Digital Signal Processing Laboratory

Final Practice

DTMF (dual tone multi-frequency)

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B-408

1 Introduction

When a user presses a key on their telephone corresponding to the digit they want to dial, two tones of different frequencies are sent. This technique is called dual tone multi-frequency dialing (DTMF). The tones can be seen in the figure, one per column and one per row, where the key is pressed.

	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

On a standard phone the fourth column does not appear.

2 Objective of the project

The objective of this project is the development of a DTMF decoder, programmed in MATLAB, and based on the International Telecommunications Union (ITU) Q.24 standard [1], [2].

For this project you will be supplied with test files with recordings of DTMF signals sampled at 8KHz:

TEST_01.m: file the the sequence: 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, #, *
TEST_02.m: file the the sequence: 9, 2, 8, 6, 7, 3, 5, 4, 1
TEST_X1.m: unknown sequence.
TEST_X2.m: unknown sequence.
TEST_X3.m: unknown sequence.
TEST_X4.m: unknown sequence.

3 Project phases

3.1 Analysis and design

Feasibility study: Previous analysis that will contain at least the following sections:

- Detailed description of multi-frequency dual tone detection. Highlight the main parameters that must be considered when programming.

- Detailed explanation of the Goertzel algorithm.

Software design: In this phase the prototype functions to be used in the project will be specified, not the code.

As an example, a possible prototype function of the Goertzel algorithm is presented:

```
function [Xo] = Goertzel(x,fs,fo)
% Goertzel algorithm function that calculates the Fourier transform value at
% frequency fo of the sampled signal x
%
% Input parameters
% x: input sequence
% fs: sampling frequency
% fo: frequency at which we want to calculate the Fourier transform
%
% Output parameters
% Xo: Fourier transform at fo
```

Results of the **Analysis and design** phase must be written in **deliverable 1**.

3.2 Coding, integration, and tests

Coding of the prototype functions, integration and test with the project attached files.

Results of the **Coding, integration, and tests** phase must be written in **deliverable 2**.

4 Deliverables

Deliverable 1. Corresponding to section 3.1 analysis and design *(UP TO: 26/11/2021)*.

Deliverable 2. Corresponding to section 3.2 coding, integration, and tests *(UP TO: 17/12/2021)*.

In this deliverable, the code of the prototype functions will be added. Also, this deliverable includes the demonstration of the practice.

Bibliography

[1] ITU-T Recommendation Q.24: MULTIFREQUENCY PUSH-BUTTON SIGNAL RECEPTION

[2] Application Note AT&T: Dual-Tone Multifrequency Receiver Using the WE DSP32 Digital Signal Processor

[3] Discrete-time Signal Processing, Alan V. Oppenheim and Ronald W. Schafer, Prentice Hall