ELEG 4603/5173L Lab # 8
Dual-Tone Multi-Frequency (DTMF) Signal Detection with FFT

DTMF (dual tone multi frequency) is the signal generated by the "Touch-tone" phone when you press a telephone's touch keys. The signal is sent to the telephone company, which decodes the phone number you want to dial by analyzing the DTMF signals. Each DTMF signal contains two sinusoidal waves with distinctive frequencies. The mapping between the frequency and the telephone key is shown Fig. 1 below. All frequencies in Fig. 1 are in the unit of Hz.

	1209	1336	1477	1633
697	1	2	3	A
770	4	5	6	B
852	7	8	9	C
941	*	0	#	D

Figure 1: DTMF key mapping

1. The DTMF signals are sampled at 8 KHz. If the FFT is performed over N = 1024 samples, then what is the duration of the 1024 samples? What is the frequency domain resolution?

2. Make a table that is similar to the one in Fig.. Replace the analog frequencies (in Hz) with the FFT index k. Assume the FFT is performed over 1024 samples, and the sampling frequency is 8 KHz.

3. Write a Matlab program to decode the phone number stored in the file `PhoneNumber.wav` by using FFT. The output of the Matlab program should be the decoded phone number.

   Program suggestions:

   (a) Use a window of size 1024 samples to divide the time domain signal into many small pieces, each with 1024 samples, and only process those pieces that have an average energy larger than a threshold. Those with average energy below the threshold usually do not contain useful information.

   (b) You can use the average energy of the entire signal as the threshold.

   (c) There is a short silence period between two digits. Once a digit is detected, your program should seek for the silence period after the digit. The next digit is after the silence period.

   (d) Due to the symmetric property, you only need to consider the frequency domain signal between the indices [0, N/2-1].

   (e) You can use the Matlab function

   ```
   [maxValue, maxIdx] = max(abs(signalFFT))
   ```

   to find the maximum amplitude, which corresponds to one of the two frequencies.