DIGITAL SIGNAL PROCESSING LABORATORY
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EXPERIMENT No. 03

Experiment : DTMF(Dual Tone Multifrequency or TouchTone) coder / decoder

Objective : Study and Analysis of DTMF (Dual Tone Multifrequency, or TouchTone) coder / decoder using Digital FIR Filter in MATLAB.

At The end Of this experiment ,You ll learn about

(a) Functionality of DTMF and it's different applications.

(b) Implementation of BandPass Digital Filters.

(c) DTMF Coder/Decoder.

(d) How to characterize a filter by knowing how it reacts to different frequency components in the input.

Theory :

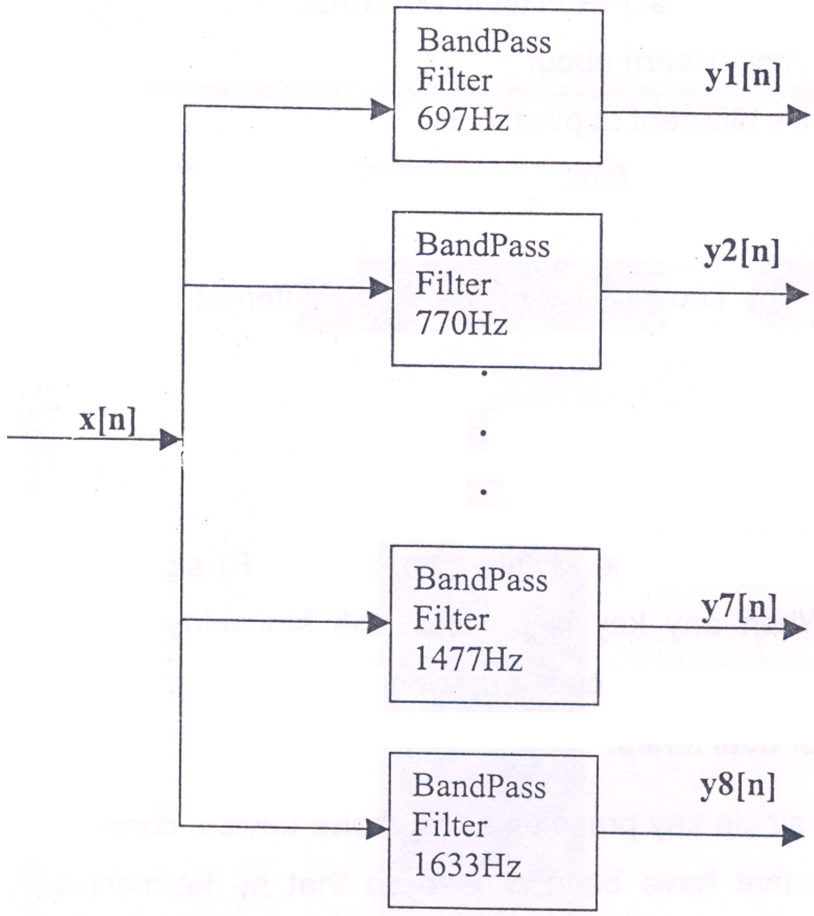
DTMF SIGNAL SYNTHESIS :

Telephone Key Pads generate Dual-Tone Multifrequency (DTMF) signals to dial a telephone number. When any key is pressed, the sinusoids of the corresponding row and column frequencies are generated and summed producing two simultaneous or dual tones.

A DTMF tone representing a single key press on a telephone device, consists of two summed frequencies that have been chosen so that no harmonics occur. I.e No frequency is an integer multiple of another and the difference or sum of any two frequencies does not equal any of the frequencies. The exact frequencies are shown in the following table, representing a telephone touch pad. The tone for a key is generated when the frequency for the keys column and row are summed together as waveform, thus pressing 4 should generate a tone containing a 770 Hz and a 1209 Hz frequency component.

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

(A telephone keypad and the DTMF frequencies for each column and row)



Filter Bank consisting of 8 Band Pass Filters(BPFs)

DTMF DECODER :

There are several steps in decoding a DTMF signal:

1.Divide the time signal into short time segments representing individual key presses.

2.Filter the individual segments. Band Pass filters are used to isolate the sinusoidal components.

3.Determine which two frequency components are present in each segment by measuring the size of the output signal from all of the Band Pass Filters.

4.Decode Which key was pressed ,0-9,A-D,* or # by converting frequency pairs back into key names according to above given table.

FIR Filter bank is used to decode DTMF signals. The Filter Bank consists of eight band pass filters, each of which passes only one of the eight possible DTMF frequencies. The input signal for all the filters is the same DTMF signal.

When the input to the filter bank is a DTMF signal, the outputs from two of the band pass filters should be larger than the rest. If we detect or measure which two outputs are the large ones, then we know the two corresponding frequencies. These frequencies are then used as row and column pointers to determine the key from the DTMF code. A good measure of the output levels is the peak value at the filter outputs, Because when the BPF is working properly it should pass only one sinusoidal signal and the peak value would be the amplitude of the sinusoid passed by the filter.

BAND PASS FILTER DESIGN: THE L-POINT AVERAGE FILTER IS A LOW PASS FILTER. Its pass bandwidth is inversely proportional to L. It is also possible to create a filter whose pass band is centered around some frequency other than zero. One simple way to do this is to define the impulse response of an L-point FIR filter as

$$h[n] = \beta\cos(\hat{w}c * n) \text{ where } 0 \le n < L.$$

Where L is the filter length, and $\hat{w}c$ is the center frequency that defines the frequency location of the pass band and β is used to adjust the gain in the pass band. So it is possible to choose β so that the maximum value of the frequency response magnitude will be one. The Band width of the band pass filter is controlled by L; The larger the value of L, the narrower the band width.