Seek and Go: Data, Algorithms, and Interactive Tools for Pedestrian Navigation*

K. Koritsoglou[1], P. Laskas[1], V. Patras[1], and I. Fudos[1]

[1] *Department of Computer Science and Engineering, University of Ioannina, Ioannina, Greece*

Abstract

In recent years, the concept of accessibility is receiving increased attention at political, scientific and social level. Furthermore, effectively handling accessibility issues and addressing the special needs of people with disabilities can provide a robust business environment and significant market exploitation opportunities. To that end, the need for accessibility, especially in urban environments, is vital and ICT can play a key role towards enhancing accessibility. Although digital geographic platforms like Google Maps or Bing Maps provide user-friendly interfaces for navigating through cities, they were designed with emphasis on the needs of motor vehicles and therefore information regarding pedestrian routes is still considered very limited. This paper reports on the development of an innovative platform called Seek & Go, which is a holistic aid application offering navigation services, especially designed for pedestrians with mobility problems and special accessibility requirements. A structured approach to the development of a pedestrian navigation data model that captures all required information is introduced. Finally, a pilot case is presented for the historical center of Thessaloniki.

Keywords

accessibility, pedestrian navigation, urban mobility, digital maps, wheelchair users, disability

1. Introduction

Accessibility, as a term, describes all those environment characteristics which allow all citizens without discrimination of age, gender or other special characteristics, to be able to independently, comfortably and safely use and access the service infrastructures and goods that are offered by the wider social environment [1]. Accessibility is thus a wide concept, the provision of which affects almost every aspect of everyday life [2]. The term also states that all structures and facilities should be accessible so that they can be used, ensuring autonomy of movement for the individual [3].

Access is a fundamental element of structured society environments as it allows citizens to participate in any social and economic activity without any exclusions. Limited mobility significantly reduces the level of independence and autonomous living of certain population groups as in some level depends on the ability to access daily needs such as nutrition, health care, education, and employment [4].

Although digital geographic platforms like Google Maps or Bing Maps provide user-friendly interfaces for navigating through cities, they were designed with emphasis on the needs of motor vehicles and therefore information regarding pedestrian routes is still considered very limited, as most of them contain little or no information about the accessibility of pedestrian networks [5].

To support people with disabilities and special needs, many smartphone applications that focus on accessibility issues have been developed during the past years. Despite the progress made in pedestrian navigation in urban centers thanks to

Published in the Workshop Proceedings of the EDBT/ICDT 2023 Joint Conference (March 28-March 31, 2023, Ioannina, Greece).
EMAIL: kkoritsoglou@uoi.gr (K. Koritsoglou), laskasp15@gmail.com (P. Laskas), vpatras@gmail.com (V. Patras), fudos@uoi.gr (I. Fudos)
ORCID: 0000-0002-4041-5169 (K. Koritsoglou); 0000-0002-4137-0986 (I. Fudos)

the emergence of various mobile applications, people with reduced mobility still face obstacles and serious difficulties as they move through their daily lives. In this context, the most important problem remains the collection and integration of accessibility information for the physical urban environment on digital maps [6].

This paper describes the methodology used to develop a simple pedestrian data model that incorporates all required information for the design of a user-friendly interactive navigation system in the terms of accessibility and "Design for All" [7].

2. Data Model and Services

A pedestrian section is considered accessible only when its width is more than 1.5 meters, and its surface is smooth. In addition, there should be no obstacles into it that make the wheelchair movement difficult or impossible. Various floor elements that create elevation differences such as stairs or surface slopes (slopes of more than 10% are not accessible without the help of an attendant) should also be recorded and evaluated.

One of the main difficulties when filling questionnaires related to geolocation details, is to align the questions with self-explanatory entities on the map for easier identification.

In the Seek & Go data collection application an innovative approach that enhances and improves the user experience is introduced. Users are guided to first select the appropriate entity among; (a) street segments, (b) points of interests (POIs), (c) segment connections, and (d) POIs / entrances connections. Each selection of these entities displays simplified steps on the screen that guide users to draw the area of interest by tapping on the map. The app, restricts the movement of the drawing elements by enforcing geometric and functional constraints. This helps to avoid errors and speed up data collection. However, a second validation step is employed by highly experienced engineers.

Figure 1 depicts an indicative screenshot of the application when a segment entity is selected, and a list of corresponding surveys is shown to inform users which questionnaires are left unanswered.

Each single entity on the map, corresponds to the appropriate survey which contains questions about accessibility details. In this context, specially designed questionnaires have been designed for each one of the four entities.

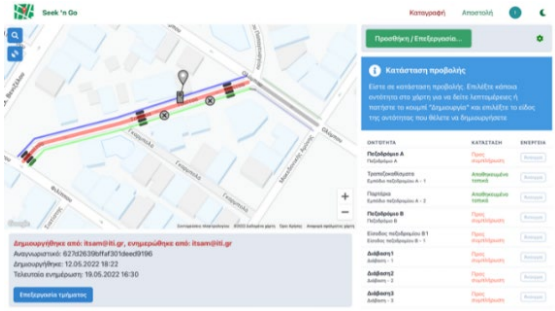

Figure 1: The application highlights a selected segment with the corresponding surveys.

The Seek & Go application follows the microservices design approach and is composed of three loosely coupled layers. This approach allows independent deployment and distinct scalability with fewer dependencies, among each layer, that leads to easier maintenance, faster updates, clearer communication interface and faster failure recovery. The overall application is implemented as a Progressive Web App (PWA) using Service Workers as the virtual proxy between the browser and the network since supporting offline use was a major requirement due to the nature of app, which is mainly for being used on the move. More specifically, the layers of the Seek & Go conceptual architecture are illustrated in **Figure 2**.

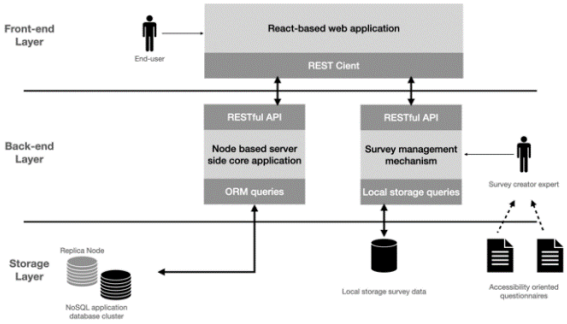

Figure 2: Seek and Go conceptual architecture.

3. User Experience

The pedestrian data model collected from the previous process yields a graph, the traversal of which produces the routes that users search for. More specifically, in Figures 3 and 4, the nodes of the graph are shown with red markers that contain their identifier. The accessible edges are represented in green, while the less accessible ones are represented in yellow. Finally, the

crosswalks are marked in blue. In the use-case shown in **Figure 3**, the graph of the specific area is initially presented on the Google maps web service, followed by the shortest route between the source and the target node, as well as the most accessible one as shown in **Figure 4**.

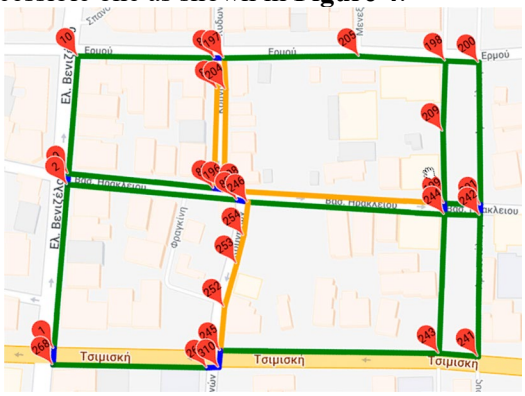

Figure 3: Use case graph dataset.

The Seek & Go mobile routing application initially receives the user's current location. If the user searches for a desired destination, i.e. a point of interest or a specific address located within the mapped area, then the search for the shortest and most accessible route is made by traversing the graph dataset derived and then the results are displayed on the maps.

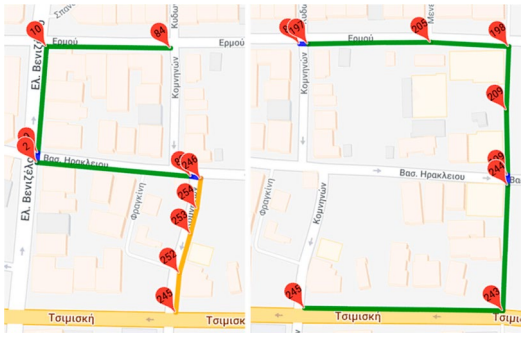

Figure 4: Shortest (left) and most accessible (right) path.

This is the most important innovative element of the Seek & Go application compared to the rest of the accessible routing applications, as the user knows in advance the route, they will have to follow to the desired destination. In the rest of the applications mentioned there is information about the accessibility level of several destinations, but none of them contains the accessibility features of the pedestrian sections to aid the navigation of people with mobility problems in urban areas.

4. Conclusions

We have reported on the development of the Seek & Go platform. We have presented a method for the systematic collection of georeferenced accessibility data for pavements, streets and points of interest in urban conurbations. An interactive tool has been developed for populating the backend database with accessibility data, which is then used to navigate users with customized needs, improving in this way the mobility of citizens with disabilities.

5. References

[1] L. Castell, "Building access for the intellectually disabled", Facilities, vol. 26(3/4), pp. 117-130, 2008.

[2] Y. Crozet, "The Three Stages of Accessibility: The Coming Challenge of Urban Mobility", Mackett, R.L., May, A.D., Kii, M. and Pan, H. (Ed.), Sustainable Transport for Chinese Cities, Transport and Sustainability, vol. 3, Emerald Group Publishing Limited, Bingley, pp. 79-97, 2012.

[3] N.V. Duarte, D. Oviedo, and A.M.A. Pinto, "Urban Mobility and Social Equity: An Introduction", Oviedo, D., Duarte, N.V. and Pinto, A.M.A. (Ed.), Urban Mobility and Social Equity in Latin America: Evidence, Concepts, Methods, Transport and Sustainability, vol. 12,Emerald Publishing Limited, Bingley, pp. 1-10, 2020.

[4] Laskas, P., Dimitriadis, S., Koritsoglou, A., Koritsoglou, K., & Fudos, I. (2021, September). A data model for pedestrian routes. In 2021 6th South-East Europe Design Automation, Computer Engineering, Computer Networks and Social Media Conference (SEEDA-CECNSM) (pp. 1-4). IEEE.

[5] Brock, A. M., Froehlich, J. E., Guerreiro, J., Tannert, B., Caspi, A., Schöning, J., & Landau, S. (2018, April). Sig: Making maps accessible and putting accessibility in maps. In Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems (pp. 1-4).

[6] Hecht, B., Schöning, J., Erickson, T., & Priedhorsky, R. (2011). Geographic human-computer interaction. In CHI'11 Extended Abstracts on Human Factors in Computing Systems (pp. 447-450).

[7] Klironomos, I., Antona, M., Basdekis, I., & Stephanidis, C. (2006). White paper: Promoting design for all and e-accessibility in Europe. Universal Access in the Information Society, 5(1), 105-119.

[*] Acknowledgements: This research has been co-financed by the European Regional Development Fund of the European Union and Greek national funds through the Operational Program Competitiveness, Entrepreneurship and Innovation, under the call RESEARCH – CREATE – INNOVATE (project code: T1EDK-00108).