1. Introduction

The auditory image model (AIM) (Patterson et al., 1992) has the stated purpose of summarising all of the signal processing that the auditory system employs to produce the perceived sound of a complex sound; this is the meaning of the term ‘auditory image’ in this model. However, your initial image of a sound includes its location, and to this point in time, the publicly available versions of AIM have been strictly monaural. Recently, we have begun a project to produce a binaural version of AIM.

2. Coincidence gate

As an example of the coincidence gate (Patterson et al., 2006) is a mechanism for implementing the traditional delay-line version of binaural processing. There is an array of coincidence gates (CgS) for each frequency channel, and they detect different combinations of inter-aural time difference (ITD). When coincidence occurs, the neural activity is gated out of the delay lines into the corresponding channel of a direction-specific auditory image. In this way the appropriate microcomponents of the neural activity flowing from the left and right cochleas is sorted into images with direction.

The coincidence gate is expected to work well for click trains in middle to high-frequency channels. In the lower frequency bands, the pulses are blurred by the impulse response of basilar membrane motion. To solve this problem, the CG concept was expanded to include channel interaction. Specifically, the occurrence of coincidence in one frequency channel is propagated to lower frequency channels to increase the probability of the lower gate opening. This enhances the detection of clicks in the lower channels considerably.

3. An implementation of coincidence gate

The CG scheme was implemented with shift-register and binary logic controller to make it efficient, from an analogy of Figure 2. The function module is called CG element. Each CG element was interconnected with data-latches. NAPs were previously matched by adaptive threshold to obtain individual NAP pulses clearly.

4. Computer simulations

Settings of computer simulations (Figure 5).

- Two sounds located in 45 degree left and 45 degree right.
- The left sound was a piano sound, the right one was a speech sound.
- Both sound with 20 kHz of sampling frequency

Figure 6 shows profiles of BNAPs onto some axes. The left two panels of Figure 7 show the NAPs from left and right ears. The right two panels of Figure 7 show the results of binaural integration NAPs for the direction of each sound by the coincidence gate scheme.

The results show that each NAP was separated clearly. In general, when both sounds did not have any overlap in time, the separation of NAPs into binaural NAPs was clear.

5. Conclusions

- The coincidence gate scheme with the coincidence information propagation was implemented. That consisted of arrays of the CG elements controlled by the CG unit. The CG unit was a simple logic gate. The whole system worked sufficiently fast.
- Computer simulations indicated the coincidence gate scheme worked well when sounds were not overlapped in time. The case of heavily overlapping is still investigated.

References


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