Redefining the Landmark - Designing Navigation Tools for people with Visual Impairments

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Abstract
GPS-enabled mobile navigation applications, such as Google Maps, have transformed the way we get around. However, these applications primarily visual in nature, often making them entirely inaccessible to people with visual impairments. In this proposal, we discuss the nature of landmarks in navigation, what constitutes a landmark, and if we can think of landmarks beyond just their visual characteristics. We further discuss how navigation applications can better support people with visual impairments.

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Navigation, Visually Imparied, Wayfinding, Landmarks

ACM Classification Keywords
H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous.

The Cast of Characters
We are three doctoral students at the University of Michigan School of Information at different junctures in our respective Ph.D. journeys. Vaishnav is a first year student, Megh is in his third year while all of us are eagerly awaiting Priyank's dissertation defense. Our backgrounds are diverse, spanning computer and electronics engineering, economics, institutional analysis,

and statistics. Despite differences in research interests, a common thread uniting our work is the intersection of Human-Computer Interaction, Accessibility, and Disability studies.

Context and Motivation

GPS-enabled mobile navigation applications, such as Google Maps, have transformed the way we get around. These apps and their integration in many services — ride-hailing apps like Uber being a prime example — give us ready access to information about our surroundings and facilitate easy, convenient, and independent travel to and in unfamiliar locations. However, the use of these apps is far from uniform with a range of factors contributing to the diverse ways in which they are appropriated. These include spatial factors, such as differences in the way urban environments are organized around the world (older cities tend not to be laid out in grid formations, for instance); but also, and more importantly, user characteristics, like gender. The fact that mainstream navigation apps do not incorporate information about safety from gendered violence in recommending routes has led, for instance, to the creation of platforms such as Hollaback!, CityWatch, Harassmap, and Protibadi. In this this paper we focus on the use of navigation apps by people with visual impairments, and argue for the an enhanced understanding of landmarks to support this use.

Pilot Study

We conducted a qualitative study of exploring blind people's use of ride-sharing services (and navigation apps) consisting of semi-structured interviews with 30 participants from eight metropolitan cities in India (Bengaluru, New Delhi, Kolkata, Chennai, Mumbai, Pune, Lucknow and Guwahati) between June and August 2017. The interviews were a combination of in-person and Skype/phone calls and were conducted in English. All participants identified as completely blind. We also observed six participants, all of whom participated in the interview study using Uber and Ola services in Bengaluru, India, the field site for the observations.

Mainstream navigation apps like Google Maps are primarily visual in nature, often making them entirely inaccessible to people who are blind. In our pilot study of blind people's navigation behaviors, we found that even participants who had access to GPS-enabled smartphones and thus mobile navigation apps, were left entirely reliant on others in determining where they were at any point in the journey – the only way to figure this out was to ask their co-passengers, bus conductors, or taxi drivers. This significantly impacts participants' sense of self-reliance, independence, and by implication, safety. Further, participants who commuted to work (and who were thus keenly familiar with the route) desired information about their location relative to local landmarks for independent navigation. However, mainstream navigation apps, particularly outside Western contexts, do not support local landmarks at all.

There is thus a clear need to make navigation apps accessible, and incorporate support for local landmarks, to ensure access and increased self-reliance in navigation for blind people. Landmarks in particular play a key role in navigation for both disabled and able-bodied people, serving as decision points in a journey and as navigation cues, helping build familiarity with surroundings.

But what are landmarks? And to whom do traditional notions of landmarks apply?

Meditations on Landmarks

In much of the Global South, people have depended on landmarks to find their way around. Uncharacteristic buildings, government offices, famous restaurants, movie theaters, actors' bungalows, public transit stations, parks, markets, a common friend's house, that-stall-you-always-go-to-for-chai, the-big-fat-tree — all of these can serve as landmarks, some more universally than others, depending on the person, the mode of transportation, the context, and the need of the hour. External environment variables such as crowds, traffic conditions, time of the day, and weather conditions can also alter perceptions of space and subsequently what is regarded as a landmark. Further, as one gets to closer to the destination, landmarks used get progressively smaller and more local - the finer details known to only those who are knowledgable about the locality. Thus, there is a need to clarify what it is we mean when calling for the incorporation of landmarks in navigation apps.

Research Questions

We ask two research questions

- RQ1: What constitutes a landmark?
- RQ2: How can navigation apps support landmarks?

Methods

To answer our research questions, we conducted an extensive literature review to understand how the concept of a landmark was addressed not only in HCI but also cognitive science and geography.

Understandings of Landmarks

While studies across disciplines stress the importance of landmarks in navigating spatial configurations, most define landmarks in terms of visibility or its sociocultural importance. Lynch in his seminal work "The Image of the City" discusses how the form of the city influences the mental image held by its inhabitants [4]. He describes landmarks as one of the elements that constitute an urban image - external points of reference that are spatially prominent. This could be either be because it is prominently visible from multiple locations or sets up a contrast with nearby structures. Siegel and White [6] offer a similarly minimal definition where any point in an urban landscape can be a landmark, while also stressing how becoming familiar with landmarks is the first step in learning new spaces. Golledge [1], in terms of how cognitive mapping influences wayfinding, instead describes landmarks as a conceptual means of organizing spatial information. As the most basic (and first) information people gather about their spatial environment, they are high-level representations of objects comprising the environments. They consequently act as anchor points that organize all other spatial information in a cognitive map, often providing a spatial index that substitutes for an absolute frame of reference.

Raubal and Winter [5] propose a formal model of landmark saliency that include the following measures for the attractiveness of a landmark - 1) Visual attraction, 2) Semantic attraction, i.e. its cultural and historical importance, and 3) Structural attraction, i.e. its role in the structure of a spatial environment. In their model, depending on which user groups we are studying and their respective modes of transports, the weights of these attraction measures need to be adjusted. Other theories of landmarks [7] have categorized landmarks into: 1) visual landmarks, which is an object that is a landmark primarily because of it's visual characteristics, 2) cognitive landmarks, where the objects has a typical meaning, or is

conversely, atypical to its environment, and 3) stuctural landmarks, which have a prominent location that makes them important to urban space.

What is missing?

While studies across disciplines stress the importance of landmarks in navigation, landmarks continue to be defined almost exclusively in visual terms. These frameworks are by definition ableist and exclusionary towards blind people. Blind people use auditory, olfactory, tactile, and kinesthetic senses to independently navigate through space. Participants in our pilot study mentioned relying on the distinctive layered sensory signatures created by the sounds, smells, and terrain of a crowded fish market, a construction site, a popular street vendor, or a particularly potholed stretch of road, for instance.

Our study will look to update Raubal and Winter [5]'s model of landmark saliency to include a measure of multi-sensory attraction. Given that majority of people with visual impairments exist on a spectrum of visual reception, definitions of landmarks should appropriately weight visual measures in conjunction with other sensory measures. By updating the definition of landmarks from primarily a visual one to a richer one, the proposed study will capture how people with visual impairment organize their spatial environments and in the process how we can improve tools for wayfinding.

Redefining a landmark
We find that each body of literature has its own set of understandings of what counts as a landmark; however, we find a paucity of frameworks that can help in the design of wayfinding tools that are usable by people with visual impairments. In doing so, we both critique and extend work by researchers who have through laboratory

experiments over the last few decades extensively assessed the cognitive map knowledge of people with visual impairments and studied how they navigate spatial environments. Kitchin and Jaconson [3], through an extensive literature review, have questioned the validity of these studies, arguing that they are not truly repesentative of complex everyday navigation in real-world settings, with almost all studies focusing on micro-level (and artifical) environments. Further, much of research on landmarks has been in the Global North setting where the urban landscape is generally more planned and more accessible to people with disabilities unlike the organic, unplanned cities in most of the Global South.

App Support
Navigational applications such as Google Maps do currently offer speech instructions for navigation along with the visual landmarks that one might encounter. However, such instructions are not optimal and are especially intrusive when the person has to also be aware of the acoustic environment they are navigating in. In response, researchers have attempted to develop non-visual supports for wayfinding through tactile displays [2]. In the pilot study, we encountered an instance of a participant using paper-based maps where the landmarks she was going to encounter were marked by her partner using bindis [1].

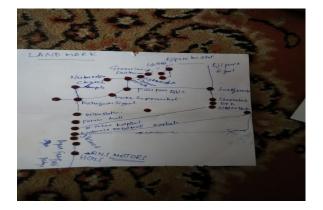[1]a decorative mark worn in the middle of the forehead by Indian women

Figure 1: Paper-based Tactile Map

These are certainly an important feature that mobile apps will need to work towards - supplementing visual and auditory outputs with tactile outputs. However, as this proposal stresses, applications will also need to accomodate alternative definitions of landmarks, accounting for the rich diversity of local environments, use-cases, and user groups.

Expected Contributions
The primary contribution of this work is to provide design recommendations for navigation applications such as Google Maps to make it more accessible to people with visual impairments. Given the ubiquity of these applications, our study of landmarks represents a key and missing perspective, one which can enhance navigation and wayfinding for blind people while fulfilling a universal design objective. Further, the study will inform related applications such as ride-hailing applications like Uber.

From an ICTD perspective, our study also captures the richness of everyday life - specifically, it looks at how the organization of information (in this case, spatial) is

contextual on environmental conditions, local experiences, and the faculties of individual users (and groups of users). Local knowledge is the primary means by which users have navigated the world around them in much of the Global South, and ICTD design interventions have, in recent times, strived to leverage it to develop more localized contextual services. We believe that the study of landmarks is a rich contribution to this line of ICTD work - by focusing on the subjective nature of everyday experiences and how urban city landscapes and the local environment are interpreted in different ways, we hope to help in the creation of more inclusionary technologies.

What we hope to gain from HCIxB
This work involves crossing several borders – not only the obvious geographic ones between the US and our field sites in India, but also academic, cultural, temporal, sensory, and socioeconomic borders between different understandings of landmarks. We would love to receive feedback on how we can work towards creating an inclusive framework based on these situated border crossings. This could come in the form of concrete guidance such as methodological recommendations; pointers to grants that would be particularly relevant; connections to NGOs, CBOs, and others who are tackling these problems on the ground; or pointers to existing literature and frameworks that we should be drawing from.

Finally, and possibly the most important border we need to cross is the one between academia and industry. Assuming that we come up with a framework and accompanying design recommendations for mobile navigation apps, how do we secure buy-in from companies such as Google and Uber? For in their hands lies the power to implement the inclusivity we seek.

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