Inclusive Mobility through Multi-Path Routing Algorithm

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Abstract

Urban orientation is intrinsically linked to mobility and it refers to the ability of a citizen to know at every moment exactly where he is, whether or not he knows the city, and to be able to get directions to a desired location [3]. Permanent or temporary mobility disabilities includes several types of segments such as visually impaired people, wheelchair users, people with autism spectrum disorder, deaf people, pregnant ladies, elder or people with toddlers. For each of these segments, the concerns and precautions to take during a route are quite different. For visually impaired people, the lack or total absence of vision makes them less aware of what is happening around them. Adding the fact that they have limited or no access to positioning information using vision, all information given to them must be as precise as possible. Based on previous studies, people belonging to this segment should not be redirected to routes where emergency vehicles exist. On the other hand, when referring to people using a wheelchair, the main concerns are related with the type of surfaces on which they move and also the slope. In these cases, the preferred surfaces for mobility must be uniform, firm and smooth while generating adequate friction for a comfortable and stable ride [4]. In turn, when talking about people with autism spectrum disorder the main concerns are related to the bustle of the streets and here there is a need to avoid these types of places during a route.

In a previous work [5], a mobile application named Viana+Acessível was developed in order to help people with some type of disability to walk around the city using the most suitable route provided by the application. It was built to work specifically in the city of Viana do Castelo, in Portugal, where the streets of the historic center of the city were classified in a Geographic Information System (GIS) by the City Council together with the institutions that represent each one of the segments. In addition to the GIS, the A-Star algorithm was used to suggest the best path to the user. When starting the application, the user can choose one segment and then, all suggestions made by the app will take into account the chosen disability. After choosing the segment, the user can choose to show the points of interest of the city on a GIS map of Viana do Castelo, divided into five categories: culture, health, public services, transport or tourism. In addition, the user can also check parking spaces for people with disabilities and all taxi locations. For each of these locations, he can obtain specific information by clicking on the desired point or start navigating towards the chosen destination. The application, developed in React Native, is available for devices which runs an Android operation system or an Apple operation system. The initial version of the app allows users to

select a point of interest as intended destination whereas the starting location is always the user's current location.

The main contribution of this work is an extension of the initial work with a multi-path routing algorithm, considering that allowing the choice of a single destination might be limited in several scenarios. By this way, this work focuses on the possibility of the user to select several destinations and to obtain the most suitable route that goes through all of them. Some changes were needed regarding the app layouts. In addition, several algorithms are used and tested to understand which one has a better performance in this situation.

The first algorithm tested was the Genetic Algorithm which is a search heuristic that is inspired by Charles Darwin's theory of natural evolution.

The second algorithm tested was the Simulated Annealing Algorithm with linear and exponential approaches and is characterized by being a stochastic global search optimization algorithm.

To evaluate the performance of each algorithm, 100 runs were performed for 2, 4, 8, and 16 destinations. It means that for both Genetic Algorithm and Simulated Annealing Algorithm 100 executions were performed so that some analysis could be done to choose the best algorithm to be used in the application. For all scenarios (2, 4, 8 and 16 destinations) and for each algorithm, the average algorithm execution time, the standard deviation, the median value, minimum execution time and the maximum execution time were registered.

In general, the Simulated Annealing Algorithm variants presented better results and always suggest the shorter path when comparing to Genetic Algorithm.

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