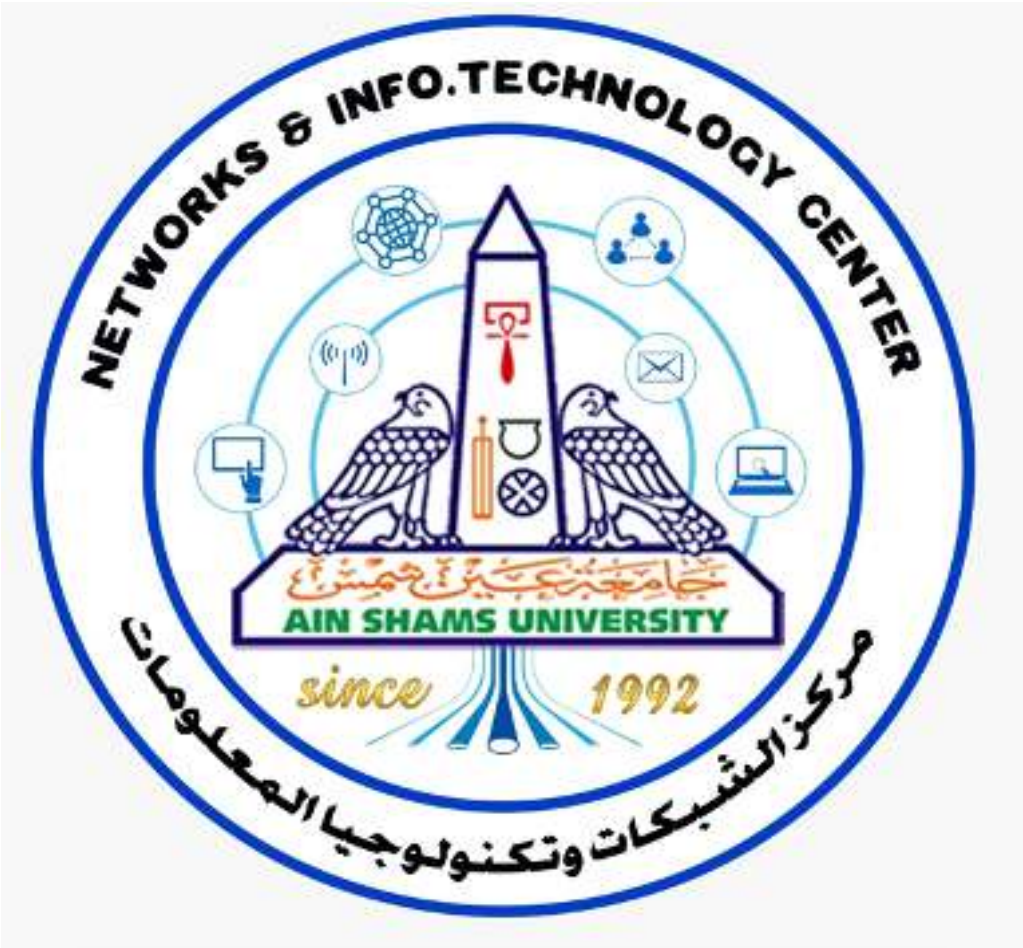
Safaa Mahmoud

بسم اللّه الرحمن الرحيم

مركز الشبكات وتكنولوجيا المعلومات

قسم التوثيق الإلكتروني



Safaa Mahmoud

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم باللّه العظيم أن المادة التي تم توثيقها وتسجيلها

علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Electronics Engineering and Electrical Communications

FPGA Implementation of Building Blocks of Conjugate Structure ACELP Speech Codec

A Thesis
Submitted in Partial Fulfillment for the Requirements of the
Degree of Master of Science in Electrical Engineering
(Electronics and Communication Engineering Department)

Submitted by

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STATEMENT

This thesis is submitted as a partial fulfillment of Master of Science. In Electrical Engineering, Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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Thesis Summary

Key words— CSACELP, Simulink, MATLAB, Visual Studio, DSK 6713, seg-SNR, LLR, MOS, PRAAT

As the emerging of real-time telecommunication systems over low bandwidth channels enforces constraints on the transmitted data rate while maintaining optimum speech quality at received destination, so speech coding techniques are being developed as waveform coder, parametric coder and hybrid coder. Hybrid coder is considered the optimal and satisfactory between speech coding algorithms to provide low bitrate with optimum speech quality.

This thesis presents one of hybrid speech coder types named Conjugate Structure Algebraic Code Excited Linear Prediction (CS-ACELP) which is nominated by International Tele-communication Union (ITU) as G.729. CS-ACELP encoder has two main stages per-frame analysis and per sub-frame analysis stages. The frame analysis stage of the Intended speech coder CS-ACELP is demonstrated by three main aspects.

Firstly, CS-ACELP is software simulated using SIMULINK model which was built from scratch based on MATLAB 2019. Four different acoustic speech signals are chosen as tested signals.

Secondly, CS-ACELP is hardware implemented on TMS320C6713 DSP kit based on C++ code generated from SIMULINK model. Additional optimizations are done to provide good reduction in the processing time by 8.564 us and reduction in the memory size used by 8% with acceptable speech quality.

Thirdly, a CS-ACELP encoder/decoder with International telecommunication union (ITU) MATLAB CSACELP code is developed, and then MATLAB coder (MEX tool) is used to generate C++ files that could compile and run it into desktop PCs. This desktop application is helpful in chat applications that require low bandwidth over the Internet and low connection speed.

The implemented CS-CELP tested signals are compared with the signals based on desktop application according to different measurements tests as objective measurements such as segmented signal-to-noise ratio (seg-SNR), log-likelihood ratio (LLR), and subjective measurements such as mean opinion score (MOS) and praat software test.

These testes are used to examine the speech quality of the synthesized signals based on the implemented C++ code generated from SIMULINK against reconstructed signals from desktop application.

This comparison proved that the reconstructed signal based on “analysis-by-synthesis” desktop application was better (less noise distortion) than the SIMULINK synthesis signal because of adding error parameters that done in the decoder side that help the decoder to estimate the original signal with minimum error as possible.

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List of Abbreviations

CELP	Code-Excited Linear Prediction
CODEC	Compression/Decompression
CS-ACELP	Conjugate-Structure Algebraic CELP
DSP	Digital Signal Processing
LAR	Log Area Ratio
LLR	Log Likelihood Ratio
LP	Linear Predictive
LSF	Line Spectral Frequency
LSP	Line Spectral Pair
MA	Moving Average
MOS	Mean Opinion Score
MSB	Most Significant Bit
MSE	Mean-Squared Error
MSVQ	Multistage VQ
Seg-SNR	Segmented signal-to-noise ratio
SNR	Signal to Noise Ratio
SVQ	Split VQ
VQ	Vector Quantization
WCDMA	Wide Band Code Division Multiple Access.