BASICS OF DESIGNING ASSISTANTS FOR ORIENTATION BLIND PEOPLE

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Abstract. *This article deals with the problems of orientation of the blind. We examined the principles of operation of the main classes of portable assistants, their advantages and disadvantages. Methods for implementing tactile feedback are also considered.*

Keywords: blind, electronic assistant, parallax, haptic feedback.

Introduction

There are more than 39 million completely blind people in the world, in more detail for the regions: Africa - 5.9 million, America - 3.2 million, Europe - 2 million. Blind people have significant limitations in daily life, the most important of which is their mobility. Such people can remember certain routes (for example, how to get to the nearest store or to work), this is equal to free movement. It is necessary that blind people be able to detect obstacles located on their walking path, avoid them and successfully follow their route. To increase the mobility of blind people, various means and helpers, such as guide dogs, have been used for centuries. To solve the problem of expanding mobility, you can create an electronic assistant. In this article, we will consider the various architectures of such solutions, the principles of their operation, the shortcomings and methods of further experiments necessary to create them [1].

The main types of electronic assistants

Modern devices for navigation of the blind can be divided into three groups according to the basic principle of operation: radar, global positioning and stereo vision [2].

The best known group of electronic assistants are radar systems. The most commonly used laser or ultrasonic beams. When a ray hits the surface of an object, it is reflected. You can then calculate the distance between the user and the object as the time difference between the emitted and received beams, and even build a depth map when using an emitter array or lidar.

In general, the distance determination method for ultrasonic rangefinders and some lidars is described as (1).

$$S = vt\ ;\ t = T/2\ ;\ S = vT/2 \tag{1}$$

Here S is the distance to the object; T is the time of wave movement from the sensor to the object and back; t is the time of wave movement from the sensor to the object; v is the speed of sound for ultrasonic sensors, or light for lidars.

The main problems in the use of radar devices are various interferences determined by the environment. Rainy weather, snow or fog will require additional adjustments in signal processing, unique to each case.

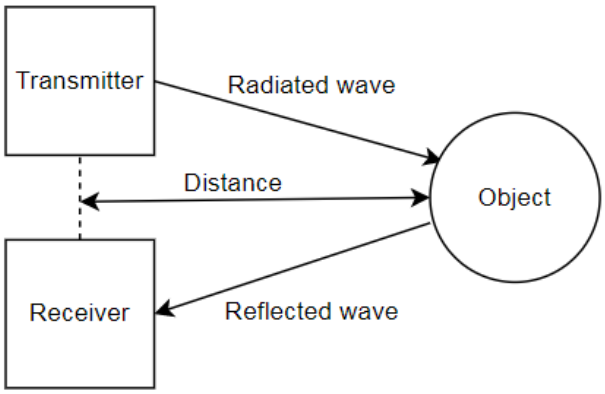

Figure 1. The principle of operation of radar systems.

The second group of electronic assistants are devices based on global positioning systems (GPS, Glonass, Galileo and Beidou). These devices allow the blind user to be guided along a pre-selected route; In addition, they determine the location of the user, such as street number, intersection, etc. [3].

Satellite positioning systems are based on the use of one-way distance measurement methods. When implementing this method, the satellite radio ranging system is divided into two main components:

– satellite-mounted transmitter;

a receiving and computing complex at the disposal of the ground user.

The position of the consumer is estimated from signal delays, so navigation signals are specially designed to simplify the assessment of these delays against the background of noise and interfering factors.

The disadvantages of positional class devices is the "floating" accuracy of work, due to the dependence on external signals. Additional efforts are also needed to build an accurate route, taking into account various local circumstances, such as route congestion, traffic jams, possible traffic accidents, etc.

The third type of electronic assistants is based on the use of a stereo camera [4]. This is a broad concept that includes several technologies, for this class of tasks it is supposed to use the Depth from Stereo camera, whose principle of operation is shown in Figure 2.

This is the most well-known direction of constructing a depth map from stereo images. Depth is calculated from the distance between the cameras, the focal length of the cameras, and the mismatch between image pixels(2).

$$Z = Bf/(x - x') \tag{2}$$

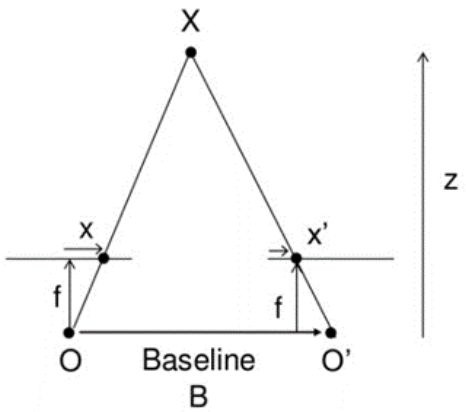

Figure 2. How Depth from Stereo Cameras Work

Methods for implementing tactile communication

To accomplish the task of creating an electronic assistant for blind people, it makes sense to use tactile feedback, taking into account that losing sight, a person relies more on the remaining senses, and most on hearing. When offering a device that uses sound alerts, there is a high probability that users will face distrust of the assistant. Consider the main methods for implementing tactile feedback:

Vibration - There are two types of vibrators (motors): ERM and LRA. The first type of vibrators works by rotating an eccentric mass on a shaft. To operate this type of motor, a constant voltage is sufficient. The second type of vibrators rely on an alternating voltage to drive a voice coil that is pressed against a moving mass connected to a spring[5]. When the voice coil is actuated at the resonant frequency of the spring, the entire actuator vibrates with a perceptible force. Although the frequency and amplitude of a linear resonant drive can be adjusted by changing the AC input, the drive must be driven at its resonant frequency in order to generate meaningful force with large currents. When vibration is generated and pressed against a moving mass, the voice coil remains stationary inside the device. By moving the magnet up and down in relation to the spring, the LRA as a whole is displaced, causing vibration, Fig. 3.

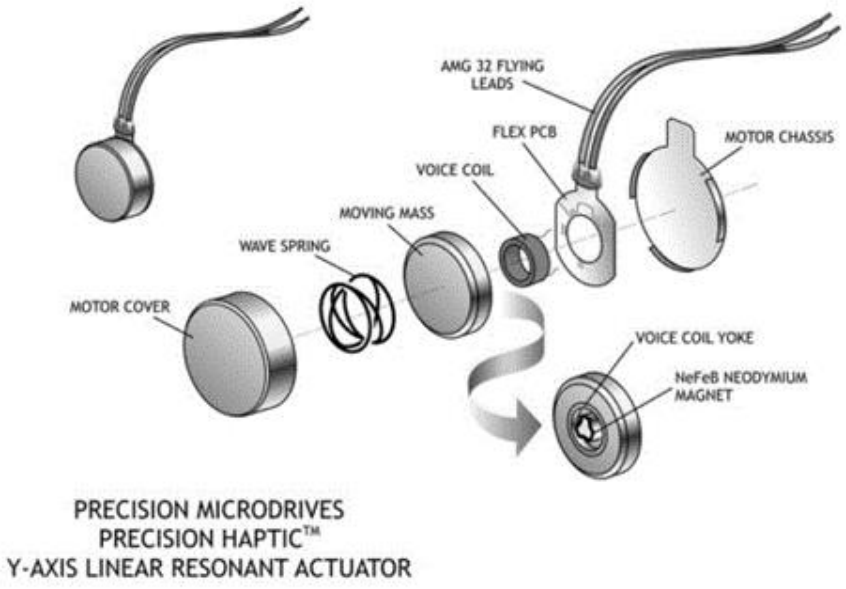

Figure 3. LRA motor structure.

Piezoelectric actuators are used to create vibrations and offer even more precise vibration control, but require higher voltages than ERM and LRA motors, making them difficult to use in portable systems.

Ultrasonic beams - can be used to create a local sensation of pressure, without direct physical contact. The focal point that creates the sensation of pressure is created by individually controlling the phase and intensity of each transducer in the ultrasonic transducer array. These beams can also be used to create sensations of vibration and to enable users to experience virtual 3D objects..

Conclusions

We have considered the main methods of operation of portable systems for blind people. To implement an affordable and inexpensive device, we propose to use the computing power of a smartphone, the Depth from Stereo module of the camera, and a feedback module based on a matrix of LRA motors.

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