Evaluating Pedestrian Routes

Ebiteme Botu[*1], Jia Wang[†1] and Mike Worboys[‡1]

[1] Department of Mathematical Sciences
University of Greenwich

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Summary

Pedestrians require more detailed information about factors such as safety, accessibility, distance and duration for routes. However, existing navigation services lack such information. In order to fill this void, we propose a set of six criteria that can be used to evaluate the appropriateness of pedestrian routes. We also provide examples to illustrate our study.

KEYWORDS: *Pedestrian routes, Pedestrian navigation, Navigation services*

1. Introduction

In this paper, we propose a set of criteria for the evaluation of pedestrian routes in order to ascertain what makes a pedestrian route adequate for traversing. Our study is driven by the desire to provide adequate pedestrian routes that are currently not supported by existing navigation services such as Google Maps, Bing Maps and OpenStreetMap (OSM). These services provide routes for pedestrians that are mostly based on road networks, and are not always suitable for pedestrians because they are designed primarily with vehicles in mind. Pedestrians are likely to move more freely unconstrained by lane changes and turnings that are associated with vehicles. Also, pedestrian routes contain elements like footpaths and footbridges that are not always identifiable on road networks. Key aspects of pedestrian routes such as the dimension and texture of path surfaces, path gradients and route furniture that form major parts of this study are not indicated by existing navigation services. To fill this void, we propose and investigate six criteria with regard to the intrinsic and extrinsic properties of pedestrian routes, as well as user aspects. The next section provides a brief background study. The six criteria for assessing pedestrian routes are defined and discussed, and the approach to evaluate them is presented in Section 3. Two examples to illustrate the idea of this study are shown in Section 4, and Section 5 concludes with a brief discussion and suggestions for future work.

2. Background

Previous researchers have studied several areas of pedestrian navigation. There is a considerable body of work on wayfinding techniques, some focused on users who have visual or cognitive impairment (de Castro, 2013; Helal *et al.*, 2001; Hettinga *et al.*, 2009; Huang & Liu, 2004; Liu *et al.*, 2009), turn by turn techniques (Robinson *et al.*, 2010), and landmark-based systems (Basiri *et al.*, 2013; Gaisbauer & Frank, 2008; Millonig & Schechtner, 2007). These research areas do not address the appropriateness of the route provided for pedestrian navigation. Kim *et al.*, (2009) described a method to construct a network for pedestrians that is based on an existing spatial dataset of pedestrian route

* e.j.botu@gre.ac.uk
† wj28@ gre.ac.uk
‡ m.worboys@gre.ac.uk

elements. The dataset uses these elements to aid the provision of an updated pedestrian network that contains pedestrian segments. Also, a graph model consisting of decision points and edges that connect them was proposed by Gaisbauer and Frank (2008) as a pedestrian wayfinding model designed to assist pedestrian navigation. Millonig and Schechtner (2007) presented an approach to employ landmarks in navigation services. A well-presented street network enhances connectivity between routes, and this can lead to shortened distances and times. Queensland Transport (2005) highlighted some factors that can contribute to having an effective walking route. These include safety and convenience, nearness to public transport, and convenient connections. Transport for London's Walking Good Practice (2012) emphasised that key walking routes link together places that people need to travel between, and as such the need for high quality walking facilities like wide pavements, improved pedestrian crossings, poles, trees, signing and street lighting becomes inevitable.

3. Pedestrian Route Criteria

From consideration of previous work, we propose six criteria for evaluating pedestrian routes, and with each criterion propose a collection of aspects by which it can be measured. The criteria are *safety, shortness, accessibility, simplicity, pleasantness, and closeness to amenities*. Each criterion has three aspects: intrinsic, extrinsic and user. Intrinsic aspects are properties specific to the walking route itself, extrinsic aspects are properties specific to the surrounding environment of the walking route, and user aspects are properties specific to the pedestrian user. Table 1 summarises the six criteria and their aspects.

Table 1 Pedestrian Route Criteria

Criteria	Aspects		
	Intrinsic	**Extrinsic**	**User**
Safety	Dimension and texture of path surface, path gradients, furniture on path, safe crossing facilities (e.g., pedestrian crossing, footbridge), path obstructions	Lighting, road conditions (e.g., speed limits, blind spots, traffic lights), time of day, weather, street furniture	Familiarity, purpose of travel
Shortness	Route length, surface texture, pedestrian speeds path allows (widths, gradients, obstructions), path sinuosity	Route congestion (pedestrians), traffic congestion (vehicles), time of day, weather, landmarks and signage	Familiarity, average speed
Accessibility	Dimension and texture of path surface, ramps, lifts, dropped kerbs, route furniture	Signage and signals catering for people with disability, rest places	Type of disability
Simplicity	Path sinuosity, path gradients	Signage, landmarks, traffic congestion, time of day, weather	Familiarity
Pleasantness	Dimension and texture of path surface, route furniture	Route congestion, vehicle fumes, noise, landmarks, landscape, weather, time of day, rest places	Familiarity, purpose of travel
Closeness to amenities	Route facilities (e.g., transport access points)	Extrinsic amenities, (e.g., shops, toilets, public transport stations, leisure facilities)	Familiarity, purpose of travel

3.1. Safety

Safety refers to the ability to be protected against physical impediments that are present on or around pedestrian routes. Safety aspects are features on routes that support the safety of pedestrians. Examples of the intrinsic aspects, dimension and texture of path surface, are pavement width and material type, respectively. One of the factors that determine the pavement widths is spatial location. In busy commercial areas widths of pavements need to be wider than in residential areas. A vital feature of the extrinsic aspect, time of day, is lighting. Familiarity of the user of a route is a safety factor that is user-dependent.

3.2. Shortness

A route can be short in spatial distance or in time. An intrinsic aspect affecting shortness is route length. One factor that makes a route longer in time to traverse is path sinuosity, i.e., the degree of curvature, especially number of turns, of the route. Another factor is route congestion: it may reduce the average speed of a pedestrian and thereby make the journey longer in time. Familiarity of the route also affects route shortness: the amount of time needed by a tourist differs from time spent by a local commuter.

3.3. Accessibility

In this paper, accessibility refers to the ability pedestrians with disabilities to access routes. The presence of ramps/lifts is essential on routes that have step access. Disabilities differ for users: pedestrians with visual impairment will require different aspects from wheelchair users.

3.4. Simplicity

A route is simple if it can easily be followed and traversed. Intrinsic aspects such as path gradients can make routes harder to traverse. For example, a sloping street with pavement steps can be challenging for some pedestrians. Other aspects, such as path sinuosity, congestion and weather can also influence route simplicity.

3.5. Pleasantness

Pleasantness of a route refers to the ability for pedestrians to have an enjoyable walking experience. The dimension and texture of a walking surface is an aspect that contributes to this. User’s familiarity and travel purpose can also contribute to a pleasant journey.

3.6. Closeness to amenities

Pedestrian routes can have amenities such as toilets, post office and shops. Routes can provide access to nearby transportation access points, such as bus stops, metro, and taxi ranks.

4. Examples

The images in Figure 1 and 2 display route directions provided by Google Maps. Each guides a pedestrian on a course without information regarding safe crossing facilities, road conditions, and ramps/lifts present on the route. In Figure 1, a pedestrian is guided through a busy five-way junction with signalled traffic lights. However, no crossing facilities are indicated for pedestrian safety. In Figure 2, the walking direction does not indicate the availability of a step-free access, the lift for the Greenwich foot tunnel is omitted. Pedestrians with disabilities finding their way would not be aware of this access.

Figure 1 Google Maps image of pedestrian route navigation in Greenwich, London

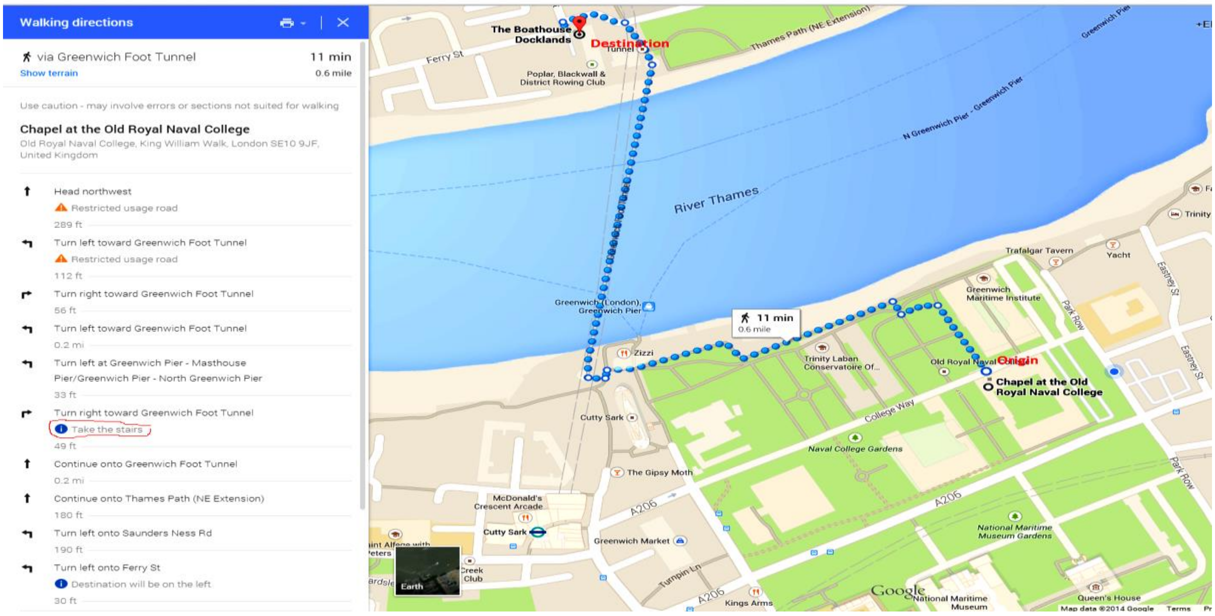

Figure 2 Google Maps image of pedestrian route navigation under the River Thames near Greenwich, London

5. Discussion and Future Work

This paper proposes a set of criteria and their aspects for evaluating pedestrian routes. We list six criteria in this study: safety, shortness, accessibility, simplicity, pleasantness, and closeness to amenities. For each criterion, we also classify aspects according to whether they are intrinsic, extrinsic, or user-related. We developed this classification from a reading of previous research. This work is part of a larger project on pedestrian movement in outdoor and indoor spaces.

Further work is still required on the classification of these criteria and their aspects. For example, we need a clear idea about whether our classification is correct and complete. Also, the classification may be dependent on location (different countries, different cultures). An important further stage of this research is to carry out empirical studies on selected locations and apply the criteria proposed in this paper. Focus will then be on how the aspects listed in this study can be measured. Some aspects, for example, spatial length, can be measured quantitatively. However, most require qualitative metrics. Also, we will consider how to compare and combine the local measurements into a global metric of route adequacy.

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7. Biography

Ebiteme Botu, Jia Wang and Mike Worboys are PhD Student, post-doc, and professor in the Greenwich GIScience Group (G^3) at the University of Greenwich, London.

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