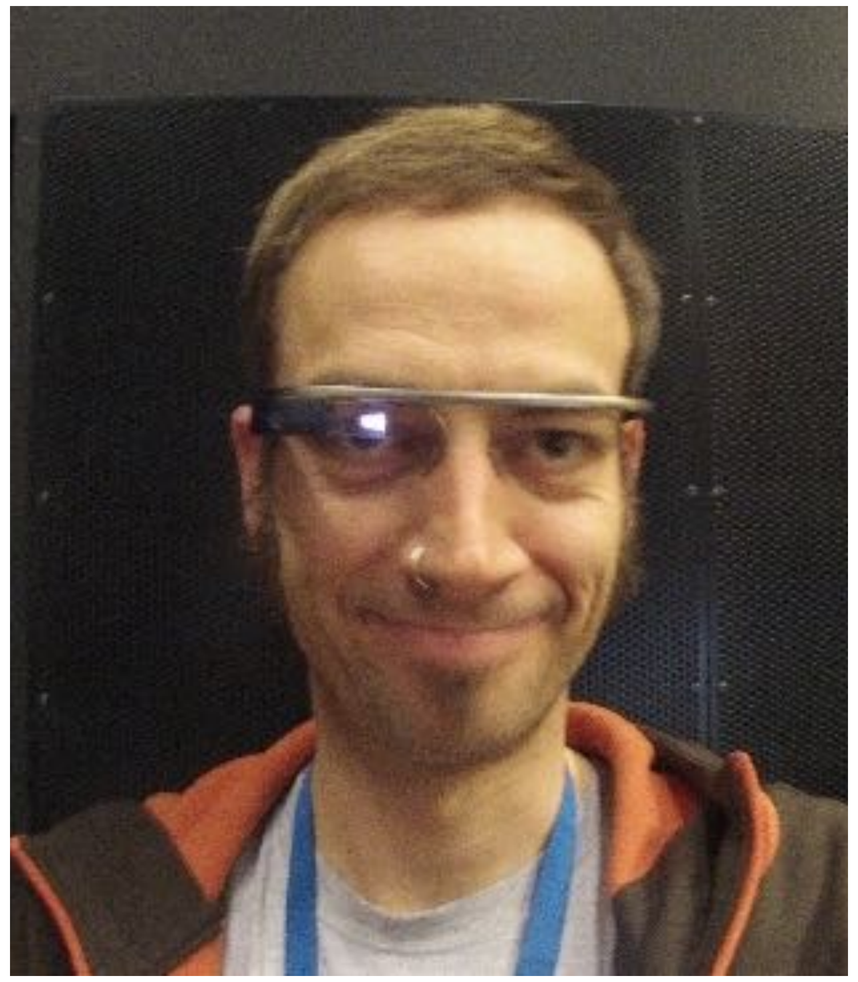


MIThril (2000)





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. synchonize different sensors)
- When collecting human data
  - Sufficient large number of participants
  - Controlled lab studies often not suitable
  - Ethical aspects (tracking location, mediacal 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 & Challanges

- 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 Mesurement 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

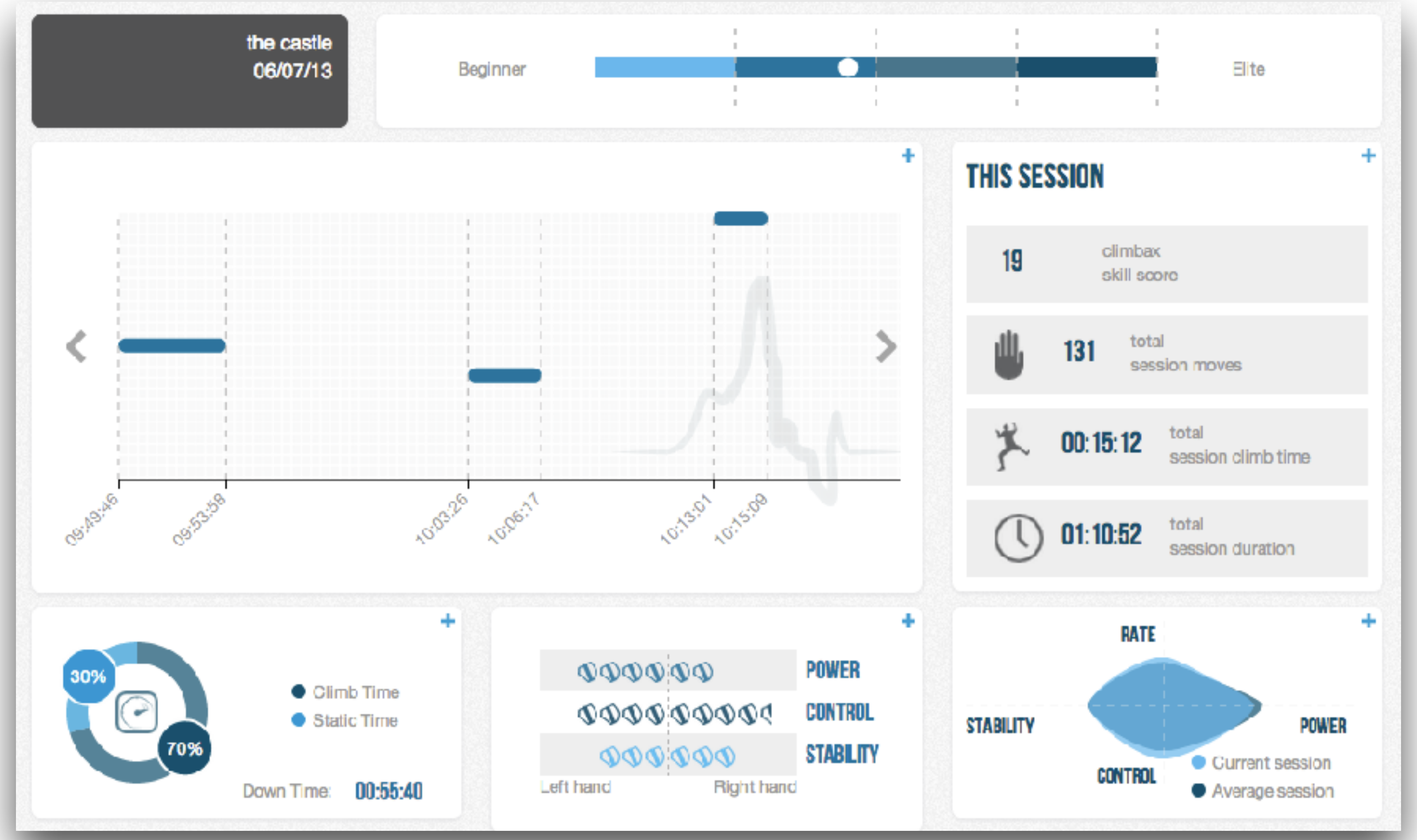
Research Examples

RecoFit

- **Tracking Strength Training**
- Challenges:
  - Segmenting exercise from intermittent non-exercise periods
  - Recognizing which exercise is being performed
  - Counting repetitions

Dan Morris, T. Scott Saponas, Andrew Guillory, and Ilya Kelner. 2014.
RecoFit: using a wearable sensor to find, recognize, and count repetitive exercises.
In Proceedings of CHI ’14. ACM, 3225-3234.

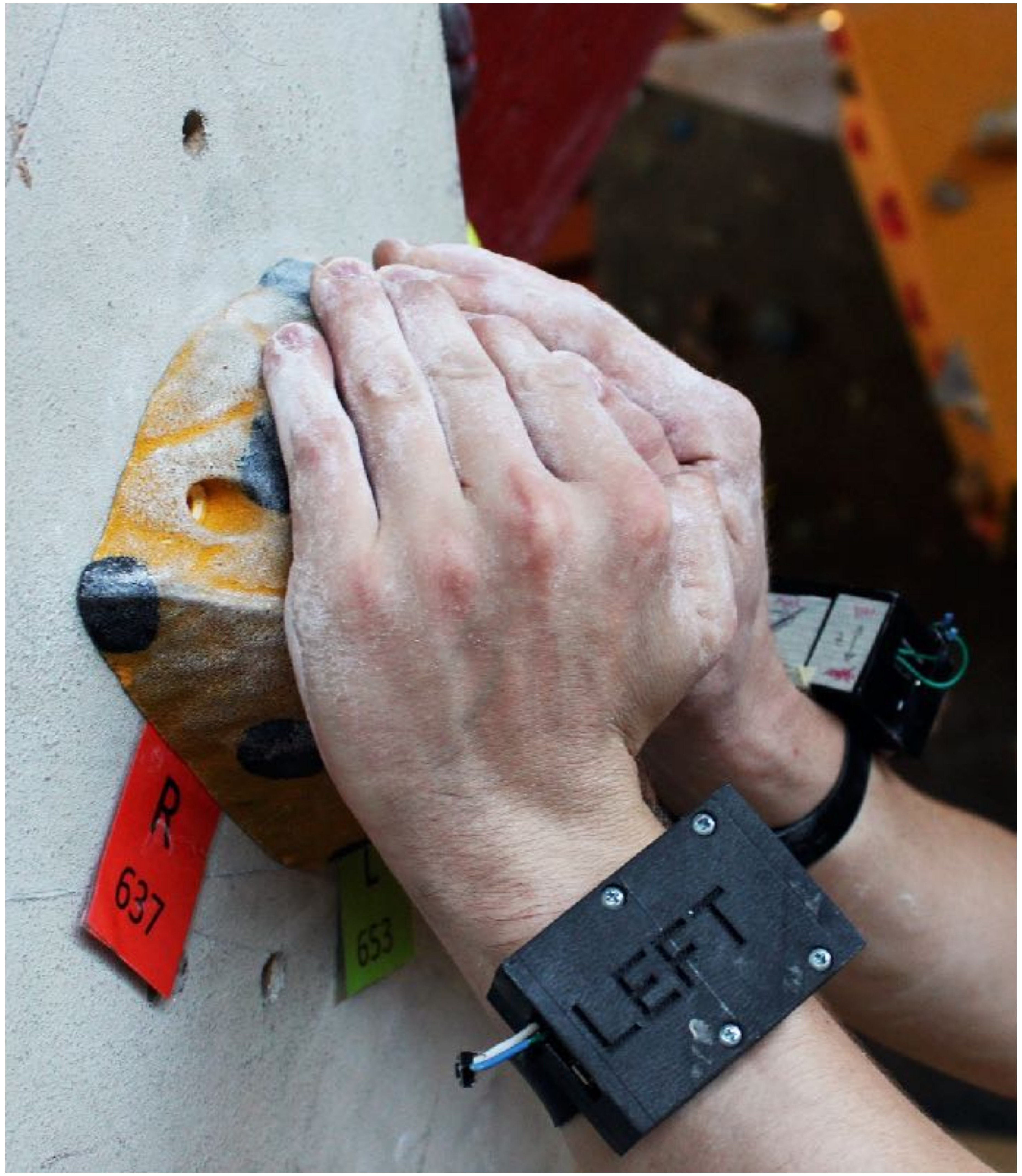
ClimbAX



Ladha, C., Hammerla, N. Y., Olivier, P., & Plötz, T. (2013)
ClimbAX: Skill assessment for climbing enthusiasts
In Proceedings of UbiComp ’13, ACM, 235-244.

ClimbSense

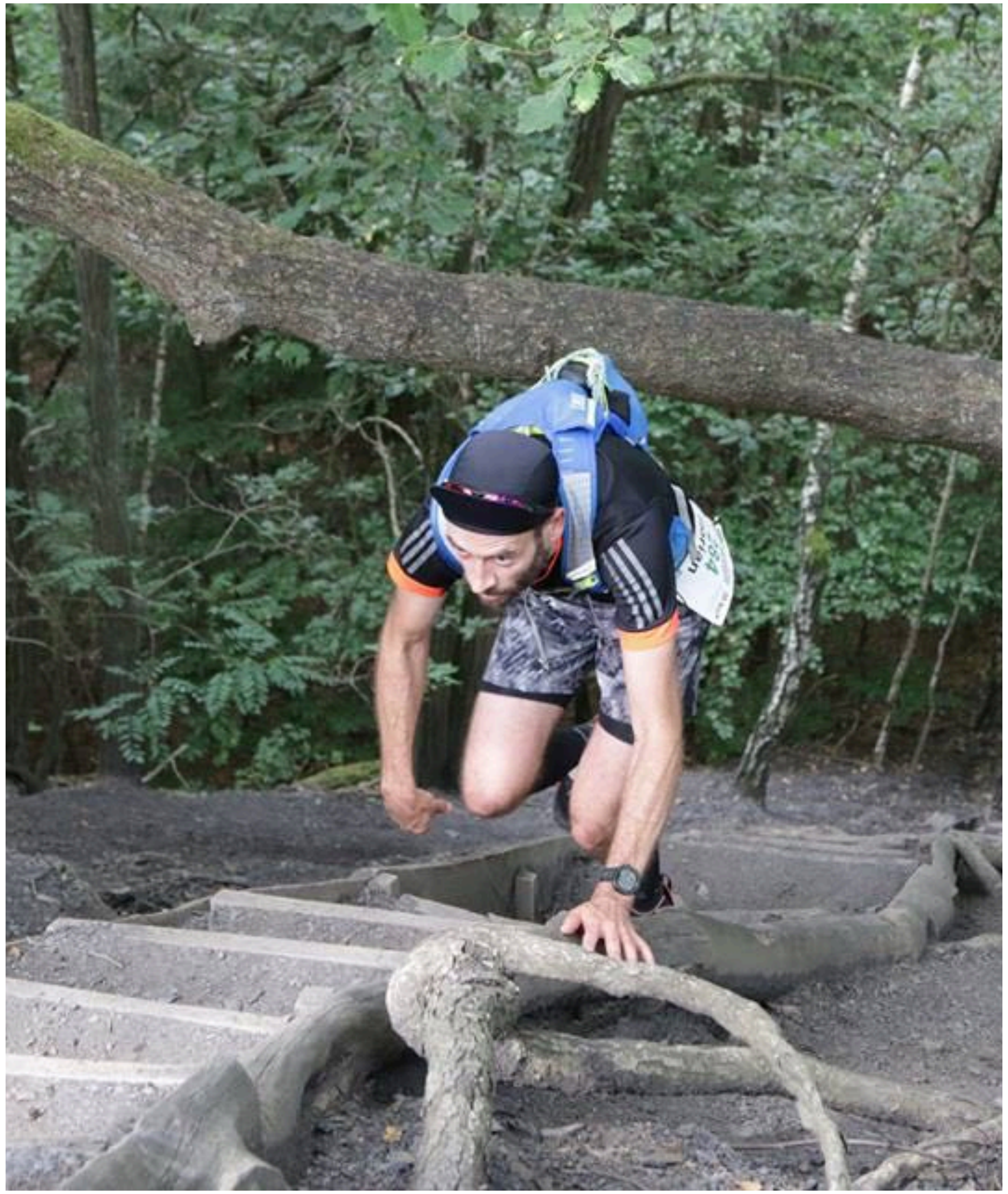
- Climbing Route Recognition and Tracking
- Approach:
  - extract arm orientations during grabbing
  - convert these to a string of symbols
  - compare the strings with the training database



Kosmalla F., Daiber F., & Krüger A. (2015).
ClimbSense: Automatic Climbing Route Recognition using Wrist-worn Inertia Measurement Units.
In Proceedings of CHI '15. ACM, 2033-2042.

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.



Eskofier, B., Kugler, P., Melzer, D., & Kuehner, P. (2012)
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.

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.

Hassan M., Daiber, F., Wiehr, F., Kosmalla, F., & Krüger, A. (2017).
FootStriker: An EMS-based Foot Strike Assistant for Running.
Proc. ACM Interact. Mob. Wearable Ubiquitous Technol. 1, 1, Article 2 (March 2017), 18 pages.

FootStriker

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 → **FINISH**

today	06.11	20.11	8.1	TBA
Groups & Topics	**Brainstorming**	**Proposal**	**Mid Presentations**	**Final Presentations**
find groups of 3-4 people and decide for topic	meet with your supervisor for moderated brainstorming	presentation of project proposals	present the current status of your project	and deadline for final report

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.

Proposals

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

Felix Kosmalla

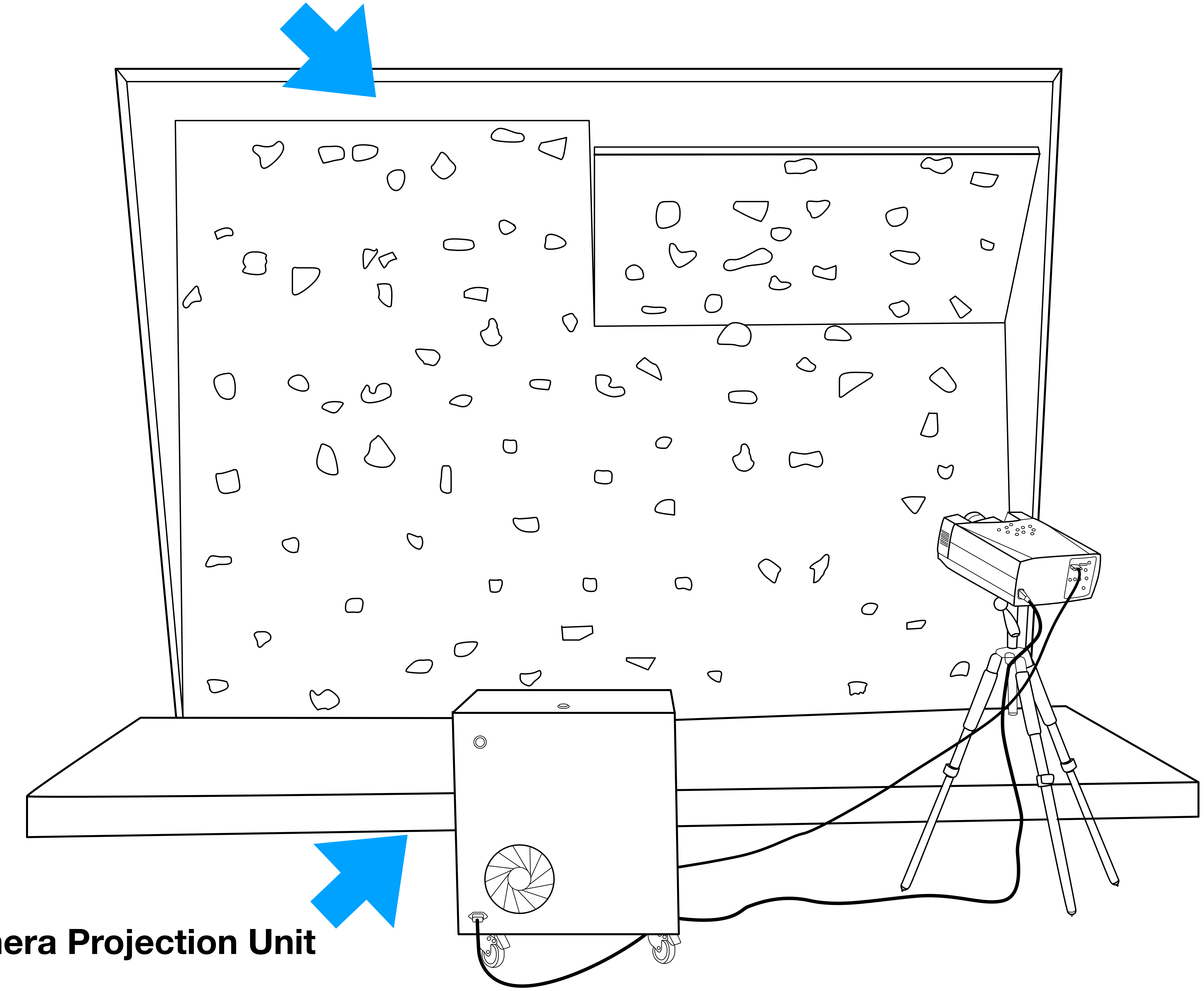
Rock Climbing

Hangboard Training
- augmented
- collaborative
- over-a-distance
- …

Interactive Training System
- projected obstacles
- user defined projections
- …

…

real-time system



Frederic Kerber

UI Adaptations for Wearables based on current User State

e.g. derived by a user's
heart rate, running speed,
the field of view, …

Frederic Kerber

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
  In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '07). Pages 853-856.
  DOI: https://doi.org/10.1145/1240624.1240752

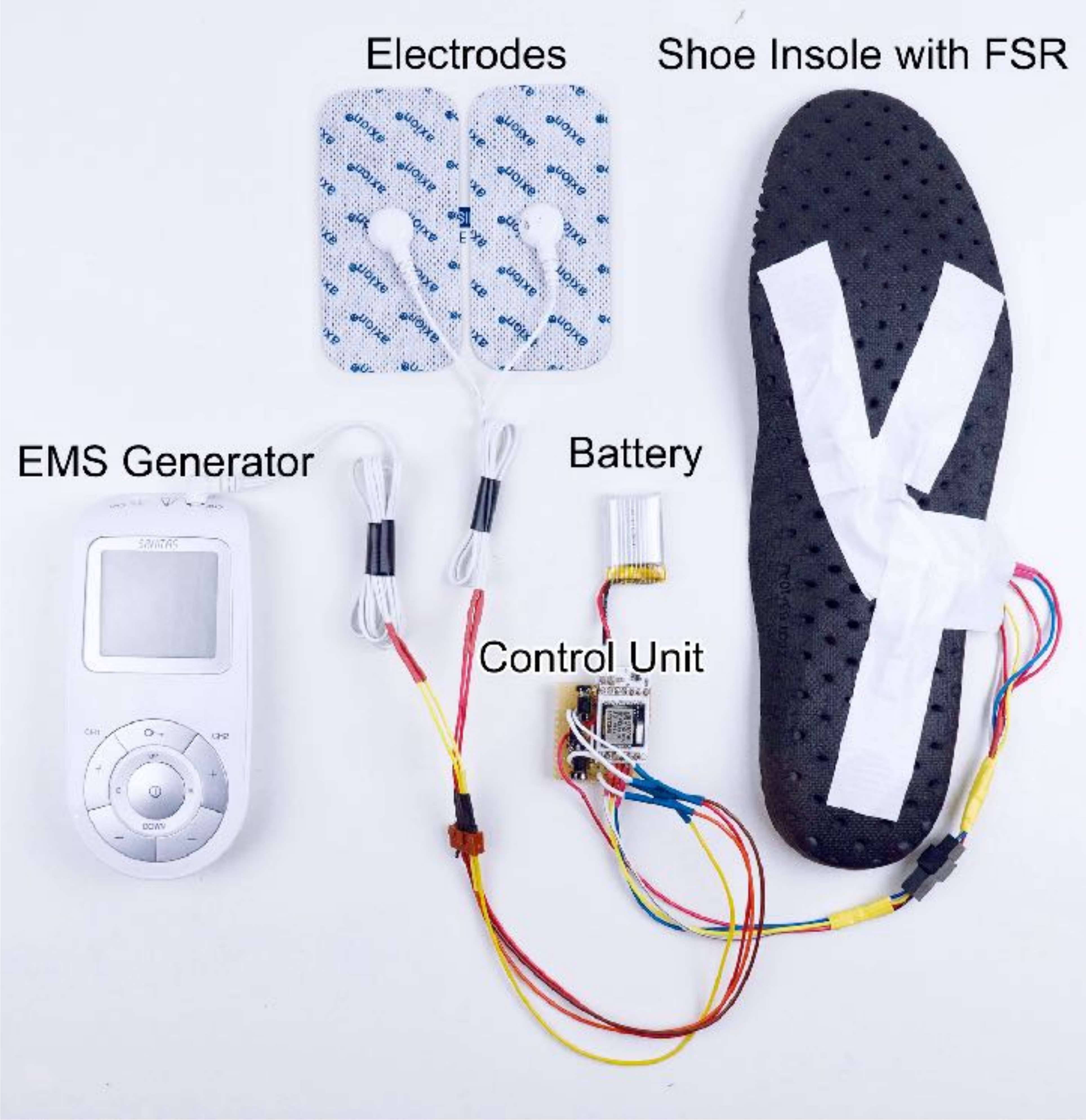
- **Heart Rate Control of Exercise Video Games**
  Tadeusz Stach, T. C. Nicholas Graham, Jeffrey Yim, and Ryan E. Rhodes
  In: Proceedings of Graphics Interface 2009 (GI ’09). Pages, 125-132.

- **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

Florian Daiber

Run Tracker++

- 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**
  Eskofier, B., Kugler, P., Melzer, D., & Kuehner, P. (2012)
  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.**
  Hassan M., Daiber, F., Wiehr, F., Kosmalla, F., & Krüger, A. (2017).
  Proc. ACM Interact. Mob. Wearable Ubiquitous Technol. 1, 1, Article 2 (March 2017), 18 pages.
  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.
  In Proceedings of ISS ’17, ACM, 280-286.
  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

Source: https://martinpurkiss.files.wordpress.com/2012/03/dsc0671.jpg

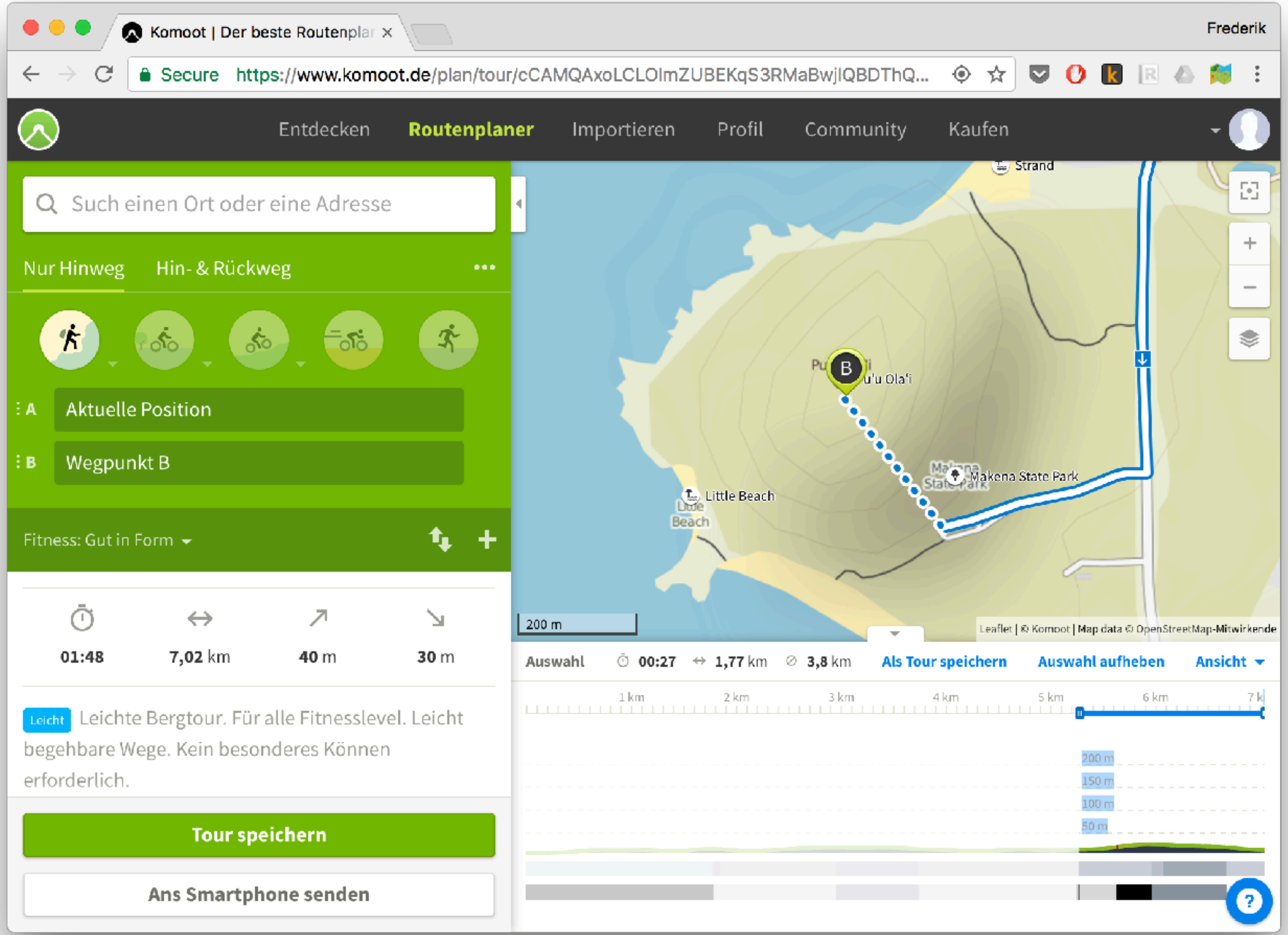
Frederik Wiehr

Interaction Context

Source: http://www.applecross.uk.com/msg/sea-kayaking-in-scotland-canada-croatia-arctic-norway/the-inner-sound-sea-kayak-expedition-scotland/

Frederik Wiehr

Digital Planning Tools



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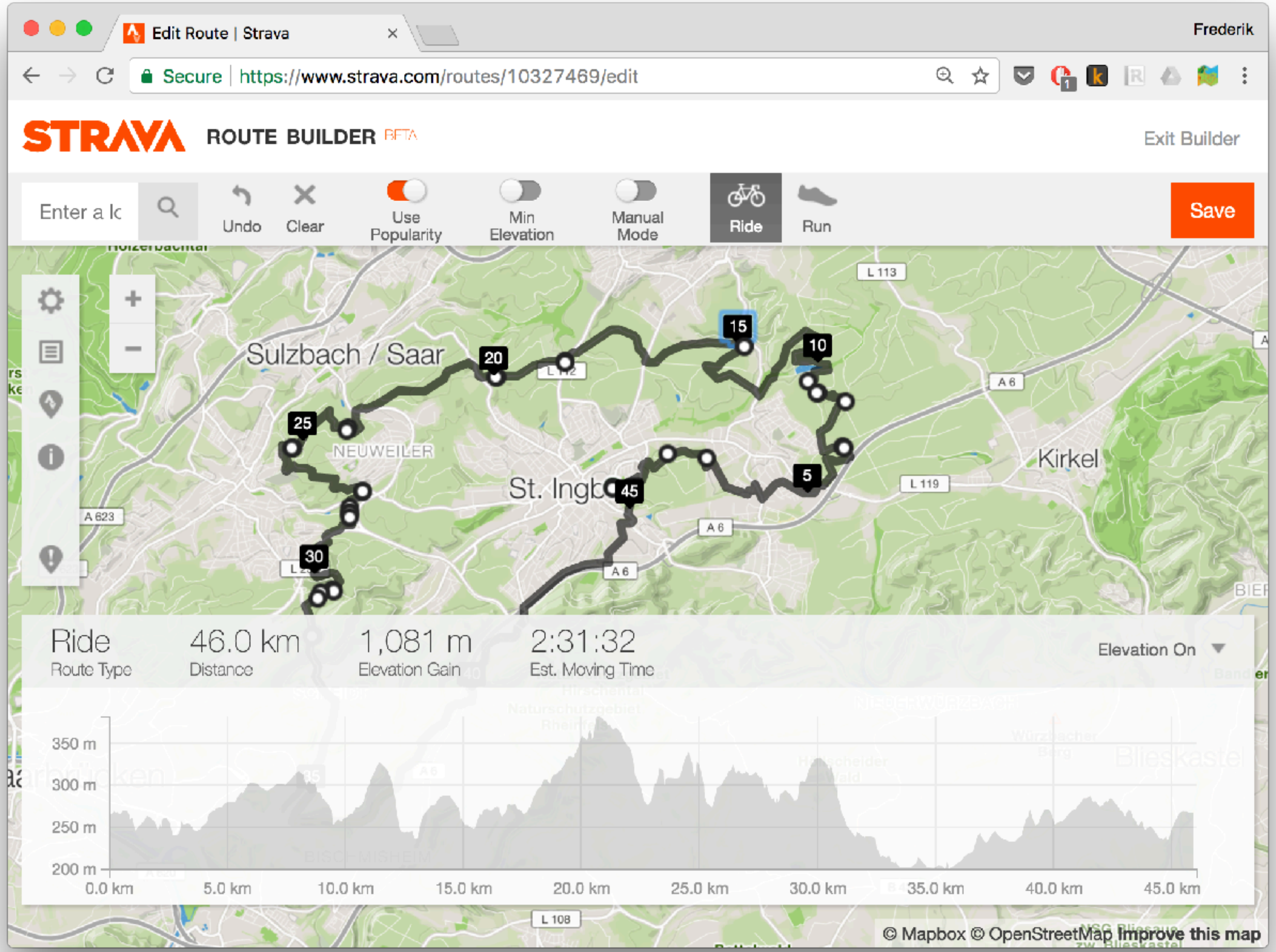
Digital Planning Tools



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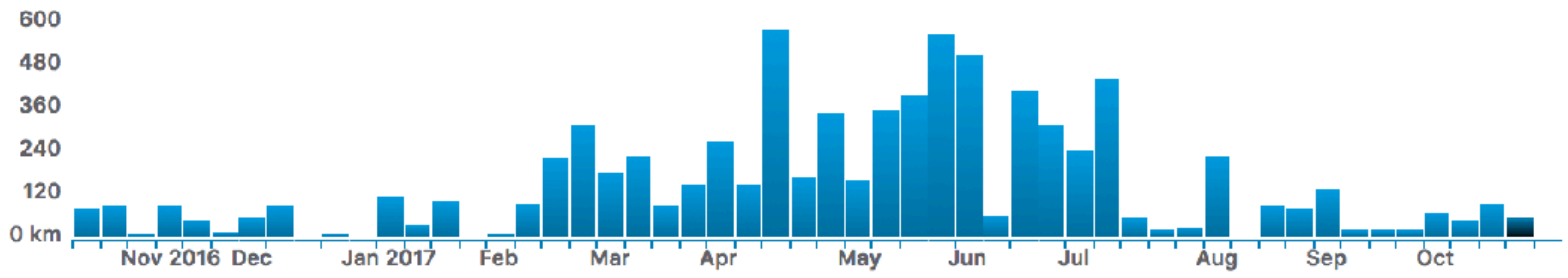
Navigation in Long Distance Endurance Sports

Activities for Oct 16, 2017 - Oct 22, 2017

Oct 17, 2016 - Oct 23, 2017

52.5km | 3h 43m | 1,318m



Time | Distance | Elev Gain

Weekly | Monthly

Fred Wiehr rode with lin. ger

Yesterday at 5:38 PM

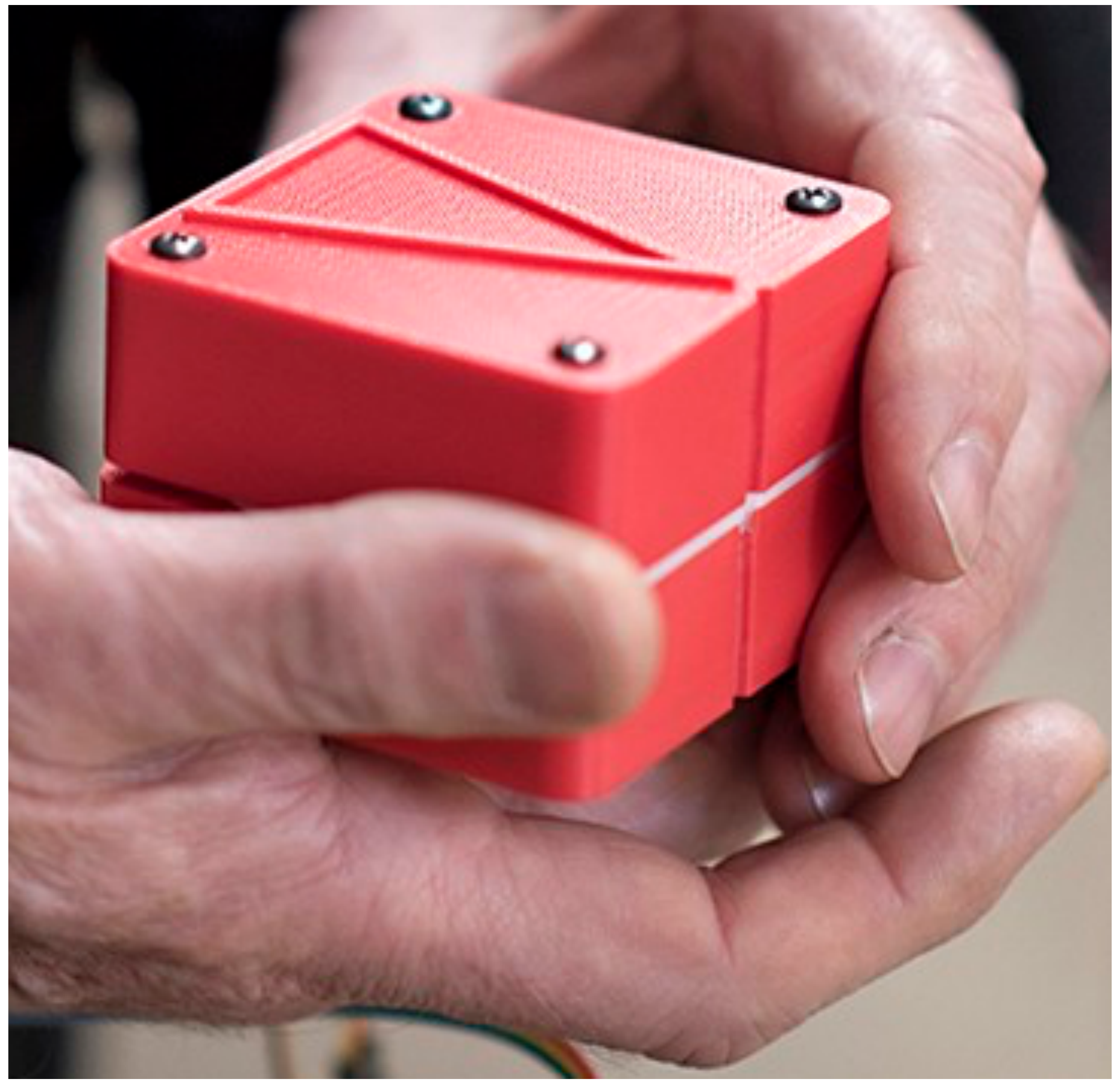
STRAVA LABS

View Flybys ›

My Stats

Last 4 Weeks	
Avg Rides / Week	3
Avg Distance / Week	41 km
Avg Time / Week	2h 55m
2017	
Distance	6,839.1 km
Time	309h 2m
Elev Gain	80,232 m
Rides	215
All-Time	
Distance	17,920.5 km
Rides	455
Biggest Ride	254.4 km
Biggest Climb	1,610 m

Haptic Sandwich
A shape changing handheld haptic navigation aid



Spiers, A., Dollar, A., Van Der Linden, J., & Oshodi, M. (2015). First validation of the Haptic Sandwich: A shape changing handheld haptic navigation aid. *Proceedings of the 17th International Conference on Advanced Robotics, ICAR 2015*, 144–151. http://doi.org/10.1109/ICAR.2015.7251447

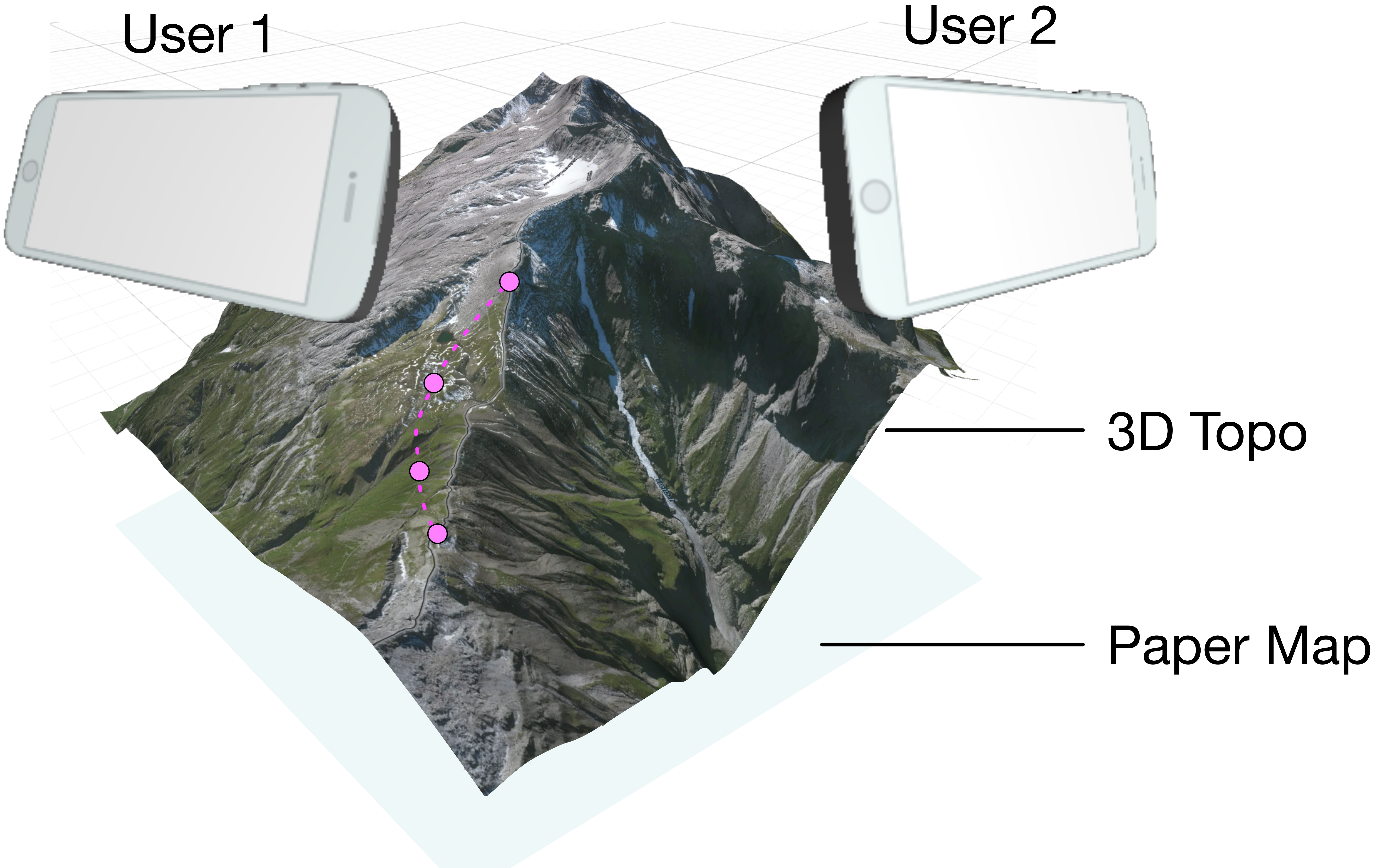
Frederik Wiehr

ARTopos

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

Wiehr, F., Daiber, F., Kosmalla, F., & Krüger, A. (2017). ARTopos: Augmented Reality Terrain Map Visualization for Collaborative Rou Planning. In Proceedings of the 2017 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedin of the 2017 ACM International Symposium on Wearable Computers (pp. 1047–1050). New York, NY, USA: ACM. http://doi.org/10.1145/3123024.3124446

ARTopos



Frederik Wiehr

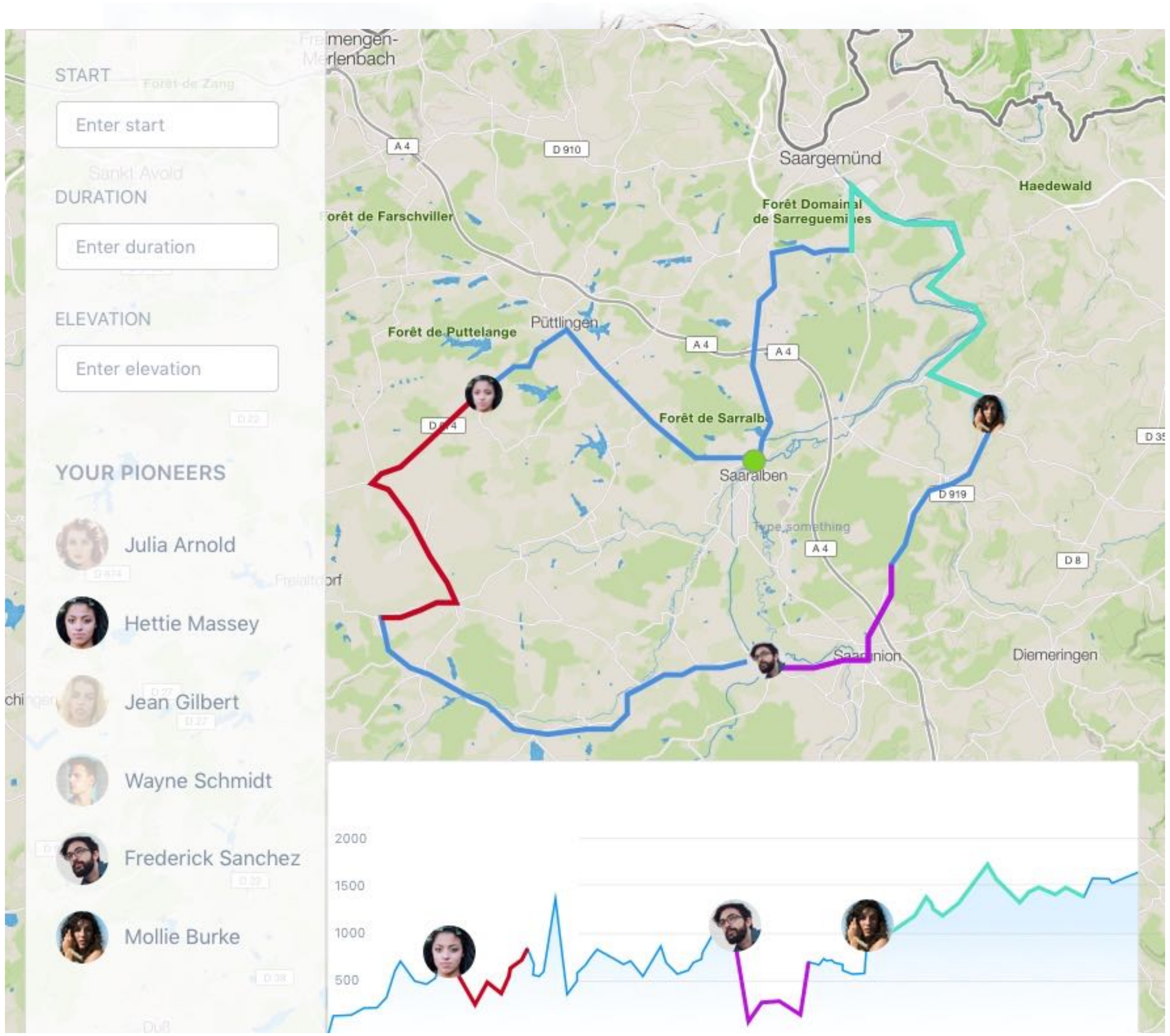
Drawing your Path: Making Realtime GPS Art for a Creative Exploration in Long Distance Sports

FOLLOW THE PIONEERS: TOWARDS PERSONALIZED CROWED-SOURCED ROUTE GENERATION FOR MOUNTAINEERS

Daiber, F., Kosmalla, F., Wiehr, F., & Krüger, A. (2017). Follow the Pioneers: Towards Personalized Crowd-sourced Route Generation for Mountaineers. In Proceedings of the 2017 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2017 ACM International Symposium on Wearable Computers (pp. 1051–1055). New York, NY, USA: ACM. http://doi.org/10.1145/3123024.3124447

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/


Q
A