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Architectures of Portable Systems for Orientation of the Blind

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***Abstract*—This paper analyzes the differences and disadvantages of various electronic assistants for the blind. It also describes our architecture.**

Keywords—blind, electronic assistant, parallax, tactile feedback.

I. Introduction

There are over 39 million totally blind people in the world, 5.9 million in Africa, 3.2 million in the Americas and 2 million in Europe. Blind people have significant limitations in daily life, mainly in mobility. While they can often learn certain routes (such as showing them how to get to the nearest store or station), this ability is far from being able to move freely.

Various means and aids, such as guide dogs, have been used for centuries to increase the mobility of the blind. In our time, it has become possible to solve this problem by technical means by creating an electronic assistant.

This article will discuss the various architectures of such solutions, the principle of their operation and disadvantages.

II. Types of Electronic Assistants

Electronic assistants are divided into three main groups according to the principle of operation: radar, global positioning, and stereo vision [1].

A. Radar systems

The most widely known electronic assistants are based on the radar principle. These devices emit laser or ultrasonic beams. When a ray hits the surface of an object, it is reflected. Then the distance between the user and the object can be calculated as the time difference between the emitted and received beam, or a depth map can be built if an emitter matrix or lidar is used. The user is then informed about the presence of the object by various methods [2, 3]

The disadvantages of this radar class of devices are various interferences depending on the environment. For example, rainy weather or laying snow will require additional corrections in signal processing.

B. Positional systems

The second type of electronic assistant includes devices based on the global positioning system (GPS). These devices are designed to guide a blind user along a previously selected route; In addition, it provides the user's location, such as street number, intersection, etc. In this group, the most well-known devices are. Their effective range is up to 5m outdoors. Using radio signals supplied by satellites, the device can provide real information about every point on the Earth, informing the user in real-time about their position in the environment.

The disadvantages of position class devices are dependent on an external signal, and as a result, “floating” accuracy of work depending on the location.

C. Parallax based systems

The third type of electronic assistant is based on the parallax effect. The real opportunity to create an affordable device appeared relatively recently, with the advent of affordable cameras. The stereo camera allows you to calculate the distance to an object if you know the base distance between the cameras. Also, having an image can be used for further processing.

The disadvantage of parallax-based devices is their sensitivity to light. Devices using cameras that are not sensitive to infrared radiation will require additional illumination for correct operation at night.

III. Peculiarities of Perception of the Blind that Should be Considered when Developing Electronic Assistants

There are a few things to keep in mind when designing helper systems:

First, 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 the assistant.

Secondly, the white cane is still the main assistant for blind people. The electronic assistant must allow their combined use [4, 5].

Thirdly, taking into account the level of material support for blind people in Ukraine, the device should be available for independent purchase.

IV. Description of the Proposed Architecture

We assume that to solve such a problem, it makes sense to use the available computing power of a smartphone, which will allow using artificial intelligence for higher efficiency and functionality.

We propose the idea of creating a device that will use a stereo camera to detect obstacles and process information on a smartphone transmitted via Bluetooth [6].

This will make it possible to implement various system reactions depending on the class of obstacles. For example, the user must first be informed about dangerous objects such as cars or animals. The use of artificial intelligence will recognize traffic lights and inform users. This will increase their mobility and integration into society.

It is possible to argue about the choice of a specific architecture only after testing its performance in practice. Perhaps it makes sense to train a neural network to recognize generalized classes of objects, such as a tree or a lamppost, these are static objects that can be bypassed. A wall or fence is a static obstacle that cannot be bypassed, and so on. This approach can reduce the required processing power requirements of the end device.

Informing the user will take place using a special feedback module, in the form of a bracer with a matrix of ERM motors that provide a tactile response for the user. Depending on the distance to the interference, with different intensity and/or frequency, the corresponding pixels of the navigation matrix will create a spatial representation of the environment. This design will allow the user to use the hand, for example, to hold a white cane, and leave the other hand free [7].

The Block diagram of the proposed device is shown in Fig.1. In the given block diagram: 1 - user, 2 - tactile response block, 3 - computing block, 4 - stereo camera block.

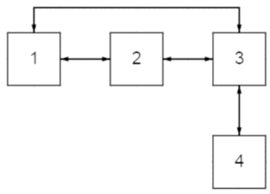

Fig. 1. Block diagram of the proposed device.

Conclusion

Despite the fact that after the Second World War, more than 40 different systems were created, of which only 13 reached the stage of a commercial product [8]. Nothing is known about them in Ukraine. In underdeveloped countries, the situation is even worse. Blind people have little hope for support from the government. Therefore, an affordable device is needed that can be used offline, including in rural areas.

We believe that the device we offer can occupy the niche of an assistant available to blind people with a low level of income, and capable of working in various conditions.

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