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Suppose that a device which directs or guides a blind individual has somehow acquired information about the direction of, and width of the path along which it should lead the blind individual [1]. The problem is the choice of sensory display of the path and its safe margins appropriate for presentation to the remaining exterio-receptive senses of the blind individual.

In this paper a method is proposed to quantitatively compare the display schemes communicating the course the blind travelers should follow according to the information the blind mobility aids have acquired, and an optimal auditory display scheme is sought.

The computer system emulates several display devices which use amplitude modulation to indicate the error of a subject's location from the indicated course. The TRACK system measures the location of a human subject in real-time [2], and the error is presented to the subject through one of the emulated devices. The indicated course, human trajectory, and the error are recorded in the computer disk memory (Fig. 1). The performance of the human in each task is evaluated by calculating a transfer function of the human with each device and then using this transfer function as the criterion for comparison (Fig. 2).

Three attributes of the display were compared;
1)whether the display is continuous or discrete;
2)whether the subject is instructed to move toward the sound or go away from it; and
3)whether the presentaion is monaural or binaural (Fig. 3).

Figure 2 shows an example of the amplitude and the phase of the transfer function of the subject TS with the emulated device of MTC-type (Monaural-Toward the sound-Continuous). The same kind of transfer functions were estimated for all twelve emulated devices used by two subjects.

A method is proposed to determine the optimal display scheme quantitatively: The sum of the effective gain and the reciprocal of the effective time delay is calculated based on the estimated open-loop transfer function of the subject with each of the display devices. The normalized distance between the alternative display schemes was statistically calculated and used as the measure to determine the superiority of one alternative display scheme to another quantitatively.

For the compensatory auditory display schemes experimented in this paper the Monaural-type (loudness cue only) and the Binaural II-type (loudness cue plus position cue) are superior to the Binaural I-type (position cue only).

The Monaural-Toward-Discrete-type was found to be the best for one subject while the Binaural II-Toward-Discrete-type was the best for another. The difference between subjects was also noticeable. The superiority of one alternative display scheme to another, however, was almost independent of the subject difference.

It has been found to be feasible to design the display scheme of blind mobilty aids using the procedure reported, and the optimal choice can be made before committing a particular design to lengthly development process.

Moreover it will be possible to find out the best display scheme for a particular subject, i.e., the custom-made mobility aid for the blind, by using the method reported.

1)S.Tachi et al.:Electrocutaneous Communication in Seeing-Eye Robot(MELDOG), Proc.4th IEEE/EMBS,1982
2) R.W.Mann et al.:Precise,rapid,automatic 3-D position and orientation tracking of multiple moving bodies, Biomechanics VIII, HKC, ILL., 1982.

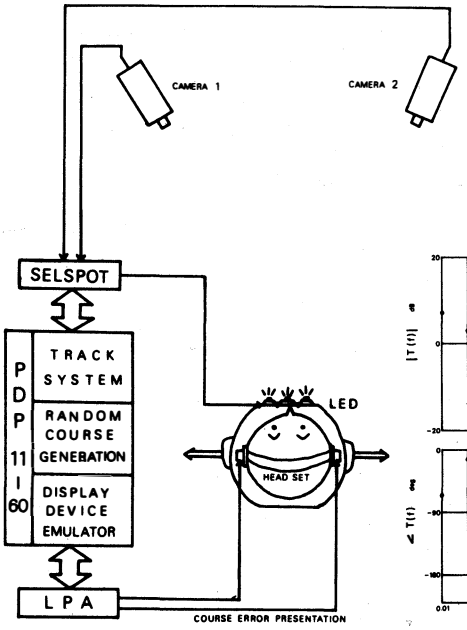

Figure 1.

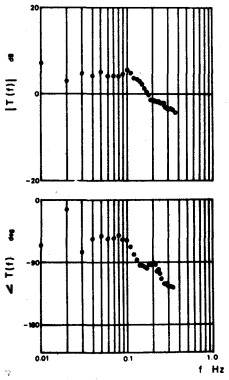

Figure 2.

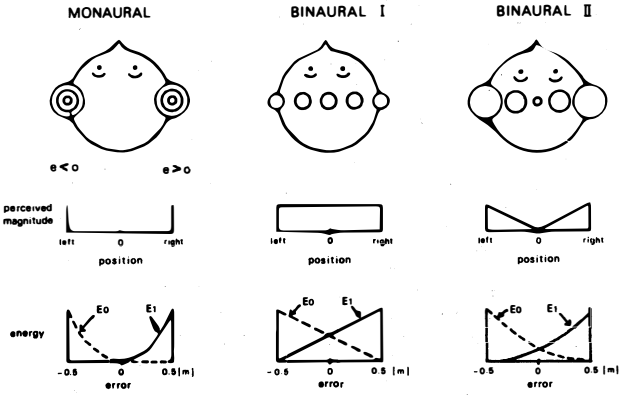

Figure 3.

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