SUPERBAT – A NAVIGATION AID FOR THE BLIND

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1. Introduction

The objective of the project is to develop a multifunction device for helping blind and visually impaired people by providing them orientation, location and other information . In order to achieve great flexibility, the solution is based on a digital signal processor.

Main functions of the device:

-Detecting nearest obstacles in front of the user by means of ultrasonic echolocation and indicating the distance and horizontal (2D) position by spatial stereo sound effects.

-Information gathering from the environment via a radio subsystem. The radio subsystem consists of tranceiver devices mounted on vehicles and public buildings and the mobile transceiver carried by the blind or visually impaired person which is used to identify the equipped buildings and vehicles. The system is particularly useful for providing information in navigation at traffic nodes. A built in voice synthetizer informs the user of the relevant data.

Our aim is to develop and test a cheap and effective multi function device taking into consideration the requirements of the blind. The components of the system are integrated in one, small size unit.

2. Echolocation component

2.1. Objectives

The potential usefulness of a navigation aid is unquestionable to help the perception of the environment for visually impaired people. Bats are well-known examples, which can perfectly navigate by the help of ultrasonic echolocation without vision, and today this technique is successfully applied in mobile robots. Independently from this field, real-time 3D sound generation has been developed to an accessible technology even in home PCs. Our basic idea is to connect these two threads using fast and power efficient DSPs (Digital Signal Processor) to produce a small, portable instrument, which can be a useful navigation aid for the blind. The ultimate goal is to indicate the environmental obstacles by such a stereo sound effect as if it had originated from the obstacle itself. The digital signal processor based system is able to determine the distance and the horizontal position of the obstacles in front of the user and to indicate the location of the nearest (most dangerous) one by stereo sound through earphones. The DSP is equipped with suitable interface circuits connected to one ultrasound transmitter and two receivers, which can be mounted, e.g., on the hat of the blind person.

2.2. Two-dimensional echolocation

The following figure shows how to determine the distance and direction of an object by means of ultrasound reflections.

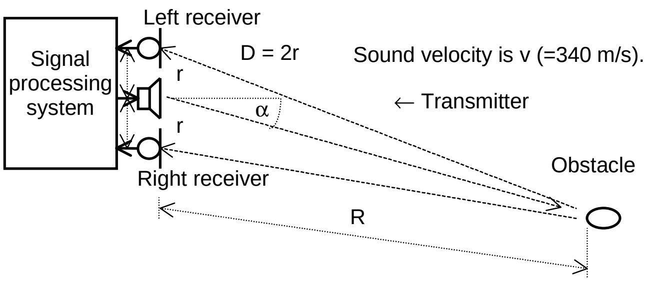

Fig. 1: 2-D echolocation

The Effects of More Realistic Conditions

-If there is more than one obstacle, the nearest one will be detected. This is quite convenient for us, and does not pose any critical problem.

-If there is only one obstacle but its size is relatively large, then similarly to the previous case, clearly its nearest part will be detected. The extrapolation to more than one or to concave obstacles is now obvious.

-If the surface of the object to be detected is poorly reflecting (because it is too small, or its material is too soft, or the angle of the surface to the receivers is too sharp) then, unfortunately, such an object cannot be detected or only from very short distances. Actually, that is the main limitation of ultrasonic echolocation.

2.3. The principle of spatialization

Spatialization of a monaural sound means virtually placing the sound source to a given point of the space related to the listener’s head. The procedure is a special transformation of the mono source to binaural signals to be transmitted to the ears typically through headphones. Here, we narrow our interest on the horizontal plane, in which it is often called 2D spatialization. The principle of the process is depicted in Fig. 2.

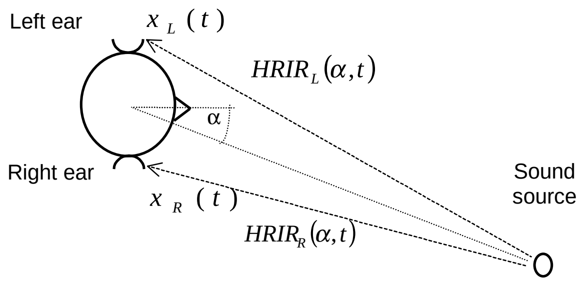

Fig. 2: 2-D spatialization

2.3. Subjective test

To investigate the usability the navigation aid – and to verify our ideas - a blind man was asked to test the experimental device. The waveform of the signaling sound was an amplitude-modulated sine wave with a shape experimentally determined to get a sound impulse similar to a chord's resonance. The ultrasound sensors were mounted on the hat of the blind person. In a closed space several obstacles (chairs, tables, columns) were placed and also 'impolite' persons crossed the blind man's path. He was allowed to move freely without help and he did not use white cane.

Fig. 3 : Prototype

Overall he was pleased with the device, he said it was the best electronic travel aid he had ever tried. The objects that were close to the floor were hardly noticed, but this was not a surprise for us, since he nearly never looked down. He could well localize the other obstacles as well as the people who came too close to him.

Fig. 4: Testing the prototype

3. Radio component and speech synthetizer

The system is complemented by a radio based information component in which a synthetic voice reports the user the information obtained from nearby radio transmitters.

Radio transceivers are to be deployed on public transport vehicles and the infrastructure servicing the public transport, public buildings (government buildings, post offices, shops, banks etc.) The device on the passing blind person receives the signals and the synthetic voice announces the encoded information to the user.

The radio transmitter (with a range of about 20 metres) transmits the number of the bus in an encoded form for the blind. The mobile radio receiver at the blind person receives the number of the bus andthe speech decoder decodes and announces the number of the bus at the bus stop. On the other hand, its transmitter signals if the user wants to get on the bus and the receiver on the bus indicates to the driver that a blind person is nearby and wants to get on the bus.

The syntetizer also provides voice feedback necessary for the manual operating of the device and facilitates further future enhancements, e.g., announcing the exact time, or screen readouts when the device is connected to a PC.

4. Conclusion

The Superbat project is still in development phase. The prototype device is scheduled for 3Q of 2003, but an experimental version proved that its principles are suitable and usable in practice. The system, however, cannot solve the blinds' ultimate problem of the perfect environment perception. It has limits due to the characteristics of the ultrasound reflections. The deployment and widespread use of the information services built upon the radio component also requires further efforts. Despite these difficulties, we do hope that the designed instrument will efficiently aid the blind at travel and enhance the quality of their everyday life.