EEL 6504

Adaptive Signal Processing

Project II

Due December 3, 2015

The purpose of this project is to detect manatee calls from real hydrophone recordings taken in an estuary. The data used for this project was collected by the Department of Biology at UF. In the course website you will find several data sets as follows: (1) a file (train_signal.wav) with 10 different manatee calls segmented by the biologist that represent the signal class we would like to detect; (2) a 2 second noise background file (noise_signal.wav) that represents the acoustic noise picked up by the hydrophone; (3) the continuous file (test_signal.wav) with unsegmented manatee calls mixed with background noise that lasts approximately 30 seconds. The sampling rate is 48 KHz. The purpose of this project is to design and evaluate an adaptive filter based detection approach to distinguish the manatee calls from the background.

There are many alternative ways to solve this problem, but I suggest the following procedure: create two adaptive filters (predictors), one to model the manatee calls and the other to model the noisy background. Once the two models are developed you are going to apply both of them in parallel to predict the test data set. Since they were trained for different time structures, the predictor that has the smallest error should represent the corresponding class (noise or manatee). There is still a little problem because we need to smooth the prediction error during a window of time because as you can expect, the noise is high frequency. The output will then be a square wave for the full duration of the test set, with high meaning manatee and low meaning background.

Your role is to select in a principled manner the free parameters of the predictors, the error smoother and to evaluate the performance of this system. I suggest that you start with linear models, and you can use either LMS or RLS trained with MSE. You can also use either FIR or gamma filters, so you already have developed most of the MATLAB code! Regarding the error smoother you can use either a window or a recurrent estimator. As a first important step you should use DSP tools to help you understand the data structure and appropriately set the free parameters. The big difficulty is the variability of both the background noise and the manatee calls, which calls for small model orders. I suggest starting with M=3 and then go higher if needed. You also need to find a way to handle the data nonstationary in both classes by assembly averaging. The last problem is that we do not have a criterion to see if the predictors are correct or not, except by hearing the data! Since you have the calls your ear can judge the quality of the decisions. You will have two types of errors, false and missed detections. The Receiver Operating Characteristics (ROC) is the best way to compare different solutions.

The aspects that I would like to see addressed (as extra credit!) are the following: design of the manatee model: shall we have a single model or multiple models? What are the advantages of single versus multiple? Can we test this from the data? Likewise for the noise.

The project requires a report explaining the experimental procedures you followed and you must include detection data, figures, and tables to support your conclusions. Please use the format of an IEEE Transactions paper (limited to 7 double column pages). This means you have to write a brief intro to the theory, explain well the methods and present carefully the results (see below) and conclusions. Remember that any scientific paper should, by definition, contain sufficient information such others can replicate your results. A scientific paper must also contain ORIGINAL material only. If you happen to use text or equations from other source you have to reference what you cut and paste (this is not allowed in a normal publication, but here it is OK provide you reference). Of course, I expect the results to be done by the student alone.