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Pedestrian Network Models for Mobile Smart Tour Guide Services

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Abstract

The global positioning system (GPS)-enabled mobile phones provide location-based applications such as car and pedestrian navigation services. The pedestrian navigation services provide safe and comfortable route and path guidance for pedestrians and handicapped or elderly people. One of the essential components for a navigation system is a spatial database used to perform navigation and routing functions. In this paper, we develop modeling and categorization of pedestrian path components for smart tour guide services using the mobile pedestrian navigation application. We create pedestrian networks using 2D base map and sky view map in urban area. We also construct pedestrian networks and attributes of node, link, and POI using on-site GPS data and photos for smart pedestrian tour guide in the major walking tourist spots in Jeju.

Keywords: *pedestrian, navigation, smart tour guide, digital tourism. point-of-interest.*

1. Introduction

The application areas of pedestrian navigation systems covers tourism, business trips, recreational trips, rescue services, individual navigational aid, military and security operations. The pedestrian navigation systems are generally based on car navigation systems due to the lack of pedestrian network data. Road networks do not adequately for pedestrian navigation services as they do not cover pedestrian paths such as sidewalks, crosswalks, footpaths, accessible entrances, pedestrian underpasses, pedestrian overpasses, steps, trails, and parks paths. The pedestrian network is modeled as a topological map that represents the geometric relationship between pedestrian path segments. Pedestrian network data are implemented as spatial and non-spatial data in Geographic Information Systems (GIS). Spatial data includes GPS trajectories, points of interests (POIs), and tagged locations. Nonspatial data includes profiles and friends' lists, region names, postal codes, road names, and speed limits.

The most common approach for constructing pedestrian network data is to manually digitize the pedestrian path using satellite images[1-4]. Pedestrian networks can be created based on national spatial data sets [5]. Collaborative mapping is an approach for collecting map data with the increased interest in Location-Based Social Networking (LBSN). The OpenStreetMap (OSM) project [6] is an example collaborative mapping project that allows registered users to upload GPX (GPS eXchange format)

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trajectories collected by cars or bicycles. The advantage of collaborative mapping is a cost effective approach for collecting a large of amount location data. A pedestrian network is stored in a spatial database system that contains both geometric and topologic information. The open geospatial consortium (OGC) [7] has been producing worldwide standards for spatial data including OpenGIS Simple Feature Specification for storing, retrieving, and updating simple geospatial features. In this paper, we create pedestrian networks and attributes of node, link, and POI for smart tour guide in the major walking tourist attractions in Jeju.

2. Pedestrian Network Models

A pedestrian is any person who goes and travels on foot or who is using a wheelchair, a stroller, a walking stick, or a guide dog. A pedestrian is not limited to the rotation or orientation in walkable road and space. A pedestrian network is a topological map that represents the geometric relationship between pedestrian path segments. A pedestrian path segment is a segment describing any pathway that is designed for a pedestrian in order to improve pedestrian safety, reduce potential accidents, and promote mobility and accessibility. Spatial data include geometric information such as longitude, latitude, shape, and non-spatial data include the descriptive element of geographic features such as name and length. The spatial data can be represented using the vector and raster data models and tabular data. The vector data model has three geometric primitives of points, lines, and polygons. A pedestrian network can be modeled as a connected graph consisted of nodes and links. Nodes are used to represent a topological junction of links, i.e. a decision point, and the location of objects such as an accessible entrance of a building and an accessible ramp. Links represented by a series of points are used to represent pedestrian paths for all pedestrian types. Nodes and links contain attribute information about those paths such as segment lengths and impedance scores such as for a wheelchair users. Unlike road networks for car navigation, pedestrian networks are not constrained to the lanes, turn restrictions, one-way streets.

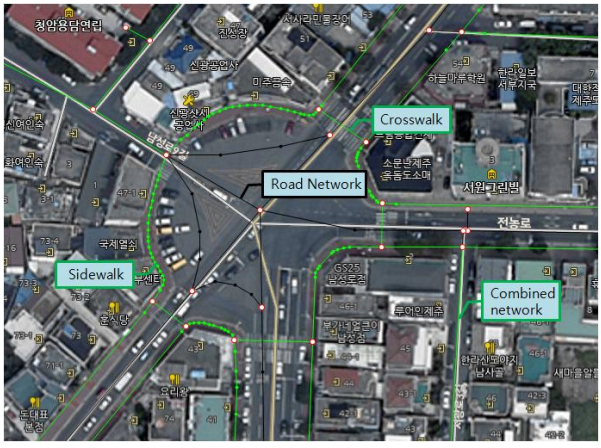
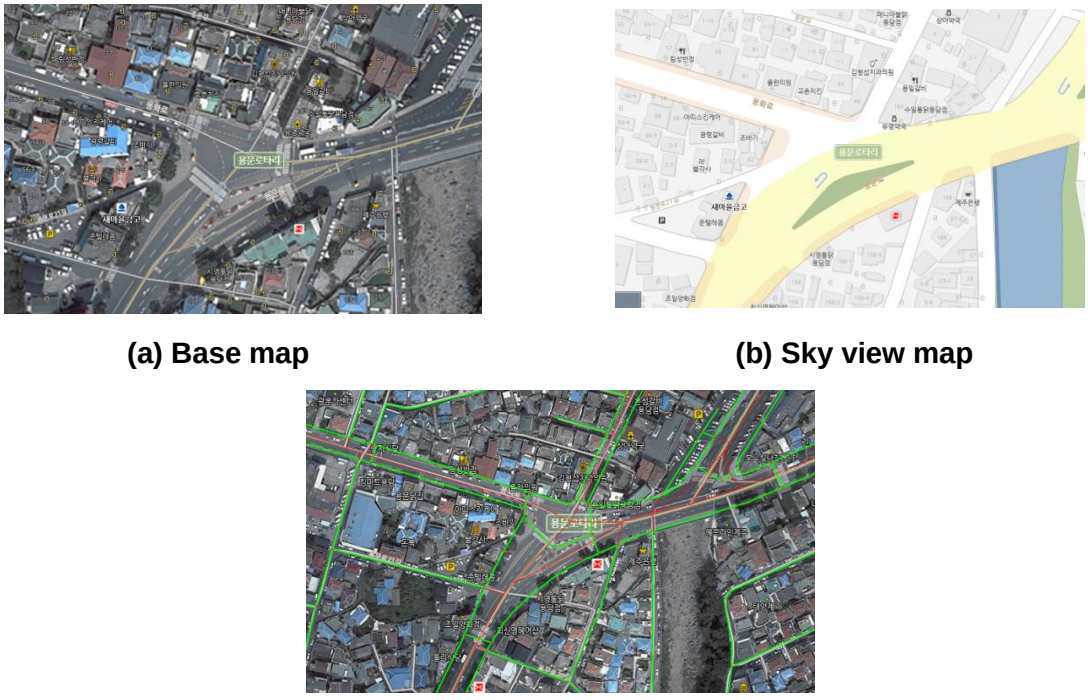


Figure 1. Pedestrian network model in urban area [2]

A pedestrian network is classified based on car network as sidewalk, crosswalk, accessible entrance, pedestrian bridge, pedestrian tunnel as shown in Fig. 1. Sidewalks provide safe travel routes for pedestrians that is set apart by curbs, barriers, markings from roadway. Crosswalks can be located either at the street intersection or at a midblock location. A crosswalk is the extension of a sidewalk across a roadway at an intersection whether the crosswalk is marked or not. Crosswalks can also exist at non-intersection locations when clearly indicated by signs, lines or other markings on the street. When a pedestrian is crossing a street at a marked or unmarked crosswalk, and there is no traffic signal. If there are no sidewalks we should walk

on the side of the road. A road network without center line can be used as a pedestrian network. An accessible entrance is a part of a pedestrian walkway and is the actual entrance to a building. The pedestrian bridge is a grade-separated crossing that is constructed over the roadway while the pedestrian tunnel is a grade-separated crossing that is a belowground passageway. A trail is a path that is mostly designed for recreational activities such as running trails or natural trails. In addition to the seven main pedestrian path types, we also identify one subtype of pedestrian path, stairs which is a facility normally located on main path types. Stairs is a series of steps designed to fill the gap in elevation. Unlike a road network, a pedestrian network is found mostly in urban areas and in some areas there may be more than one pedestrian network. Ideally, a pedestrian network should connect with a road network and a public transportation network to provide complete navigation assistance for different modes of transportation.

The smart tour guide services using pedestrian navigation applications require pedestrian networks, pedestrian facilities, and POIs for route guidance (RG). In this paper, we classify pedestrian networks as walkways along a road and pedestrian only networks. We create pedestrian networks of walkways along a road based on car networks using 2D base map and sky view map as shown in Fig. 2.



(a) Base map **(b) Sky view map**

(c) Pedestrian networks in urban area

Figure 2. Construction of pedestrian networks using 2D map and sky view in urban area.

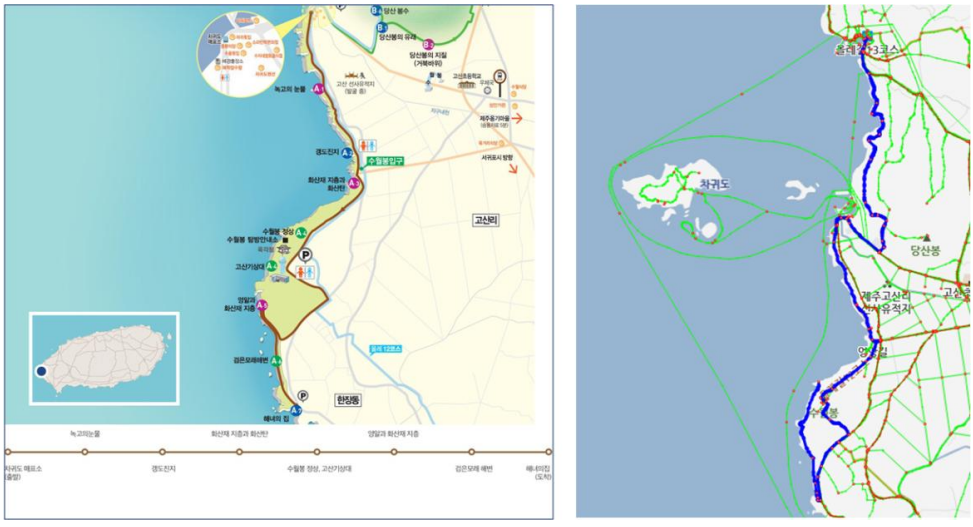
Pedestrian only networks are created in a tourist attraction that does not exist vehicle networks. We construct pedestrian only networks through four iterative steps: on-site data collection, path generation, annotation, and on-site inspection. In the on-site data collection process, we collect raw GPS data using GPS-enabled devices and photos as shown in Fig. 3. The GPS data contains coordinate, altitude, speed, and time. Figure 3(a) shows GPS trajectories combined with photos using timestamps and 3(b) shows photos of road surfaces and conditions. We correct and update pedestrian networks and annotations obtained from GPS trajectories and photos. We construct pedestrian networks for smart tour guide in the major walking tourist attractions such as Hallasan national park, oreums, Olle trails, global geoparks, natural recreation forests in

Jeju. We also construct pedestrian networks using GPS trajectories and photos in the walking tourist attractions in urban area.

Figure 4 shows pedestrian networks of suwolbong peak geo-trail compared with tour guide map provided by jeju island geopark [8]. Jeju received Global Geopark status in 2010 and it now has 12 sites from Udo in the east to Suwolbong Peak in the west. Suwolbong peak geo-trail comes together with the dangsan peak geo-trail and the chagwi island geo-trail located in gosan-ri, jeju and opened in 2011. We create pedestrian networks and attributes of node, link, and POI to provide smart tour guide based on the mobile pedestrian navigation system**.** We also make geo-tagging contents about history, culture, mythology and life of the villages that evolve around geological heritage to provide map-based storytelling for walking tour.

(a) GPS data combined with photos **(b) Photos of Road surface and Conditions**

Figure 3. On-site data collection for construction of pedestrian only networks in tourist attractions.

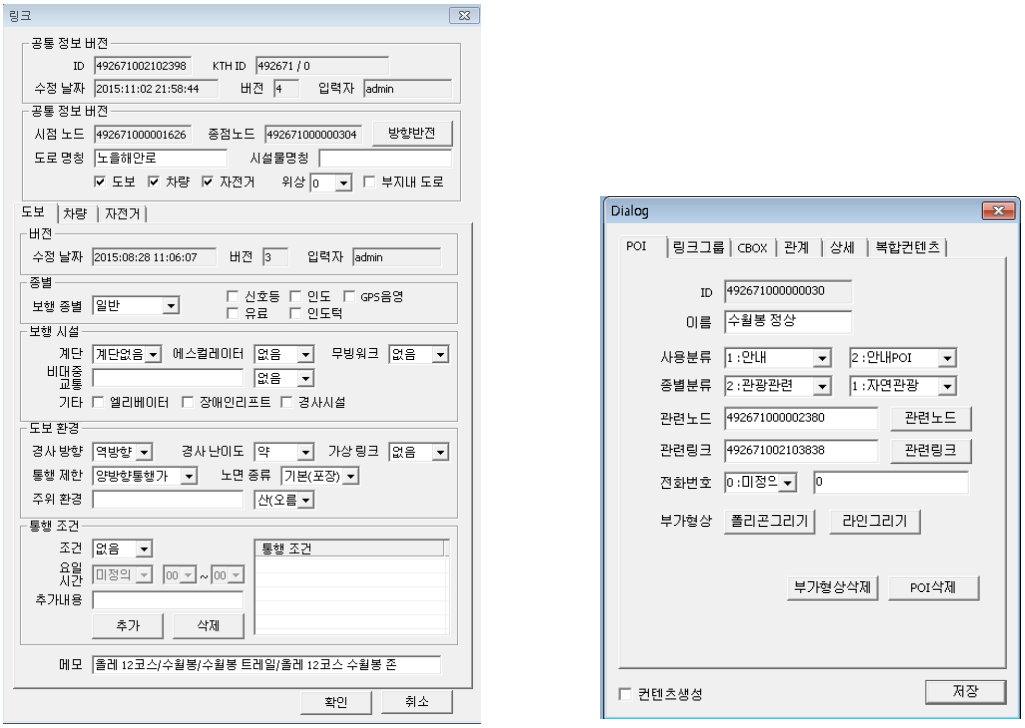


(a) Tour guide map of suwolbong perk geo-trail **(b) Pedestrian network**

Figure 4 Pedestrian networks of suwolbong perk geo-trail for smart tour guide services

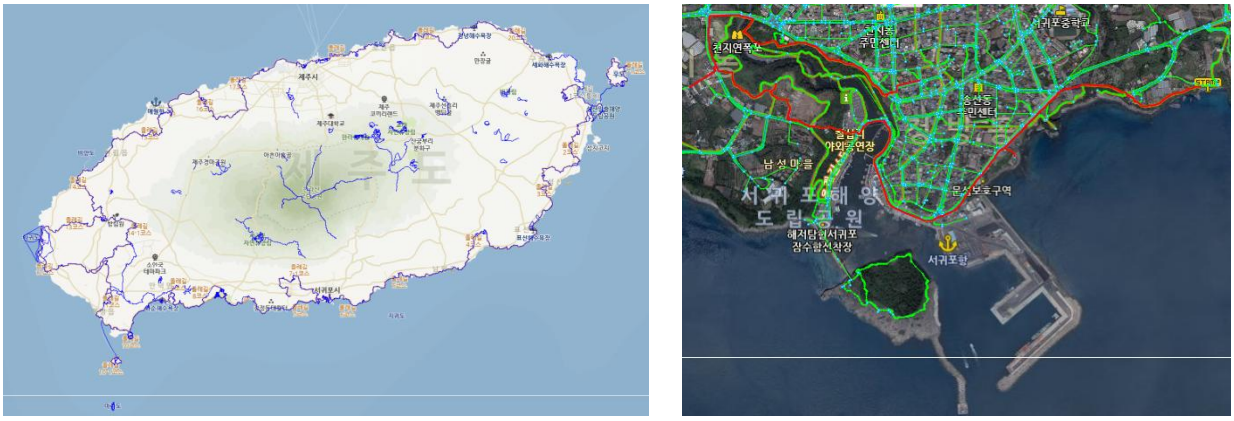
Figure 5 shows attributes of link and POI in the pedestrian network editing tool. We create attributes of node and link to provide information on the geometry of the map based on car networks used in the car navigation system. Attribute data are used to provide safe and comfortable route and path guidance for pedestrians and handicapped or elderly people. Attribute data includes road types, pedestrian facilities,

surrounding environments, road conditions, road surfaces, and annotations. Pedestrian facilities such as stairs, escalators, elevators, and moving walks are used for selecting a safe and comfortable route in the tourist attraction. Annotations of links are used to denote and create the shapefile of the walking tourist attraction. Attributes of POI include information on the adjacent link and node for selecting an accurate route. Attribute data make the geographic information more valuable for smart tour guide. Figure 6(a) shows the built pedestrian networks in the major walking tourist attractions in Jeju. Figure 6(b) shows the pedestrian network of Seogwipo writers' promenade (red) and pedestrian networks in Seogwipo city (sky-blue and green).



(a) Link dialogue **(b) POI dialogue**

Figure 5. Attributes of link and POI in the pedestrian network tool.



(a) Pedestrian networks in tourist attractions **(b) Seogwipo Writers' Promenade**

Figure 6. Pedestrian networks in the major walking tourist attractions in Jeju.

3. Conclusions and Discussions

In this paper, we develop pedestrian network model and create a pedestrian network database using on-site GPS trajectories matched with photos for smart tour guide. The buildup of pedestrian geodatabase covers major tourist attractions such as Hallasan national park, oreums, Olle trails, global geoparks, natural recreation forests in Jeju. We also create attribute data of node, link, and POI to provide safe and comfortable route and path guidance for pedestrians and handicapped or elderly people in the major walking tourist attractions. We will develop mobile applications for smart tour guide in the major walking tourist attractions using the pedestrian navigation system based on the constructed pedestrian geodatabase.

References

[1] J.Y.S. Lee, W.H.K. Lam and S.C. Wong, "Pedestrian Simulation Model for Hong Kong Underground Stations," *IEEE Intelligent Transportation Systems Conference Proceedings*, pp. 554-558, 2001.

[2] P. Kasemsuppakorn and H. A. Karimi, "Pedestrian Network Data Collection through Location-Based Social Networks," *CollaborateCom*, pp.11-14, 2009.

[3] P. Kasemsuppakorn, H. A. Karimi, "A pedestrian network construction algorithm based on multiple GPS traces," *Transportation Research Part C*, pp. 285–300, 2013.

[4] P. Kasemsuppakorn, *Methodology and Algorithms for Pedestrian Network Construction*, Doctor of Philosophy, University of Pittsburgh, 2011.

[5] J.Y. Kim, S.Y. Park, Y.S. Bang, K.Y. Yu, "Automatic derivation of a pedestrian network based on existing spatial data sets," *In Proceedings of ASPRS-MAPPS Fall Conference*, 2009.

[6] OpenStreetMap(OSM), *www.openstreetmap.org*

[7] Open Geospatial Consortium(OGC), *http://www.opengeospatial.org*

[8] Jeju Island Geopark, *http://geopark.jeju.go.kr*