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ENVISION: Assisted Navigation of Visually Impaired Smartphone Users

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Abstract

In this work, we propose ENVISION an assistance system for safe navigation of visually impaired smartphone users. The proposed system generates an intelligent decision to manage the navigation of visually impaired people based on the fusion of GPS technology directions and a new obstacle detection method. It copes with many challenges related to such application processing steps and inherent to constraints of the smartphone platform. These include illumination changes, diversity of background and road textures, low quality of the video streams, and low processing capacity. ENVISION uses a new method to detect static and dynamic obstacles robustly and accurately in real-time video streaming recorded by a smartphone with an average hardware capacity.

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1. Introduction

The lack of visual information about the surrounding environment imposes major challenges on a visually impaired person in performing daily life activities, such as mobility. Indeed, navigation can be extremely difficult and

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dangerous, especially in unfamiliar environments. Recent attempts have been made to employ software solutions using different technologies and devices.

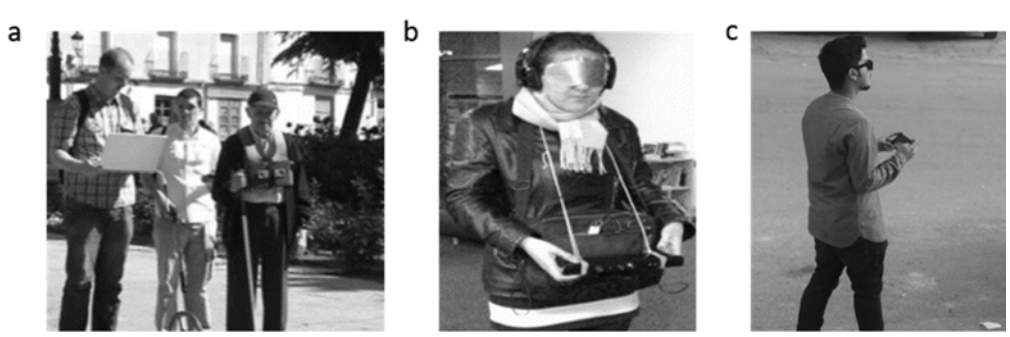

Fig. 1. (a) A visually impaired user carrying a stereo camera using a chest mounted harness [4]; (b) A blind-folded user equipped with the depth camera (a Microsoft Kinect) [5] ; (c) Our proposed smartphone ENVISION system does not require the user to carry any additional devices

Among the proposed solutions developed to assist visually impaired people to navigate safely is Microsoft 3D Soundscape [1]. It uses a headset that talks to the user through their routes in cities. In addition, it uses location information from Microsoft's Bing maps, which can be supplemented using tiny Bluetooth-enabled beacons stuck to lampposts around the city. A second assistance system is TrAVEl [2] which aims to assist the user in their bus routes. It uses GPS to track the traveller and bus arrivals to give a running commentary about bus stops and route, and to alert the traveller if he/she needs to change buses. On the other hand, ViaOpta Nav [3] walks a visually impaired person through their route by offering useful, turn by turn directions from the user's current position to their final destination. The aforementioned systems can produce specific semantic information such as "an obstacle in front of the user", "the arrival of a bus". However, they are restricted by requiring certain types of platforms or special types of hardware (*cf.* Fig. 1), providing information related to buses directions only *(e.g.*, TrAVEl), or not providing speech recognition capability (*e.g.*, ViaOpta Nav). Furthermore, these solutions do not provide real-time obstacle detection (neither static nor dynamic obstacle). These limits motivated us to propose ENVISION, which is a system capable of recognising speech, guiding the user to the requested destination, detecting static and dynamic obstacles and generating intelligent decisions to walk the user safely by avoiding obstacles and changing their route accordingly when needed.

The remainder of this paper is organised as the following: In section 2, we first present our proposed approach for ENVISION and then detail the new method for detecting static and dynamic obstacles in real-time video streaming. In section 3, we detail the major off-line work prerequisite to developing our proposed obstacle detection method. Experimental evaluation is discussed in section 4. Finally, the proposed approach is summarised and future work directions are presented in section 5.

2. Overview of ENVISION and its Obstacle Detection Method

The development of the ENVISION system has a three-fold objective. The first objective is to remove special hardware requirements and produce a solution deployable on an average range smartphone configuration. The second objective is to produce a solution that is a user-friendly as possible. To attain this second objective, our system uses speech recognition to receive destination requests from the user and it produces voice directives and alerts to avoid potential obstacles. The third objective is to produce a robust, high performant obstacle detection method.

Before detailing this latter objective which is the main focus of this paper, we next overview the conceptual architecture of ENVISION.