

ELEC4600/7602 Signal and Image Processing II

Tutorial 1

(Due date: 20/3/2012)

Q1) We have a dual microphone handsfree. Mic#1 is located towards mouth while Mic#2 is placed to pickup only ambient noise (Fig. 1). We would like to design an LMS filter to remove the noise from Mic#1.

- a) Write a function to perform LMS adaptation algorithm. (3 Marks)
- b) Let your LMS filter to adapt for the first 3sec of the signal (Fig. 2). Study the error signal for the filter lengths of 16, 32 and 64 (3 Marks).
- c) Use the best filter from part b and remove the noise from Mic#1 (3 Marks).
- d) Repeat parts (b) and (c) by adapting the filter for the signal between second 12 to second 15 (2 Marks).
- e) Why the designed filter in parts (b) and (d) does not work fine for all time? (1 Marks).
- f) Propose a method to automate the adaptation process and discuss its pros and cons (Optional, 2 extra marks).

The input signal for this problem is [Adaptive Filter Input.wav](#) which is a stereo file. The first channel corresponds to Mic#1 input and the second channel is Mic#2 input.

(12 Marks)



Fig. 1 Dual Microphone handsfree

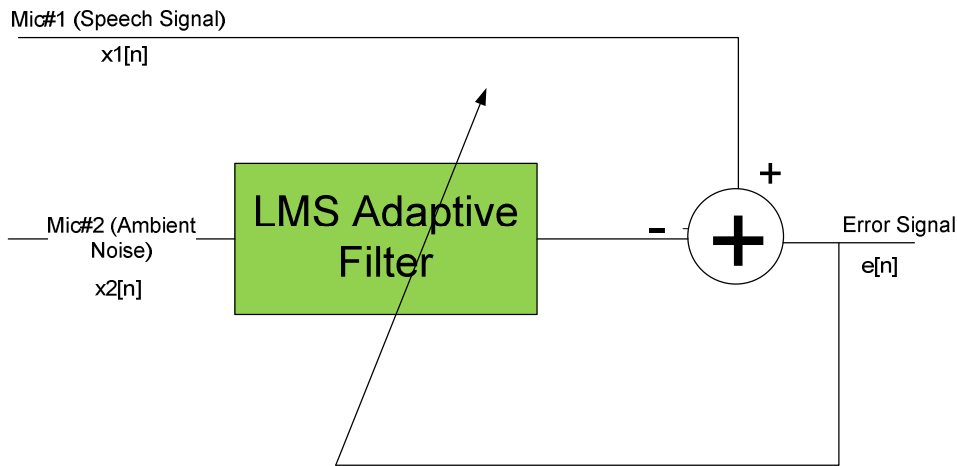
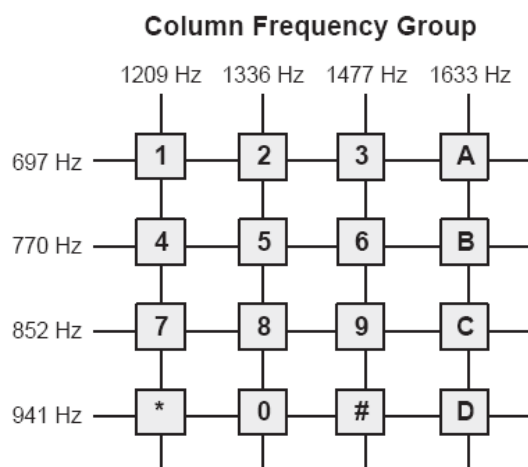


Fig. 2 Filter structure for removing noise from speech microphone (Mic#1)

Q2) We want to use the Goertzel algorithm to decode DTMF signals. Considering that the frequency resolution of an N-sample DFT is approximately $\frac{f_s}{N}$

- Study the spectrogram of the wav files provided for this problem with a suitable N such that different DTMF codes can be discriminated correctly (f_s is equal to 16kHz here) (2 Marks).
- Suppose we want to decode key 0, implement the Goertzel algorithm to compute the DFT at 941Hz and 1336Hz, study the energy of DFT components at these frequency and derive a suitable threshold to decode the key using Cleaned_DTMF.wav (4 Marks).
- Study the effect of noise on the derived thresholds when the input signal is contaminated by Additive White Gaussian Noise (AWGN). Consider variable SNR (range [+18dB,-18dB] and provide diagrams and discussion that shows how your algorithm performs in noisy situations (2 Marks).

(8 Marks)



Row and Column tones associated with each key in DTMF