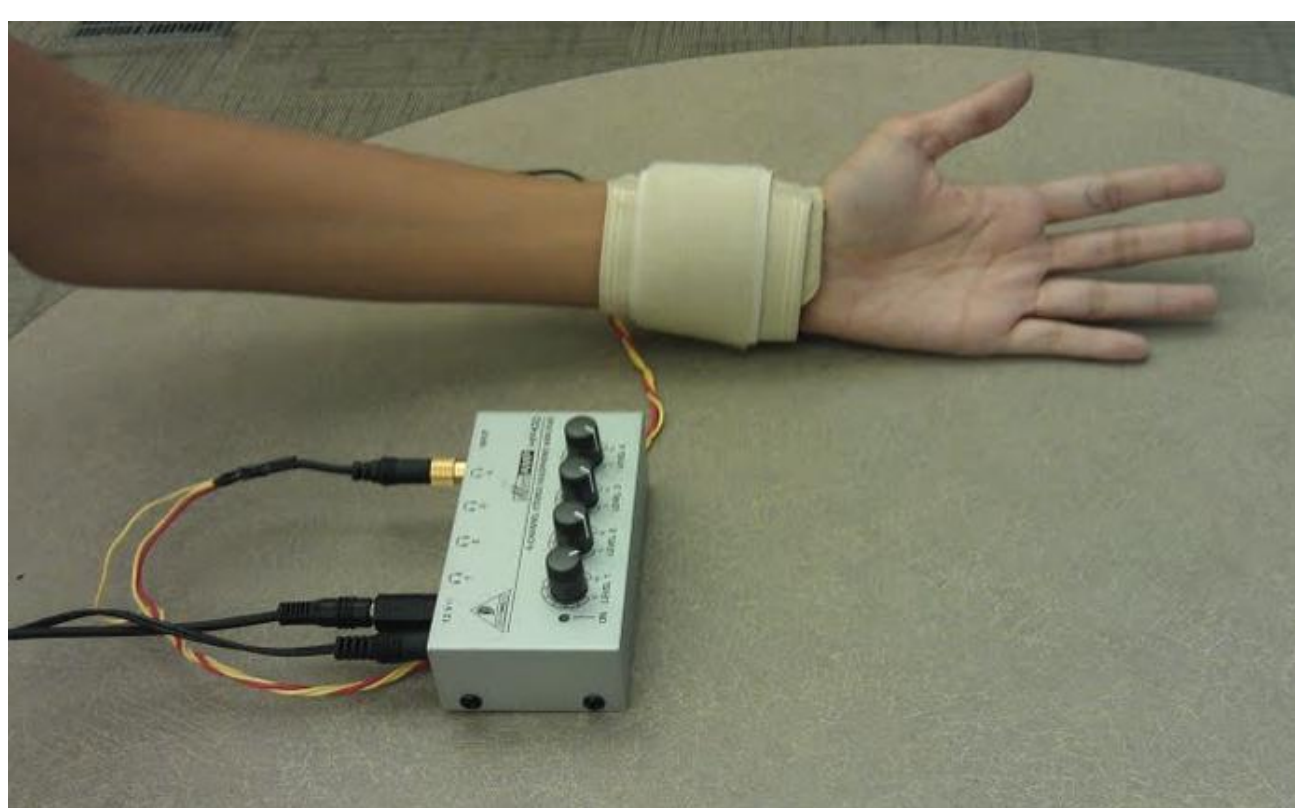


Skin Surface Input Interface

Murium Iqbal, Robert Xiao, Benjamin Shih

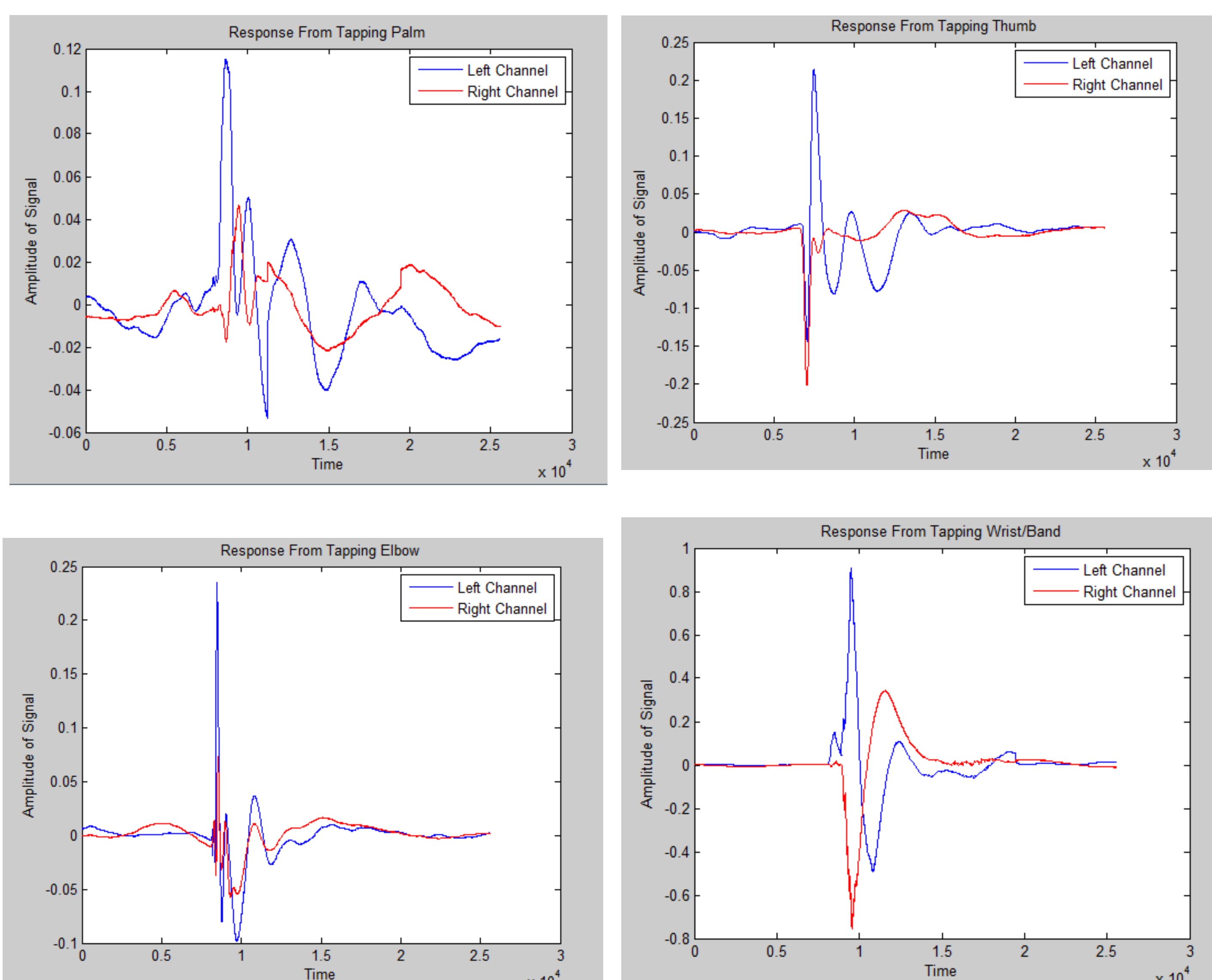
Background

Current technology is restricted by the need for touch interfaces. Our project proposes using a person's own hand as a surface with which to interact with his/her electronic devices, thus removing the need for bulky touch screens.



Method

Using two piezo-contact microphones, which are stitched into a wristband, we can listen to sounds traveling through a person's arm in response to taps or touches. Localizing these taps allows us to assign a function associated with a tap on a specific part of the hand or arm and, thus, ultimately create a touch interface on a person's skin.



Data from the microphones is taken as stereo input into an amplifier and then fed into a computer. If the signal on either channel exceeds a preset threshold, this is considered a "tap" and a sample of the signal at this instance is stored as data for the tap. A set of 100 samples from each of these regions is taken and features are extracted to train a classifier to recognize taps from the recorded regions.

Results

Using various spectral features, we were able to distinguish between taps on certain regions of the hand.

- Power spectral density – Power carried by the signal per unit frequency.

- Spectral Centroid – Center of mass of a spectrum.

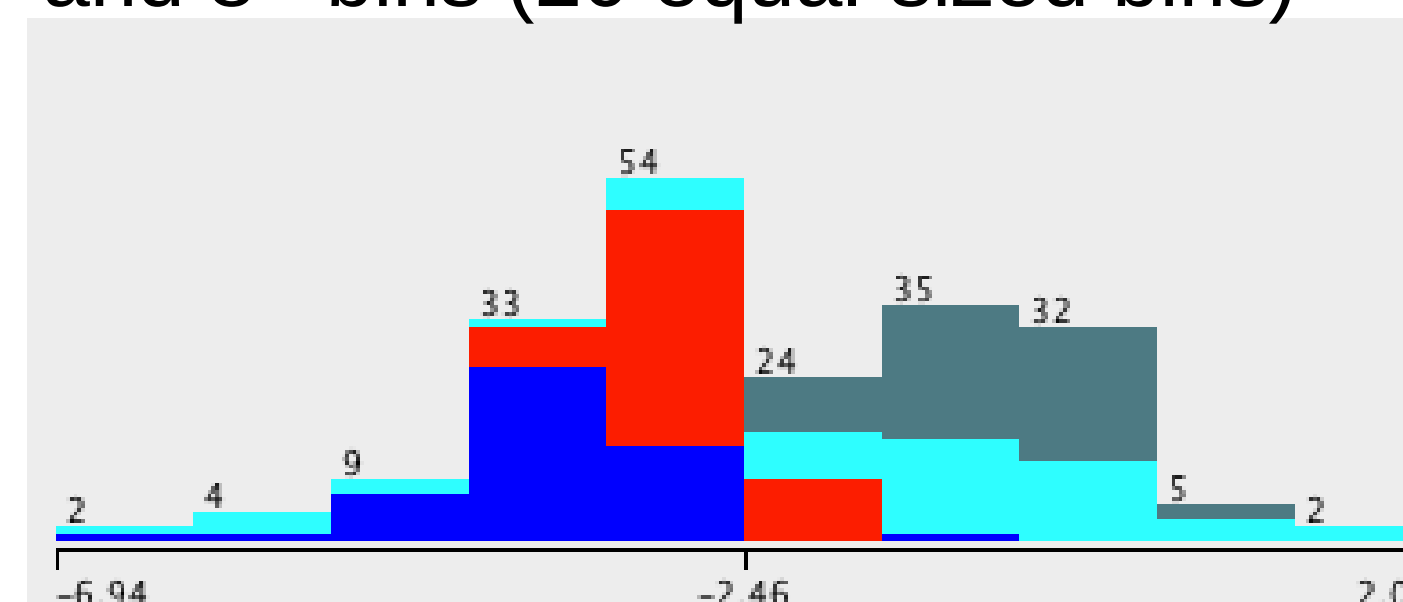
$$Centroid = \frac{\sum_{n=0}^{N-1} f(n) x(n)}{\sum_{n=0}^{N-1} x(n)}$$

- Band Energy Ratio – The ratio of energy across different bands of frequencies. Shows variation of energy in the signal across variously sized bins.

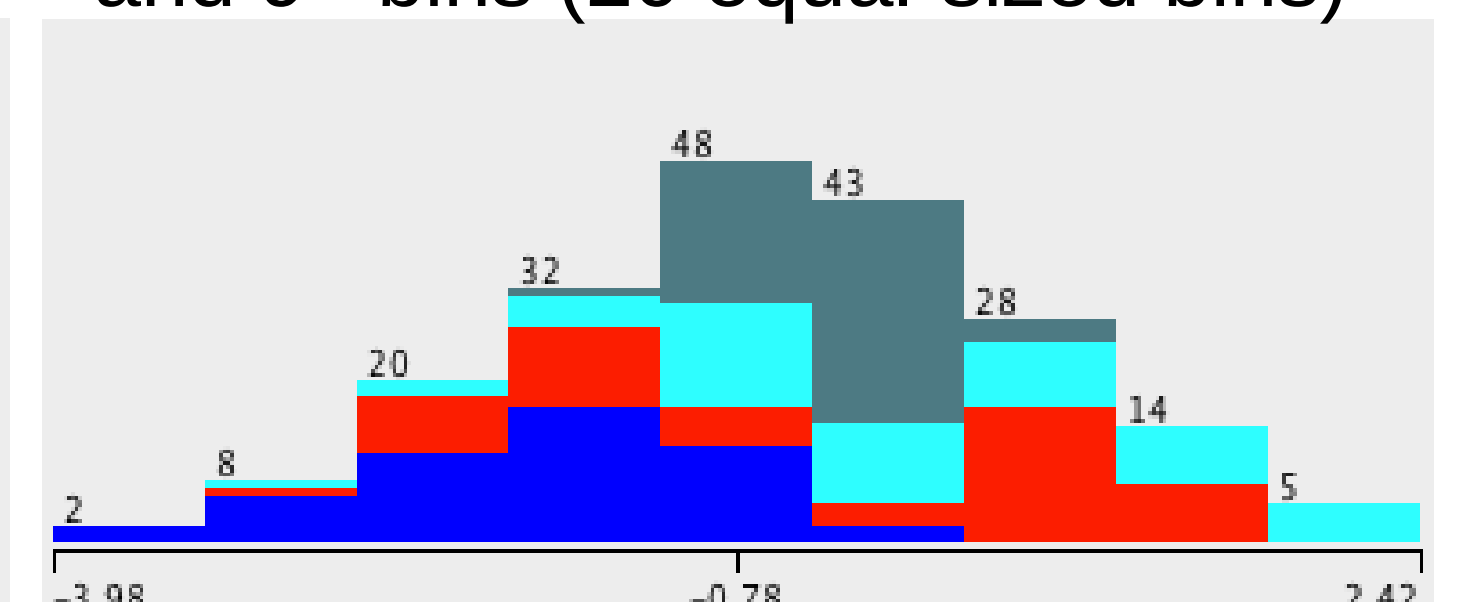
$$E_B = \sum_{k \in B} |X_k|^2 \quad BER = 10 \log_{10} E_{B_1} / E_{B_2}$$

- Log Spectral Band Ratio – Emphasizes spectral differences and helps reveal relationships in spectrums between signals in response to the same stimuli

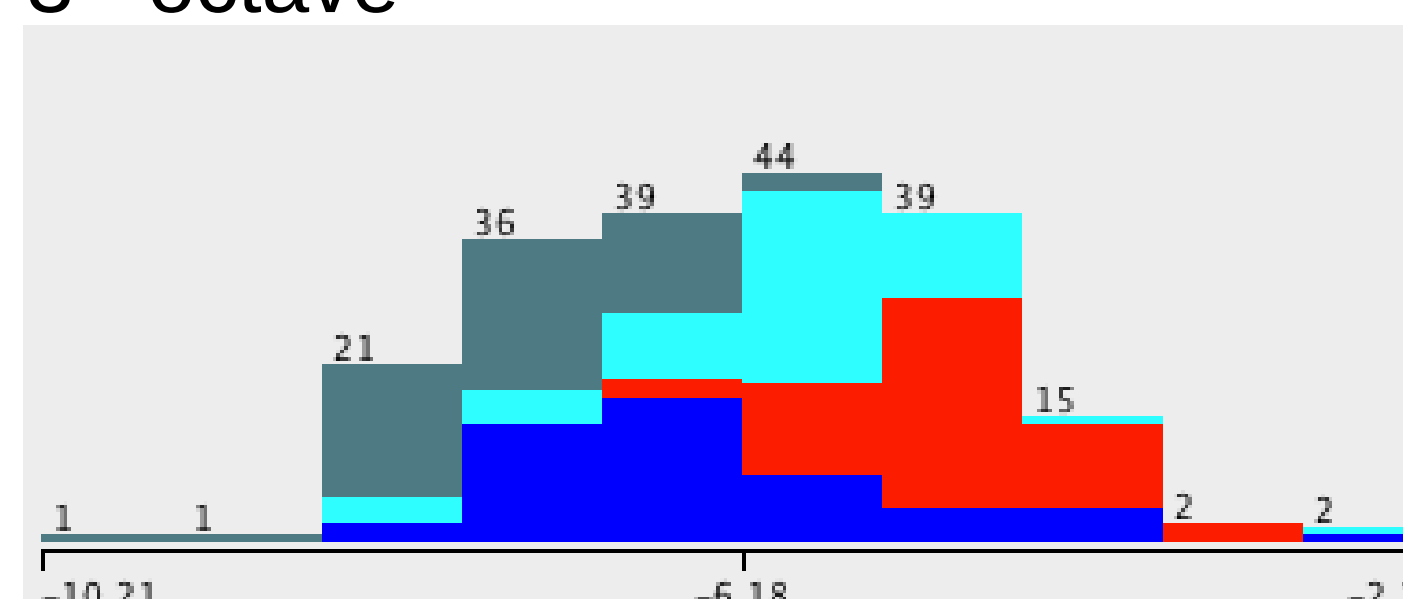
Log Spectral Band Ratio for 14th and 8th bins (20 equal-sized bins)



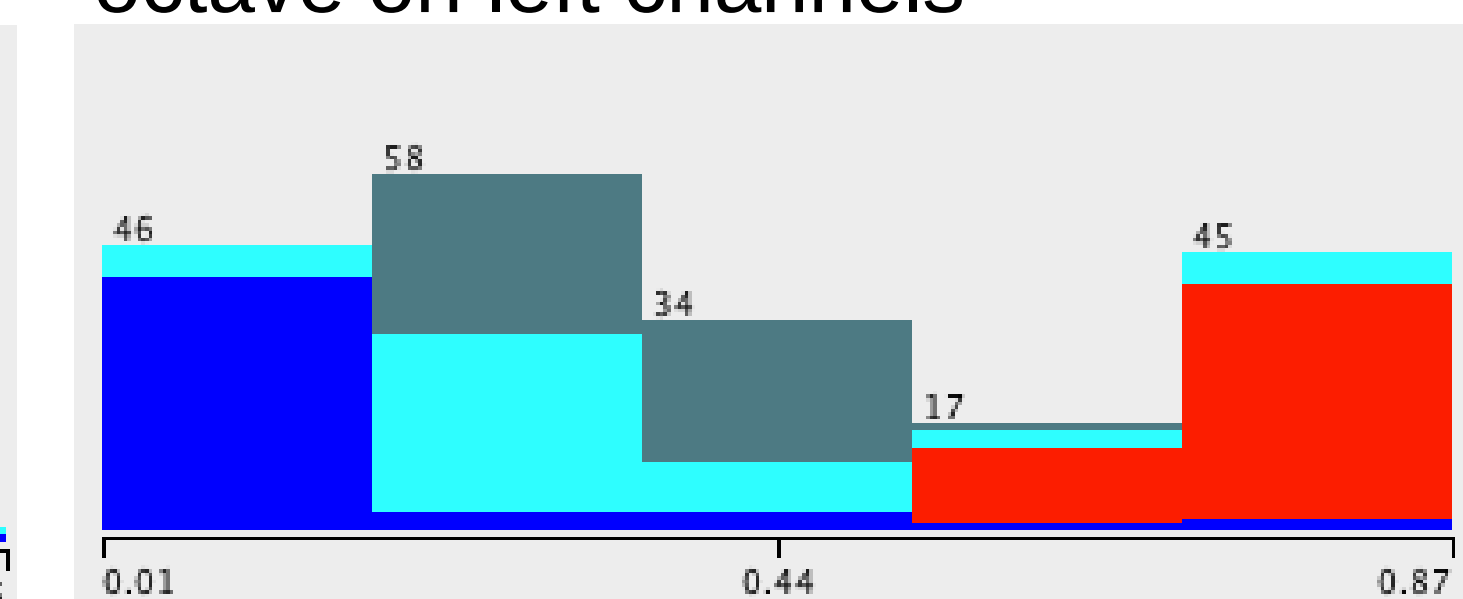
Log Spectral Band Ratio for 20th and 9th bins (20 equal-sized bins)



Log Spectral Band Ratio of 6th and 3rd octave



Band Energy Ratio across 2nd octave on left channels



Obtained ~95% accuracy on these four locations of the hand by using the above features with Weka and training an SVM.

Future Work

Next steps include making the system more robust to changes in the positioning of the wristband in order to de-sensitize the system to shifting of the microphones, in order to reduce re-training. It is also very difficult to distinguish between very specific regions on the arm/hand, because it is hard for an individual to tap consistently in adjacent skin areas. More advanced features and classifiers may help localize taps on more specific locations, e.g. specific fingers, or specific locations of the palm.