Towards Guidance in and Life-Logging of Multi-pitch Climbing Using Wearables and Drones

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Abstract
In alpine multi-pitch climbing orientation and wayfinding is a complex and crucial task. So called topo maps usually provide a rough overview of multi-pitch routes. However, these topo maps require high expertise in reading and wayfinding during the actual climb. In such alpine environments taking the “wrong turn” may quickly lead into critical situations.

This position paper proposes a vision towards navigation and life-logging of multi-pitch climbing using wearables and drones. First, we introduce a scenario that describes how the approach works in an alpine multi-pitch climbing route. Second, we discuss our technology visions more in detail.

Author Keywords
Climbing; sports technologies; wearable computing, human-drone interaction.

ACM Classification Keywords
H.5.1 [Information Interfaces and Presentation (e.g. HCI)]: Multimedia Information Systems

Motivation
In alpine multi-pitch climbing orientation and wayfinding is a complex and crucial task. Taking the “wrong turn” may quickly lead into critical situations. In addition quickly changing weather condition sometimes make orientation even

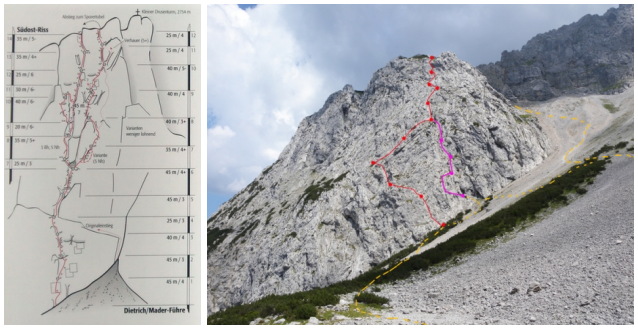

Figure 1: Example topos:hand-drawn topo sketch (left) and annotated photograph(right).

more complicated. In outdoor rock climbing, routes are commonly described in topo maps. These topos give a detailed description of the route by hand-drawn sketches or annotated photographs (see Figure 1 [4, 6]). However especially for long multi-pitch routes these topos can only provide a rough overview of the actual climb and thus require high expertise in route reading and wayfinding during the climb.

Very few related work exists with respect to the tracking of climbing routes and navigation in multi-pitch climbing. Schöning et al. [5] envisioned location based services and navigation in the vertical domain. They discussed ideas such as augmented reality and hands-free interaction. Ladha et al. [3] used wrist worn accelerometer sensors to assess the climbing performance of the user. An evaluation of the system during a climbing competition resulted in a positive correlation between the predicted and the actual score of the participants. Kosmalla et al. [2] proposed an approach that uses sensor-fused orientation information and accelerometer data of a 9 degrees of freedom (DOF) IMU to track and automatically recognize climbed indoor routes. Their approach achieved high recognition rates for indoor routes but in its current form it most probably will not work for outdoor climbing due to the diversity of holds and climbing styles on natural rock. Kajastila and Hämäläinen [1] investigated 3D topo maps. They present an interactive 3D topo of a large boulder and discuss the creation process. An online survey gave initial insights how 3D topos can be utilized for information sharing and planning in rock climbing.

In the following we propose a vision towards navigation and life-logging of multi-pitch climbing using Wearables and Drones. First, we introduce a scenario that describes how the approach works in an alpine multi-pitch climbing route. Second, we discuss how we aim to acheive this vision with wearbale and drone technology.

Scenario

Jon and Jane have carefully planned an alpine climb in the Rätikon area. The weather forecast predicts isolated thunderstorms. Since they are experienced climbers they decide to give it a try. Guided by their outdoor GPS device they hike up early in the morning. The approach to the actual base of the climb was strenuous due to old snow fields and thus took longer than expected. Shortly before they reach the base of the climb they try to get an overview of the whole route by inspecting the mountain from farther away in order to match the topo sketch of the route to the actual structure of the rock (see Figures 1 and 2). The switch off the GPS since it is not possible to navigate in the vertical with such a device. They now prepare the printed topo sketch and activate their both their ClimbTracker wearable and a small drone that is attached to the backpack of the climber. In the third pitch they are unsure which line to follow. So they use the drone as scout to explore the terrain

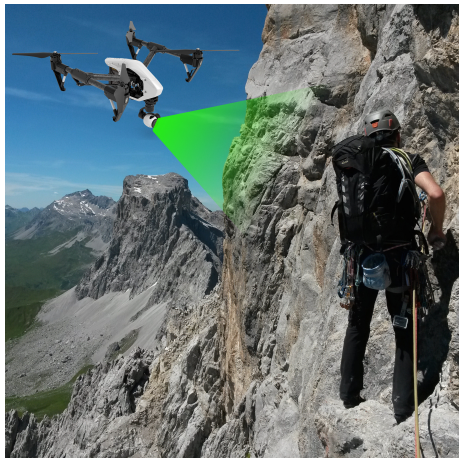

Figure 2: Climbing in a multi-pitch route.

above the belay. Happily, with the help of the drone they were able to spot the next belay and plan a strategy how to climb this pitch. In the middle of their climb there is a long and difficult traverse which is a point of no return since abseiling or climbing-back is almost impossible. So they have to decide if they should proceed based on the weather conditions. They check their current fatigue level on the climb tracker and use the drone to inspect the clouds behind the mountain to get an impression about potential thunderstorms. Since they feel good and the sky looks promising the decide to continue up the mountain.

Multi-pitch Climb Tracking and Navigation

We envision the following approach that consists of a wearable device and a personal drone to guide climbers and allow life-logging of their climbing experience. We plan to explore this approach at the workshop.

Climb Tracking
The wearable device can be used to continuously log sensor data such as IMU data, barometric altitude, bio sensor data in order to match it with drone photos in order to generate an interactive topo map of the climb that improves orientation during the climb.

The drone can be used to capture (representative) imagery of the route or video footage of (parts of) the climb.

The logged data can be then used as input for the navigation system. Due to the inaccuracy of GPS especially in the vertical dimension a climbing navigation system requires a more elaborated approach

Navigation
Besides investigating which sensor data is useful it needs to be explored how the climb needs to be captured to provide a comprehensive visualisation to optimally guide the climber in real-time.

Based on the knowledge of current position of the climber in the route potential user interfaces to navigate the climber while standing at a belay or climbing a pitch.

At the belay:

- Textual or static image information that describe the next pitch
- Aerial drone imagery that is annotated by route information

During climbing:

- Auditory information, a compass view on a smartwatch or smart glasses

- Augmented Reality the projects the route into the field of view
- Drone-based Life-Logging Experiences in the Mountains

The life-log of the climb consists of progress of the climb that is matched to the topo map and annotated with biosensor information as well as drone-selfies. This enables climbers to analyse their personal performance but also provide new ways to tell and present the story of their climbing experience.

Conclusion

In this position paper we discuss our vision towards navigation and life-logging of multi-pitch climbing using wearables and drones. First, we introduced a scenario that describes technology use in alpine multi-pitch climbing. Second, we discussed how we aim to acheive this scenario with wearbale and drone technology.

In future work we will develop a prototype that implements these ideas. We will further evaluate the prototype in an alpine environment and during the field trip of the UbiMount workshop at the outdoor climbing crack.

REFERENCES

1. Raine Kajastila and Perttu Hämäläinen. 2014. Benefits of 3D topos for information sharing and planning in rock climbing. *Sports Technology* 7, 3-4 (2014), 128–140. DOI: http://dx.doi.org/10.1080/19346182.2014.968249
2. Felix Kosmalla, Florian Daiber, and Antonio Krüger. 2015. ClimbSense: Automatic Climbing Route Recognition Using Wrist-worn Inertia Measurement Units. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI '15)*. ACM, New York, NY, USA, 2033–2042. DOI: http://dx.doi.org/10.1145/2702123.2702311
3. Cassim Ladha, Nils Y. Hammerla, Patrick Olivier, and Thomas Plötz. 2013. ClimbAX: Skill Assessment for Climbing Enthusiasts. In *Proceedings of the 2013 ACM International Joint Conference on Pervasive and Ubiquitous Computing (UbiComp '13)*. ACM, 235–244. DOI:http://dx.doi.org/10.1145/2493432.2493492
4. Mario Luginbühl. 2008. *Alpinkletterführer Rätikon Süd* (3 ed.). Panico Alpinverlag.
5. J. Schöning, Panov, and C. Keßler. 2007. No Vertical Limit -Conceptual Design of a LBS for climbers. In *Proceedings of the Workshop on Mobile Spatial Interaction (MSI) on the Conference on Computer Human Interaction (CHI)*.
6. www.bergsteigen.com. soldatenweg-dammkar. (????). http://www.bergsteigen.com/sites/default/files/topos/soldatenweg_predigtstuhl_dammkar_topo.pdf