**Title: Immersive journey preparation and wayfinding aid for people with low vision or blindness**

**A brief description of your idea (200 words)**

We propose to develop an integrated journey preparation and wayfinding tool for pedestrians with low vision or blindness travelling in Melbourne’s CBD. Our technology will enable users to learn about places they wish to travel, familiarize themselves with the soundscape, identify features of interest, prepare for expected conditions on specific journeys and choose the direction they need to go. This will be realised through a voice-commanded, interactive smart phone application. State-of-the-art surround-sound technology that provides full-sphere and directional play back will deliver realistic, immersive sound from key city locations. Users will be able to orientate themselves using these environmental sounds as the sound changes in accordance with their body/head rotation. On-demand location-specific audio descriptions will prompt awareness of landmarks and environmental conditions, as well as current information derived from City of Melbourne open data, and user-generated content.

The same smart phone application will then deliver wayfinding assistance using GPS and Bluetooth Beacons deployed city-wide to guide travellers along their prepared journey. Directional sound will provide orientation cues, linking the user's current physical location to the virtually explored locations experienced during journey preparation. This project aims to address key challenges around cognitive mapping and recall during pedestrian travel in urban environments.

**Innovation: How is your solution different or unique to something that may already exist? (200 words)**

Our proposal represents a novel and unique solution in the following key ways:

-- Immersive journey preparation tool: while virtual reality has been previously considered for familiarisation and O&M skill acquisition, no current system exists for urban-scale journey preparation, nor incorporates up-to-date data feeds in the delivery of salient location/route specific information.

-- Full-sphere binaural sound recording and playback approximating human hearing. The use of the 3DIO Omnidirectional Binaural microphone, designed to replicate the characteristics of human hearing (see attachment 2) will deliver true auditory immersion never before used for virtual journey preparation, or indeed assistive technologies generally.

-- Integrating journey preparation and on-foot guidance: this will be the first app to facilitate both immersive journey planning and on-foot GPS and Bluetooth Beacon-based navigation assistance in a single mobile app, allowing navigation assistance during the journey to explicitly incorporate the user’s known preparation activities. While smart-phone applications for navigation have been previously proposed, no current low vision assistive application integrates both immersive sensory cueing during journey preparation with on-foot way-finding guidance via a Bluetooth Beacon network. This fusing of route familiarisation with on-foot navigation assistance represents a key point of difference, with potential to reduce travel-related anxiety and progress research in this field.

**Impact: What is the potential impact of your solution? (200 words)**

Our proposed journey preparation and guidance tool aims to address key challenges associated with cognitive mapping and recall during on-foot journeys in urban environments, allowing users to build associations and familiarisation with the environment before embarking. Our goal is to reduce stress, increase contextual awareness and ultimately enhance independence for people with low vision or blindness when navigating dynamic and unfamiliar urban environments. We envisage this will increase participation in inner-urban activities, while also providing a medium for sharing information and experiences through user-generated content, increasing connectivity between people with diverse needs, but common goals. The immersion of users in a realistic full-sphere soundscape also has the potential to serve as a training aid for orientation and mobility skills, in which users may practise orientating to sounds such as arriving trains on a platform, or traffic on the road, etc. Once established in Melbourne's CBD, we anticipate wider interest, leading to deployment of our tool across different cities in Australia, and abroad. Our use of open data portals providing up-to-date information on events, construction work, tactile ground surface indicators, footpath gradients, etc will support risk-mitigating journey planning to ensure the highest chance of success.

**Scaleability: Briefly describe your strategy to implement and scale your solution (200 words)**

Initial focus will be on journey preparation for specific locations and routes important to people with low vision or blindness. Our consultation has identified Flinders Street Station to Ross House, in Flinders Lane as a priority route for the vision impaired community, where numerous relevant services exist. Focus on this route will allow functional and usability requirements to be thoroughly explored before expanding city-wide. Technical development is underway, with the entirety of Flinders St Station’s concourse already mapped in a proof-of-concept web-based prototype (Attachment 1). On-foot guidance will also be developed for the Ross House route, supported by a Bluetooth Beacon network already funded for deployment in this area. Simultaneously, city-wide 360 Ambisonic and video recording will be undertaken, focusing on the following key areas:

--Queen Victoria Market

--Melbourne Central and State Library

--Swanston St (RMIT University, incorporating Metro Tunnel sites)

--Southern Cross Station and exits

We expect these priority locations to be captured and incorporated into an initial release within the first 12 months. Expansion to other city councils will also be pursued, including the City of Port Phillip where initial discussions have already scoped how best to support travel in and around the South Melbourne Market.

**To what extent is your solution supported by quantitative or qualitative data (i.e use of City of Melbourne’s Open Data or consultation with the disability sector). Describe how this data has influenced the development of your solution (200 words)**

Ideation and concept development was inspired directly from the City of Melbourne's commissioned research report evaluating Melbourne’s accessibility for the sensory-impaired (Riordan & Potter, 2015). This research uncovered a wealth of challenges faced by those experiencing vision and/or hearing loss, including the high cognitive demands associated with navigating busy sections of the CBD, dealing with unforeseen obstacles, events and rallies, and tracking progress along specific routes based on mental models and sensory information. Subsequent development of this idea over the last 12 months has been guided by consultation with low vision experts within our team, Accessibility Officers in both the City of Melbourne and City of Port Phillip, and discussions with potential end-users, who are members of the vision impaired community. Subsequent inspection of the City of Melbourne’s Open Data Portal has uncovered a number of directly relevant data sets, including foot path steepness, tactile ground surface indicators, pedestrian volumes, event and construction permits. These datasets, along with user-generated content, now form the backbone of the proposed live update location information delivery, for both journey preparation and on-foot navigation modalities.

**If you were to win; how do you plan to use $20,000 and how do you envision City of Melbourne or the partner organisations supporting you in developing and scaling your solution? (500 words)**

If successful, resources will be allocated to three key objectives: (1) Journey preparation software development and on-foot guidance research for an initial prototype focused on the Flinders Street to Ross House route, (2) city-wide 360 Ambisonic sound and video recording, and (3) user experience testing. In-kind support from Swinburne will support these objectives through student projects and relevant staff time contributions.

Software Development – Journey preparation

$10K will hire a software engineer to integrate the core technologies already developed in our proof-of-concept applications (see supplementary material) into a smart phone app. This person has already developed the software for our proof-of-concept systems. We will focus on establishing core software infrastructure for voice-based user interaction, motion-compensated sound playback, incorporating relevant City of Melbourne open data sources, and facilities for adding new recorded locations, allowing scale up to city-wide (and beyond) locations.

Software Development – On-foot guidance

GPS and smart phone motion sensing will be integrated with features developed for journey preparation to provide users with on-foot information and guidance along specific routes. In addition, real-time Ambisonic localised sound cues will orientate the user towards their destination and/or other environmental features. Our expertise in artificial intelligence and image processing will enable us to incorporate on-demand processing of phone-captured image/video data to detect obstacles and landmarks, from which users may be guided via localised auditory landmarks through cluttered and/or disrupted environments. $6K is allocated to support R&D activities.

City-wide 360 sound/video recording:

$3K is allocated to hiring Swinburne students with relevant experience to capture sound and video recordings across Melbourne’s CBD, focusing on the key areas outlined in our scalability response. We will consult with competition partners, Metro, on railway stations within the CBD as well as key construction sites for the Metro tunnel.

Consultation and user evaluation:

An aligned final year student research project will conduct focus group meetings with members of the vision-impaired community, and initial user testing along the Ross House route. Focus groups will aim to elicit other key journeys/locations within the CBD, and refine the information being delivered by the app. Initial user testing will focus on both the utility and usability of the tool for the Ross House route. We will seek direct support from the City of Melbourne’s Disability Liaison committee and associated community groups for direct feedback, and recruitment of participants for these activities.

Remaining funds ($1K) will be utilised for marketing and promotion of the app, along with in-kind contributions from Swinburne University.

Partnership

We envisage that the City of Melbourne will support this project by providing access to relevant infrastructure, and in particular, route and usage data for specific locations. The City of Melbourne would also facilitate connections between the Swinburne research team and other stakeholders. For example, Metro Rail Tunnel and other construction companies, community groups etc. Bluetooth Beacon deployment for on-foot guidance will already be deployed as part of an existing project with the City of Melbourne, ensuring key infrastructure requirements are in place. Our project would require access to the existing network.

**Please provide any supplementary information to support your submission (500 words)**

Proof-of-concept

Numerous technical challenges associated with the journey preparation tool have already been addressed through initial research and development conducted by our team at Swinburne University. With a focus on the concourse area of Flinders Street Station (Metro Trains approved), we have captured Ambisonic sound and video recordings (1 minute each) from 17 locations throughout the station. As shown in Attachment 1, these locations were chosen to provide a regular grid across the concourse and onto one of the platforms, allowing a user to virtually navigate between recording locations as they progress through the environment. Using these Ambisonic sound and video recordings, two proof-of-concept systems have been developed, which together, have allowed us to identify all the necessary technical components for our proposed journey preparation system. These are detailed in our supplementary information and summarised here.

1. A web-based application, designed to overcome technical challenges associated with 360 sound encoding, provides a voice-command driven exploration tool for the Flinders Street Concourse area. For this, the Ambisonic sound capsule has been encoded in 360 video using Facebook 360 Encoder and deployed in YouTube, allowing users to explore the sound scape using either mouse, or through head-rotation when wearing a virtual reality headset such as Google cardboard or Oculus Rift. While not our target platform for deployment, this web-based prototype proves the feasibility of online access to our system using existing cloud-based services.

2. A smart phone application, being our primary target platform, has also been developed using the same sounds and video recorded data, allowing users to interact with the recorded soundscapes through rotations of the phone. The app prototype also allows users to query landmarks or environmental conditions in the direction they are currently facing. Further development will incorporate open data portals to deliver location relevant information as a voice-over.

Evidence of utilisation/uptake of this tech

The proposed aims of this project have been directly derived from key findings listed in the City of Melbourne’s 2015 Accessibility Report (Riordan & Potter, 2015). While it is well understood that user needs for assistive aids are highly diverse, the proposed assistive technology aims to facilitate a multitude of user preferences and needs. In particular, the proposed journey planner directly addresses the most widely stated concern among people with low vision or blindness that high cognitive load during navigation is eased by familiarity. Notably, a recent study of Guide Dog users in Victoria also indicated that 92% travel with a mobile phone, and many seek tech solutions to mobility problems as an adjunct to the dog’s skills (Deverell & Meyer, 2016)

Our team

Our established multi-disciplinary team within Swinburne delivers outcome-focussed research and development of assistive technologies, targeting mobility and navigation for people with low vision or blindness. Our technical team includes expertise in software development and artificial intelligence, acoustics and hearing sciences, 3D Ambisonic audio recording and augmentation, and augmented reality. Our technical team is complimented by additional expertise in disability research, orientation and mobility training, mental health and statistics.