Unexpected Journeys with the HOBBIT – The Design and Evaluation of an Asocial Hiking App

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ABSTRACT
In the age of mobile communications and social media, users are connected to interact with other people, and often obliged to be socially active as technology drives to connect us. In this paper, we harness the technology for the opposite use: helping people to avoid company instead of encouraging interaction. We have developed the concept of an asocial hiking application (app), in which users can generate routes that avoid meeting other people. We developed the concept based on user feedback data derived from an online survey (n=157) and two focus groups, and created a tool that generates solitary hiking routes based on OpenStreetMap data and additional information from the web. In addition, to make the application react to dynamic changes in the environment, we developed a mobile application prototype that scans Wi-Fi signals to detect other hikers nearby and warn of their approach. The prototype was tested and evaluated with 8 hikers in-the-wild. In addition to the concept design and the functional prototype, we present findings on people's, especially hikers, need for solitude, and introduce user feedback from each stage of the prototype design process as well as design recommendations for an asocial navigation application.

Author Keywords
Location-based services (LBS); Hiking; Solitude; Context-aware computing; Mobile devices; User studies.

ACM Classification Keywords
H.5.1 [Multimedia Information Systems]: Artificial, Augmented, and Virtual Reality, Hypertext navigation and Maps, Location-based services (LBS)

INTRODUCTION & MOTIVATION
The past decade has witnessed the rapid raise of mobile

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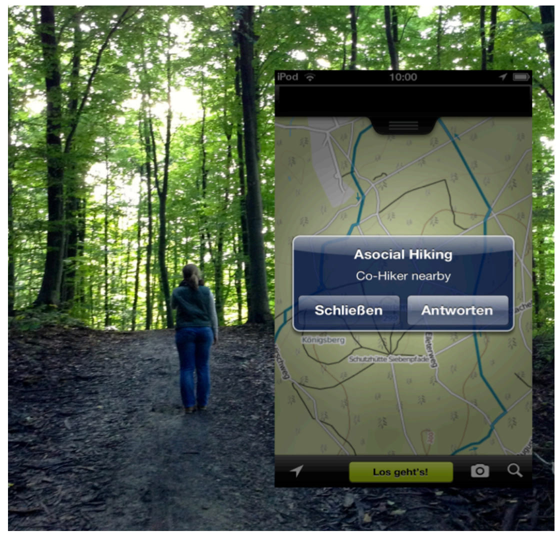

Figure 1: The asocial hiking app HOBBIT in use during the in-the-wild study. Users get warnings on their mobile device if an unknown hiker is nearby.

communications and social media applications, which lets us be connected with other people virtually always and everywhere. Many mobile applications are designed to exchange information between people and bring them closer together by digital means. With increased use of mobile phones and ever-evolving mobile Internet access, people are nowadays more connected than ever. For instance, smart phone users are reported to spend the average of an hour daily using apps [4]. Following this trend, mobile map and travel applications are one of the most popular application categories in various online application stores for mobile devices [4]. Classical location-based services (LBS) [13, 18] are taking advantage of this fact by providing more and more social services and add-ons. These range from commercial applications such as Foursquare, Google Latitude, (recently merged into Google Plus), or other friend-finding services to research prototypes [22, 25]. However, it has also been reported that users sometimes wish to be unavailable and disconnected, and purposefully avoid responding to communication attempts [20]. In this paper, we want to more closely examine people's wishes and behaviour on seeking solitude, focusing on the specific context of hiking.

Whereas some navigation systems and concept designs already utilize information about location or preferences of other people, this information has so far been used to find or gather people together, or recommend popular routes or points of interest (POIs) [21, 26]. In this paper, we introduce the opposite approach and want to present the concept of our Asocial Hiking App, which could be considered as a complete inverse approach to existing system mentioned above. Instead of connecting people and bringing them together by digital means, the goal of our mobile application is to let hikers experience solitude during their hikes through nature. The application enables quiet hiking routes by giving the user a sign of an upcoming encounter with other people. The aim is to support users seeking solitude and the perception of being on their own which are often regarded as an integral part of a hiking experience in the mountains or woods.

For developing the application we followed a classical user-centered design approach [17]. To get an overview of the hiking practices as well as preliminary asocial hiking concept feedback, we set up an online survey (n=157) and organized two focus group sessions with altogether 14 people. The themes and conclusions derived from the studies formed the basis of the final application prototype. Combining data from the OpenStreetMap (OSM) project, Flickr photo website, and including dynamic information (Wi-Fi probe request and signal strength), static and dynamic sources of information were used to calculate solitary, private routes. In addition, we present the in-the-wild evaluation of the prototype with 8 users, and report on different strategies to avoid fellow hikers.

The contributions presented in this paper are threefold:

- We present an online survey and results from two focus groups on hiking, with a focus on technical and social aspects.
- Secondly, based on the findings, we developed a route planning system to plan solitary routes. We present an algorithm to find lonely routes within a certain region of interest based on OSM and Flickr data. In addition we developed a mobile app, which informed the users about hikers nearby based on Wi-Fi signals.
- Finally, 8 participants tested the feasibility of the prototype. By conducting the final study in-the-wild, we were able to gain insights about how people used our application to avoid other hikers.

The overall contribution is to chart user perceptions on the asocial navigation concept, and to design, implement and evaluate a proof-of-concept prototype that enables the user to avoid unwanted social company by utilizing geographical information and Wi-Fi signals, and to chart design drivers and lessons learnt for asocial navigation and further application development.

RELATED WORK

LBS and Pedestrian Navigation Systems

Together with the omnipresence of mobile devices, position technology, and an increasing number and variety of mobile apps, location based services (LBS) have become increasingly popular in both research and industry. Raper et al. [18] provide a thorough overview of mobile guides that rely on maps or map-like representations, and discusses both technical and HCI related challenges. With LBS, the focus has very much been in use cases and UI design solutions for wayfinding [8, 12, 14], and locating shops or other POIs [5, 21], people (e.g. Google Latitude), or even cars [16], and ranging from graphical user interface (GUI) based applications to systems combining different, less conventional interaction techniques. Examples of the latter include the Rotating Compass, which combines a mobile phone and a public display for presenting navigation instructions [19] and ActiveBelt, which provides directional guidance through haptic feedback [27]. In addition, location has been used together with other information, such as sensor data, to create smart applications that can react to dynamically changing conditions [23], i.e. become context-aware [2]. Pedestrian navigation systems have been a point of study in the HCI community for nearly two decades, Cyberguide [1] and GUIDE tourist guide [5] represent the nominal work in the area. Kray et al. [12] compared different wayfinding visualization techniques on a mobile phone, and found out, e.g., that people used the 3D virtual world representation to compare the view to their surroundings and orientate themselves [12]. May et al. report that in their study on pedestrian navigation, landmarks were the most used category of navigation aids, when compared to distance, junctions, and street names or numbers [14]. Schöning et al. [24] used content mined from Wikipedia to automatically generate location-based audio stories between different POIs. Hile et al. [11] combined landmark-based navigation with geotagged photos, which are shown to the user on the mobile phone screen together with instructions with direction.

Social Navigation and Match Making

Whereas traditional navigation applications have focused on wayfinding, social navigation applications focus on bringing people together. Integrating social interaction aspects with the navigation application has become an important feature for many LBS, especially due to the rise of social media. For instance, in [21] the user is able to see the location of his/her Facebook friends in the indoor navigation application for a shopping mall, and an application called Space Recommender System [26] merges "like" data from social network to improve walking experiences in urban spaces. There, instead of following main routes, the application tries to balance walking distance and walking along places "liked" by a high number of other users of a social network, therefore increasing the pleasure of urban strolling. Another social navigation system, Social Gravity, allows groups of people to rendezvous by determining a centre of gravity for the group of distributed people in the city, and leading them to that meeting point while preserving the privacy of who was where [28]. Virtual social networks merge with the real world to provide users with an enjoyable walking experience through urban spaces. Several similar approaches and ideas also emerged in the area of psychogeography. MacFarlane [13] introduced an exercise, where one put a glass on a city map, drew a circle, and then followed the route drawn. Unlike the Space Recommender System, this is not avoiding busy, popular areas, but simply random.

Positioning of Our Work

Our research differs from prior articles in various aspects. Firstly, it provides a novel perspective on navigation applications and location based services, which, instead of seeking to find POIs (i.e. people) offers users an opportunity to avoid them. Secondly, we focus on a little explored domain; hiking instead of cities [5] and shopping malls [21]. Thirdly, although earlier research has reported that people adopt practices to support occasional unavailability by purposefully avoiding answering mobile phone calls or messages [20], we take it a step further by introducing the concept of avoiding social contact in the physical world setting - we do not consider managing availability through digital tools, but through physical presence. The fourth aspect, where our research differs from prior articles, is related to aspects of privacy and location sharing. In the past, the focus has been on either general privacy concerns, e.g., with whom the location is shared [7], or lies exposed by location-based social media [15]. Contrary to these, our approach does not consider these aspects but focuses on avoiding face-to-face encounters. Moreover, our approach is not dependent on people's location sharing in social media, as, e.g., in [10] or other recent apps like [3,6].

RESEARCH ON USER GROUP

Already in the early planning phase, we decided to include participants in every stage of the application design phase according to the practices of user centric design. User feedback contributes novel development ideas as well as possible further use cases for such an application.

At the beginning of the project, an online survey with 157 participants, as well as two focus group sessions with altogether 14 participants, were arranged to receive user feedback. The online survey investigated:

- Users' hiking behaviour by charting the hiking frequency, preferred seasons and locations, preparation actions before the hike as well as some in-depth questions such as reasons for hiking.
- The asocial concept attitudes. Three pre-designed application alternatives with varying amounts of information were presented (see Figure 2). The aim was to discover the most preferred design and investigate the appropriate amount of information needed for a satisfying user experience.

Figure 2. Three designs presented in the online survey: 1) SMS alert, 2) radar view and 3) map with alert.

The online survey link was distributed internationally via professional and student mailing lists as well as Facebook. The survey took approximately 20 minutes to complete and was conducted via Survey Monkey online service. Gathered data was both quantitative (7-point Likert scale evaluations) and qualitative, open-ended responses.

RESULTS

Online Survey

Demographics

Of the online survey participants, the majority (92 %) were between 18-39 years of age, 66 % lived in northern Europe, 18 % lived in central Europe and 62 % were male. In general, participants were from all over the world, excluding South America and Africa. 90 % stated that they used map applications regularly, whereas the use of tracking applications was less frequent (40 % mentioned using Endomondo, Nike Run, Sports Tracker or Google Latitude).

Hiking experiences

64 % of the participants had hiked, although 56 % of them mentioned going hiking only 1-2 times a year. Popular hiking areas were different natural locations (i.e. forests, countryside, mountains). Urban environments were preferred destinations for only 16 % of the respondents.

Reason for hiking	Reply count (x/100) %
Enjoying the nature	47 %
Physical exercise	38 %
Relaxation	25 %
For fun	14 %

Table 1. Quantified categories arguing reasons for hiking.

As seen in Table 1, the most frequently emerged themes for hiking were enjoying the nature, or related to exercising and fitness, relaxation and fun. Hiking in the nature is a way to escape the hectic urban sprawl and the constant technological interaction. When preparing for the hike, in regard to technology use, nearly half (44 %) replied that they used Google Maps for studying the route beforehand. Online forums and blogs were browsed for recommendations and peer-reviews, whereas more familiar routes required only a little preparation. Almost all (96 %) carried a mobile phone with them while hiking. However, the phone was mainly used for backup, but occasionally also for taking pictures and navigation if a signal was available.

Asocial concept feedback

The results of the application evaluation section were somewhat polarized. The opinions towards asocial navigation were for or against the concept (44 % positive and 40 % negative evaluations). The responses indicate that others did not mind at all encountering unfamiliar people whereas others wished to avoid unwanted interaction while hiking. *"I like the idea. I have hiked a couple of times, and when I did it, I went because I wanted to see nature and beautiful scenery instead of other people. I completely get this idea, it's awesome"* (participant #14). "*I think it's an interesting concept but I wouldn't use it. … I also think serious hikers tend to use other tools and not their phone for GPS as phones sometimes tend to lose reception when hiking in remote areas. I personally like to hike with others and meet other hikers. Good way to get tips and learn about other great hiking places*" (participant #7).

Design preferences

After general concept-related questions the study ended with three asocial application designs representing different content levels. The first design showed a plain SMS notification of an approaching hiker, whereas the second design revealed a radar view showing other hikers inside the radar. The third design represented a map of the area, location and a notification of an approaching hiker (see Figure 2).

Each design was presented one-by-one separately and participants were then asked to assess them with variables *useful* and *disturbing* using a 7-point Likert scale. After individual assessments, the three were presented together in a row and respondents were asked to vote for their favourite design and give feedback about their choice.

Altogether 73 % of the respondents voted design no. 3 (map) to be the best design concept. Participants valued the spatial, geographical information and the alternative route suggestions helping to avoid approaching unwanted company. A plain SMS was perceived fast and easy but also stressful since the signal could disturb the hiking experience. Also, an SMS did not provide enough information about the approaching hiker, which was criticized by the respondents. The radar view received the second best ratings but it also lacked information about the speed and direction of other hikers seen in the radar view. When comparing hikers and non-hikers preferences for the best design, it appeared that there are no statistically significant differences between the two groups.

Respondents were asked to choose a suitable modality (visual notification, haptic notification or sonification) of how they wanted to be informed of other hikers nearby. 64 % opted for a visual notification (checking smart phone screen for approach signals when needed), 47 % opted for a haptic notification (e.g. vibrating belt) and just 27 % preferred a notification via sound (e.g. ring tone of a phone).

Focus Groups

Two focus group sessions were arranged to deepen the understanding of the emergent design themes. 14 participants were selected by using purposive sampling to get versatile and diverse feedback. The interviews consisted of two different samples so that the first group of eight participants profiled as non-hikers, but were more active with tracking and mobile applications in general. The second group of six participants were somewhat active hikers (hiking at least once a month), but less active with using mobile applications.

The sessions lasted one hour during which the interviewer introduced the asocial concept and asked questions

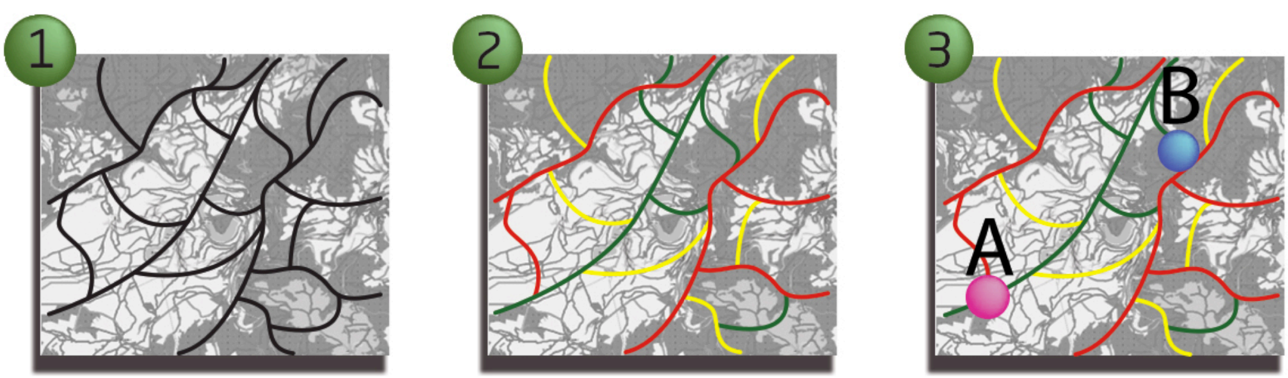

Figure 3: The Asocial Hiking App System Overview: The network of paths in the ROI is classified using data from OSM and Flickr. This results in a ranking how likely it is to meet people on the different paths. Different routes can be calculated based on distance and loneliness (see examples in Figure 5). While on the hike dynamic information can be incorporated as shown in Figure 4.

concerning the overall concept idea as well as avoiding approaching company. The three alternative application designs were presented and feedback asked about them individually. Finally, the participants chose their favourite modality (vision, haptic, sound) for the application signal. Before the sessions, each participant filled out a demographics questionnaire and afterwards a feedback form where everybody voted for the best design and stated their perceptions in general about the concept. Each session was recorded with a video camera and transcribed.

Demographics

The average age was 29.4 years and 38 % were female. 54 % were students, 46 % were working in different jobs varying from office desk jobs to farming. 92 % owned a smartphone whereas 77 % were familiar with tracking applications such as Google Latitude, Endomondo and Sports Tracker, but only 38 % stated using them on a regular basis.

Design Drivers for Prototype Implementation

The results from the design and modality section aligned with the results derived from the online survey. 92 % preferred the map design for its informative nature. Information about surroundings, locations, route alternatives, direction and speed of an approaching hiker were favored in both groups. An asocial signal was not enough but rather extra information on top of a map application was preferred. "*This is more useful because it has a map. I would like to know additional routes if I am about to encounter somebody"* (participant #3, focus group 1). In the first group, the preferred notification modality was haptic. It was considered to give a subtler signal than sound, which was associated with stress and work-related messages. *"I associate ringtone to work, and I do not want that while hiking"* (participant #2, focus group 1). The second group favored a visual signal, thus having the freedom to decide when to check information about nearby hikers. *"It is not always crucial information if somebody is approaching. I would like to decide for myself whether I need the information or not"* (participant #4, focus group 2).

When participants were asked about possible reactions for the approach signal, the majority of them hoped for an alternative route option to be presented on the application map. Hiding was considered awkward. However, leaving the route for the hikers to pass by was considered a worthy option for avoiding interaction.

The online study as well as the focus group interviews provided critical viewpoints to be considered with the prototype implementation process.

- Users perceived the asocial hiking application as extra information on top of an LBS application.
- A combination of approach signal and map provides sufficient amount of information.
- A plain visual message gives the user the freedom to decide whether and when to check possible encounters. Vibration was perceived a subtler indicator than sound. Sound is perceived to be stressful and annoying in the hiking context although being an efficient indicator.
- The most preferred way to deal with approaching hikers is to adapt hiking speed, leave or change the route before encountering. Hiding is perceived awkward.

HOBBIT – THE ASOCIAL HIKING SYSTEM

Based on the viewpoints of the survey and the focus groups' interviews we developed HOBBIT, the asocial hiking system. The HOBBIT system consists of two main parts: the first part is a desktop application that allows users to generate solitary hiking routes within a region of their interest (ROI). The routes are based on OSM data. This is depicted in Figures 5 and 6. These routes can be transferred to a mobile device and user can walk along these routes with the help of most standard hiking apps of their choice. In addition, users can be informed about approaching hikers with the help of a Wi-Fi sniffing component as can be seen in Figure 4. A Wi-Fi card turned into passive mode is constantly looking for nearby Wi-Fi devices in the environment of the hiker to generate warnings (as described in detail in the implementation section).

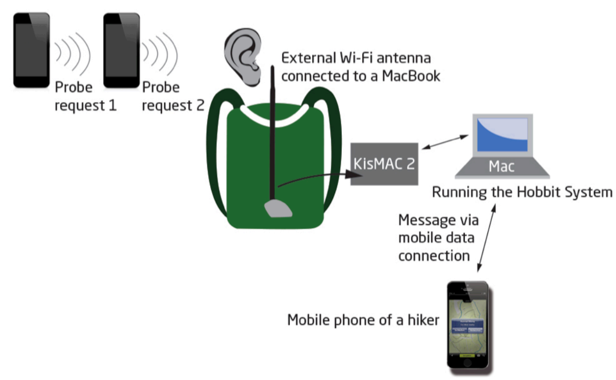

Figure 4. Illustration of the components used during the user test. The backpack of the experimenter contained an external Wi-Fi antenna connected to a MacBook. The KisMAC 2.0 software running on the MacBook is constantly looking for probe requests. If a probe request from an unknown Wi-Fi device is detected the hiker is receives a notification on his/her mobile device.

As can be seen in Figure 3, the users have to perform three main steps to generate a solitary route. First, the users need to select a ROI in which they wish to hike. In this ROI the HOBBIT system then classifies all hiking paths regarding the chance to meet other hikers, as explained later in detail. Then users can select a start and endpoint of a hike in the application and the system calculates a solitary route. The prototype was also able to react to other hikers presence by dynamically updating the route and contained a simulation mode.

In the following, we describe in detail how we classify routes into segments, where one would likely meet other hikers, and segments where one will likely be on his/her own. We also use the terms path or edge (as multiple paths/edges form a graph) for a route segment. Then we describe the different options to calculate a path on this route network and also describe the functionality of our Wi-Fi sniffing component that detects other hikers based on probe requests from their Wi-Fi cards. In the following description, *track* and *route* carry the same meaning.

Classification of Routes

As can be seen in Figure 3, to generate solitary routes we used information about the editing history of OSM as well as point of interest (POI) information from Flickr to add weights (indicating the "loneliness" of a route segment) to the edges of the graph. We classified each edge with an overall classification into nine classes ranging from not very likely (low weight) to run into other people to very likely (high weight) for the selected ROI using a set of different variables consisting of Timestamp and version number of a path in OSM, POI data from OSM and geotagged photos from Flickr.

Visually this will be represented with weight-coded colours ranging from green to yellow to red, where green indicates a low weight and red indicates a high weight. Different routing options can be used (see Figure 5) trying to find a good trade-off between the shortest path between two points and less crowded routes.

Editing History of OSM based on timestamp and version number

The timestamp and version number of a path from the OSM dataset represent how long ago and how often a path has been updated respectively. We have chosen to classify these values separately and then combine them into a single weight, which we call the *update weight.* The update weight is the average weight using timestamp data and version number and calculated as follows:

Timestamp data gives us the information when the edge was last updated in OSM. We used simple standard deviation classification technique for timestamps. This classification method finds the mean value, then places class breaks above and below the mean at intervals of either .5, standard deviation until all the data values are contained within the nine classes. We count edges, updated a long time ago, as lonelier than edges recently updated, as these get more attention than edges updated in the past.

The version numbers give us information about how often a path was updated. Again, we count paths, updated just once or twice, as lonelier paths are updated less frequently. To classify the version numbers we first transformed the data on a logarithmic scale. We do this to give low version numbers a noticeable weight if there are relatively much larger version numbers present in the data set. Then we classified them into 9 same sized classes.

To calculate the *update weight* (w_u) for a single path we simply used the average of both weights.

POIs Information based on OSM and Flickr data

POIs are the locations we want to avoid because, as the name implies, many people are generally attracted by these places. The POIs taken into account from OSM are pubs, restaurants, shops, tourist attractions and historical sites. Each POI category is considered of equal importance to avoid, since the idea of the application is to help to enjoy the solitude, not to guide to popular attractions. We use the same heuristics for the Flickr data. From Flickr we can receive a list of geotagged pictures in the ROI. Each picture indicates that someone has been there before and the place was worth taking a picture. Based on this we assume that the specific locations are rated more crowded than places where no pictures were taken. Several pictures taken in a given radius will result in a higher weight.

For both data sets we used a simple k-mean clustering approach ("k" is dependent on the size of the ROI and the number of geotagged pictures within that area), that groups nearby POIs based on their vicinity. After that the clusters were classified based on the number of data points they contain. Unlike the timestamp and version data, which exist for every single path, POI and Flickr data are only relevant to paths in their vicinity. Their clusters represent regions that exert an influence (their weight) on all nearby paths (about 100-125m and 75-100m for typically sized hiking areas; again this depends on the selected ROI). This means that in the absence of nearby POI or Flickr data points, a road will always have a weight of "0". An edge that is influenced by (i.e. intersects with) one or more clusters will receive the weight of the highest weighted cluster. We call this weight (w_{poi}).

Combining Editing History and POI

From both weights (w_u) and (w_{poi}) a single weighted graph is created. For each path it is checked if (w_{poi}) is larger than (w_u). If (w_{poi}) > (w_u) is true, (w_{poi}) is assigned as a weight for that path. Otherwise, we calculate the weight that is assigned to the path by using (w_{poi}+w_u)/2. This reduced the weight of the *update weight* by lowering the weight in areas with few POI data. We found that the combined approach succeeds in preserving POI and Flickr information, while slightly lowering the importance of the update weights for areas that are lacking POI data. We evaluated our approach, by letting different ROI experts judge the feasibility of our classification approach. Basically they confirmed that this rating schema produces a good classification how often a path is used by hikers. In general, this was also confirmed by our results in the user study and comments by the users after the study (see below).

Route Planning

In order to perform routing on a weighted graph the algorithm A* is used. A* typically uses distance as a basis to calculate the "shortest path" in a graph. In our case, we also took the "loneliness weights" of the paths into account. The routing (modes) options are:

1. Shortest Path (SP): Used as a reference.
2. Weighted (W): Path of *lowest cumulative weight* under a certain threshold *t*.
3. Weighted Distance (WD): A combination of (1) and (2)
4. Minimal (MIN): Path that minimizes the highest encountered weight (such routing might take an enormous detour)

Figure 5 shows how the four different options effect the route planning in a given ROI.

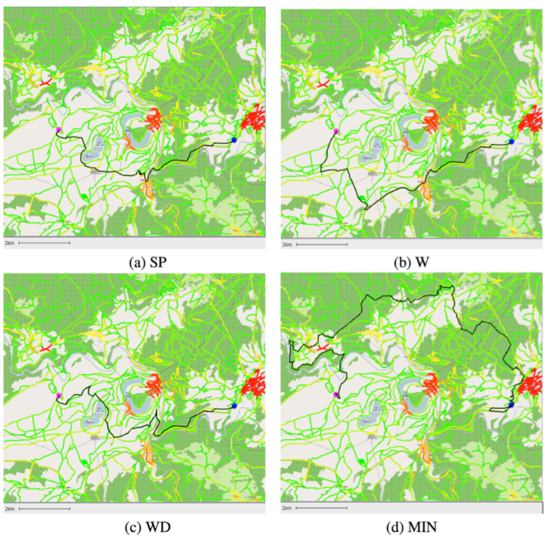

Figure 5. Results using different routing. All edges in the graph are classified by their "degree of loneliness". The ROI is a famous hiking area near Spa, Belgium (waterfalls of Coo). (a) shortest path, (b) lowest cumulative weight, (c) weighted distance, (d) path that minimizes the highest encountered weight.

Implementation

The first part of the HOBBIT system, which is the route-planning tool, was developed as a desktop application using J2SE. OSM and Flickr information are crawled from the Internet when a certain ROI is selected and stored in a local XML format. Tracks can be saved in the GPX format to hand them over e.g. to a mobile application (the user study section). We also developed a mobile extension of HOBBIT to inform hikers about nearby hikers using Wi-Fi signal detection. We utilized the fact that a device having a Wi-Fi card constantly transmits probe requests. A probe request is a special frame sent by a client requesting information from either a specific access point, specified by SSID, or all access points in the area, specified with the broadcast SSID. In other words, the client wants to check if networks are around (by looking at the SSID) to which it was connected before, to connect again. To detect these probe requests KisMAC 2.0, a wireless network discovery tool for Mac OS X, was used, running on a MacBookAir. Using KisMAC 2.0 we put an external Alfa AWUS036NHR wireless card with an additional antenna (see Figure 4) into passive mode and we performed a scan every 5 seconds. Passive mode is also more commonly known as monitor mode. In passive mode a Wi-Fi card monitors all Wi-Fi traffic nearby without transmitting or interfering with it. With this setup we can identify if unknown Wi-Fi devices are near the hiker. By doing *war driving* before the test-run we filtered out stationary Wi-Fi devices that already existed in our hiking environment. Once a probe request from an unknown device was found, we sent an iMessage to the hiker's device informing about a nearby hiker (as also shown in Figure 4).

EVALUATION

We ran a user study to test the feasibility of the HOBBIT system. The goal of the user study was to get insights about the use of such an application by hikers in-the-wild. As there is no-standard protocol for evaluating asocial technologies in-the-wild yet, we needed to make a few compromises, when conducting the study. In general we carefully balanced the advantages and disadvantages of all the decisions involved in the setup of the evaluation to get the best grasp on how people would use such a novel technology and react to it. For example we decided to have a researcher companying the test subjects, as we rated the risk of the users getting completely lost in the woods higher than having a silent companion interrupting the moments of solitudes. Similarly we decided that the researcher would record all the users' interaction rather having the users wearing a bulky video recording system.

Participants & Apparatus

The study took place in a local hiking area near the city of Aachen in Germany with 8 participants, 5 males and 3 females with an average age of 29.1 years. 4 participants were graduates from two different universities nearby the hiking area and 4 participants worked in different jobs. All participants were active hikers (hiking more than once a month) and all owned a smartphone. The study was conducted during 3 days (2 Sundays and one Saturday) within 2 weeks in late August 2013. Weekends are typically busy hiking days in this hiking area. We wanted to have the track most likely populated by other hikers to investigate, how people react when the HOBBIT system detects them and shows warnings. In addition, we also wanted to find out how well the HOBBIT system creates solitary routes, when comparing them to more standard tracks in the area. Therefore the researcher also walked an official trail of 6.5 km before the user tests on the 3 days and counted all hikers passing by. Overall, the hiking conditions were good (as also confirmed by the participants) with partly cloudy sky to sunshine and temperatures between 18 and 27 degrees Celsius with no rain.

The calculated track by the HOBBIT system within hiking area Aachener Wald was approximately 6.5 km long. The route was transferred to the commercially available hiking application. The application was running on an iPhone 4s. 2

users were already familiar with this application; the others were briefly introduced to hiking app. The application provides a simple map view and lets the users walk along the track highlighted on the map (see Figure 1). During the hike, participants were accompanied by the researcher, who was equipped with a backpack with the Wi-Fi-Sniffing software and hardware as described in the implementation section. Of course, this was not optimal for experiencing pure solitude, but was the best trade-off between having the participants also carry the mobile parts of HOBBIT and equipping them with additional cameras to record their reactions, or feeling uncomfortable during the hike. The researcher was not allowed to engage in conversation with the participants and only reacted to questions regarding the use of the HOBBIT application. The participants were instructed to hike and act as if they were alone. Prior to each test day, besides hiking the official track, the track calculated by the HOBBIT System was hiked by the researcher to detect static Wi-Fi devices and filter them out (this is described as *war driving* in the implementation section). The warnings, as we developed them from our interviews, were sent as a visual message on the screen with a subtle vibration of the iPhone without sound.

Before the test, the participants filled out a background questionnaire. The participants were instructed not to leave the route. They could react to (or not) any warnings, as they wished. After the test, feedback was collected from a semi-structured interview, and the participants could try out the HOBBIT system and plan their own solitary routes.

Results

All hikers were able to successfully complete the hike without any mistakes (e.g. leaving the route). The overall completion time was about 84 minutes on average, and the encounter rate was 5.4 people per hike. Despite receiving approximately 3.9 warnings from the HOBBIT system on average, the participants still met 1-3 people (with people we also refer to small groups of people and count them as "1 person", the maximum amount of people in a group was 4) on their hikes. The warnings were sent out about 1 minute before they encountered other hikers (the range of the Wi-Fi antenna was about 90 meters). While hiking the official trail (6.5km) the researcher met 8.3 people on average. This gives a good indication that the HOBBIT system calculates solitary routes for a certain ROI. All participants reacted to all warnings; except two participants who ignored two warnings (94 % reaction rate). When asked the reason for ignoring, both people said, that the warning and the vibration alone was already a mental preparation for them to meet other people.

The participants reacted differently to the warnings. In most cases the participants first tried to locate the approaching hiker. Most common was then to slightly adjust the walking speed (slowing down or speeding up) to avoid meeting the hiker. The participants also reported afterwards that they would also have left the route at some points to avoid a hiker. Leaving the route was not allowed to ensure that all hikers walked along the same route and that the participant and researcher did not get lost in the woods. This strategy was very successfully used by all participants. Another strategy observed was that participants took a short break and turned away from the track to have a packed lunch or take a photo while waiting for the other hikers to pass behind them. Again, none of the hikers wanted to hide in the woods, as was also reported in the focus groups. Two other strategies were used by two separate participants. The first participant started to hum a song, not being able to greet the hiker passing by. The other did up his shoelaces at the moment the other hiker passed by.

The HOBBIT system was not able to detect mountain bikers and horse riders in time for the participants to react to since their speed was too fast. The application was also unable to detect hikers who had their Wi-Fi turned off or did not have a mobile phone with them at all. Another limitation is the inability to show the direction of movement of the approaching hiker. During the interviews, after the hike, participants expressed overall very positive feedback and were interested in the application for future use. We received comments like "*Where can I download it to use it again tomorrow?*" (participants #2, 4, 5, 6). The main advantage for the solitary hiking experience reported by 6 out of 8 participants was the ability to be aware of the approaching hikers and not being suddenly surprised by them. A feeling of being in control was highly valued as well as the ease of use. The participants also valued that to use the application, they do not have to sign up for any service beforehand and share any information with a service. The technical fact that HOBBIT uses Wi-Fi probes to detect nearby hikers was appreciated by all participants and was considered as the most important technical design decision of the HOBBIT system. Participants also suggested using the application for contrary purposes, i.e. for security reasons. It would be comforting to know if help would be near in an emergency situation.

DISCUSSION & CONCLUSION

In this paper we have presented HOBBIT, the concept, development and evaluation of an asocial hiking application, which enables solitary hiking by informing the user of approaching people. In addition to the prototype implementation, we have investigated user expectations and needs by conducting vast and thorough inquiries regarding application design guidelines and modalities. We researched how people can avoid interaction with one another through technology. We show that *hiking alone* can be supported or mediated by the use of technologies.

Design Drivers from the User Research

The results from the online survey as well as two focus groups show that users prefer having a map UI attached to asocial notifications. A map provides other useful information for hikers, such as information about the location and surroundings as well as visual guidelines (i.e.

alternative routes) for avoiding the company of approaching hikers. Regarding social aspects, a map provides the user with an excuse to check the locations of other hikers while viewing useful information about the surroundings.

Approach signals were preferred to be tactile, enabling users to have subtle feedback. Mostly users wanted to decide for themselves whether they wanted to be aware of other hikers. In the prototype, the signal was a subtle vibration with a visual message on the smart phone screen. Sound was perceived as stressful, occupying the user's attention. However, during the in-the-wild interview, the participants suggested using bird sounds as approach signals.

Perceptions of the Asocial Application Concept

The gathered feedback provided overall two-fold opinions towards the asocial hiking concept. Half of the participants found the concept interesting and probably useful. These users appreciated solitude in their hiking and enjoyed the tranquillity of nature whereas the other half could not comprehend the need for such an application. During the in-the-wild study, every participant of the user study enjoyed and valued the use of the HOBBIT system.

As pointed out in a prior article [9], context-aware systems should be designed so that they do not cause unnecessary interruptions. This could also be seen in the prior interviews, where subsequent alarms were found irritating, and which should be corrected in the next iteration by introducing a longer time window to block sequential notifications. During the user test, combining a visual message with a subtle vibration enabled us to ensure that the participant became aware of the approaching company and reacted to the upcoming encounter, rather than potentially accidentally missing a plain visual indication.

Technical Approach

In our case the use of technology could be considered as passive. The application does not rely on social media data since users do not have to sign up for the service online. This is the main contrast to similar solutions such as the Hell Is Other People app [8], that simply monitors friends' check-ins on Foursquare to figure out where they might be and then creates Voronoi diagrams on a map around these place and warns the user, when entering them.

A potential challenge to our application is a condition, where all other hikers turn their WLAN off (which did not occur during our in-the-wild study). Assuming this, we can argue with a twofold solution: 1) the desktop tool will still be able to provide you with lonely tours - independent of whether people use their mobiles on the hikes or not. 2) We could also source more digital noise, such as Bluetooth or GSM signals. It is our belief that the digital noise, tracking technologies, and technology use in general will be more and more prominent in the future in various sectors of life, including the hiking context. We emphasize that our technical solution is already functional for short hikes, and opens possibilities for further technical development. We also want to stress, that our application is not for avoiding everybody. Primarily, it provides the user a possibility to lessen the encounters with other hikers.

Methodological and Cultural Considerations

We acknowledge that our work is limited by the spatial, social and cultural settings of our research. For the practicalities related to the concept evaluation, we were restricted to the use of hiking tracks taking only a few hours, instead of longer trails, which would probably have attracted hikers seeking solitude. Also, the researcher shadowing the hiker may have caused some interference with the study, although the interaction was kept to a minimum. We acknowledge that the sample does not consist of hikers only; with the versatile participant sample we received feedback concerning technical and visual aspects as well as how the app would be best utilized during hiking. However, we still have a good representation of hikers: a) In the call, the online survey was advertised especially for hikers, but included hikers with different activity levels as well as non-hikers. b) Focus group (FG) 1 included tech-oriented people to give insights into application development, whereas FG 2 consisted of active hikers. c) Participants of the field test were all active hikers.

Although the study was conducted in an international environment, there are cultural differences that need to be addressed when designing the asocial application further. As noted from the online questionnaire, the opinions towards the concept were strongly twofold. In addition, the application should be designed to provide sufficient information, but not overwhelming the hiker with an excessive amount of signals and content that would disrupt the actual activity – the hiking. We acknowledge that leaving technology behind can be one key aspect of hiking. However, our concept does not seek to be a general solution everybody should use, but it offers a tool for such hikers, who would appreciate a mobile tool that could help in avoiding encounters with other hikers.

Future Work

Our plans for future research include a diary study for long-term hikes, where people stay in the wilderness for several days. By looking at these really solitary hikes, we seek to understand the desires and strategies related to asocial navigation, and look closer at what role technology plays in preparing and conducting hikes. We also aim to make the HOBBIT system more mobile. Therefore the Wi-Fi module of the mobile device needs to be turned to passive mode. This is currently not possible without rooting the device and also no external antenna could be attached.

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