

Signal Processing - Report

Lab 4 – Group 2

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Telephone Touch Tone Dialing

1. DTMF Encoding

Here is the code added to the given skeleton.

```
samp = 0:1/fs:durTone;

x =
0.5*cos(2*pi*freqTable(1,number+1)*samp)+0.5*cos(2*pi*freqTable(2,number+1)*samp);
```

Samp contains the times corresponding to each sample.

X is the output signal, according to the definition : $f(t) = 0.5 \cos(2 \pi f_1 t) + 0.5 \cos(2 \pi f_2 t)$, where t is replaced with the values of samp and f_1 and f_2 are taken from the array freqTable.

2. DTMF Decoding

a. Band pass filters

```
function h=bandpassFilter(L,fb,fs)
    n = 0:L-1;
    h = (2/L)*cos(2*pi*fb*n/fs);
```

Creating the band pass filter is just implementing the given formula : $h[n] = \frac{2}{L} \cos\left(\frac{2\pi f_b n}{f_s}\right)$

In the previous formula, fb represents the center of the band and L controls the width of the band. Indeed, reducing L decreases the frequency answer of signals with other frequencies than fb and the other way around.

b. Decoding

Here is the code added to the given skeleton.

```
freqPresent =
    zeros(size(freqTable));
[n, m] = size(freqTable);

for n = 1:n
    for m = 1:m
        freqPresent(n,m) =
            norm(conv(bandpassFilter(L,
                freqTable(n,m), fs), x),2);
    end
end

freqPresent(1,:) = freqPresent(1,:)
    == max (freqPresent(1,:));
freqPresent(2,:) = freqPresent(2,:)
    == max (freqPresent(2,:));
```

We build a matrix with the size of freqTable.

We store in this matrix the value of the energy of the convolution of the input signal and a band pass filter for the frequencies in freqTable.

We replace each entry with 1 if the entry is the maximum of the line and 0 otherwise.

```
[C,I] = max (freqPresent  
    (1,:).*freqPresent(2,:));  
number = I-1;
```

We multiply element wise the two lines of the matrix and return the number of the only entry equals to 1, minus 1.

The program works because the freqTable matrix is designed so in each line, only one frequency is present in a tone. When we compute the energies and keep the maxima, we have ones for indices corresponding to a frequency that is present in the sound. freqTable is also designed so each number correspond to a column. Therefore, the only column containing two ones corresponds to the number.