	A Smart-Phone Based System To Detect Warning Sound For Hearing Impaired People	

Hearing impaired people can not notice warning sounds such as sirens of emergency vehicles, horns of cars, and alarms of railroad crossings and thus can not behave properly. For example, when they walk on the road and an ambulance is approaching, they can not hear the siren and are likely to get into danger. This paper proposes a system to detect a warning sound for a pedestrian.

The system detects the warning sounds as following. First, an IIR band pass filter is applied to limit to the frequency band which includes the frequency of warning sounds. Next, an IIR comb filter is applied to remove the the fundamental and the harmonic frequency components of the warning sounds. Finally, threshold processing is conducted for the amplitude ratio of the input signal to the output signal. If the amplitude ratio is below a threshold, the system notifies the user of the existence of the warning sound. This system is simple and easy to implement on smart phones which most people carry commonly every day.

We conducted experiments to evaluate the performance of the proposed system. An ambulance siren and noises were synthesized with SNR -10dB, SNR 0dB and SNR 10dB and inputted to the system. The results of this experiment showed that the system can detect an ambulance siren with accuracy above 96% under noisy environments above SNR 0dB. In addition, we conducted an experiment in which an ambulance siren recorded on the road is inputted to the system. We found that the siren affected by the Doppler effect is difficult to be detected by the proposed system.
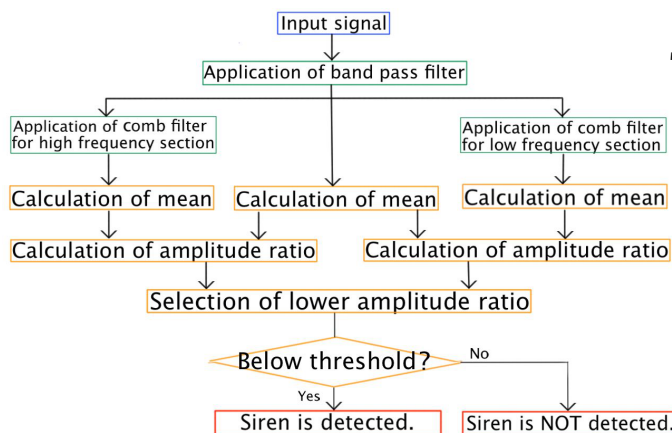

Table. Result of experiment

Noisy siren		Accuracy rate[%]
Noiseless		100
NU_{test}	-10dB	80
	0dB	98
	10dB	99
$Sakae_{test}$	-10dB	66
	0dB	96
	10dB	99
White noise	-10dB	78
	0dB	99
	10dB	99

Fig. Outline of the proposed system