Investigating and Supporting Undirected Navigation for Runners

David K. McGookin and Stephen A. Brewster  
Glasgow Interactive Systems Group  
School of Computing Science  
University of Glasgow  
Glasgow, G12 8QQ  
davidmcgookin@gmail.com  
stephen.brewster@glasgow.ac.uk

Abstract  
We present an analysis of how runners navigate the environment when running. Results from 153 questionnaire, and 8 interview participants found navigation was often not pre-planned, had no clear route and changed organically as running was undertaken. From this we present the design of RunNav, a novel navigation system that uses Foursquare to provide support for the navigation practices runners employ. We illustrate its basic design, and plans for its future development and evaluation.

Author Keywords  
Running; Navigation; Social Media; Wayfinding

ACM Classification Keywords  
H.5.2. Information Interfaces and Presentation: User Interfaces - Interaction Styles

Introduction  
The rise of smartphones has fuelled new interest in supporting "on-foot" (pedestrian) navigation. Such navigation is significantly more diverse than the directed, turn-by-turn navigation adopted from car GPS systems [1], where users are explicitly directed to a destination. For example, pedestrians often wander to explore an area [6]. In addition navigation is undertaken during diverse activities (e.g. cycling [3]).
One such activity is running. Whilst running has been investigated from an HCI perspective before, there is no existing work on the way in which runners plan and execute navigation. Nor is there work that investigates how what runners do can, or should, be supported.

**Background**

Whilst prior work surrounding technological support for running exists, none has considered navigation. Mueller *et al.* [2] developed “Jogging over a Distance” to support social relationships between pairs of geographically separated joggers. Participants could talk to, and hear, their partner through a stereo headset. The objective was to encourage exertion by getting participants to maintain a target heart rate communicated using the perceived audio location of their partner’s voice (e.g. in-front or behind) to indicate if the target heart rate was met. Evaluations showed participants would ad-hoc alter their intended running path to increase heart rate (e.g. running up a hill) to beat their partner. Whilst only an example, this indicates running is certainly turn-by-turn navigation.

Commercial applications have also emerged to support running activities. Some present current location on a map whilst running (e.g. the Nike+ (www.nikeplus.com) iOS app (see Figure 1)), but largely focus on metrics and performance over time. Other services, such as MapMyRun (see Figure 2) provide a social network for runners to upload and share routes in an area from worn GPS devices.

However, there is no prior work, either as research or commercially available, which investigates how runners plan and execute their runs, or how they stay on track. It is this that we seek to investigate and support.

**How Runners Run**

We carried out both an online questionnaire (153 responses) and in-depth follow-up interviews with 8 respondents. The questionnaire covered how runners planned, executed and modified their runs in familiar (e.g. at home) and unfamiliar (e.g. on holiday) locations, and was distributed to running mailing lists and directly to running clubs. Responses were analysed using a framework approach [5]. Planning, getting lost, en-route changes, as well as familiar and un-familiar locations were used as initial codes.

**Familiar Location Running**

We defined familiar location running as running that would be executed regularly over the same area and close to the runner’s home. Respondents carried out such running 2–4 times per week. Initial plans were based on a variety of sources, including running magazines, discussions with others and local knowledge. Such running is characterized by loops: runs which start and end at the same location, but which do not retrace their path (see Figure 3). These loops were described as "loose", and kept solely in the head, rather than by carrying maps or other navigation aids. As familiarity with locations increases, and runners’ mental models improve, augmentations to the loops, which could be added (or removed) to increase (or decrease) the distance or terrain covered, were identified. Rather than having a clearly defined plan of exactly where to run, runners had a plan on how far or hard to run, and ad-hoc added or subtracted parts of the loop to reflect this. As such, navigation is organic, changing during the run itself, as runners feel tired and remove a section, or wish to run harder. It was also noted that environmental factors, such as improving or deteriorating weather, had a similar influence.
This lack of explicit detailed planning was found to be an example of the key motivations for running: freedom. Respondents noted that freedom, time to think and to avoid daily life and its pressures were key reasons for running. This extended to not being tied down to explicit routes or plans. One particularly critical respondent from the questionnaire noted: “Runners are concerned with getting their daily run in. They aren’t really concerned very much about where it is... Running is about getting up off the couch and getting on with it. The other details don’t really matter”. This highlights that navigation, whilst essential, is a secondary rather than primary part of running. In familiar location running, times, pace and effort are the most important attributes. Where a person runs is mostly irrelevant, provided the environment (as previously mentioned, and further discussed in Unfamiliar Location Running) is suitable for running. In keeping with the importance of pace and effort, running watches that recorded time, pace and effort were often used. Whilst these also recorded GPS log data, this was only accessible via a website after completing a run (see Figure 3). This was used for post-run reflection, improving the runner’s mental model and allowing new loops to be identified. Maps, guides, or other navigation aids were not regularly carried or used by runners as these interfered with the act of running: runners would have had to stop running to reference them.

As the runner will use familiar locations more than once, a detailed mental model of the environment will emerge, and there were few instances of runners becoming lost. However, respondents did note that they could become lost when running new areas: “I knew vaguely where I was going and I knew vaguely how long the route was going to be. ..... It all just became a bit isolated and I thought: “This is wrong. This is not where I’m meant to be”. And I just, I just felt a bit out in the middle of nowhere and a bit isolated.” It was also clear that “lost”, given the lack of an explicit geographical route, reflected a state where runners would have to stop running and try to gather their bearings, rather than simply adjusting direction because a wrong turn had been taken, even if that meant a detour through an unknown location: “As long as you are confident you can find your way to something you’ll find your way back from, then count that as not actually lost.” The same respondent said “when I think of myself as lost, it’s when I have no idea if I should go left, right, that kind of way and I can’t recognis the route that I’ve come from.”

Unfamiliar Location Running
We defined unfamiliar location running as running in new locations for a limited time, e.g. when on holiday or a business trip. Whilst there are many similarities with familiar location running, such as the enjoyment of freedom and switching off, fundamental differences in the motivation and nature of running were identified.

The first was reasons for not running in such situations. From the questionnaire, 29% of respondents did not run when on holiday or business, or confined running to a treadmill in the hotel. Lack of understanding of the environment, terrain, safe locations and getting lost were all noted as reasons: “I don’t run on holiday as I would get lost, wouldn’t know where safe areas are, so I prefer the safety of the gym.” As with familiar location running, maps and other navigation aids were not carried on runs. Therefore, although navigation assistance would be useful during a run, current aids do not effectively provide it. For respondents that did run...
on holiday, as with familiar running, there was a lack of pre-planning. Interview respondents noted that they were more likely to look at a map, but it was the obviousness of a good "runnable" location (e.g. a park or beach) in the environment that most strongly incentivised running or not.

THE PURPOSE OF RUNNING
Familiar location running was characterized by repeated runs over the same general paths, the primary objective being to meet a distance, time or pace target, rather than enjoying the environment. In unfamiliar location running this is reversed. As an area may be used only once or twice, coupled with holiday food and alcohol excess, running became a way to explore the environment and identify places to later visit: "So on holiday it'd be much more about taking in the surroundings as well, as opposed to maybe in Glasgow I'm just pounding the streets. And I'm thinking I need to get, well, speed up. On holiday it'll be much more: "That looks nice, or I might give the beach a try".

Whilst familiar location running was characterised by loops, unfamiliar location running was more often characterised by out and back runs. Here, at the midpoint of the run, the runner reverses his or her path, retracing it back to the start location. Through the interviews it was made clear that loop runs were more desirable, as these allowed the runner to see more of the environment. However, there were two clear reasons why out and back runs were more often employed. The first was a commitment of time. Family and other commitments meant that running time was limited. Running for half the time and then reversing course meant that these other commitments would not be jeopardised. The second reason was the same as why many runners did not run on holiday: the lack of familiarity with the environment and the danger of becoming lost. Looped runs require a good mental model of the environment to ensure a new way back to the start can be found. Without one this may not be possible. E.g. a 5km run may unexpectedly turn into a 10km run if the runner cannot find a loop and is forced to retrace his or her steps. An out and back run is more predictable, making it harder to become lost.

EN-ROUTE CHANGES
When running in familiar locations runners work from, and develop, a mental model of the environment. Changes to an intended path are largely attributable to a desire to increase or decrease run length or intensity. In unfamiliar locations however, no initial mental model exists. In such situations, navigation is similar to environmental foraging techniques, where animals constantly evaluate their immediate environment to choose places where they are likely to find food or shelter [4]. Runners navigate similarly, constantly evaluating their immediate environment and choosing a direction that appears to offer the “best” conditions for running. There were a number of environmental features that runners noted would cause them to change direction. However, all can be classed as either proactive (reasons to run in a particular direction), or reactive (reasons to run in a direction other than the current one). For example, a large number of road junctions, or shopping areas with many pedestrians "getting in the way" requiring the runner to slow down and weave to avoid, would cause reactive changes in direction. A park, beach, view or other quiet points of interest would all proactively prompt a direction change.
Running Navigation Summary

Our analysis shows that rather than rigidly following a predefined route, as might be suggested from existing apps (see Figure 1), navigation is undertaken *ad-hoc* as a runner executes his or her run. The decisions that guide navigation are fluidic and depend on the intent of the run, which in turn determines the environmental characteristics that are important. However, whilst successful navigation through the environment is essential to running, it is not the primary goal. All respondents emphasized freedom, and not being constrained to a route, was key. Additionally, the start and destination of the run are often the same. Runners who start at their car, or hotel, will want to return there. Existing navigation solutions do not support this collocation of start and destination. Whilst non-visual approaches (e.g. vibrating a device when pointed in the "correct" direction [6]) could provide an indication back to the start location of a run, it is difficult to provide an area overview (we return to this in future work). It is clear that navigation support for runners is desirable, but existing techniques (including maps) that focus on reaching a known destination are not suitable. To investigate how support this, we developed RunNav.

RunNav

The design of RunNav is based on key findings identified. Most importantly, no initial planning should be needed, and no explicit destination should need to be set (RunNav assumes the start location is also the destination). RunNav should be able to assist the user in navigating the environment, but not try to force the user into a particular route, and should be glanceable and not interfere with the act of running. RunNav has been influenced by the ability of runners to so easily classify changes in direction as either proactive or reactive (see En-Route Changes). That runners' are so clear in what constitutes a positive or negative location supports the potential of automatic classification of the environment into good and bad locations. RunNav draws on both these points to provide an overview of the area around the user, initially focusing on supporting unfamiliar running locations.

Figure 4 shows the RunNav visualization. RunNav runs on an Android mobile device, using a Bluetooth connected 3.5cm Sony SmartWatch display. RunNav splits a 1.5km circle around the user's current location into eight sectors, and subdivides each of these into three levels (each with a 500m radius). See Figure 5 for an example. The environment in each segment is then classified as neutral (yellow). Based on the environmental features located in each segment, this classification is either increased positively to good (green), or reduced negatively to bad (red). The visualization is egocentric and dynamically updates during running. To support the more desirable loop running, the segment containing the run start, and thus end, location is always coloured blue (see Figure 4).

RunNav uses the Foursquare social media service (www.foursquare.com) to supply information about the environment around the user. Such "check-in" services provide quick access to the types and frequency of locations in an area. All segments start off as neutral (2.5 on a 5 point scale). Each feature found in the segment is given a score. Undesirable features, such as shops, which indicate busy pedestrian areas, are given negative scores. Desirable places, such as parks or beaches, are given positive scores. Scores are then weighted. E.g. a cluster of shops, or a shopping mall, is given a greater negative weight than a single shop, as
these indicate a denser group of pedestrians who might "get in the way". A park containing a point of interest is given a slightly greater weight. The summed score then provides our three-colour area rating. The user can customise the scores and weights of features, so that they fit with individual runner preference.

In this way RunNav provides a lightweight overview of the area, providing a better understanding of good and bad places to run. It provides extended range for the environmental foraging that runners engage in when navigating unfamiliar locations, supporting better decisions as to when and where to run, but ultimately leaving these to the runner.

**Future Work and Discussion**

There are limitations to our current work. Foursquare provides good coverage of public places (e.g. shops, parks etc.), but residential areas are not shown. This leads to "dark segments" where no data is available. In addition, some negative environmental features, such as busy roads a runner must cross, are not represented in Foursquare. We are incorporating other services (e.g. Google Traffic) into RunNav to provide this information. We explicitly avoided non-visual feedback techniques (e.g. [3,6]) as they cannot provide the area overview at a glance. The Sony Smartwatch contains a vibration motor, and there may be a use for it (e.g. indicating the direction back to the start location). However, our initial goal is to establish the utility of the RunNav visualisation before augmenting it.

We are currently planning both technical evaluations to tune the classification system, and field trials where RunNav will be deployed to runners for a period of months. In this way RunNav will help change perspectives on the environment and how runners navigate through it.

**Acknowledgements**

This work is supported by EU FP7 Project No.224675 "Haptimap". We also thank Muffy Calder, Chris Johnson and David Watt for feedback on early questionnaire drafts.

**References**


