HCI Outdoors: How Smart Wearables can Help to Promote a Better Lifestyle

Frederic Kerber
German Research Center for
Artificial Intelligence (DFKI),
Saarland Informatics Campus
Saarbrücken, Germany
frederic.kerber@dfki.de

Florian Daiber
German Research Center for
Artificial Intelligence (DFKI),
Saarland Informatics Campus
Saarbrücken, Germany
florian.daiber@dfki.de

Antonio Krüger
German Research Center for
Artificial Intelligence (DFKI),
Saarland Informatics Campus
Saarbrücken, Germany
krueger@dfki.de

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Abstract
The ongoing miniaturization of technology brought a new device class to the mass market: wearables. Although there already exist a variety of devices such as specialized fitness trackers or more general smartwatches, there is still a lack of understanding and development when it comes to how these devices are integrated in our everyday lives. Instead of the devices being directly supportive, people often have to deal with annoying aspects before, during and after using them – especially when using them on the go, e.g. in outdoor activities. In this position paper, we outline possible next steps to deal with these problems and point out how the devices can then help to promote a better lifestyle.

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Wearables; fitness trail; fitness tracking.

ACM Classification Keywords
H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous

Introduction
The importance of wearable devices, e.g. fitness trackers or smartwatches with features similar to a smartphone, has rapidly increased. With current developments such

as the Fitbit Charge 2[1], the Apple Watch 3[2] or the Samsung Gear S3[3], sophisticated devices are available. Consequently, the market size for wrist-worn devices is expected to grow in the next three years to over 80 million sold units per year [4]. Although some of these devices recently were equipped with stand-alone capabilities, they are still often only perceived as extensions to smartphones [23]. The placement on the user's wrist allows for faster access [1] and makes it easier to consume information at a glance [10], but it still remains an open question how users can benefit from these advantages. While improvements at work, e.g. better notification handling, seem more obvious, it is especially of interest to investigate this topic with respect to leisure time such as sports activities. Since many of these activities, e.g. running or cycling, take place outdoors, other aspects such as changing environments, but also the user's situation, have to be taken into account.

Related Work

In recent years, the topic of human-computer interaction in the outdoors gained more attention (see e.g. [2, 3, 9]). We also addressed several topics in this respect, both at general venues such as CHI, MobileHCI or UbiComp, as well as in a Special Interest Group at CHI [14] and in specialized workshops [5, 6, 11, 12].

Already in 2013, we investigated how instant performance feedback and context-aware notifications could be provided using a Google Glass during bicycle training [24]. In OmniSports [20], we studied the concept of digital fitness trails. Based on a mobile app, suitable spots for outdoor fitness exercises could be tagged/found along with user-provided multimedia content to illustrate exercises.

[1] www.fitbit.com/charge2, last accessed 12/03/2018
[2] www.apple.com/watch/, last accessed 12/03/2018
[3] www.samsung.com/gears3, last accessed 12/03/2018

Focusing on climbing, we investigated [18] how wearables are perceived in general and especially with respect to their provided output mechanisms. The results show that the most suited notification channel is sound, followed by vibrotactile output, while light has been found to be inappropriate. To get insights into the acceptance of technology in climbing, we conducted an online survey [7]. The results show that climbers can be divided into two distinct groups: (a) climbers who perform climbing predominantly for leisure and relaxation purposes without any interest in quantifying their sport or even using technology at all and (b) sports-oriented indoor climbers that already track different sports and are also interested in tracking their climbing progress. For the latter, our ClimbSense system [17] provides an automatic route recognition based on wrist-worn inertia measurement units. We further developed the concept of pioneers in outdoor activities [8]. Pioneers are defined as ambitious athletes who are well known and trusted experts in a specific area. Based on the preferences of a user and the activities of a pioneer, personalized routes can be recommended. Recently, we investigated how electrical muscle stimulation could be used to coach a more efficient running style. Based on sensor data collected by a self-made insole with force sensing resistors, the FootStriker system [13] actuates the calf muscles during the flight phase to control the foot angle before landing if necessary to decrease the heel striking rate. Mobile notifications are an integral part of our everyday life [22], but depending on the situation, they can be distracting [19]. Thus, we investigated how their auditory presentation can be made more comfortable [15]. As one of the considered usage contexts, we investigated a natural environment, i.e. a forest in which people might be walking for recreational purposes. The results show that people prefer sounds that match the environment, e.g. a bird's song when in the woods, as being less disruptive – especially in a scenario that is associated with leisure activity.

HCI in the Outdoors – Status Quo

HCI is nowadays an integral part of our lives. Thanks to the miniaturization of technology, it is no longer problematic to use even powerful hardware while on the go. Consequently, context-awareness plays an important role as the user's requirements often change based on the situation she is currently in. If we consider a user on a day-long bike tour, we see a number of changing interests and requirements throughout the day. At the beginning of the tour, route planning typically is the main focus. While on the bike, the current fitness and health status (often combined with self-tracking) is of highest interest, but also collaboration with friends who are doing the tour together might play a role. Meanwhile, weather updates could also get important and towards evening, the search for an accommodation (e.g. hotel, lodge or camping ground) takes center stage. Currently, most of the different information has to be gathered by the user manually – often involving more than one app and several requests per app. Although more universal approaches, such as Google Assistant[4] for example, are basically ready to go, they are not yet capable of handling the required conditions to provide the requested information, e.g. the rather complex context detection is problematic, especially when it comes to distinguishing the user's current activity – a hiker needs different information than a biker, e.g. due to the different movement speed.

Summarizing the current status quo with respect to HCI in the outdoors, there is a lot of potential that is currently not (fully) exploited:

1. Current hardware is small enough to be easily carried around outdoors and powerful enough for many computational tasks.
2. Current hardware provides sensors to measure health-related aspects such as the user's heart rate or galvanic skin response.
3. Context-related information, as for example the user's schedule, the weather or the current environment (via GPS), is basically available.

The missing piece is a system that is able to combine the aforementioned aspects to provide a solution that seamlessly integrates into the user's everyday life without requiring him to specifically interact with the system. In the following, we propose a scenario towards this vision.

Towards Digitally Enhanced Exercise Trails using Smart Wearables

As described above, to further promote HCI in the outdoors, it is important to provide a consistent user experience that makes the available components consistently available without the user having to interact with certain aspects of information retrieval or delivery.

Fitness trails are typically characterized by a series of exercise stations connected by footpaths that are used for jogging between stations. Each station often offers more than one exercise so that athletes can assemble their own individual training program. This variety of activities poses new challenges for HCI in the outdoors. We envision a system that is capable of supporting the athlete during the whole exercise time and ideally without any need for manual intervention. To provide information to the user, e.g. about the current progress or health-related data, we propose a wrist-worn device, as it can be easily glanced at. However, a standard smartwatch or fitness tracker has the disadvantage that the display is only located on one side of the arm, which makes it hard or even impossible to observe it, depending on the exercise that is currently being pur-

[4] https://assistant.google.com/, last accessed 12/03/2018

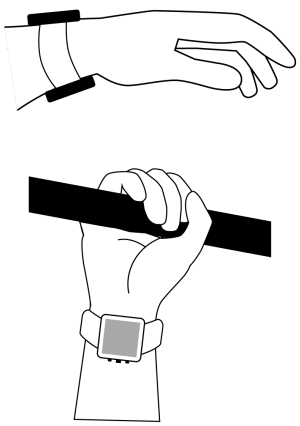

Figure 1: Smartwatch concept with two displays – one on each side of the user's arm. Depending on the arm's orientation, the content can be shifted between the displays: when doing pull-ups for example, the inner display can still be seen while the outer one is not in the user's field of view.

sued, e.g. pull-ups. To get rid of this limitation, a device with two displays (one on each side of the arm, see Figure 1) or even more (such as e.g. [21]) could be used.

Thanks to a good cross-linking, the system is aware of the current weather conditions and upcoming appointments, so that the user could already be addressed while still sitting at his desk and be motivated to go outdoors and start exercising. The integrated navigation leads the user to the first spot where some exercises are offered. As soon as the user approaches a specific one, an instruction video is played on the device, so that the user is prepared for the exercise. Based on data from the integrated sensors, the device is able to derive the best possible position and orientation for the content to be displayed. During the exercise, relevant data such as the number of repetitions or the time spent is recorded automatically, so that the user gets an overview about their training progress, which could also be shared in social networks if desired. To further motivate the athlete, results (e.g. timings or repetition counts) from other users are displayed during the training. At the same time, the system can provide a personalized workout plan for the user based on the set training goals. As soon as the system detects a possible health problem (e.g. based on the user's heart rate (variability) or galvanic skin response measurements), a corresponding warning is displayed to the user. When the user finishes the desired exercises at a particular spot, the navigation system comes into play again and guides the user to the next exercise location.

Due to the efficient usage of appropriate slots in the user's schedule, the envisioned system could help to promote a more active lifestyle. As the workout plan is automatically adapted to the user's needs and capabilities, while also considering health-related aspects, it can be ensured that the outcome is beneficial for the user.

Conclusion & Future Work

To allow the proposed scenario to become reality, certain steps have to be taken. First of all, it has to be ensured that all necessary data such as context information or the user's current activity are available in one place. To achieve this, we propose a plugin-based data collection/delivery service to which all interested providers and recipients can easily connect. For the Android platform, we are currently developing such a framework – in the first iteration, we are focusing on sensor data from built-in or Bluetooth-connected sensors for smartphones and smartwatches, but based on the plugin mechanism, the framework is easily extensible to other information, such as external data, like the weather forecast for example. Regarding the presentation of content to the user, it is important to have an understanding about what the user is able to perceive, e.g. depending on position and orientation of the device's display with respect to the user's eyes. With the mathematical model presented in [16] we have started to investigate this topic. However, more work in this respect has to be done, e.g. focusing on general guidelines that could be taken into account when designing a user interface.

If these more technical aspects have successfully been addressed, the users' requirements and desired experiences have to be targeted. To be able to do so, we expect a number of user studies to be necessary. While a requirements analysis might be conducted via one or several online questionnaires, the assessment of perceived experiences typically requires in-the-wild studies.

For the workshop, we are very interested in discussing our proposed scenario to generate a common research agenda for the future.

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