Haptic Human-Robot Interfaces on Guide Robots for Visually Impaired People

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Abstract

In this paper, we presents two different haptic and intelligent guide robots for people with visual impairments. One guide robot has a haptic rein which would sense and interactive with users' grasp force, while the other one does not have a haptic rein, but equipped with a wireless tactile belt to receive navigation instructions.

1 Introduction

Although in the last decades there are many novel electronic travel aids (ETAs) for visually impaired and blind people, it is still a challenge for them to have independent and safe outdoor/indoor journey. The low cost white cane has a short range and fails to detect hanging obstacles, and guide dogs are too expensive to be affordable for most of visually impaired people. In addition to various obstacles on their way, it is difficult for visually impaired people to visit and explore unfamiliar environment, like a hospital building and a railway station.

In addition to wearable or portable ETAs with cameras (Meijer, 1992; Zeng et al., 2017), there is a trend that accessible guide robots are becoming promising to provide intelligent guidance services in public buildings, specifically in medium- and large-scale buildings. Therefore, apart from detecting and avoiding obstacles those guide robots should provide accessible non-visual user interface to acquire turn-by-turn navigation instructions and other spatial information, such as a floor plan.

According to physical user interface, basically, there are two categories of assistive guide robots: with a physical rein (e.g. a hard rein or a soft rein) and without a rein which physically connects to the robot. One of the technical issues is how to balance the walking speed between

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a guide robot and a blind people. In this paper, we presents two types of those guide robots to offer guidance services for visually impaired people.

2 Kuka Guidance: A Guide Robot with a Haptic Rein

The Kuka guidance robot is based on a KUKA-Youbot 4-wheel robot platform (weight 20kg, and max. speed 0.8 m/s), and a 2D laser LiDAR sensor is able to detect obstacles. A customized metal rein is fixed on the robot (see Fig. 1,), and a haptic handle is one the top of the rein (at a height of 0.8m). On the haptic handle, a series of sensors are used: 6 force-sensing sensors around the handle, 3 vibrated actuators, an ARDUNIO UNO board and a thumb joystick (see Fig. 2).

The force-sensing sensors are able to detect the force while pushing, pulling and pressing, that leads to control the speed of the guide robot (e.g., speed up/down) for balancing their speed in a natural way, and turn directions (i.e., left/right). Besides, visually impaired people can receive simple haptic messages via the vibrators (e.g., turning left/right and stopping). We report a pilot study with blindfolded users in (Zeng et. al., 2018).

Figure 1: The Kuka Guidance Robot and a real guide dog

3 Loomo Guidance: A Guide Robot without a Rein

The Loomo Guidance is based on a two-wheel Loomo robot which has a built-in RGBD camera, Android environment and other sensors. The robot APIs offer the interfaces for speech interaction, human tracking and robot movement control. The max. speed of the robot is about 4.9 m/s. One big challenge is once the robot walk too fast, visually impaired and blind people would have a problem to access them well.

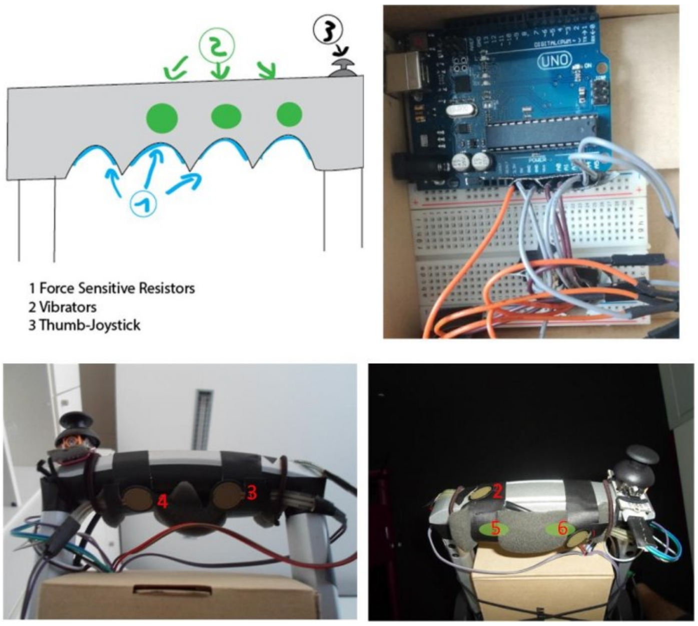

Figure 2: The hardware components of the HapticRein system (top-left: an overview layout of the main sensors; top-right: the ARDUNIO board; bottom-left: bottom view of the handle; bottom-right: front view of the handle).

As illustrated in Fig. 3 and Fig. 4, a Google Tango table with multiple-cameras is attached in the front of the robot. The Tango table is used to scan and build an indoor map, detect obstacles and positioning users on the map while walking. A wireless (i.e., Bluetooth) tactile belt having 8 vibratos (Zeng et al., 2017) is employed to receive haptic navigation instructions, in addition to a speech input user interface. Importantly, to solve the issue of balancing user's and robot's speed, the built-in RGBD camera is used to track a user and keep the range max. 3 meters.

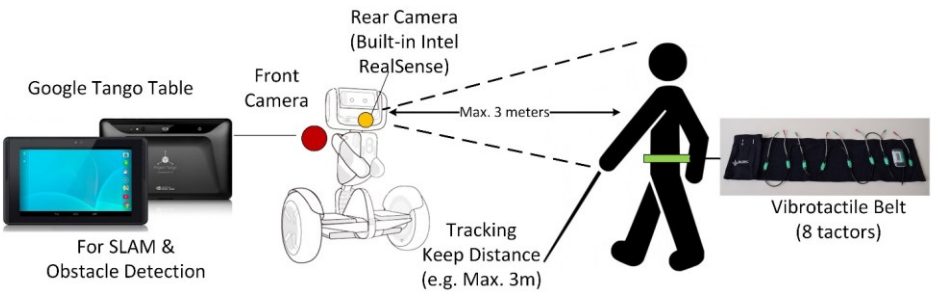

Figure 3: The overview of the Loomo Guidance Robot

Figure 4: The front view and the rear view of the Loomo Guidance Robot

4 Conclusions

The two guide robots are both planned to be demoed, and the participants would try them. Considering the limited size of demo space, we will mount the Kuka robot and the wheels are able to work in a fixed position, and the participants can try the haptic handle and the joystick handle. The Loomo robot will be demoed with its interaction, as well as a prepared demo video.

References

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