CARE: Campus-wide Accessible Route Estimation through Surface Analysis

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ABSTRACT

Travelling is not always fun for wheelchair users in the built environment (both indoor and outdoor) in presence of various unknown barriers, such as, uneven sidewalks, curb heights, stairs, ramps, cobbled streets, etc. [1] [2]. Also, elderly individuals are more likely to require assistance while using self-propelled and non-motorized wheelchairs. However, along with barriers there are also various wheelchair-friendly facilities, such as, supervised crosswalks and elevators, which improve accessibility of environments and facilities.

Various indoor environments, including buildings, might have infrastructure in place for wheelchair accessibility, but it is not always easy to find a path to the nearest accessible entrance and exit, especially in the face of an emergency, such as a fire, tornado, or the worst, campus violence. The challenges are manifold.

- *Firstly*, the user may not know exactly where s/he is located and how far it is from the emergency event's location. This is even more difficult for indoor locations void of GPS coverage or missing information about the area. Moreover, the user should be able to share their location to external emergency personnel in case of requiring assistance or extraction.
- *Secondly*, an emergency event, such as a fire, can spread rapidly, requiring real-time alternative path finding. In addition, some surfaces are inaccessible for wheelchair users, such as, stairs, gravels, grass, mud, etc.
- *Finally*, the suggested path must exclude hindrances to wheelchair users customized to their needs depending on the wheelchair type and the capability of the user.

In this project, we plan to develop a Campus-wide Accessible Route Estimation (CARE) System which works through a large-scale vibration data analysis (created by wheelchair movement) from different built or natural surfaces and aims to classify the surfaces into accessible and inaccessible. The goal is to find accessible routes for wheelchair users. We have the following three concrete objectives to achieve through the project.

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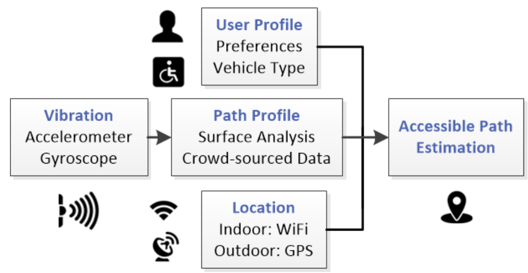

Figure 1: Accessible Route Estimation System

(1) We develop a Wi-Fi based indoor localization scheme for wheelchair users using their smartphones. The system will capture wireless probes and received signal strength values in a secured and non-intrusive manner (protecting user privacy) and it will determine the relative location of a wheelchair user with respect to the nearest wireless access points. User locations in the outdoor environment are estimated through their GPS coordinates.

(2) An Android app has been developed to collect vibration (accelerometer and gyroscope sensors) data during wheelchair movement through various indoor and outdoor surfaces in the Miami University campus. We have used a manual wheelchair and two different Android smartphones for data collection. Based on that, we label the data and train the machine learning system using several features in order to classify the surfaces into accessible and inaccessible categories. At a later stage, multiple crowd-sourced wheelchair vibration data streams are forwarded to the system to successfully classify the surfaces.

(3) Based on the user location and desired destination, we can then generate accessible routes adaptively and in real time customized to the user and wheelchair requirement.

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