Experiment 3

DTMF (Dual Tone Multi-frequency 0r Touch-Tone) coder/ decoder

3.1 Aim:

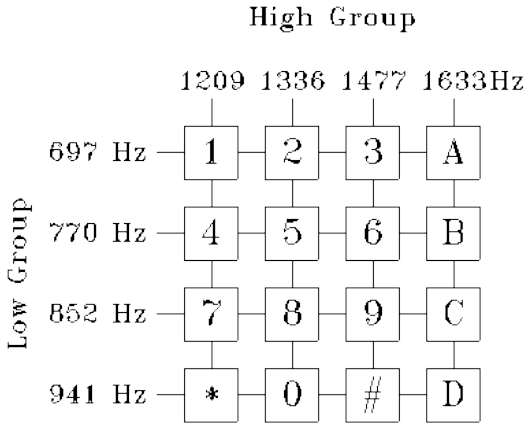
To study and Analyse DTMF (Dual Tone Multi-frequency, or Touch-Tone) coder/decoder using FIR Filter in MATLAB.

3.2 Theory:

DTMF stands for Dual Tone - Multi Frequency and it is the basis for your telephone system. DTMF is actually the generic term for Touch-Tone (touch-tone is a registered trademark of AT&T). Your touch-tone phone is technically a DTMF generator that produces DTMF tones as you press the buttons.

When you press the buttons on the keypad, a connection is made that generates two tones at the same time. A "Row" tone and a "Column" tone. The sinusoids of the corresponding row and column frequencies are generated and summed producing two simultaneous or dual tones. Tones representing a single key press on a telephone device, consists of two summed frequencies that have been chosen so that no harmonics occur.

These two tones identify the key you pressed to any equipment you are controlling. If the keypad is on your phone, the telephone company's "Central Office" equipment knows what numbers you are dialing by these tones, and will switch your call accordingly. If you are using a DTMF keypad to remotely control equipment, the tones can identify what unit you want to control, as well as which unique function you want it to perform.



When you press the digit 1 on the keypad, you generate the tones 1209 Hz and 697 Hz.

Pressing the digit 2 will generate the tones 1336 Hz and 697 Hz.

Sure, the tone 697 is the same for both digits, but it take two tones to make a digit and the decoding equipment knows the difference between the 1209 Hz that would complete the digit 1, and a 1336 Hz that completes a digit 2.

DTMF Decoder

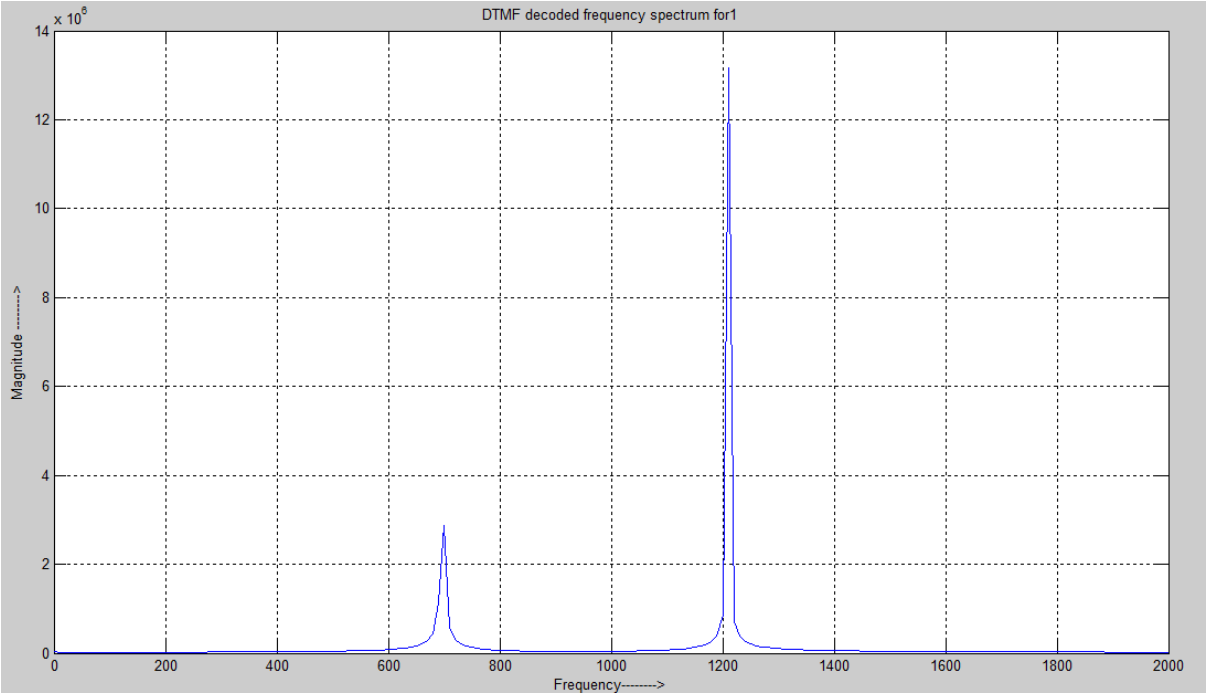
As with other multi-frequency receivers, DTMF was originally decoded by tuned filter banks. Late in the 20th century most were replaced with digital signal processors. Although DTMF can be decoded using any frequency domain transform (such as the popular Fast Fourier transform)

3.3 Source Code:

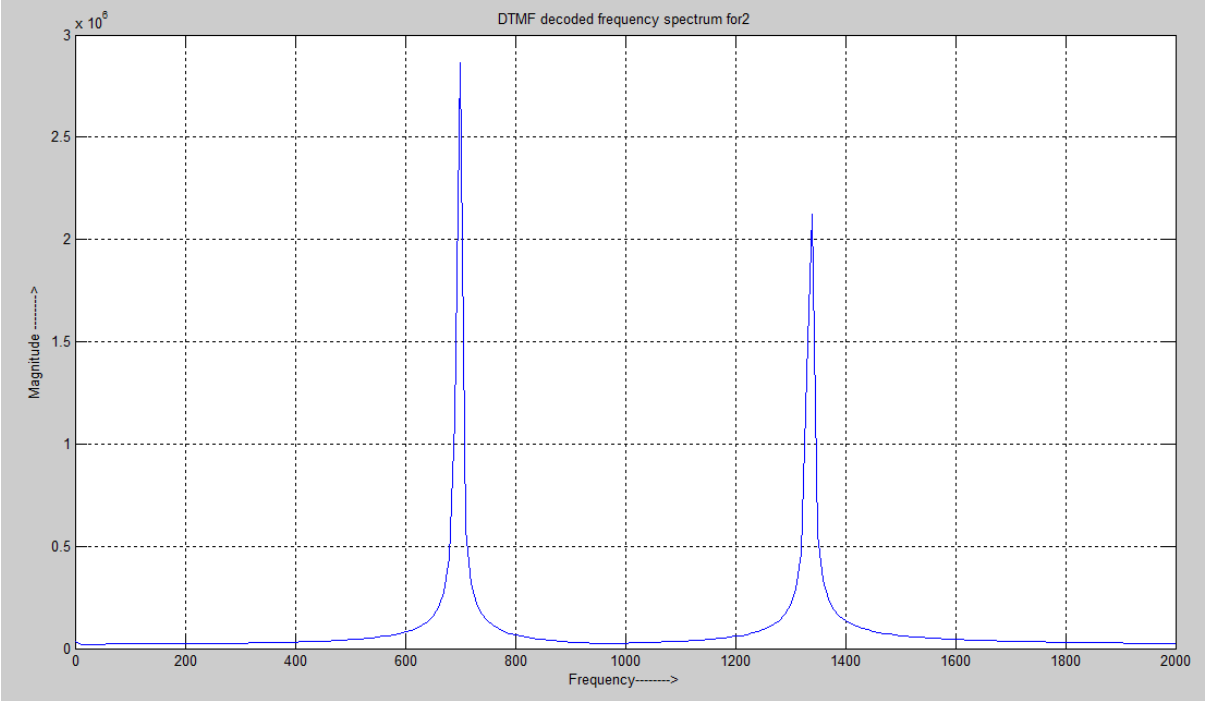
```
close all;clc; clear all;

 Num=input('Enter a number','s');


omega1=0;omeg2=0;
if(Num=='1' || Num=='2' || Num=='3' || Num=='A')
    omega1=697;
end
if(Num=='4' || Num=='5' || Num=='6' || Num=='B')
    omega1=770;
end;
 if(Num=='7' || Num=='8' || Num=='9' || Num=='C')
     omega1=852;
 end;
if(Num=='*' || Num=='0' || Num=='#' || Num=='D')
    omega1=941;
end;


if(Num=='1' || Num=='4' || Num=='7' || Num=='*')
    omega2=1209;
end
if(Num=='2' || Num=='5' || Num=='8' || Num=='0')
    omega2=1336;
end;
if(Num=='3' || Num=='6' || Num=='9' || Num=='#')
     omega2=1477;
end;
if(Num=='A' || Num=='B' || Num=='C' || Num=='D')
    omega2=1633;
end;

res=zeros(1,8);
tim=linspace(0,1,8192);
n=tim;
signal=cos(2*pi*omega1*tim)+cos(2*pi*omega2*tim);
flist=0:10:2000;
for i=1:201
Wc=2*pi*flist(1,i);
b=2;

h=b*cos(Wc*n);
x=conv(h,signal);

res(1,i)=max(abs(fft(x)));
end
plot(flist,res);grid on;
title(strcat('DTMF decoded frequency spectrum for ', num2str( Num),'
'));xlabel('Frequency-------->');ylabel('Magnitude -------->');
```

3.4 Result:

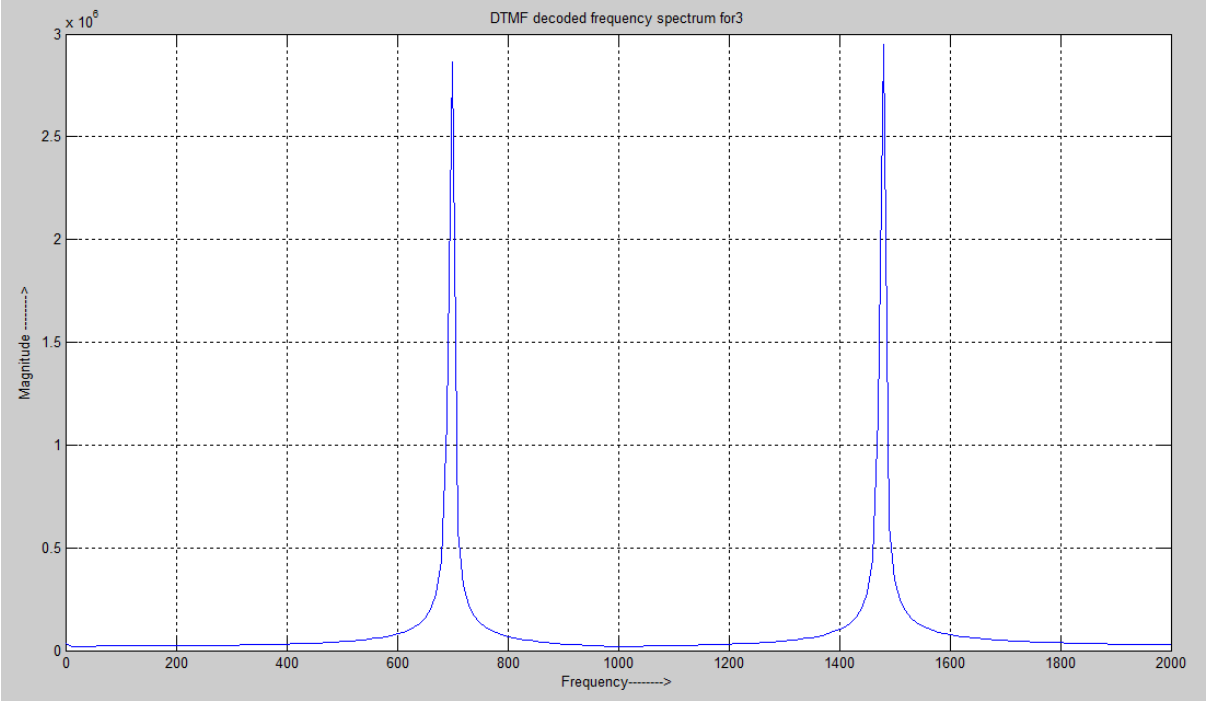
Number = 1 Row Frequency = 679Hz Column Frequency = 1209Hz



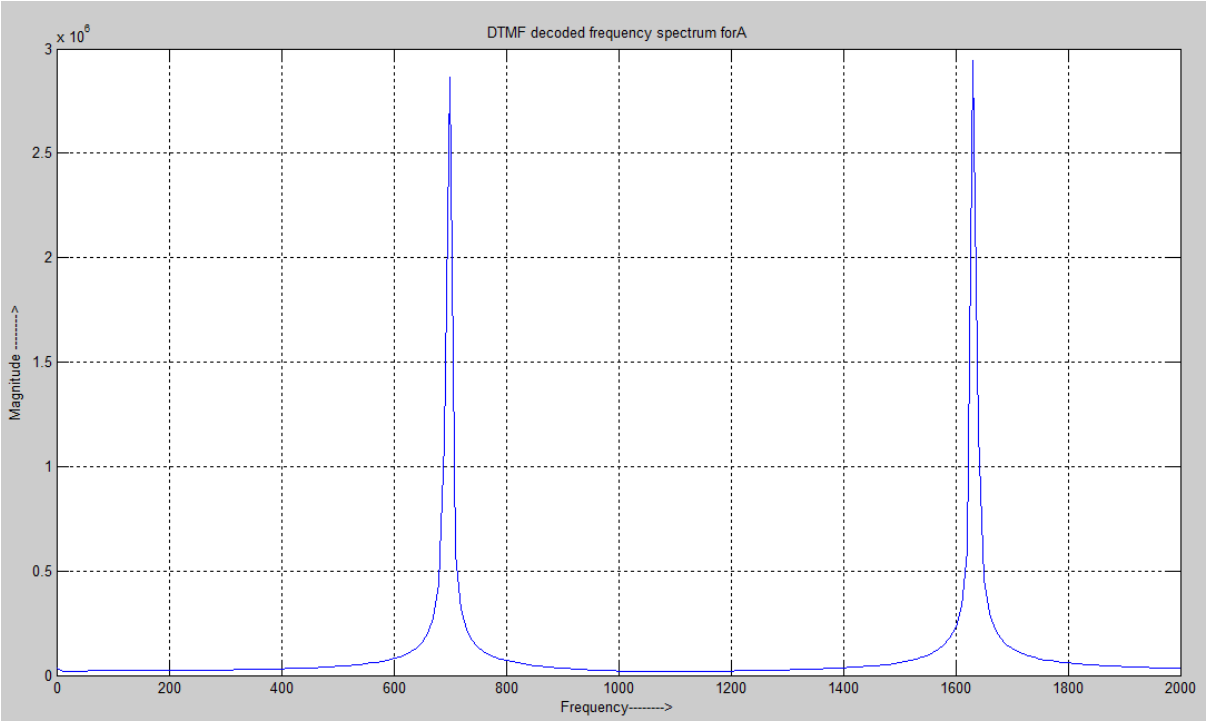
Number = 2 Row Frequency = 679Hz Column Frequency = 1336Hz



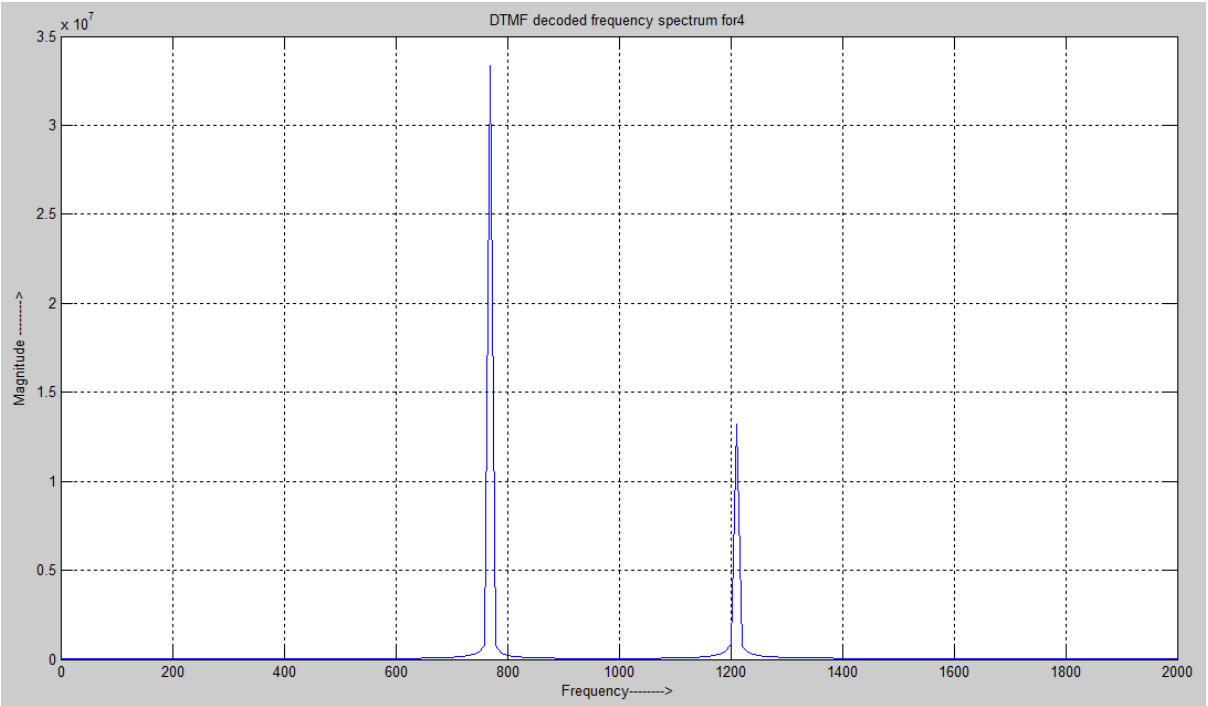
NUMBER = 3 ROW FREQUENCY = 679HZ COLUMN FREQUENCY = 1477HZ



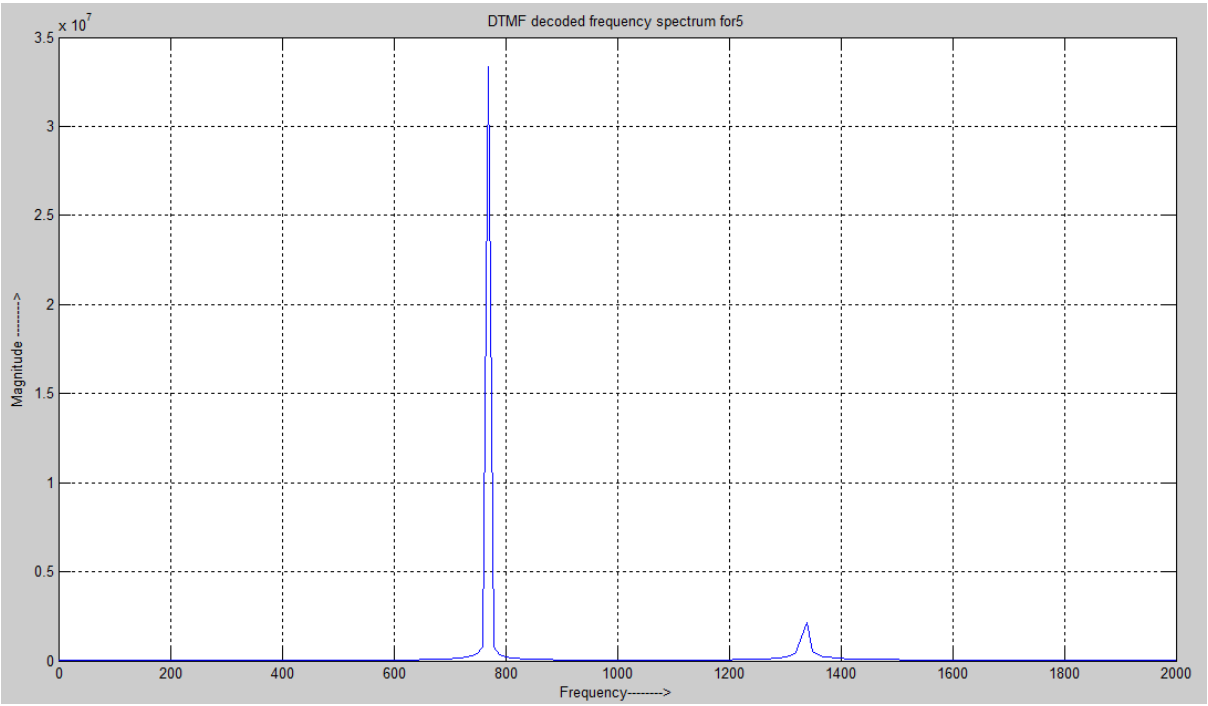
NUMBER = A ROW FREQUENCY = 679HZ COLUMN FREQUENCY = 1633HZ



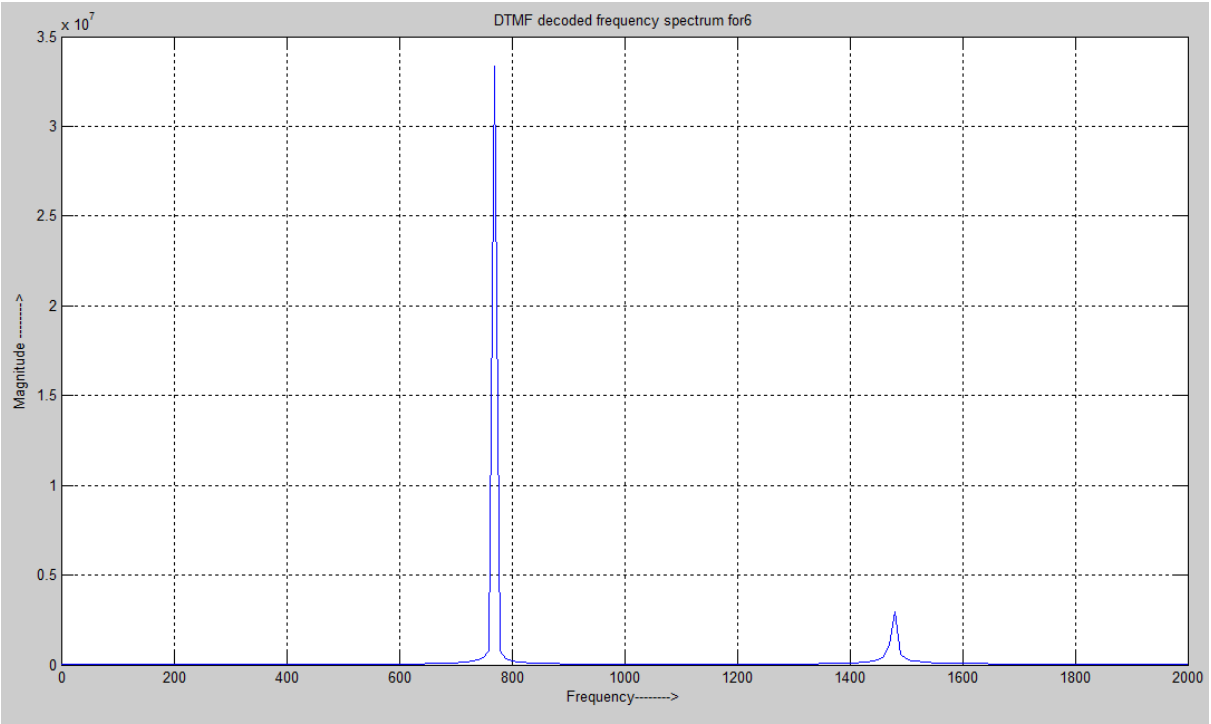
NUMBER = 4 ROW FREQUENCY = 770HZ COLUMN FREQUENCY = 1209HZ



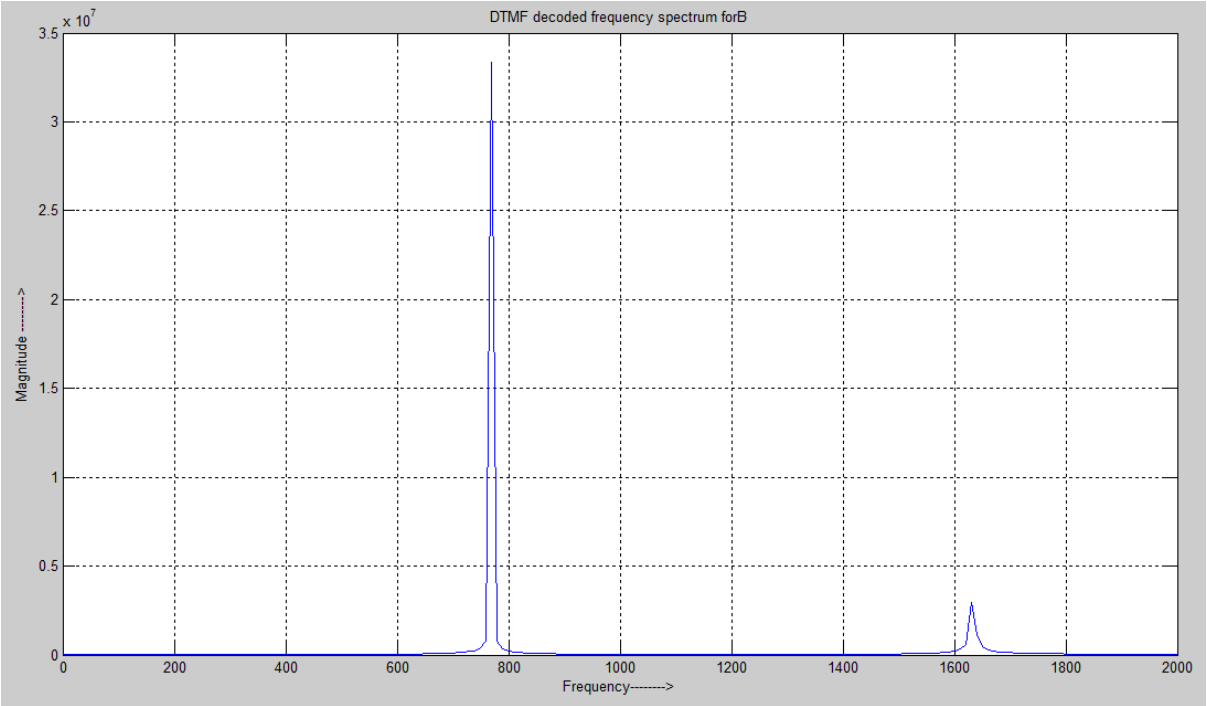
NUMBER = 5 ROW FREQUENCY = 770HZ COLUMN FREQUENCY = 1336HZ



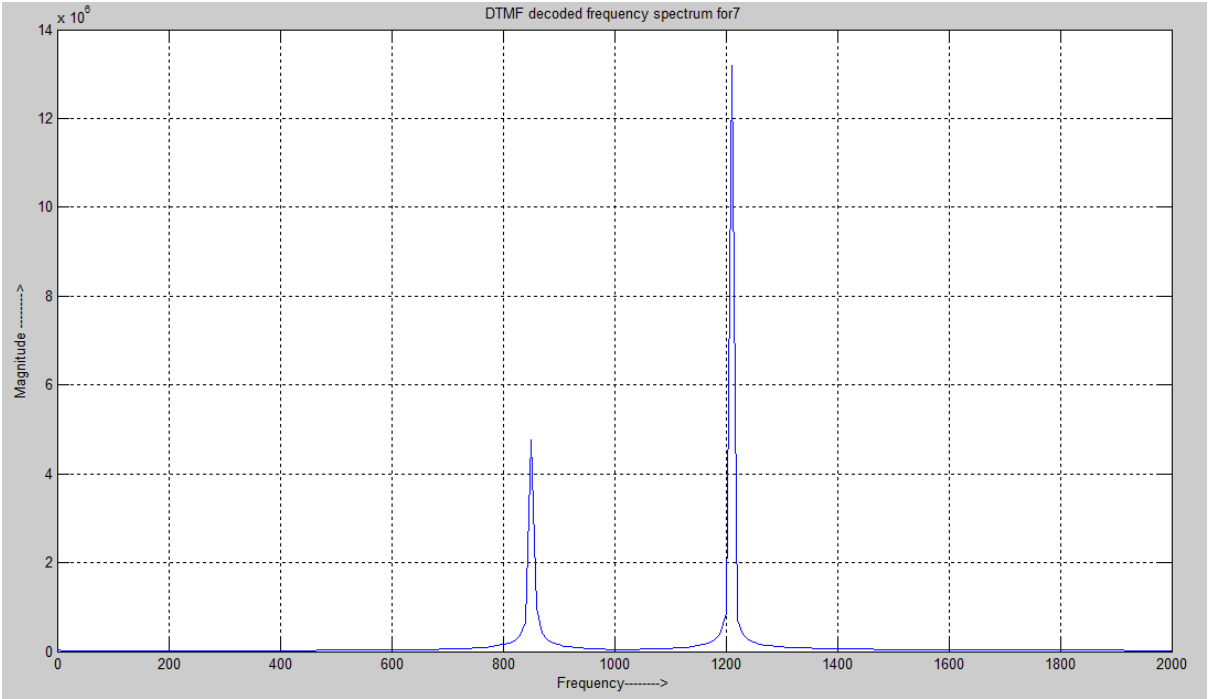
NUMBER = 6 ROW FREQUENCY = 770HZ COLUMN FREQUENCY = 1477HZ



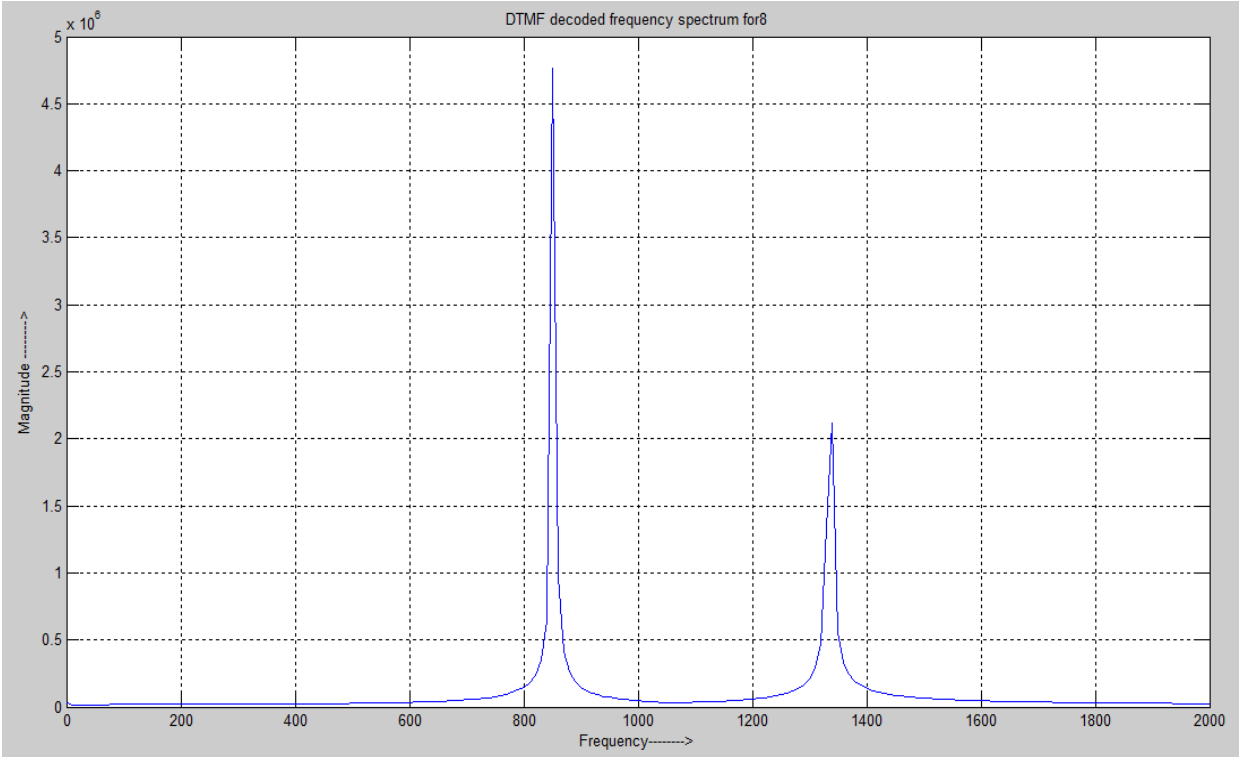
NUMBER = B ROW FREQUENCY = 770HZ COLUMN FREQUENCY = 1633HZ



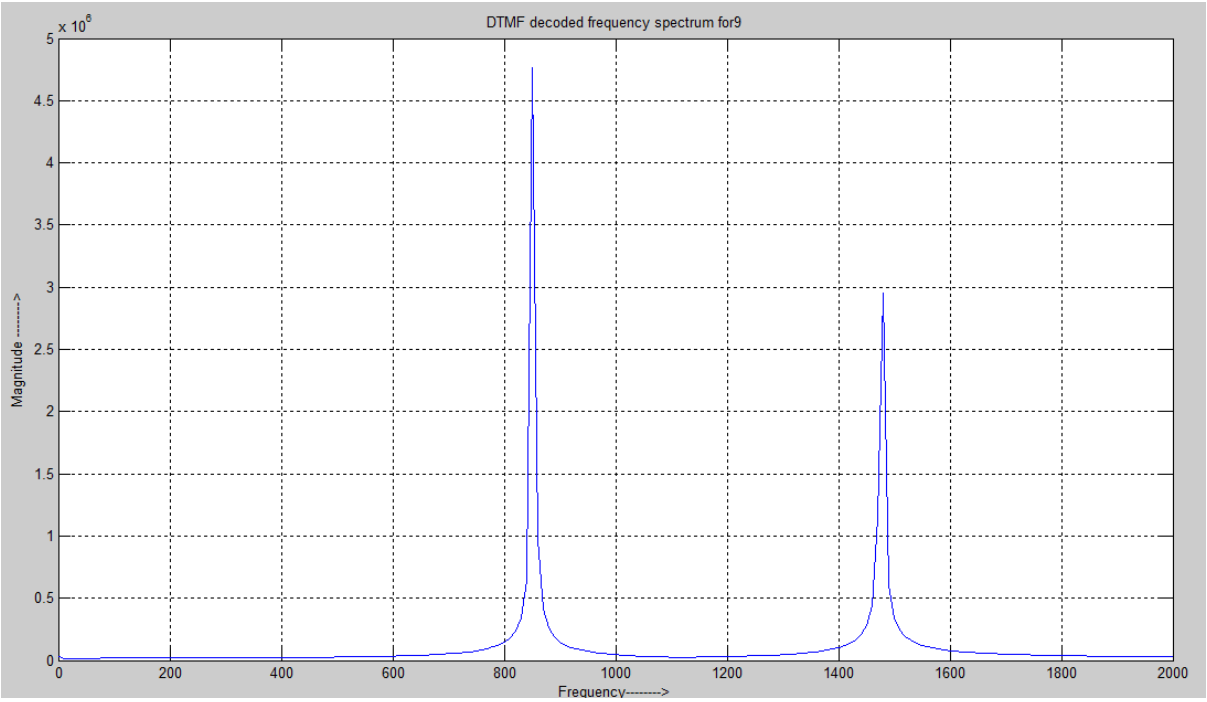
NUMBER = 7 ROW FREQUENCY =852HZ COLUMN FREQUENCY = 1209HZ



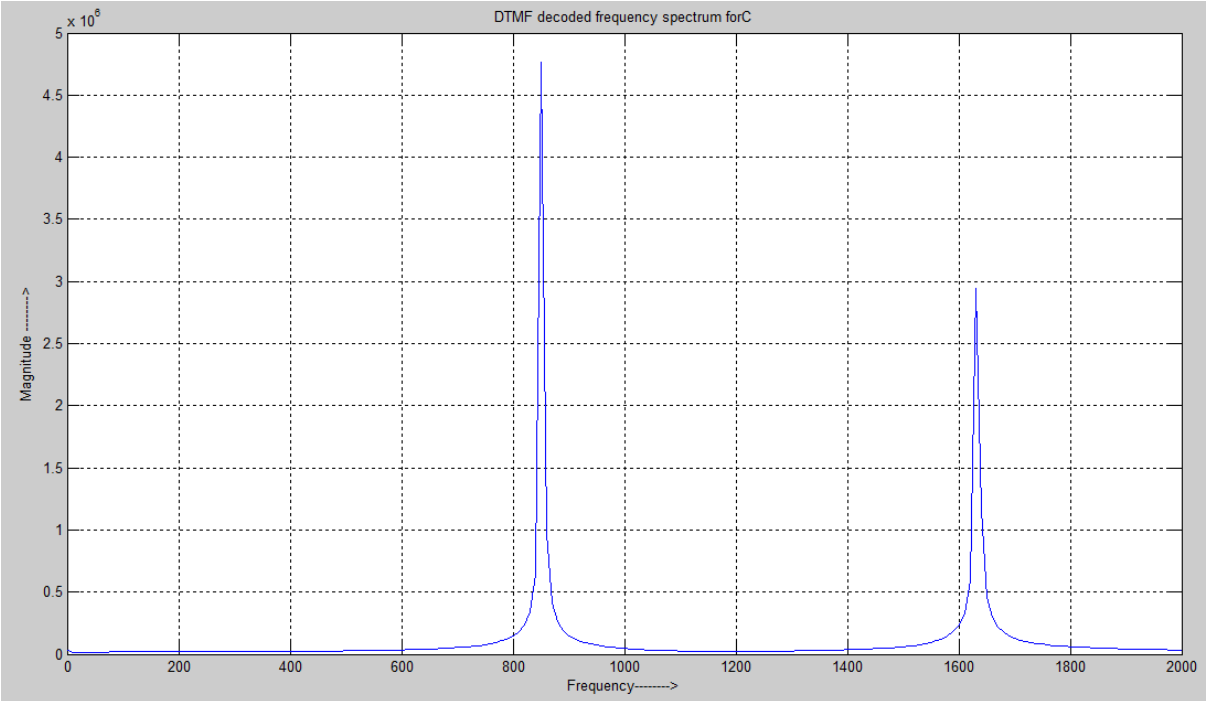
NUMBER = 8 ROW FREQUENCY = 852HZ COLUMN FREQUENCY = 1336HZ



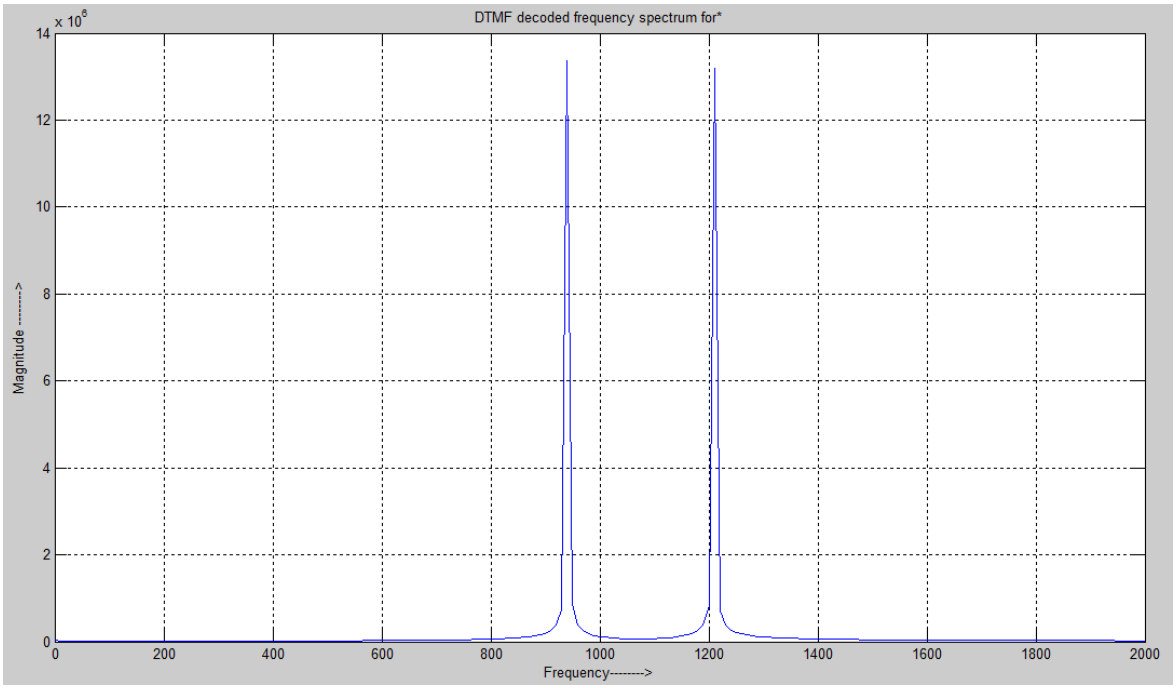
NUMBER = 9 ROW FREQUENCY = 852HZ COLUMN FREQUENCY = 1477HZ



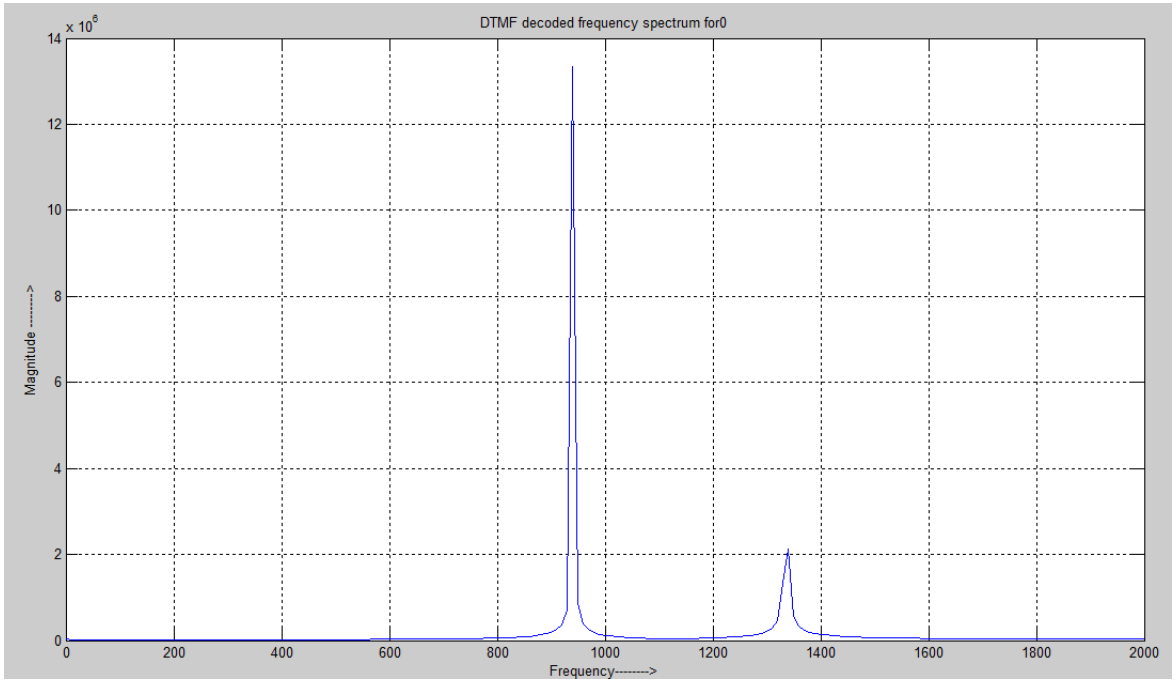
NUMBER = C ROW FREQUENCY = 852HZ COLUMN FREQUENCY = 1633HZ



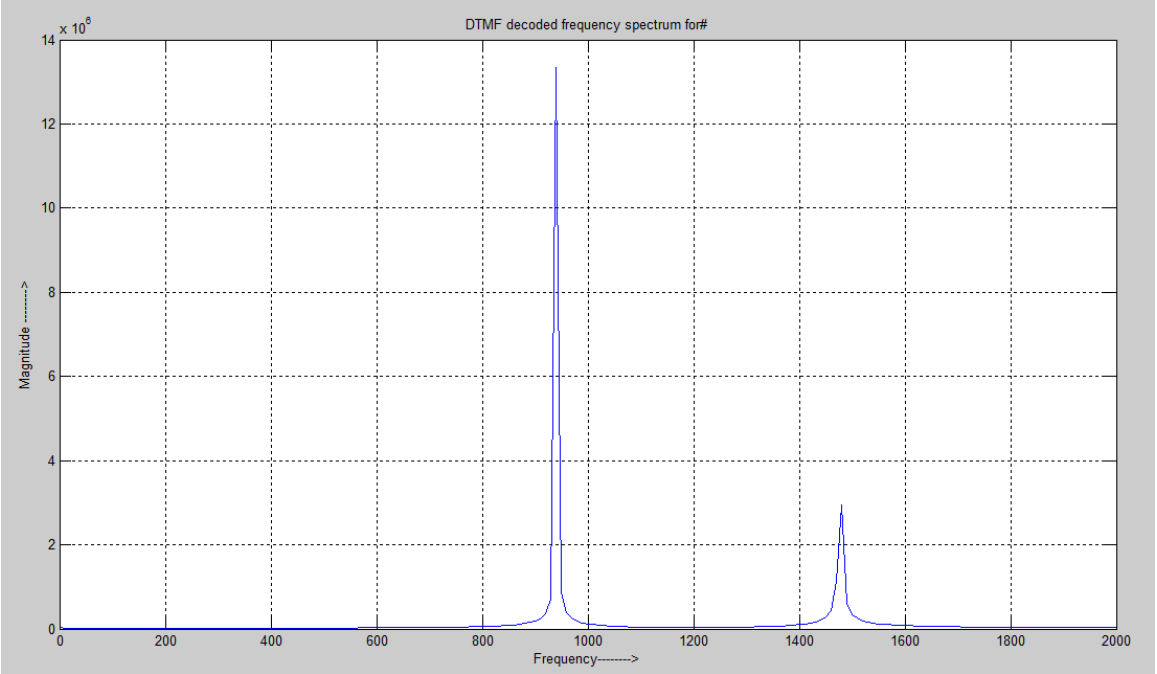
NUMBER = * ROW FREQUENCY = 941Hz COLUMN FREQUENCY = 1209Hz



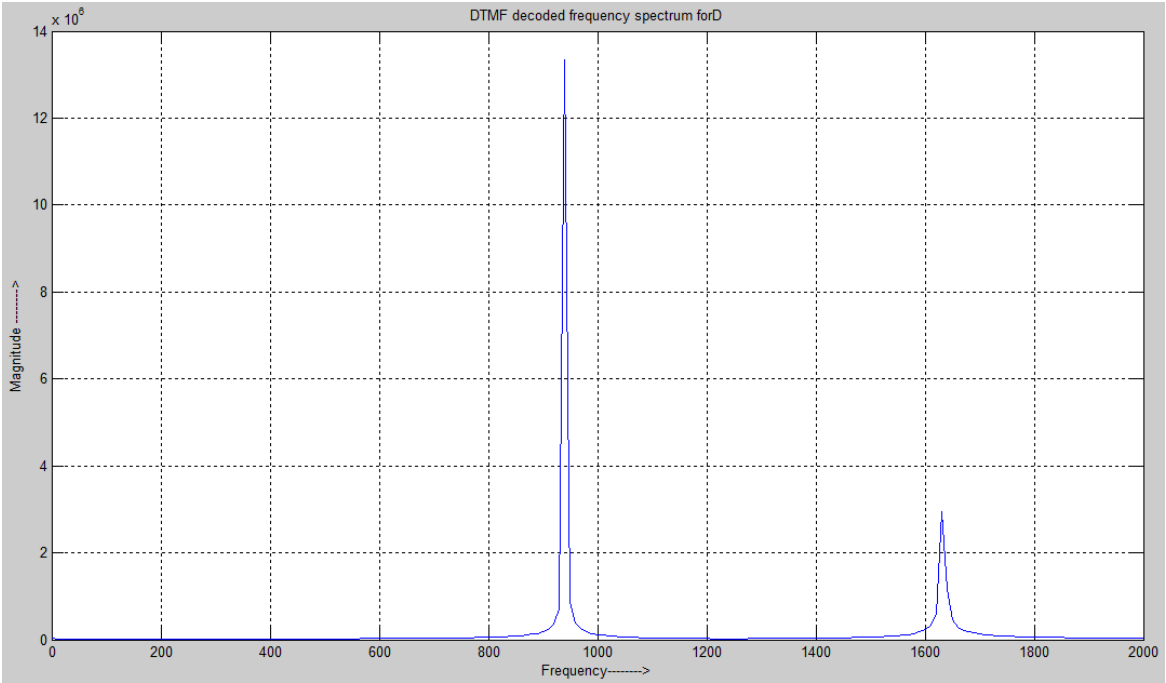
NUMBER = 0 ROW FREQUENCY = 941Hz COLUMN FREQUENCY = 1336Hz



NUMBER = # ROW FREQUENCY = 941HZ COLUMN FREQUENCY = 1447HZ



NUMBER = D ROW FREQUENCY =941HZ COLUMN FREQUENCY = 1633HZ



3.5 DISCUSSION: DEEP KIRAN SHROTI

- DTMF is a signalling system for identifying the keys or better say the number dialled on a pushbutton or DTMF keypad. The early telephone systems used pulse dialling or loop disconnect signalling. This was replaced by multi frequency (MF) dialling. DTMF is a multi-frequency tone dialling system used by the push button keypads in telephone and mobile sets to convey the number or key dialled by the caller.

- DTMF has enabled the long distance signalling of dialled numbers in voice frequency range over telephone lines. This has eliminated the need of telecom operator between the caller and the callee and evolved automated dialling in the telephone switching centres.

- DTMF (Dual tone multi frequency) as the name suggests uses a combination of two sine wave tones to represent a key. These tones are called row and column frequencies as they correspond to the layout of a telephone keypad.

- A DTMF keypad (generator or encoder) generates a sinusoidal tone which is mixture of the row and column frequencies. The row frequencies are low group frequencies. The column frequencies belong to high group frequencies. This prevents misinterpretation of the harmonics. Also the frequencies for *DTMF* are so chosen that none have a harmonic relationship with the others and that mixing the frequencies would not produce sum or product frequencies that could mimic another valid tone.

- *DTMF tones* are able to represent one of the 16 different states or symbols on the keypad. This is equivalent to 4 bits of data, also known as nibble.

- National telephone systems define other tones that indicate the status of lines, equipment, or the result of calls. Such call-progress tones are often also composed of multiple frequencies and are standardized in each country. The Bell System defines them in the Precise Tone Plan. However, such signalling systems are not considered to belong to the DTMF system.

DISCUSSION: VED PRAKASH TIWARI

- Touch tone scheme implements two frequencies for one signal as identification for the exact location of symbol in symbol table; row number and column number.

- More efficient implementation can be representation of one symbol by more than two frequencies. It can be seen that while representing a symbol by source coding techniques we are placing the bits sequentially in time but in touch tone scheme we are decoding the message at that particular instant of time when we are receiving it based on different frequencies available in the signal. It can be viewed as a parallel implementation of source coding technique.

- Requirement of sharp transition band pass filter is there to implement this scheme for large set of source values as it can be seen that 2n different values of frequencies are needed to represent n^2 symbols.

- For practical implementation of the DTMF scheme, we have to place frequencies taking channel's frequency response and noise performance into consideration.