The 'when, how and what' of Text Based Wayfinding Instructions for Urban Pedestrians

William Mackaness[1], Phil Bartie[2], Candela Sanchez-Rodilla Espeso[1]

[1]School of GeoSciences, The University of Edinburgh, Drummond St, Edinburgh EH8 9XP
[2]School of Natural Sciences, Stirling University, Stirling FK9 4LA
william.mackaness@ed.ac.uk

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1.0 A Context – urban pedestrian wayfinding

The smartphone has become a conduit by which we access many different services (Raper et al. 2007; Kray et al 2005) in many different ways (Shneiderman 2004). Increasingly wayfinding in urban environments is supported by smartphone technology using maps and images; these demand our full attention (Gluck 1991; May et al. 2003). But our ambition is technology that is concealed (Weiser and Brown 1998), delivering only spoken instructions (Bartie and Mackaness 2006; Mackaness et al. 2013), thus leaving the pedestrian 'eyes free' and 'hands free' to enjoy the city. As a precursor to their spoken delivery, we report on the evaluation of a text based system in which subjects were directed by a series of landmark based instructions or street based instructions that were geo-located. Section 2.0 describes the underlying model, Section 3.0 the experiment and subsequent feedback and analysis gained through: trajectory analysis, questionnaires and a focus group.

2.0 A City Model to support Landmark modelling and instruction construction

A map is data rich (hence requiring a lot of cognitive effort), whilst a dialogue based system needs to be efficient, and minimalist (we don't want to bore the pedestrian to death), yet sufficiently robust that the user does not get lost. What constitutes a minimum set of unambiguous instructions will be governed by:

1. the preferences and previous experiences/area familiarity of the subject;
2. the morphology and topological complexity of the route (multi path junctions, offset roads);
3. whether it is multi modal (stairs, concourses, streets);
4. richness (or absence) of readily identifiable prominent landmarks.

Potentially following landmarks can be much easier than using a map (Raubal and Winter 2002; Ross et al. 2004) (e.g. 'head towards the Castle on the hill') thus leaving the pedestrian to indulge in all the other tasks associated with city walking. The automatic generation of landmark based instructions depends upon the existence of a rich city model. The city model (developed as part of the SpaceBook project) includes a 2.5D LiDAR derived model from which we can calculate visibility. The saliency of a landmark is calculated according to various criteria (Table 1).

Table 1: Saliency metrics and the means by which they were calculated

Metric	Method of calculation
visible façade area	Product of street frontage calculated from OS MasterMap and height from LiDAR data
viewing distance	Dynamic distance of pedestrian from landmark (using smartphone GNSS)
visual unusualness	Count of unique user Flickr images
function(s)	Count of FourSquare venue check-ins
proximity to a decision point	Distance between landmark and 'junction' in multi modal path graph
prototypical form	Ranked preference according to: church, monument, tower, hotel
Name recognition	Recognisable wrt web search (eg 'McDonalds', 'Subway')

The richness of attribute description, and topological modelling between entities enabled us to enrich the description of landmarks (Table 2). By utilising these metrics and combining these adjectives, we can generate a set of phrases that describe any given action (Table 3). Since the device is GNSS enabled, when asked, the city model can calculate a route from the current location to the requested place, identify the most suitable landmarks, and in this manner guide the tourist to their destination – providing the next instruction at the appropriate point along the route, (rather than requiring the subject to memorise the whole route description at the start of the route).

Table 2: Adjectives, prepositions, verbs, adverbs, nouns and proper nouns

Adjectives	left, right, sharp, straight
Prepositions	towards
Verbs	turn, walk, carry on
Adverbs	after, before, downhill, uphill, immediately
Nouns	metres, minutes, steps, bend, distance
Proper nouns	streets and landmarks

3.0 The Experiment – Text based Mobile App and Subject Analysis

Four routes were identified, in the city of Edinburgh, each taking about 20 minutes to walk, varying in complexity (junction, roads, stairs, plazas), landmark types and vista (Figure 1). The experiments were conducted via an Android App that delivered simple text strings whilst gathering locational data. The instructions (Table 4) were georeferenced such that as the smartphone fell within 30m of the reference point, the phone vibrated, and the text was presented.

The subjects were recruited by advertising the experiment across several Facebook community groups in Edinburgh. Each of the 30 subjects (15 male 15 female) was paid £15 to participate in the experiment; half of the subjects used Smartphones on a regular basis and were aged between 17 and 65. Each subject did two of the legs using landmark instructions and two using street based instructions (Table 4). The order and sequence in which subjects used these different instruction sets was managed by the Application and the subjects were not aware of which system they were using during each leg; neither where they told of the final destination to avoid 'cheating'.

Table 3: Sentence construction of street and landmark based instructions

Street name instructions	**Information**	**Landmark based instructions**
Go <x> metres	**Distance of activity**	Walk about <x> metres
About <x> minutes	**Duration of activity**	
Head <cardinal> (cardinal=west, north, etc) Toward <y> (y=streetname) Slightly right/left	**Orientation**	Walk towards <feature>
Turn < direction > (left, right)	**Network guidance terms (path descriptors)**	Turn <direction> (left, right) Immediately turn <direction>
On <streetname>	**Locational information**	Stand with < feature> on your <relativelocation> (relativelocation is left, right)
	Topological descriptions	Opposite < feature >, next to < feature >
	Topographic descriptions	Walk <up hill, downhill, up steep hill>
Stairs, roundabout, street	**Object classifications**	Squares, public gardens, buildings, streets, stairs
Road <street name>	**Object descriptors**	Road <straight, bendy, sharp bend> Building <stone, turrets, towers, domes> Junctions <cross roads, T junction, forks>
	Object visibility	< feature> is visible on your <relativelocation> (relativelocation is left, right)
	Confirmatory cues	You should see < feature >
Continue onto <streetname>	**Decision point features**	At junction <type> turn <direction> before <feature>

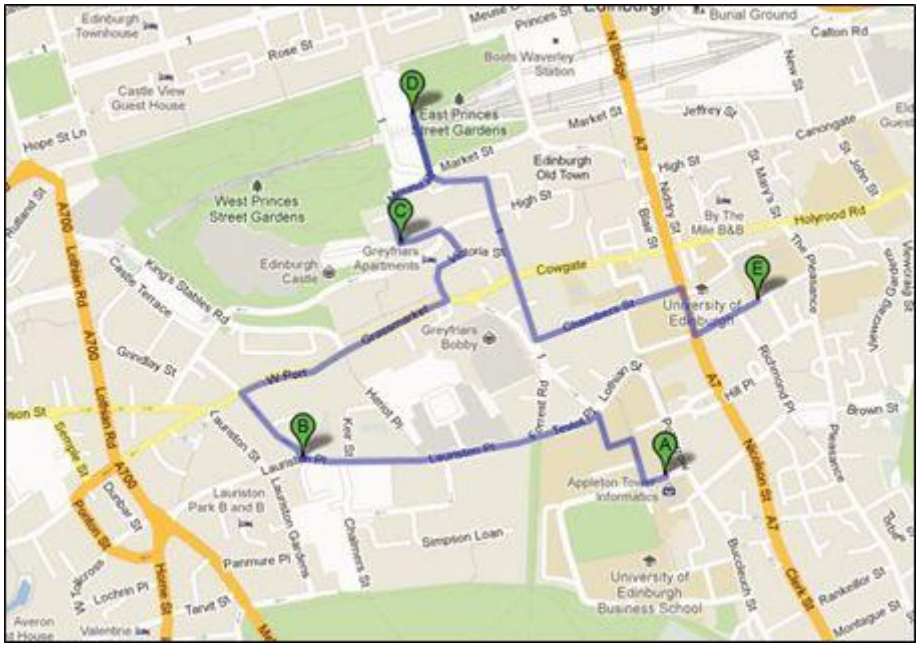


Figure 1: 'end to end' for logistical simplicity – four routes.

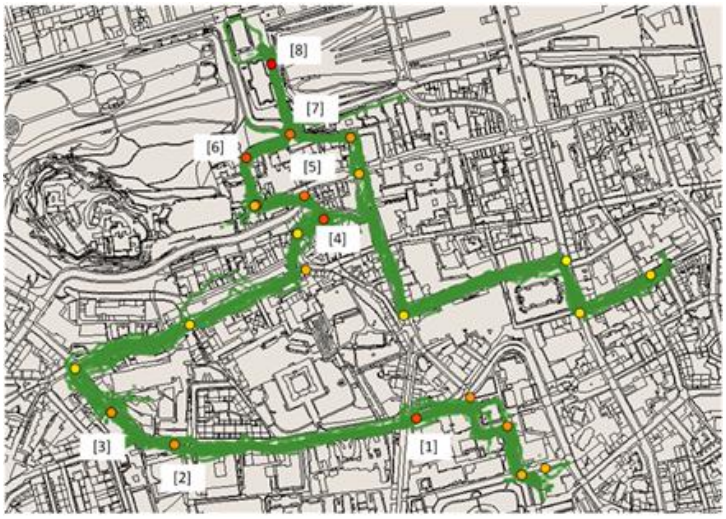
Table 4: route descriptions from street based and landmark based descriptions for the same route.

Street based instructions	Landmark based instructions
1. Head west on Crichton St toward Charles St - go 45 metres 2. Turn right onto Charles St About 1 min - go 94 metres 3. Turn left toward Teviot Pl About 2 mins - go 120 metres 4. Turn left onto Teviot Pl About 2 mins - go 110 metres 5. Continue onto 1/Lauriston Pl Continue to follow Lauriston Pl 6. Destination will be on the right About 6 mins - go 500 metres * Your destination is: Edinburgh College Of Art	1. Stand with Informatics Forum on your right and Appleton Tower on your left. 2. Walk about 50 metres towards George Square. 3. Turn right before George Square at the cross roads. 4. Walk about 100 metres (with Informatics forum on your right). 5. Turn left to cross Bristo Square walking slightly uphill towards McEwan Hall (large building with a dome). 6. Turn left on to Teviot Place, McEwan Hall on your left. 7. Walk along Teviot Place continuing straight for about 100 metres. You should pass Royal Bank of Scotland on your right. 8. Carry on straight at the junction on to Lauriston Place. Walk for about 500 metres. You should pass George Heriot's School on your right. 9. After the slight bend in the road, you will go downhill. 10. Turn off right on to Lady Lawson Street, and walk for 40 metres. Your destination will be on your right, opposite the Novotel. * Your destination is: Edinburgh College Of Art

4.0 Observations

4.1 Analysis of trajectories

Figure 2 shows the paths taken by subjects in response to the instructions (revealing a few who took the wrong route). The location of each coloured dot is the point at which the text was displayed on the mobile device, and its colour is the average level of satisfaction (from 5 – very effective instruction, to 2 – hard to interpret instruction). Three observations are made: 1) there are more instructions in the landmark based experiment since it was possible to take advantage of many more landmarks than there are streets, 2) that subjects were far happier with landmark based instructions than street names, 3) there is some correlation between poorer ratings being given to both forms of instructions and the complexity of the route at that point.



(a)

(b)

Figure 2: Comparing effectiveness ratings between a) street based, and b) landmark based instructions.

Analysis of the trajectories recorded on the device identified ‘dwell points’ along the route, and places where subjects became lost (vertical markings in Figure 3). For landmark based

instructions, Figure 3 consistently shows shorter dwell time and fewer occasions when subjects became lost. Kernel density analysis applied to the graph, identified points along the route that consistently raised problems for the subjects – indicating the need for additional landmarks at those locations.

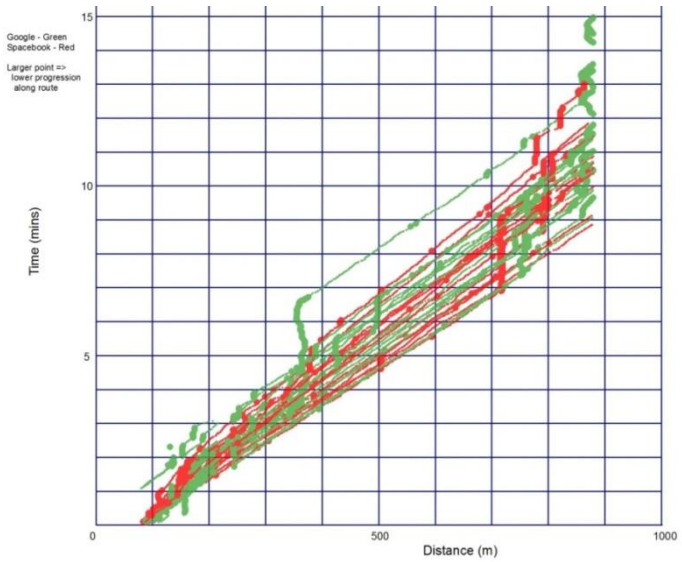


Figure 3: Comparing progress along the route

4.2 Questionnaire Responses

At the end of each leg, subjects were asked to complete a questionnaire covering eight topics. The ambition of the questionnaire was to 1) compare landmark based instructions against street name instructions, and 2) assess the ease with which these different forms were recognised, 3) determine if the instructions were sufficient. A final section allowed subjects to comment generally about their experience, and to comment on the contexts in which they might utilise this sort of technology.

There was something of a frustration with street based directions resulting in expressions of preference for paper maps:

> *"I am really not interested in electronic/GPS navigation – I would always just have a (paper) map. I much prefer to be more in control of where I am going and see where I am in relation with the rest of the city."*
>
> *"It's fun to work out where you are on a map when you are exploring."*

Many commented on the difficulty of finding signs:

> *"Reference to street names only very unhelpful, particularly in Edinburgh where there isn't a clear layout. Needs to be more descriptive."*

Subjects expressed a desire for more instructions when using the street based system:

> *"Instructions could have been more frequent to reassure me I had taken the right route."*
>
> *"There was quite a long gap between instructions."*

The majority of subjects expressed a clear preference for confirmatory cues:

> *The [landmark based] systems were more reassuring because they told you which buildings you should have walked past if you were going the right way but this one didn't therefore you could have been walking for 5 minutes and not known."*

4.3 Focus Group

As a final part to the research, we transcribed results of a focus group meeting held a month after the street experiments were concluded. The meeting of five participants aged between 17 and 65 explored issues of preference in instruction and system improvements. The group was also asked how they remembered and conveyed routes. Four findings were identified: users expressed a preference for mixed media (map, images of landmarks, and text) because they offered a palimpsest of safety nets in terms of knowing where you were, and where you were trying to get to. Secondly the group expressed preference for shape and texture descriptors instead of names (e.g. the tall black statue rather than 'The statue of the black Watch'). When participants were asked to visualise and describe routes known to them, they relied on objects in the scene rather than names of streets. Participants commented on the large visibility range of landmarks and the limited reading distance of a street sign. In this sense landmark based route following has much greater flexibility and potential than street name based instructions – particularly in complex regions of the city.

5.0 Conclusion: Design Heuristics and Database requirements

The urban pedestrian, at any one time, is typically pursuing a basket of inter related tasks; the creation and form of delivery of wayfinding instructions needs to reflect this competing context. The sole use of text based instructions as a way of guiding pedestrians sought to echo Weiser and Brown's ambition of calm, concealed technologies; indeed this work is in anticipation of its incorporation within a dialogue based system. That pedestrians prefer landmarks to other visual cues is well understood (Tom and Denis 2004; Caduff and Timpf 2008). But this analysis has enabled us to assess the correct points at which to deliver instructions (Michon and Denis 2001) with a specific focus on text only systems. The research has shown that: we need to model the complexity of the city – so we can 'densify' instructions in complex parts of the city; that we need a visibility model so we can determine what can be seen from where; that we need a saliency model so we can use the most striking landmarks in our descriptions, and that we need to include confirmatory instructions to build trust and assure the user.

6.0 Acknowledgement

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