HIDDEN SIGNATURE FEATURE EXTRACTION FROM NOISY NON-STATIONARY SIGNALS THROUGH SUBSPACE TECHNIQUES

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Analysis and classification of non-stationary signals are of very high importance in a vast number of applications such as EEG signal analysis, speech signal processing, *etc*. This is a much studied and difficult problem due to the difficulty of capturing the variations accurately in both time and frequency domains that are unique to a particular non-stationary signal type. The existing stationary subspace based techniques tend to fail in capturing the non-stationary nature of these signals because they take the whole observation period of the signal into consideration when determining the subspaces that correspond to the unique hidden signature features. This paper presents a dynamic subspace based approach which is capable of successfully tracking the subspaces that correspond to the hidden signature features of non-stationary signals.

In this novel approach, the observation space of the signal is first partitioned in to several segments and the Autocorrelation Matrices (ACMs) of those segments are obtained. The eigen decomposition is applied to each of those ACMs and by observing the eigen values, the most dominant eigen filters are obtained for each of the segments. By obtaining these most dominant eigen filters, the noise that is contained in the original signal can be eliminated. Then the eigen filters that gives the hidden signature spectral components can be selected for each of the segments. This would make it possible to track the subspaces that filter out the hidden signature features of a signal. If the stationary approach of considering all the signal samples at once in determining the useful subspaces, it would not take the variation of the spectral power with time into account and thus make the feature extraction unsuccessful. After the subspace selection is done a novel method is used to observe the dynamic nature of the signals. Here, initially the frequency corresponding to the peak of the main lobe of the most dominant eigen filter was plotted against the segment index for all the segments. This would reveal the variation of the most dominant spectral component with time. The same was done for the other subspaces as well. By looking at those plots, it was observed that there is a pattern that is unique to a particular class of signals and therefore the plots can be used to identify the class that a particular signal belongs. It was also observed that this method has a finer frequency resolution (with proper tuning of parameters according to the application in concern) than the existing methods such as spectrograms etc.

The above techniques were developed using synthetically generated signals which were corrupted by adding noise. After observing the better performance of the methods for synthetic signals, the methods were tested using the acoustic signals generated by the impacts between Glass-Metal and Glass-Plastic signals which are audibly undistinguishable due to the extreme similarity that exists between these signals. The plots obtained using the proposed methods were considerably different for the signals of these two classes and hence it was able to accurately classify signals according to their respective classes.