Assignment reports are to be placed in the ELEC4404 Assignment Box no later than:

11am, Friday, May 29, 2015

Processing and Handling of Late Assignments:

- A penalty of 1% per hour overdue may be applied to late submissions after 12pm on the date due and a penalty of 10% per day will apply automatically for each day late (weekends count as one day).

Assessment

- The **maximum mark** for this report (including required data) is **40**.
- This project activity is worth **20% of the final mark** for this unit

Introduction

Background: A saying from a famous person was recorded in very noisy conditions: destroyer operations noise from the nearby military warship, speech babble from the annual navy officers' ball nearby using a defective microphone pre-amp which generated an audible humming noise. You can model the noisy recording, $x(n)$, as follows:

$$x(n) = y(n) + h_1(n) * v_1(n) + h_2(n) * v_2(n) + \cos(\Omega n + \phi)$$

where:

- $y(n)$ is the original clean speech
- $v_1(n)$ is the destroyer ops noise, and $v_2(n)$ is the speech babble noise
- $h_1(n)$ and $h_2(n)$ are the unknown acoustic source to receiver impulse response functions
- $\cos(\Omega n + \phi)$ is the audible hum of unknown frequency and phase.

Your Mission: To provide an estimate of the clean signal, $\hat{y}(n)$, given the noisy recording, $x(n)$ (in file `NoisySignal.wav`), and recordings of the two noise sources, $v_1(n)$ and $v_2(n)$ (in files `NoiseRef1.wav` and `NoiseRef2.wav` respectively). What is being said and who is the famous person saying it?

An Important Clue: Investigations reveal that the acoustic environment on the military base was designed to provide an RT60 reverberation time of between 20ms and 40ms.

Tasks and Teams

You are required work as a team of 3-5 students. Part of the assessment will be your reflections on working in a team environment and what you learned by working in a team both in terms of useful (and not so useful) interactions, productive discussions, and how the team was able to agree on a solution, implement and evaluate it. You will need to appoint a team leader who will be responsible for the submission and any correspondence.

Setup and Preliminary Analysis

You will need to use the MATLAB environment for this assignment and can use workstations in either 1.51 or 2.71 in the EE building (but check if there are any scheduled labs from other units). Download the 'Group Project: Data and Scripts', extract the contents and read the README.txt file.

To familiarise yourself it is recommended you run the `Plot_Spectrogram.m` script to see what a spectrogram is (research this too), for both the noisy signal and also the noise reference signals. Notice the difference between the spectrogram of the noisy signal and the clean signal. Also play out the audio to hear what the noisy signal sounds like, can you make out what is being said at all? Compare the spectrogram of the noisy signal with that of the clean signal (`CleanSignal_Spectrogram.jpg`) so you can appreciate how noisy the signal is. Also play out the audio of the noise references to gauge what they sound like so you know what you have to deal with.

Some Solution Ideas

There is no one single design solution and indeed there is no guarantee as to how easy it will be to enhance the speech signal and by how much. These are just ideas which may or may not work for you:

- Can any form of low-pass, band-pass, or high-pass filtering be used?
- Can you use any of the noise reference signals and apply an NLMS or RLS adaptive filter?
- Or maybe you can derive the optimum MMSE FIR equations using least-squares estimation (LSE) analysis to estimate the autocorrelation and cross-correlation parameters?
- Can the Kalman filter be used for this? How about signal modelling given a speech signal can usually be modelled by an AR process (research this!)?

For the above feel free to reuse any of the m-files provided in Lab 2 for this project. Where possible use the available MATLAB filter functions as they will usually be more efficient. Consult http://au.mathworks.com/help/dsp/filter-implementation.html for details. **NOTE: Please only use the MATLAB filter functionality which has been covered by the ENSC3015 (Signals and Systems) and ELEC4404 (Signal Processing) units**. Remember you have full control, so if you think you need a combination approach, do whatever it takes, just as long as you can explain it.

Submission Requirements

WHAT EACH TEAM NEEDS TO SUBMIT

- A properly completed Assignment Cover Sheet completed as GROUP ASSIGNMENT (complete electronically or PDF scan hardcopy).
- **A**: (24 marks): A professionally presented (i.e not hand written!) report is to be submitted by the team and should include the following sections:
    - Introduction (Aims and Objectives)
    - Design Methodology (include justification/rationale for your choice, block diagram/configuration clearly showing all input/output data used (not MATLAB code!), also all configuration parameters, and how the values were chosen/determined)
    - Experimental Evaluations (what did you do to evaluate the performance? Include multiple runs of your solution as you perhaps explore different parameter settings to show the evolution of your design thinking and troubleshooting to the final solution)
    - Conclusions and Limitations (Summary of what you have achieved and/or discussion of issues you had, or limitations you came across).
- **B**: (6 marks) Reflections: Each member of the team is to complete a personal reflection on what was learned from the project: working as a team and interacting, having to deal with a real-world challenge and what the lecturer didn't tell you, etc. Use the Reflections pro forma attached to this instruction sheet (one for each team member). You can either hand write this or produce a word processed facsimile.

- **C**: (10 marks) A zip archive file with the following:
    - A README.txt describing the contents and how to use the scripts. This should also include the student IDs and Surnames of the team members so your zip file can be associated with report.
    - A MATLAB script (include any supporting scripts and input data files) of your final solution which can be executed to produce the enhanced speech file. This zip file will be extracted and the MATLAB script executed to verify your solution using the EECE MATLAB environment. Include any ancillary MATLAB files you used to evaluate performance.
    - The enhanced speech waveform (*.wav) file. This will be checked against the output of your MATLAB script.

NOTE: The zip file is only used to verify your design evaluations and check the clarity of your code, it should NOT be used to work out what you did; that should be fully described in the report under Design Methodology.

SUBMISSION PROCEDURE

The team leader should email as follows:

- From: Team Leader Student Name and official UWA email address
- To: roberto.togneri@uwa.edu.au
- Subject: ELEC4404 Group Project Submission (Team <X>)
- Cc: Student Members Name and official UWA email addresses
- Attachments:
    - Assignment Cover Sheet (PDF)
    - **A**: Written Report (PDF only, so convert from Word / LaTeX)
    - **B**: Reflections (ZIP or RAR archive file containing one PDF per student)
    - **C**: Zip file (ZIP or RAR format)

Your submission will only be deemed complete when you receive an acknowledge confirming all attachments have been received without error, please allow 2 hours for this. Please be sure you know your team designation <X> (which will be provided by your lecturer, if you don't know, ask!).
Please adhere to the above format to ensure a quick response acknowledgement, if in doubt contact the lecturer at no later than the day before. **NO MORE SUBMISSIONS WILL BE ACCEPTED AFTER 11AM, FRIDAY, MAY 29, 2015, any submissions after this time will be processed as late submissions. PLEASE AVOID MULTIPLE SUBMISSIONS AS THERE IS NO GUARANTEE WHICH VERSION WILL BE ASSESSED.**

Assessment

The assessment will consist of: 15% (30 marks) for the report/reflections and 5% (10 marks) for the zip file sources. You will be severely penalised for both if the two are not consistent (e.g. report is vague and indicates success but your MATLAB script file doesn't work or doesn't produce what was expected), conversely there will be minimal reduction in marks on the report where there is consistency and evidence of the engineering process at work (e.g. MATLAB script file doesn't work but report explains and documents the issues you had, troubleshooting you undertook, etc.).

ELEC4404 Group Project
Reflections

Surname:_____ Student ID: _____

Please reflect on what you learned from working in a team, both what worked for you and what didn't work (so you are ready for your next team experience!):

Please reflect on what you learned from having to deal with a real world and open ended problem especially in context with lectures, tutorials and the group lab experience:

Anything else you would like to reflect on?