Iterative Design of Sonification Techniques to Support People with Visual Impairments in Obstacle Avoidance

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Obstacle avoidance is a major challenge during independent mobility for blind or visually impaired (BVI) people. Typically, BVI people can only perceive obstacles at a short distance (about 1 m, in case they are using the white cane), and some obstacles are hard to detect (e.g., those elevated from the ground), or should not be hit by the white cane (e.g., a standing person). A solution to these problems can be found in recent computer-vision techniques that can run on mobile and wearable devices to detect obstacles at a distance. However, in addition to detecting obstacles, it is also necessary to convey information about them in real time.

This contribution presents *WatchOut*, a sonification technique for conveying real-time information about the main properties of an obstacle to a BVI person, who can then use this additional feedback to safely navigate in the environment. *WatchOut* was designed with a user-centered approach, involving four iterations of online listening tests with BVI participants in order to define, improve and evaluate the sonification technique, eventually obtaining an almost perfect recognition accuracy. *WatchOut* was also implemented and tested as a module of a mobile app that detects obstacles using state-of-the-art computer vision technology. Results show that the system is considered usable and can guide the users to avoid more than 85% of the obstacles.

CCS Concepts: • Human-centered computing \rightarrow Empirical studies in accessibility; • Social and professional topics \rightarrow Assistive technologies; • Information systems \rightarrow Geographic information systems;

Additional Key Words and Phrases: Turn-by-turn navigation, orientation & mobility, navigation assistance

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1 INTRODUCTION

There are about 285 million **blind or visually impaired (BVI)** people worldwide [59]. For most of them, **Orientation and Mobility (O&M)** is a challenge experienced in the everyday life. Issues range from environmental orientation to perception, involving psychosocial, educational

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