PROJECT 1: DUAL-TONE MULTI-FREQUENCY SIGNAL DETECTION

Individual Project – worth 25% of your grade

Project Demonstrations: November 11-14 [in your registered session]

Reports are due November 15

Introduction:

In the first project, you will be using Arduino Uno to receive and detect Dual-Tone Multi-Frequency (DTMF) signals, used in classic telephone signalling.

The DTMF system uses a set of eight audio frequencies transmitted in pairs to represent 16 signals, as shown in the table below. For example, to represent the number "2", two tones with frequencies of 697 Hz and 1336 Hz are generated at the same time.

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

For more info, refer to: https://en.wikipedia.org/wiki/Dual-tone_multi-frequency_signaling

Obtaining the DTMF Signals:

You could use a standard audio jack connected to a PC or smartphone, to generate the DTMF signals, then feed this signal to your Arduino via the "Analog Input". Arduino will then sample and quantize this analog signal, to convert it to digital domain, to which we can apply digital processing techniques. Please note that if the transmitted signal strength is too weak, you may need to use an amplifier before feeding it into Arduino analog input. **PC:** http://onlinetonegenerator.com/dtmf.html

Android app example: https://play.google.com/store/apps/details?id=com.amknott.ToneGen

System Design and Desiderata:

The selection and design of the filtering and detection techniques that you will use is left to you. However, at the very least you will need to use digital low/high/band pass filtering to separate the DTMF signals. (This involves the design choice of using FIR vs IIR filters, as well as the coefficient selection). Using the energy levels at the output of a set of band-pass filters, and making decisions using thresholds is one possible way of detecting individual DTMF tones. (Of course, the selection of the threshold levels is another design parameter)

The system that you will design will need to detect the DTMF signals within an acceptable time frame. (For example, the industry standard is 40 milliseconds. That is, the systems can detect DTMF signals as short as 40 ms) These detected DTMF signals will need to be displayed/recorded (for example, in the form of 053xxxxxxxx) for use of the user.

Equipment & Components :

You should have already acquired one Arduino Uno as it is announced earlier. You are free to use the equipment in the lab (oscilloscopes, signal generators, etc.) by appoinment (please email numansu@gmail.com or ramazanylmz@windowslive.com beforehand).

In your design, you might need extra components and equipment, including, but not limited to: resistors, capacitors, transistors, integrated circuits (OP-AMP...), stereo jack/cables. You can order them from http://www.direnc.net/ or from Karaköy or other outlets. Therefore it would be wise to complete your design early.

Reports:

You will need to provide a project report, your codes and a short tutorial to use the system (inputs/outputs, etc). You have to comment your code, so that we can understand the purpose of each line or block of codes. The report should include the background on DTMF signals, and the processing and detection techniques that you have used in implementation. Explain your design choices (why you used certain techniques over others) and how you selected various parameters (filter coefficients, thresholds, etc.) in detail.