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DTMF Encoder Decoder

Group Members:

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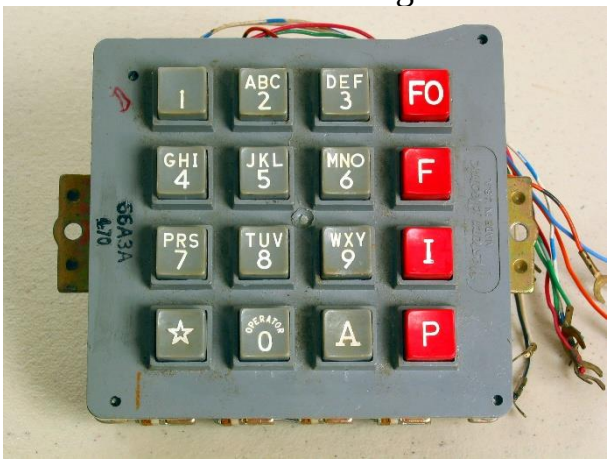
Introduction:

Dual-tone multi-frequency signaling (DTMF) is a telecommunication signaling system using the voice-frequency band over telephone lines between telephone equipment and other communications devices and switching centers.

The Touch-Tone system using a telephone keypad gradually replaced the use of rotary dial and has become the industry standard for landline and mobile service. Other multi-frequency systems are used for internal signaling within the telephone network.



Work Distribution:

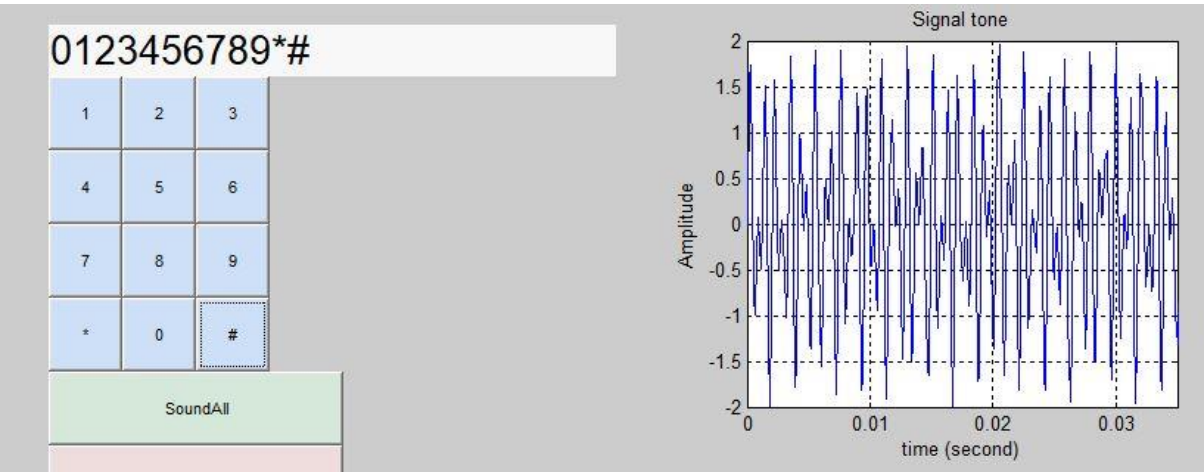
- M. Saud Zahir and Abdul Hanan performed the first task.
- Rafae and Qadoom performed the second task.
- M. Saud Zahir and Qadoom performed the third task.
- Abdul Hanan and Rafae performed the last task.

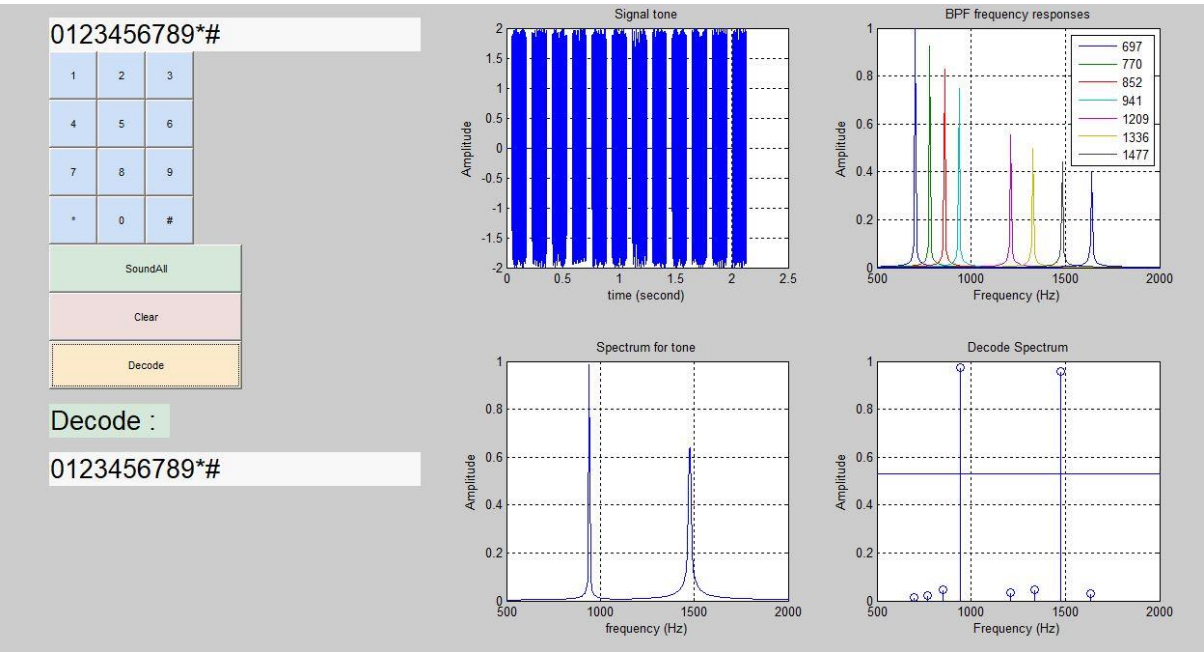
Explanation:

When we touch a touch-tone pad of Telephone it generates signals in the form of dual tone multiple frequency (DTMF) to dial a telephone. When any number is dialed and the key is pressed, s sinusoidal waves of the corresponding row and column frequencies are generated and summed together. The frequencies for each number are given in the table. For instance, if a 3 key is pressed, signal is generated containing the sum of the two frequencies/tones, 697 Hz and 1477 Hz. The frequencies for each digit are chosen by design engineers to avoid harmonics. The sum and difference between any two frequencies does not come equal to any of the given frequency and no frequency is an integer multiple of another. This allows to detect the tones in the dialed signal easily even in the presence of non-linear line distortions.

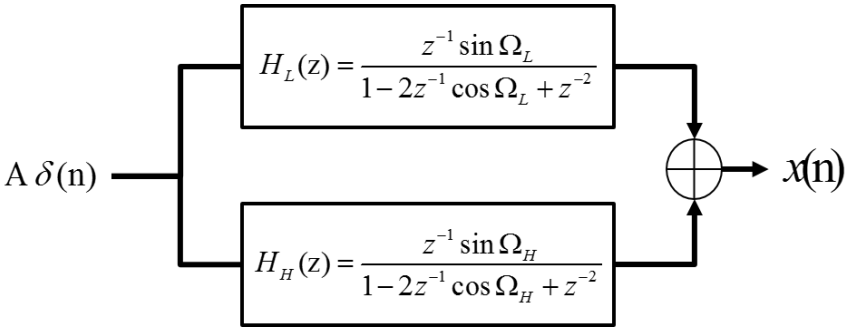
	1209 Hz	1336 Hz	1477 Hz
697 Hz	1	2	3
770 Hz	4	5	6
852 Hz	7	8	9
941 Hz	*	0	#

The decoding of DTMF signals can be done using a simple FIR filter bank. The input of the filters is the same DTMF signal. When the input to the filter bank is given as a DTMF signal, the outputs from two of the BPFs should be larger than the rest. The two outputs will be detected to find out the corresponding frequencies. These frequencies can be mapped with the table to determine the key from the DTMF code. A good measure of the output levels is the peak value at the output of the filter, because a BPF should pass only one sinusoidal signal and the peak value will be the amplitude of the sinusoidal signal passed by the filter. We have actually used Goertzel algorithm, which has a form of digital filter. We have also used the GUI (Graphical User Interface) interface of Matlab.





The **Goertzel algorithm** is a technique in **digital signal processing** (DSP) for efficient evaluation of the individual terms of the discrete Fourier transform (DFT). It is useful in certain practical applications, such as recognition of dual-tone multi-frequency signaling (DTMF) tones produced by the push buttons of the keypad of a traditional analog telephone. The algorithm was first described by Gerald Goertzel in 1958.



$$H_k(z) = \frac{X_k(z)}{X(z)} = \frac{1}{1-2\cos\left(\frac{2\pi k}{N}\right)z^{-1}+z^{-2}}$$

We have designed a complete system that is capable of DTMF dial tones generation and then decoding them.

Results Achieved:

We were successful in making the DTMF decoder and we effectively generated tones by setting the to a particular frequency and decoded them.