Pinna Feature Extraction from Handheld Device Capture

Gabriele Carotti-Sha (gcarotti@stanford.edu)
Yujia Zhang (yujiaz@stanford.edu)

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1 Overview

Humans are capable of localizing the elevation position of sound sources relative to them. Identifying the exact location, however, is a difficult perceptual task, and even more difficult to model. The pinna (outer ear) plays an important role in this process as it generates a series of elevation cues while filtering the acoustic signal. This can be described via a frequency response function called the head related transfer function (HRTF) [2]. Different individuals have distinctive HRTFs since the biometric parameters vary significantly in relation to size, shape, and orientation. Fast and convenient extraction of pinna edges from 2D images is beneficial for mapping subjective pinna features to a filter model databank for aural spatialization (specifically, elevation correction based on the pinna impulse response) [3].

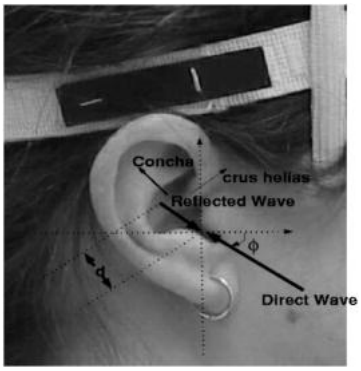

Figure 1: A simple reflection model for the pinna spectral notches. The direct wave incident at an angle phi gets reflected from the concha. The time delay corresponds to a length of 2d. [2]

2 Goals

The project can be decomposed into the following parts:

1. Image binarization and denoising
We plan to capture ear images using the provided Android device. Depending on the collection environment (i.e low illumination) and subject to subject differences such as skin tone, we will first binarize image with appropriate thresholding. Then, we will denoise the image to obtain clean result for the next processing stage.

2. Edge detection:
Before analyzing the biometric characteristics, a crucial step is to obtain the contour of the pinna from the collected image. Since the images of the outer ear tend to have low contrast, challenges in edge detection are expected. We will survey the different detection algorithms, such as Canny method and Sobel method, to develop a robust algorithm customized for pinna edge detection. [1]

Figure 2: Example of ear contour extraction [3]

3. Biometric parameter extraction and spectral analysis:
This step aims to use the generated pinna contour image to extract relevant parameters (i.e radius, centroid location) which determines the pinna impulse response.

4. Android device integration
The previous steps will be first implemented and prototyped in MATLAB. If the results are positive and time is allowed, we will adapt the algorithm for Android device. This will allow for personalized data collection.

3 Android device usage

If we arrive at satisfactory prototyping results, we will adapt our algorithms to Android. We may implement a simple audio playback system while running standard spatialization methods (by convolution). Regardless, success in spatializing sound is not within the scope of this project, and will therefore only be treated if time allows.

References

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[3] Simone Spagnol, Michele Geronazzo, Davide Rocchesso, and Federico Avanzini. Extraction of pinna features for customized binaural audio delivery on mobile devices. In *Proceedings of International Conference on Advances in Mobile Computing & Multimedia*, MoMM '13, pages 514:514–514:517, New York, NY, USA, 2013. ACM.