PEDESTRIAN NAVIGATION SERVICES: CHALLENGES AND CURRENT TRENDS

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With the success and popularity of vehicle navigation services, the demand for Pedestrian Navigation Services (PNS) has increased in recent years. PNS, while overlap in functionality with vehicle navigation services, must be designed specifically for the wayfinding and navigational needs and preferences of pedestrians. One major shortcoming of most existing PNS in outdoors is that they utilize and provide services based on road networks, resulting in PNS that do not effectively and properly track pedestrians as they usually walk on sidewalks, which have more segments and are narrower than roads. Challenges in building PNS include constructing appropriate sidewalk networks, continually tracking users in real time on sidewalks without interruption, and providing personalized routes as well as directions. In this paper, these challenges are highlighted and current trends in PNS, for both outdoors and indoors, are discussed and analyzed. A prototype PNS designed for the University of Pittsburg's main campus sidewalk network (PNS-Pitt) is also discussed.

Avec le succès et la popularité des systèmes de navigation automobile, la demande pour les services de navigation piétonnière (PNS) a augmenté au cours des dernières années. Les PNS, bien qu'ils chevauchent en fonctionnalité les systèmes de navigation automobile, doivent être conçus spécifiquement pour les besoins particuliers en orientation et en navigation des piétons ainsi que leurs préférences. L'une des principales lacunes de la plupart des PNS existants pour l'extérieur est qu'ils utilisent et offrent des services en fonction des réseaux routiers, ce qui fait en sorte que les PNS ne font pas un suivi efficace et adéquat des piétons étant donné qu'ils marchent habituellement sur les trottoirs, lesquels ont plus de segments que les routes et sont plus étroits que celles-ci. Les défis dans l'élaboration des PNS comprennent la construction de réseaux de trottoirs appropriés, le suivi continu des utilisateurs en temps réel sur les trottoirs sans interruption et la capacité d'offrir des directions et des itinéraires personnalisés. Dans le présent article, ces défis sont mis en évidence et les tendances actuelles dans les PNS, tant pour les activités extérieures qu'intérieures, font l'objet d'une discussion et sont analysées. Un prototype de PNS qui a été conçu pour le réseau de trottoirs du campus principal de l'Université de Pittsburgh (PNS-Pitt) fait également l'objet d'une discussion.

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1. Introduction

Navigation is the process of dealing with the trajectory determination and guidance of moving objects [*Hofmann-Wellenhof et al*. 2003]. Today, people rely on services; such as Google Maps and Yelp; for wayfinding and finding nearby Points of Interest (POIs) such as restaurants. With the popularity of in-car navigation systems and the advancement of powerful mobile devices, such as smartphones, the demand for Pedestrian Navigation Services (PNS) is continually increasing. The main characteristics of PNS, distinctly different than Vehicle Navigation Services (VNS), are: (a) restricted distance—walking is not a practical mode of transportation when destinations are too far away from origins [*Millonig and Schechtner* 2007; *May et al*. 2003]; (b) extensive range of vision—pedestrians can turn around their head freely as they walk to see the environment in any directions [*Millonig and Schechtner* 2007]; and (c) free mobility—pedestrians are not restricted to follow specific paths, unlike drivers who have to drive only on roads and follow

road directions, when walking and may take short cuts [*Millonig and Schechtner* 2007; *Holone et al*. 2007]. These differences and the challenges they introduce, the success of VNS, which have evolved and been in use over the past two decades, and the increased demand for PNS are the main reasons for the interest in researching and developing PNS in recent years.
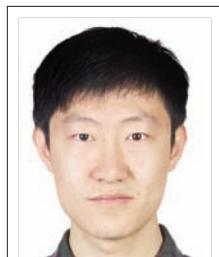
May et al. [2003] stated that understanding "the nature of the navigation task" and "the information requirements of the pedestrian" are two key prerequisites for designing a successful PNS. *Kim et al*. [2004] argued that finding the precise location of users is an important function in designing PNS. Existing PNS mostly utilize road networks in GPS-based map matching algorithms [*Arikawa et al*. 2007] or in dead reckoning algorithms based on sensors such as accelerometers, gyroscopes, and compasses [*Cho and Park* 2006] to estimate user's location. However, as pedestrians generally walk

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