DroneNavigator: Using Drones for Navigating Visually Impaired Persons

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ABSTRACT

Even after decades of research about navigation support for visually impaired people, moving independently still remains a major challenge. Previous work in HCI explored a large number of navigation aids, including auditory and tactile guidance systems. In this poster we propose a novel approach to guide visually impaired people. We use small lightweight drones that can be perceived through the distinct sound and the airflow they naturally produce. We describe the interaction concept we envision, first insights from proof-of-concept tests with a visually impaired participant, and provide an overview of potential application scenarios.

Keywords

navigation aid; visual impairments; drones;

Categories and Subject Descriptors

H.5.2. [**Information Interfaces and Presentation (e.g. HCI)**]: User Interfaces

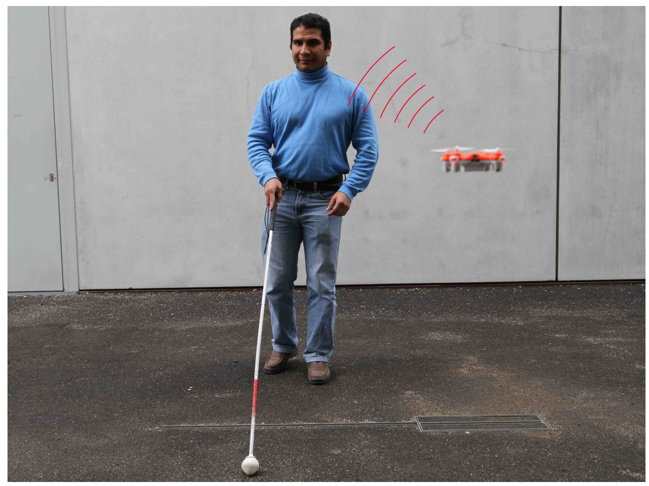

Figure 1: A user is perceiving navigation instructions by following the sound of a small drone.

1. INTRODUCTION & BACKGROUND

Assisted guidance for visually impaired persons inside unknown and known places is an important factor which increase traveling efficiency and traveler's confidence [6]. A large number of approaches have been investigated to support visually impaired users. Previous research focused on audio augmented reality [1] , tactile navigation systems [4], and smartcanes [5]. While previous work made substantial progress to support blind people, recent advances in technology enable novel wayfinding systems.

In this paper, we propose using small lightweight drones to help visually impaired persons to find their way and to locate objects. Our work is mainly inspired by work on the use of drones as companions for sports [3]. Blind users can set a destination using voice control. A small lightweight drone guides the way to the entered target. The user can easily perceive the position of the drone as it's motors emit a distinct sound. Having the drone equipped with a camera also enables to identify and locate items which are hard to spot without eyesight.

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2. CONCEPT

In this work, we propose using small drones to navigate visually impaired persons in everyday situations. Therefore, we propose a small wearable prototype. The visually impaired person is wearing a bracelet that is carried around the wrist. A small drone is mounted on top of the bracelet. Using a voice command, the user can issue verbal commands e.g. *"navigate me to the office"*. Once the system recognized the command and calculated the shortest route, the drone starts flying and the visually impaired user can start following the drone. By tracking the distance between bracelet and drone using Bluetooth signal strength the drone always remains at a distance of 1-2 meters from the user and adjusts to the user's speed. Once the drone is at the target position, it hovers above the target coordinates. Finally, the user can issue a return to home command to attach the drone to the user's bracelet again.

While we believe that this approach has great potential for everyday situations, we envision two major scenarios for using drones as a navigation aid for visually impaired persons.

2.1 Using drones to navigate to an address or room

The first scenario is using the drone for navigating to a defined address or room. Both indoors and outdoors, a drone could follow a previously recorded path that a sighted person pre-records. Indoors the system can use a positioning system that uses the strength of WiFi-signals to navigate to a destination on a room-level accuracy. To not crash against walls or other persons drones can be equipped with distance sensors. Some drones already come with built-in distance sensors (e.g. the DJI Matrice 100[1]. Outdoors the system can use GPS to navigate the user to a previously defined address. The drone tries to stay on paths by using a built-in camera.

2.2 Using drones to find misplaced objects

More and more drones are equipped with a camera. While most drones use their camera to record videos or take pictures from a distance, a drone-carried camera can also be used to identify misplaced objects using computer vision [2]. We envision a second use-case, where a drone visually searches an environment by flying through it and comparing a reference image to a sought object. In case the object was found, the drone can guide the visually impaired person to the location of the misplaced object.

3. INITIAL INSIGHTS

As a proof of concept, we conducted two initial tests with one blind participant (male, age 37) to evaluate the feasibility of our approach. The participant had no remaining vision. For the study, we used a Cheerson CX-10 nano quadcopter, which is $4,2$ cm $\times 4,2$ cm wide, 2 cm high, and has a weight of 29 g. We chose a lightweight drone to not risk hurting the user or passers-by. We used a wizard of oz approach for flying the drone. The experimenter was controlling the drone and kept the drone in a distance of approximately 1-2 meters in front of the participant. When the target was reached, the experimenter landed the drone at the target position. As targets we used persons, furniture, and target points inside a hallway.

3.1 A lab study

To evaluate the general idea, we conducted a first lab experiment which consists of a simple navigation task i.e. walking down a corridor to a defined position. In 5 test walks, the participant had to walk to a target position and stop when the drone landed. The paths that were chosen for the test walks included straight lines and turns. One of the 5 paths included a 180° turn. Each path had an approximate length of 20 meters.

3.2 Testing external validity

Second, we conducted an experiment to verify the external validity of our approach. Thereby, the participant was guided through a crowded room with approximately 30 persons. The distance from the starting point to the target location was 20 meters.

The participant was able to follow the drone and was reaching the targets. Further, the participant did not hit any walls or other persons with the cane. The participant stated that the drone was easy to spot by its distinct sound even though the environment was noisy or reverberant. He said that *"[I] can perceive its position, beside, behind or ahead me, even when it moves around"*. Another advantage of the approach is that the participant did not need to carry additional technology. He could use his cane and follow the drone in a way he would normally walk. The three-dimensional position of the target can be perceived in a very fine-grained way. E.g. the participant was able to find an empty spot on a sofa that was 50 cm wide.

[1] `http://store.dji.com/product/matrice-100` last access 06-24-2015

4. CONCLUSION & FUTURE WORK

In this poster, we present a novel approach for navigating visually impaired persons by using small drones. In a proof-of-concept study, we found that our approach is feasible and could be used to accurately guide a visually impaired person. Further, in an everyday scenario, we show that our approach even works in noisy environments, e.g. navigating through a crowded room. Our participant liked that the drone was easy to spot and and to follow as it produces a distinct sound.

In future work, we want to conduct a user study with more participants and look into multi-user scenarios using different sound patterns for the drones. Further we want to investigate the potential of the drone's airflow as another modality to guide visually impaired users, and explore the social implications of drone-navigation for both users and passers-by.

5. ACKNOWLEDGEMENTS

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