EE 217

Final Project: **"Hunt for Noise: Extracting Audio Information from Noisy Environment"**

General Information: In practice, during surveillance, it is often observed that the audio information, of interest, is recorded in a noisy environment. The embedded audio information is not discernible in the noisy background when playing the audio recording owing to an observed poor Signal to Noise Ratio (SNR). Increasing the volume, of the playback device, does not help, because the SNR remains unchanged. Conventional filtering techniques help in easily removing noise signals that lie outside the spectrum of the audio information. Often noise sources emit noise signals that overlap with the interested audio information. Such noise sources emit noisy signals that are consistent in signal level and spectral content as compared to the audio signal of interest. Also, the actual observed noise power is significantly greater than the observed signal power resulting in poor SNR. Since the observed noise signal's spectrum overlaps the interested audio signal's spectrum, conventional filtering techniques do not help in removing the noisy signals. Many times, the final solution to the problem is to obtain a sample of the noise source and subtract the noisy signal from the recorded noisy audio signal, which helps in extracting the interested audio information. The main goals of this project are

- Search for such noisy sources that emit noisy signals that interfere with audio signals, such as, recorded conversations, which are of interest.
- Run benchmark experiments to discern whether found noisy signals interfere with interested audio signals.
- Run experiments to conclude which of the found noise sources can be easily eliminated using conventional filtering techniques and which need a noise signal sample to extract the required audio information.

Specific Project Goals:

- Search for at least 3 noise sources, of which at least 2 must interfere with the interested audio signal, which must be an audio conversation or dialogue. The noise sources must emit signals that are consistent with respect to noise level and spectrum.
- Design an experiment plan to test whether the found noise signal is easily discernible from the interested audio signal. The plan must include analysis of multiple types of recordings including:

- Multiple recordings of the noise at different distances alone.
- Multiple recordings of the noise, including the audio conversation at different distances.
- Multiple recordings of the audio conversation alone at different distances.

Since there are multiple variables, your experimental plan must include provisions for keeping a variable/s constant, while varying only one variable. This exercise will ensure consistent datasets, and, therefore, consistent results that will help draw useful technical conclusions. Note, record all the different variations, as described above, for each noise source, during the same time frame to avoid any spurious recordings.

- Execute the designed experimental plan. All technical analyses must be supported by detailed MATLAB analysis, including FFT analysis of recording signals. Conventional filtering techniques must be used as a first step to remove the observed noise signal. Prove, through experimentation and data analysis, which of the chosen noise signals cannot be removed, using conventional filtering techniques, without distorting the audio conversation of interest. Prove, through experimentation and data analysis, which noise sources need a noise sample to adequately remove the noise and extract the audio conversation. Note, all conclusions must be supported by detailed analysis, code, results, and demonstrations.
- Deliverables: A detailed project report, demonstration and presentation are required. The project report must be professionally formatted, thorough, and well typed in MS Word. Be creative! The project presentation must be a Power Point presentation. The project demonstration must demonstrate all components of the project including running of the FFT code, and listening of the audio samples pre and post processing. Be prepared to answer questions!

Project Preliminary: Before running experiments on found noise sources,

- Find a recording device that will let you record audio signals and create an audio file that can be opened in MATLAB. Make sure to find the sampling frequency, of the recording device, that will help you run your MATLAB FFT code.
- Calibration experiments:
  - First record a single frequency signal. You may use the speaker, connected to the signal generator, to obtain the audio signal.

Download the recorded data file, open it in MATLAB and observe its spectrum. If you see the single frequency component, you are set to record and run experiments.

- Create multiple recordings of the audio conversation sample, which should be kept a constant for all the experiment. Download the recordings and observe the spectrum and see if the spectrums look consistent. If so, then you are set to begin your experiments. If not, then see which recordings were consistent. You will have to maintain the consistency of voice signals, when recording in a noisy environment.

Project Grading: The project will include the following components:

- Project Demonstration: 35%
- Project Presentation: 25%
- Project Report: 25%
- Project Creativity: 15%

Project Deadlines: All components are due during the week before the finals week. Specific dates will be announced at a later stage.