

Pinna Feature Extraction from hand-held device and HRTF response recovery

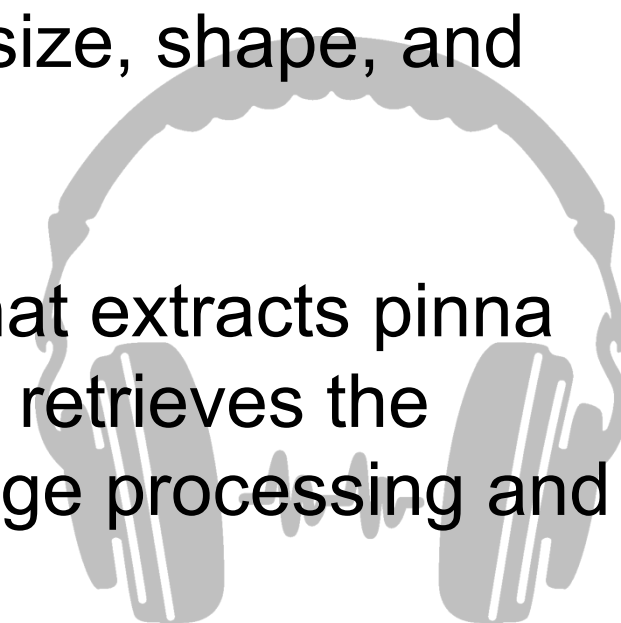
Gabriele Carotti-Sha, Yujia Zhang

Department of Electrical Engineering, Stanford University

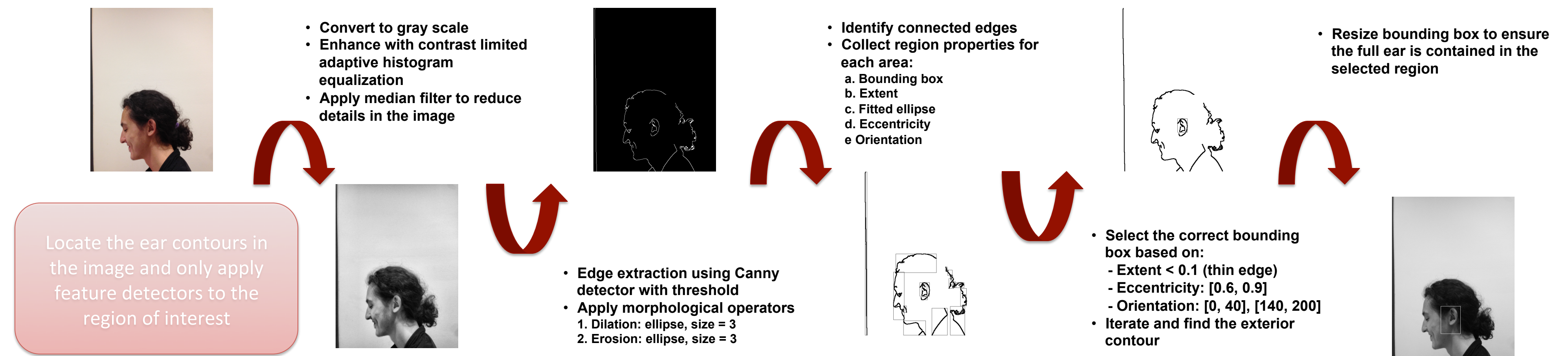
I. Motivation

The pinna (outer ear) plays an important role in localizing the elevation position of sound sources 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). Different individuals have distinctive HRTFs since the biometric parameters vary significantly in relation to size, shape, and orientation.

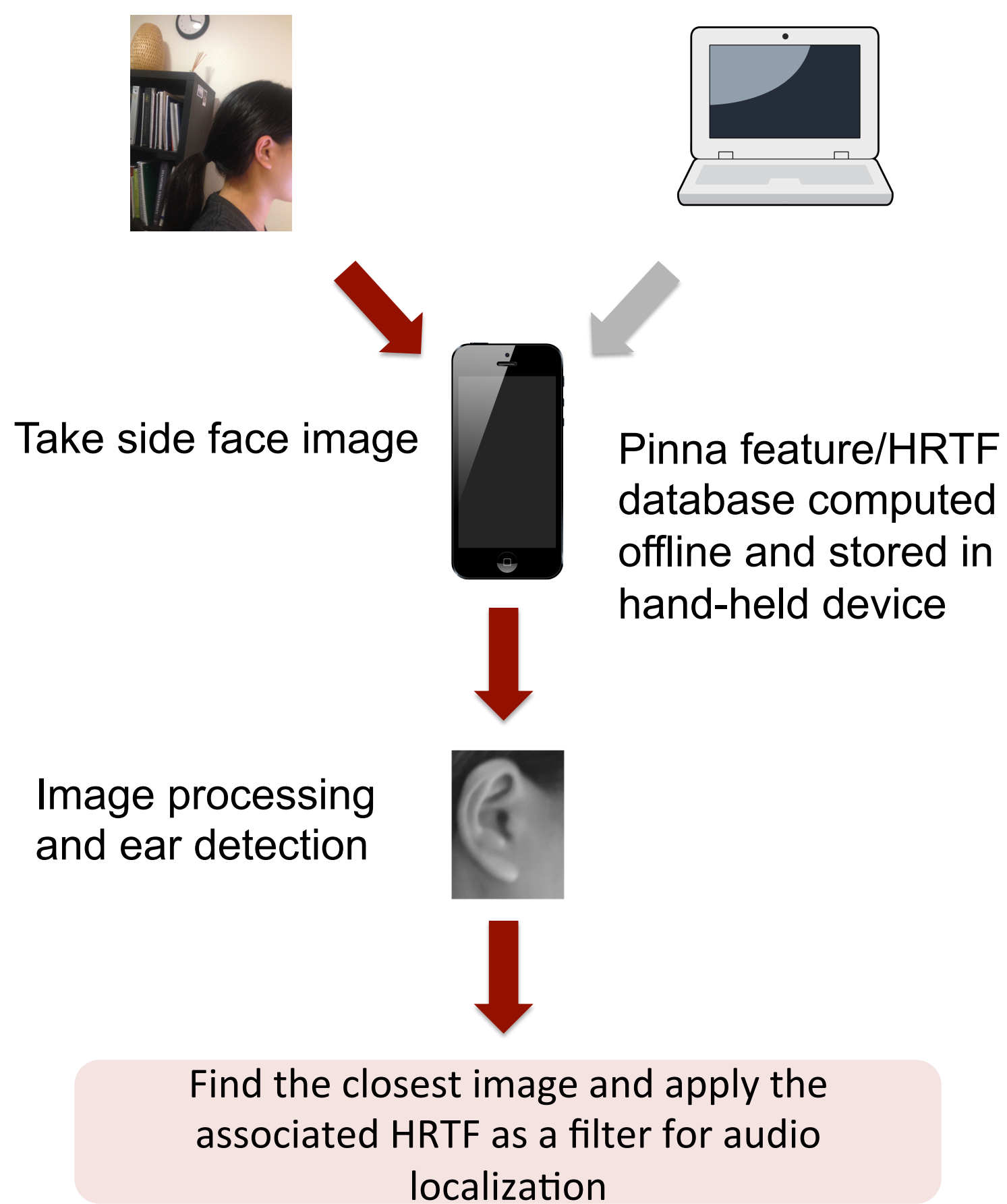
This project designed and prototyped an algorithm that extracts pinna features from images captured by mobile device and retrieves the closest HRTF response from database. Both the image processing and classification are done on hand held device.



III. Image Preprocessing and ear localization



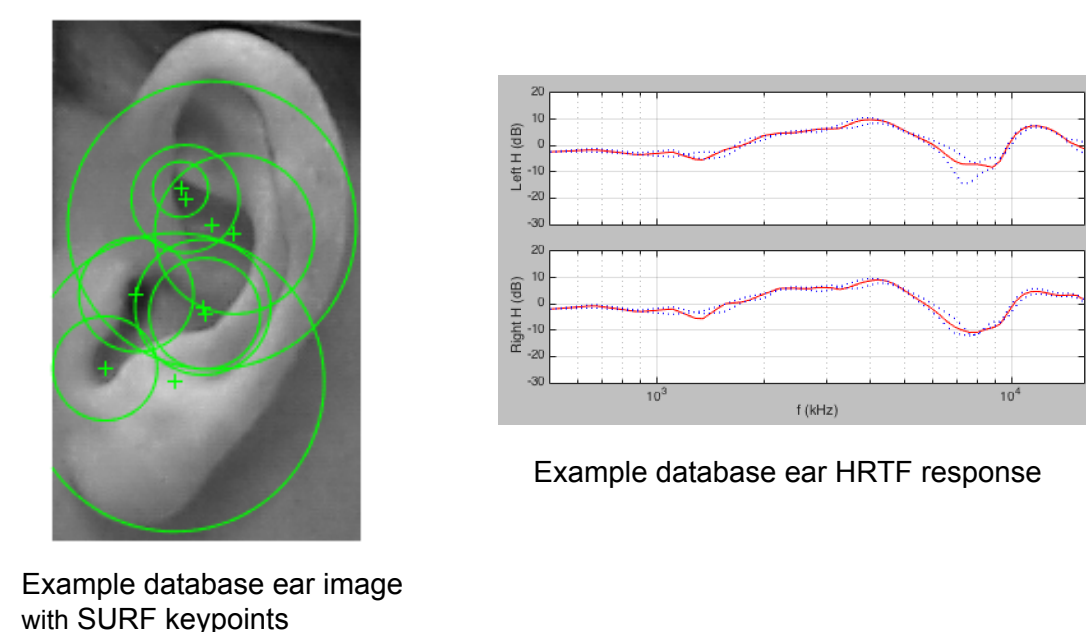
II. Workflow



Algorithm

Extract SURF descriptors of ear images from CIPIC database (MATLAB) (<http://interface.cipic.ucdavis.edu/sound/hrtf.html>)

Build a database consisting of ear features and corresponding HRTFs. (41 left, 11 right, stored in mobile device)



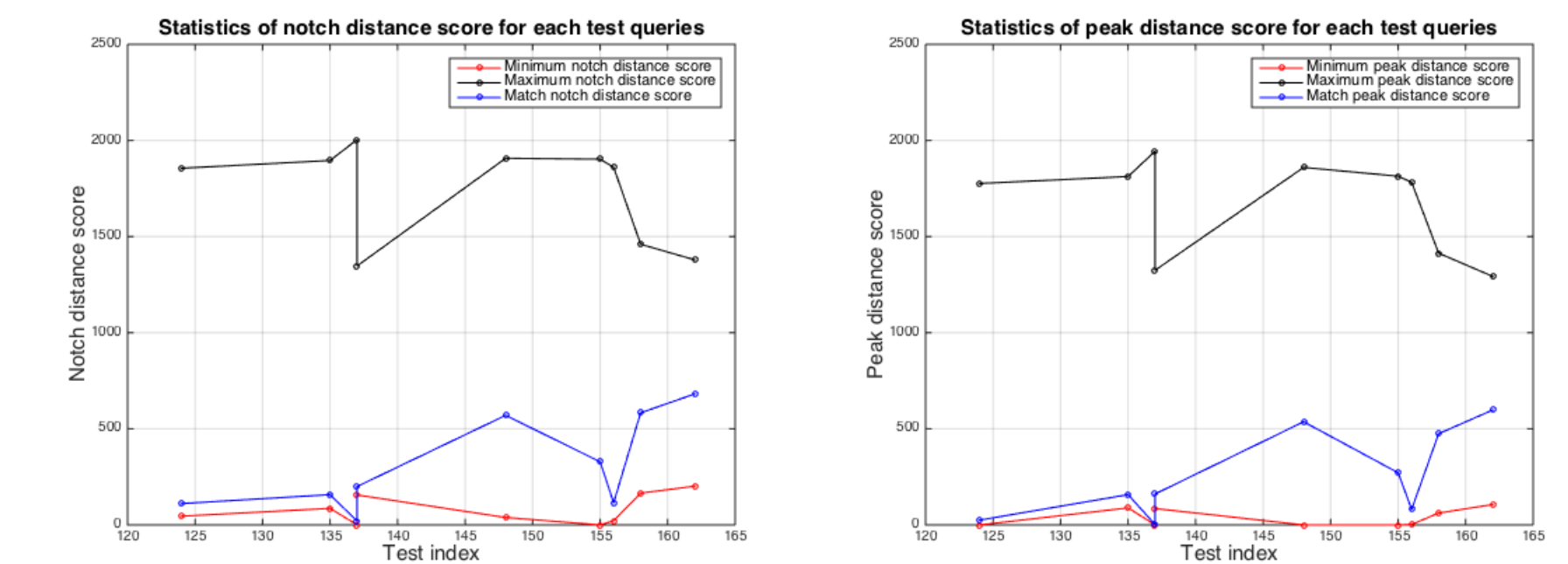
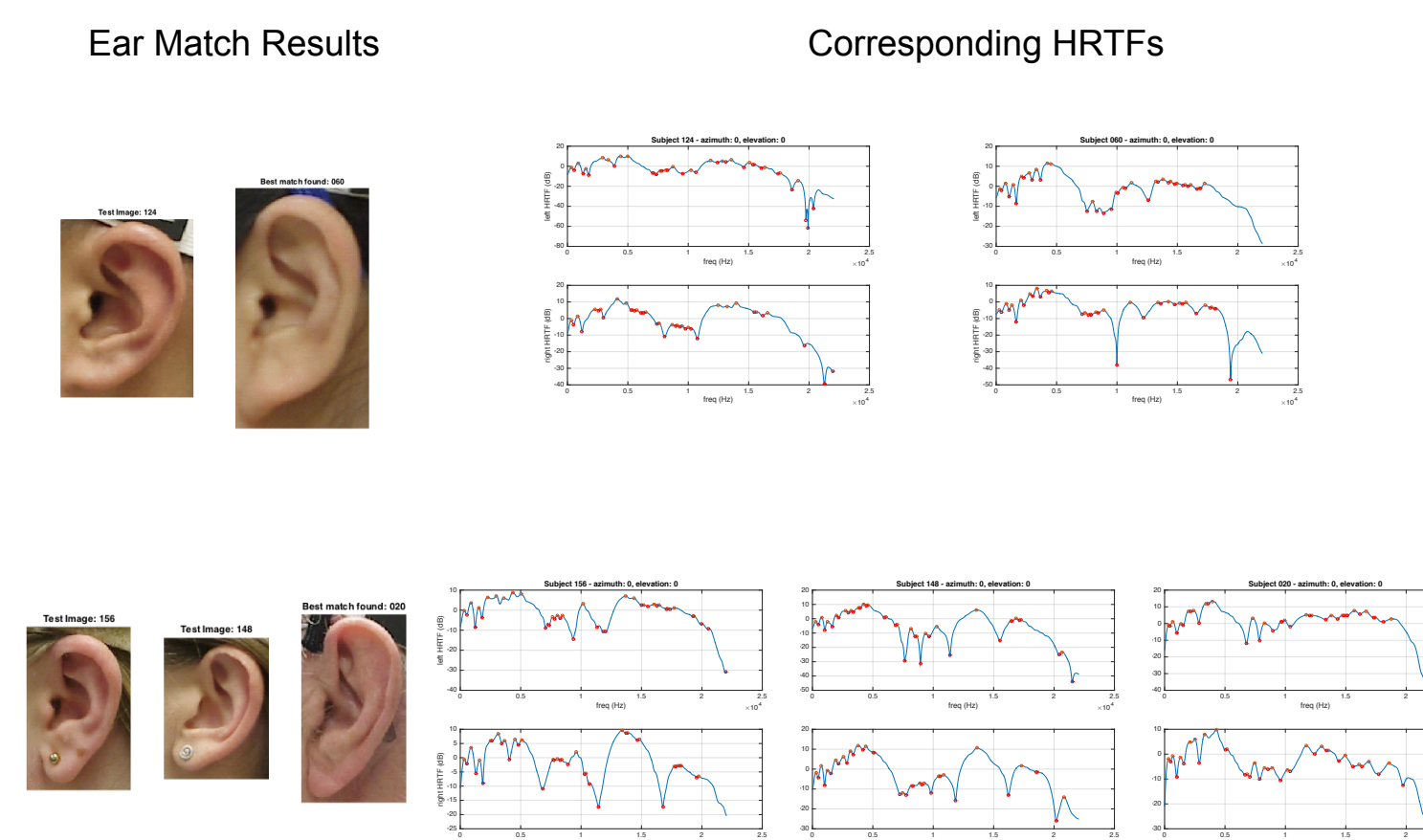
Compute SURF descriptors and find the closest HRTF using K nearest neighbor match method (OpenCV, iOS)

IV. Finding the nearest HRTF

Proof of Concept

- Sub-divide database images into training and testing sets
- Form database using training set
- Perform Query search with testing images and compute the corresponding Knn matches
- Compare query and its nearest neighbor's HRTFs to evaluate algorithm

Example of Knn Match Results



Measure of results comparison:

- HRTF responses are characterized by local max and min values (peak and notch) and their respective center frequencies
- Query image's HRTF is compared against that of the match by computing the distance score for the peaks and notches.

Resulting observation:

- The matched response are close to the minimum distance points over the small set. Matching can be improved with increasing database size.

	Training	Testing
Left	28	13
right	7	4