Supporting Natural Navigation for Running in Unknown Places

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Abstract
Providing natural navigation support for runners in unfamiliar places constitutes a major challenge. Runners want to simply enjoy their run without fear of getting lost or being disturbed by intrusive turn-by-turn directions at every intersection. We propose a design supporting navigation in a natural way exploiting the runners’ natural head movements when scanning possible path options at an intersection. We provide runners with sound cues about the path they are looking at that indicate whether this path is good or not. We explain how our design works and discuss the outcomes of a preliminary user test.

Author Keywords
Natural interfaces; Navigation; Audio; Music; Exploration; Running; Concept design.

CSS Concepts
• Human-centered computing~Auditory feedback • Human-centered computing ~Interface design prototyping • Human-centered computing~User studies • Human-centered computing~Usability testing

Introduction
Running is one of the most popular and practiced sports around the world. There has been much work to

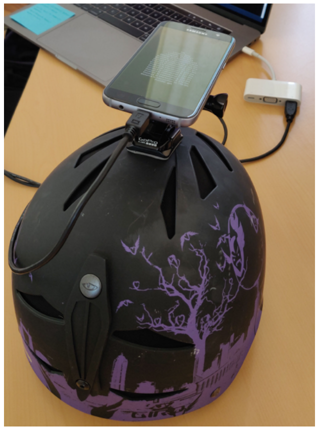

Figure 1: In this image, the android phone is attached on the top of the ski helmet.

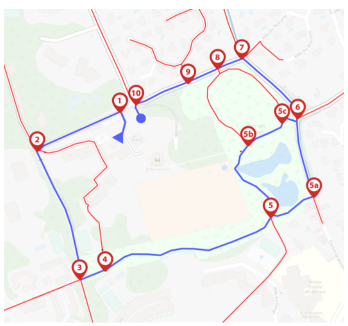

Figure 2: This shows the mapped 1.3 km pre-defined path with all the intersections and good/bad paths. The Blue paths are good while the Red are bad.

support runners technologically, in tracking their activity, monitoring their body statistics, sharing with peers, etc. In this paper, we address another issue: supporting runners when running in unknown places. This brings navigational issues to the forefront. Indeed, to avoid getting lost, runners often do not practice their activity if there is no obvious path to follow [6].

Runners may still try existing turn-by-turn navigation solutions, provided via voice, visually on a mobile phone or watch, or through haptic cues delivered via a wrist band or a chest belt as investigated in previous work. A problem with visual support is, that it requires the user to modify his movements to explicitly look at it. Even if provided via a smart watch that is more easily glanceable [6], it still requires intentional arm movements to look at the information provided. Haptic cues are less intrusive than visual ones. However, they can be easily missed or misunderstood [7][8][11].

Audio has the advantage of freeing the users from having to look at mobile screens and reduces cognitive load to understand complex vibrotactile cues. It has been explored for waypoint navigation and touristic POI discovery [3][4][5]. Others have exploited the sound stereo effect to encode the overall bearing direction towards a target location, and the sound volume to encode the current distance form that location [10] [12]. Such audio feedback is generally provided as a return on the user’s scanning movements with hand held devices [2][9].

Our objective is to provide less intrusive and more natural navigation support to runners. In the rest of the paper we are first going to briefly discuss our own user research. We found that head movements combined with sound are promising means to convey navigation support to runners. We will illustrate how we use them in our design, discuss first user tests, and conclude with ongoing and future work.

User Research

Through semi-structured, approximately 45 minutes’ user interviews, conducted with 7 local people (5 men, 2 women, age 35-55) who run several times a week, we found out that runners generally prefer to run without too much technical support. More than half of the interviewees stated that they like to discover new routes but did not find existing navigation that is sufficiently practical and non-intrusive. When still daring to go out for a run, they just looked around and followed the path that was more visually appealing to them. This gave us the idea to exploit this visual scanning behaviour in our solution.

During the study, we saw two types of runners, those that run with music to be motivated and entertained, and those who run without music, to be immersed in the natural sound of the environment. In order to effectively use sound to support navigation we had to consider this and propose thus two versions of our design one for each preference.

Concept Design

Currently, in our concept, we explore the non-intrusive nature of audio for navigational feedback. We combine this with the use of the natural head movement when scanning the environment which we have not found in any of the existing work.

Our solution is based on the following two hypotheses:

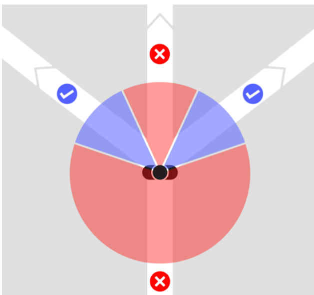

Figure 3: This image shows an intersection with the vision angle range for each path. Two paths are good, one is bad. If the user looks in the direction of a good path, the music volume remains high; when he looks in the direction of a bad path, it becomes barely audible.

Figure 4: Participant followed and recorded with a GoPro during the run.

1. The head movement, i.e. turning the head at intersections to scan and evaluate the possible path options, is natural for runners.
2. Sound and audio cues are a minimally intrusive way to provide navigation support to them.

We propose two versions of our design:

Version 1: Modulating music
For runners who run with music we modulate the volume of the music to indicate and distinguish good and bad paths. If the path the runner is looking at is good, the volume remains high and unchanged. If the path is bad, the volume is significantly reduced to tell the user he should not take this path.

Version 2: Audio snippets
For runners who run without music, we play audio snippets corresponding to the quality of the scanned paths, for instance through the phone, the watch or bone conduction headphones. A warning audio snippet indicates bad paths. Other snippets may indicate good paths; however, another option is to not bother the runner with (positive) audio snippets as long as s/he remains on a good path. This is equivalent to not changing the volume in the first version.

The motion scanning and sound modulation mechanism is activated when the runner comes close to a decision point, at a distance of around 15 meters, so that it corresponds also to the visual horizon of the runner. Between intersections the sound remains unmodulated.

Initial Prototype

In order to assess the viability of our design idea and to get early feedback from runners, we developed an initial prototype implementing the first version of the concept. It consists of an Android phone attached to a ski helmet, and regular earphones connected to the phone (Figure 1). We used Processing software [1] to develop an app that could run on the phone and access the data gathered by its built-in sensors, providing all the required information:

- The compass data (magnetometer sensor) provides the phone orientation in degrees in relation to the magnetic north, which is used to detect the head orientation.
- The location data (GPS and network) provides real time latitude and longitude.

We manually pre-defined a running path and mapped the location of every intersection as well as the degree with respect to the north of every available path at each of those intersections and assigned a tag (good or bad) to each of the path. In future, this will be done by an algorithm generating running tours based on the geographical characteristics of the surroundings. During navigation, when the runner approaches an intersection, the system then modulates the volume of the music according to the path s/he is looking at. We defined an angle range of vision for each path from the user point of view. If the user looks in the direction of a good path, the music volume remains high; when he looks in the direction of a bad path, it becomes barely audible (Figure 3). After trying the system and a few modifications in the code we were successfully able to reach the desired results with the system.

User Testing

We recruited 5 regular runners (3 men, 2 women, age 25-55), 3 of them regularly listening to music while

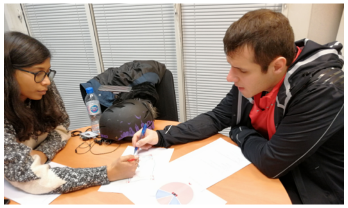

Figure 5: Personal interview conducted after running.

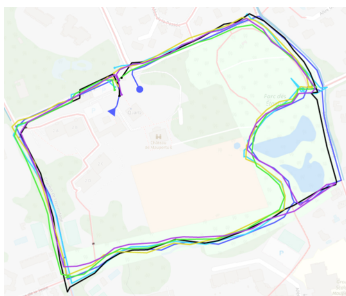

Figure 6: This image shows the path ran by all the participants differentiated by color. The path trace was generated by the Garmin watch that the participant wore during the run.

running. We defined a running path of 1.3 km containing 12 intersections (Figure 2). Before making the participants run we introduced the concept and presented the prototype to them. We used the first intersection to train them on how to use the system. During the run, one of us followed and recorded each participant using a GoPro (Figure 4), observing whether they stopped slowed down, took wrong directions, etc.

After the run, we conducted a semi-structured interview with each participant, with pre-defined open-ended questions. We used a map of the path they had run to support the discussion (Figure 5). Overall the feedback was very positive and the concept appreciated, even for runners that usually run without music.

Our user test confirmed our initial hypotheses: all participants agreed that the head scanning movement was rather natural for them when running and selecting paths. They all understood the sound cues and were able to follow the path (Figure 6). However, in three cases, our test runners took a wrong direction at one of the intersections and we had to stop them. For example, in one case the runner had previous knowledge about the area and followed what he considered the “best” path to take, simply ignoring the sound cue. In another case there was a barrier to cross which disturbed the runner and prevented him from taking that path.

Another issue that the participants highlighted was some uncertainty related to inherent volume changes in the songs or the silence between two of them. These could be understood as indications of bad paths or prevent runners from recognizing a cue. Also, a change in volume that occurred during a straight path was mentioned, but most probably this was the result of poor GPS accuracy, deriving wrong cues from other, close-by intersections.

Most of these issues could have been avoided if we had implemented one of the already conceived features: keeping the volume low when the runner persists in following a wrong path instead of resetting it back to normal as soon as the runner leaves the threshold area around the intersection.

Another interesting suggestion from the participants was to give a succinct alert to the runner whenever s/he approaches a critical navigation point, i.e. an intersection with a direction change. This could prepare them and make them more attentive to upcoming sound cues. Indeed, some runners preventively slowed down when approaching intersections to be prepared for the sound cues.

Conclusion and Future Work

We presented a novel design to support navigation while running in unknown places. We tested a first version of the design with a small user group. They gave us constructive feedback on possible improvements which we will integrate in the next more compact version of the prototype, which we are currently developing. Despite some minor issues, the participants were keen to use our solution in the future as it gives them the possibility to enjoy a run in unknown places. We plan to verify the acceptance of our solution over long term usage in another longitudinal study. In parallel, we also started to build the second concept version to understand its viability.

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