

ADAPTIVE COMPRESSIVE SENSING BASED ON LEVEL- CROSSING SAMPLING PRINCIPLE

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OUTLINE

- Introduction
- Adaptive compressive sensing
- Level crossing sampling
- Implementation
- Simulation and results
- Conclusions

INTRODUCTION

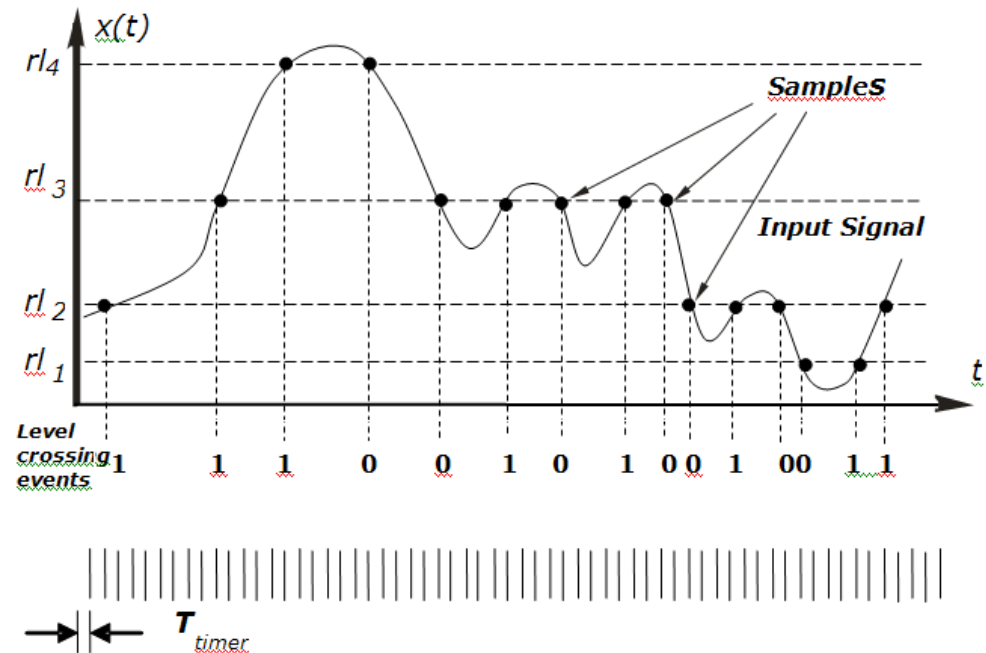
- To search for applicable ADC principles in order to essentially decrease amount of sampled data
- Proposed compressive sampling approach is based on modified level crossing sampling method. Data processing (selection) is performed during the sampling process in order to compress data
- Modified level crossing sampling as a compromise between decreased amount of data by decreasing number of reference levels and precise signal reconstruction
- To determine relationship between signal reconstruction quality and signal compression

ADAPTIVE COMPRESSIVE SENSING

- ❑ Adaptive compressive sensing is a term used to process a sparse signal – image processing
- ❑ It is using limited number of signal samples to recover the original signal
- ❑ We are proposing to implement modified level crossing sampling approach in order to decrease number of signal samples and retain expected quality of the recovered signal
- ❑ Two approaches of level crossing sampling are implemented. One is an unmodified approach, another is a modified approach

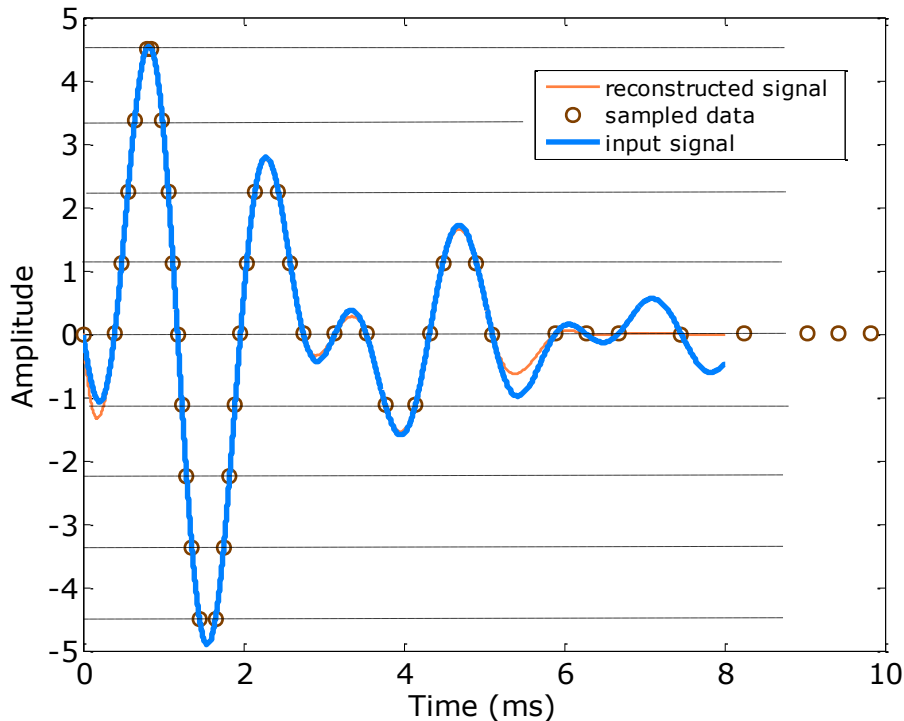
LEVEL CROSSING SAMPLING

- Level crossing sampling is used to adapt to the signal changes and to perform signal sampling if necessary
- Level crossing sampling is an approach for sensing signal changes. Sampling is not uniform. Signal reconstruction is more complicated.

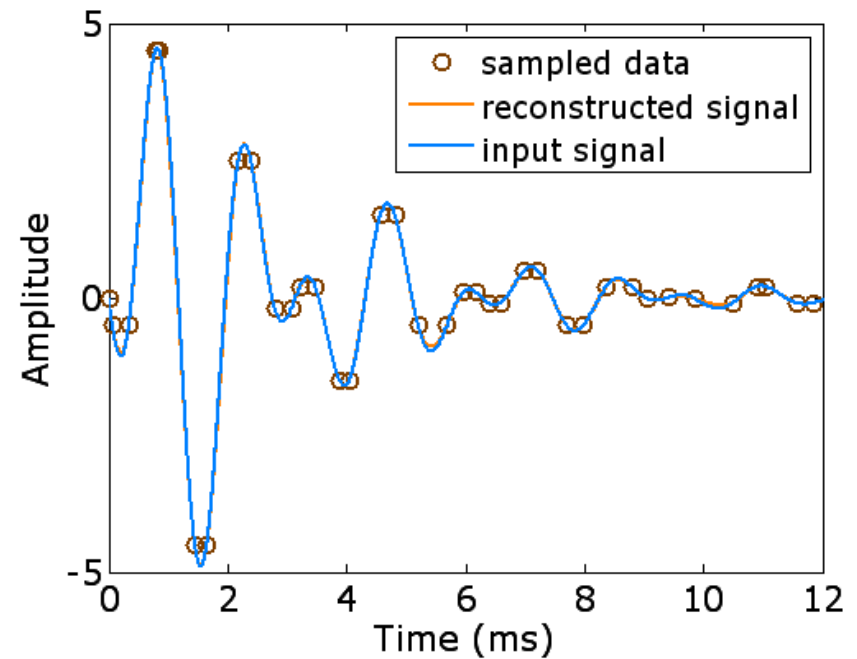


TWO APPROACHES

1. Unmodified level crossing sampling



2. Modified level crossing sampling



1. Level crossing sampling is using all crossings of reference levels - LC1
2. Level crossing sampling is using only extreme crossings – LC2

IMPLEMENTATION

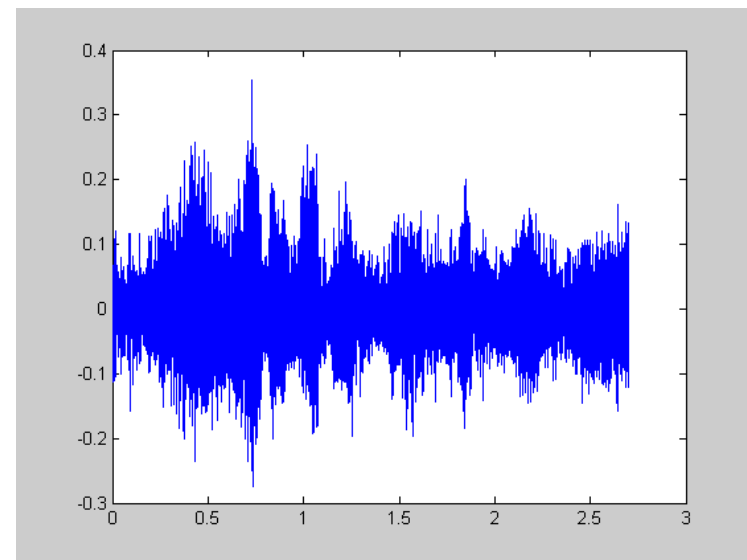
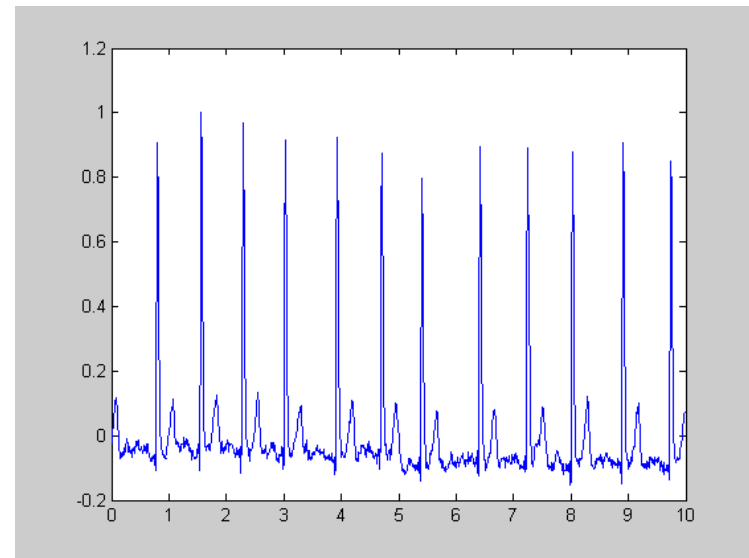
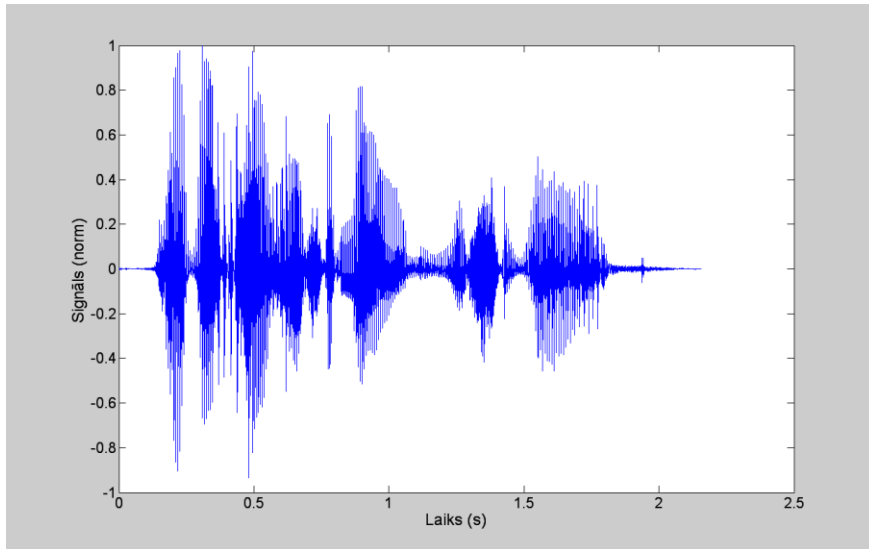
- The proposed approaches LC1, LC2 were simulated using a model - Matlab program which performed sampling with different number of reference levels
- Initially input signal was resampled using 16 x oversampling
- Level crossing sampling of input signal was performed at preset number of reference levels
- Recovery of non-uniformly sampled signal was performed using cubic spline function
- Recovered signals of both approaches were compared with original input signal

USED INPUT SIGNALS

- The proposed approaches were evaluated using three different sets of signals
- TIMIT CORPUS SAMPLES speech signals from http://web.mit.edu/course/6/6.863/share/nltk_lite/timit/
- Noise signals (airport, bubble, station, street etc) from NOIZEUS
- ECG signals from <http://physionet.org/cgi-bin/ATM>

SET OF SIGNALS

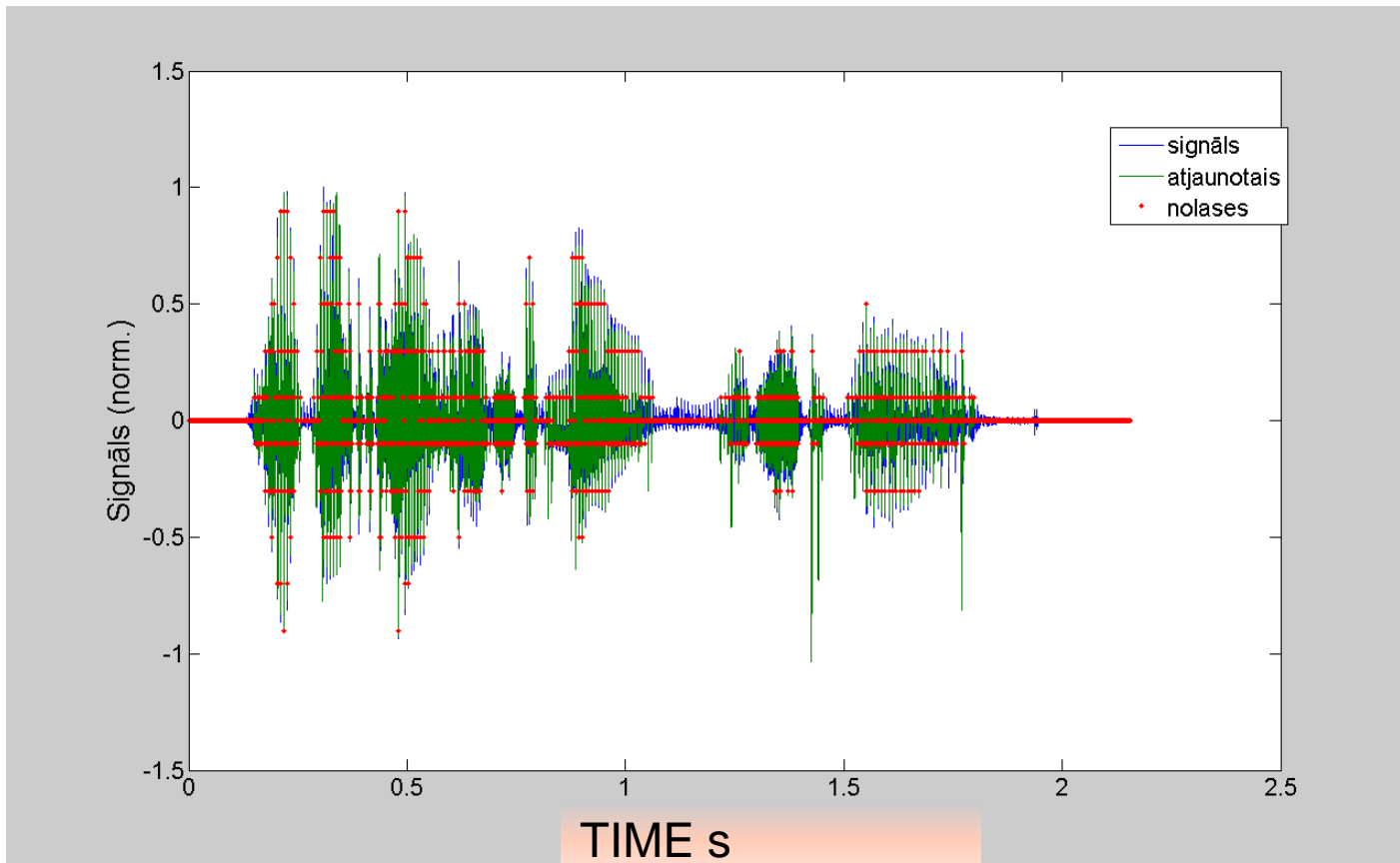
Although always alone, we survive



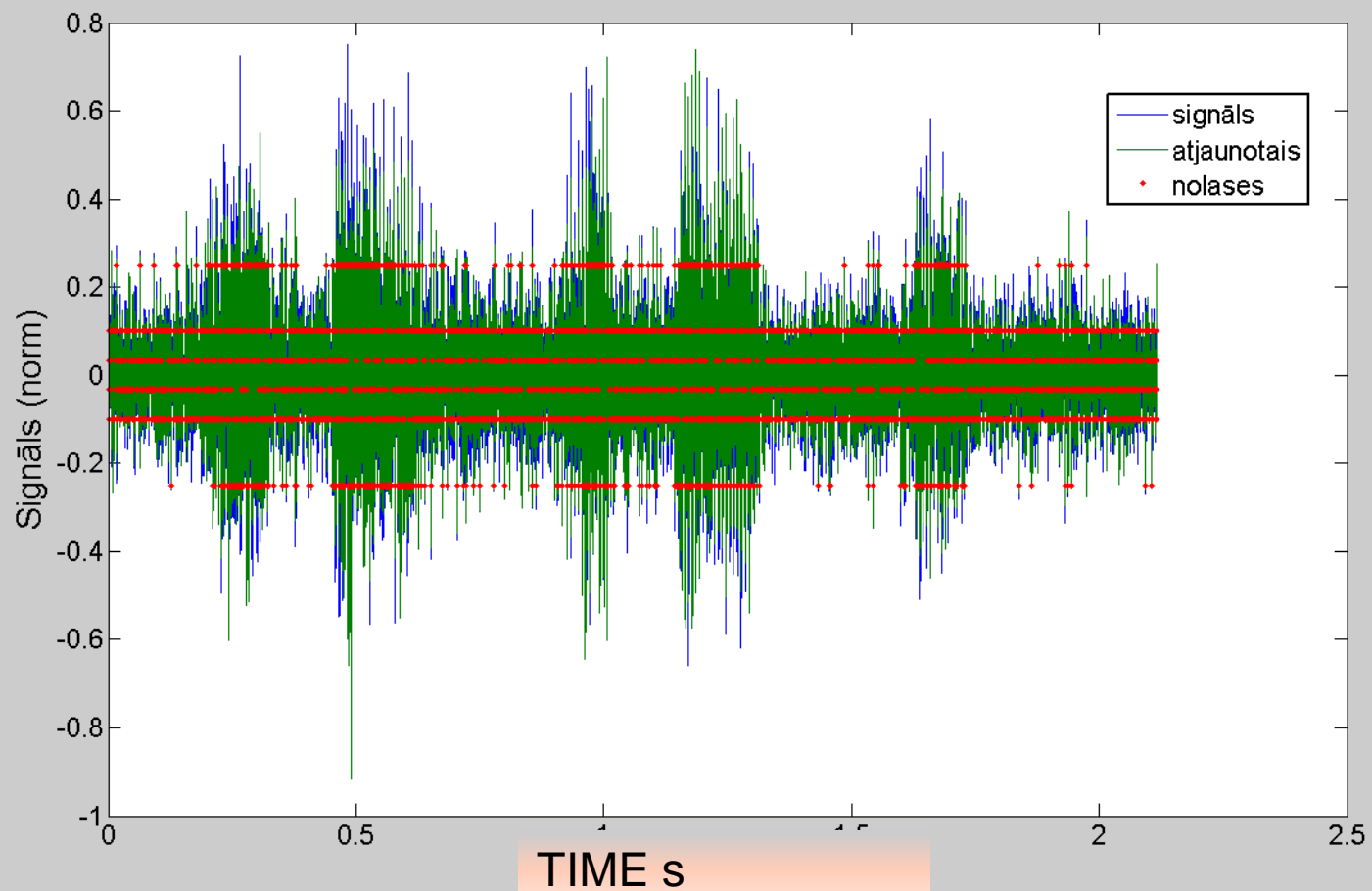
COMPARISON

- Resampled uniform input signal is compared with the signal recovered from non-uniformly sampled data using cubic spline function
- Recovered signals using both approaches are compared with input signal
- Quality of recovery is determined calculating and comparing correlation coefficients
- Number of data sampled at different number of reference levels are compared
- Values of signal correlations at different number of reference levels are compared

SPEECH SIGNAL SENSING (11 LEVEL SAMPLING)



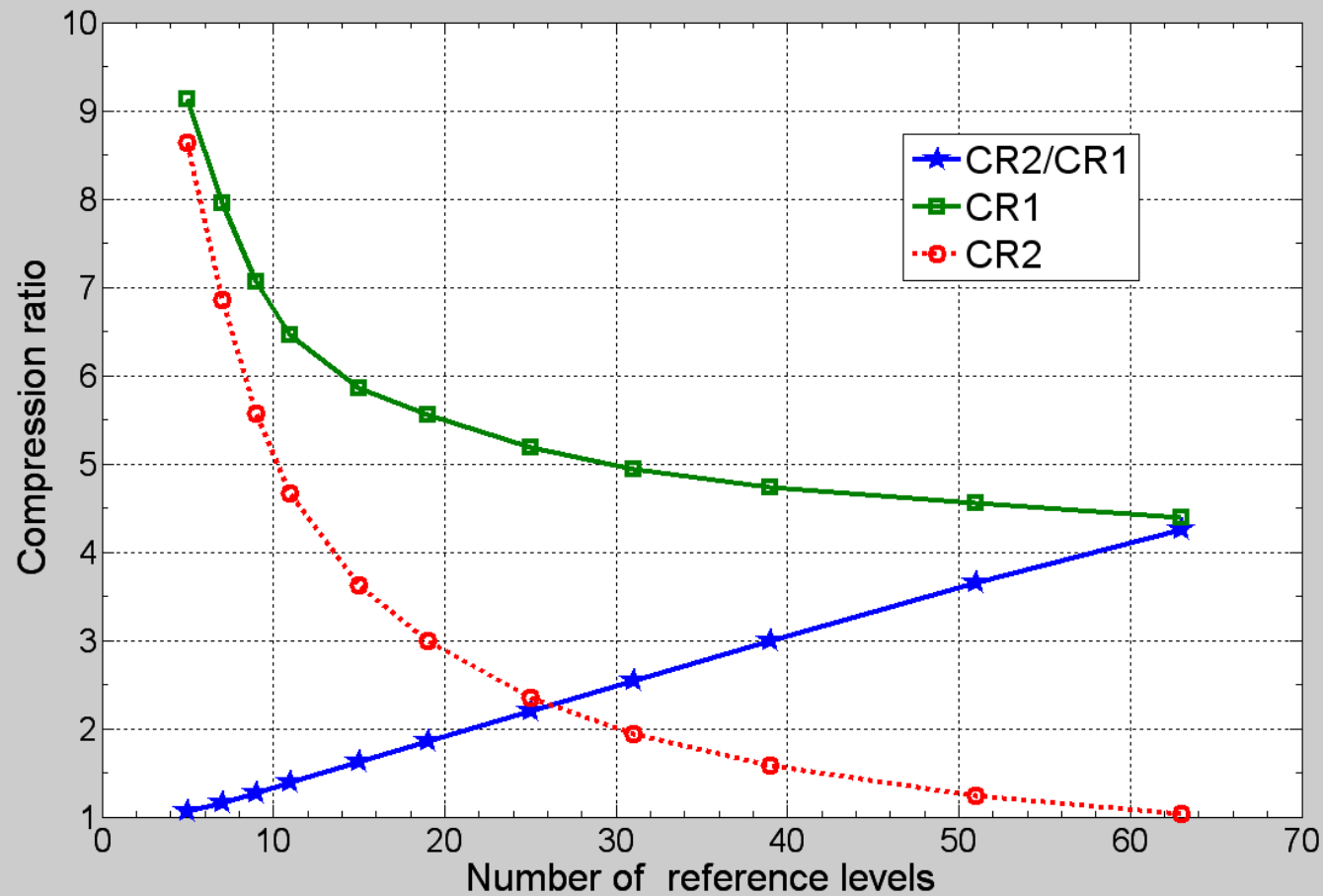
AIRPORT NOISE



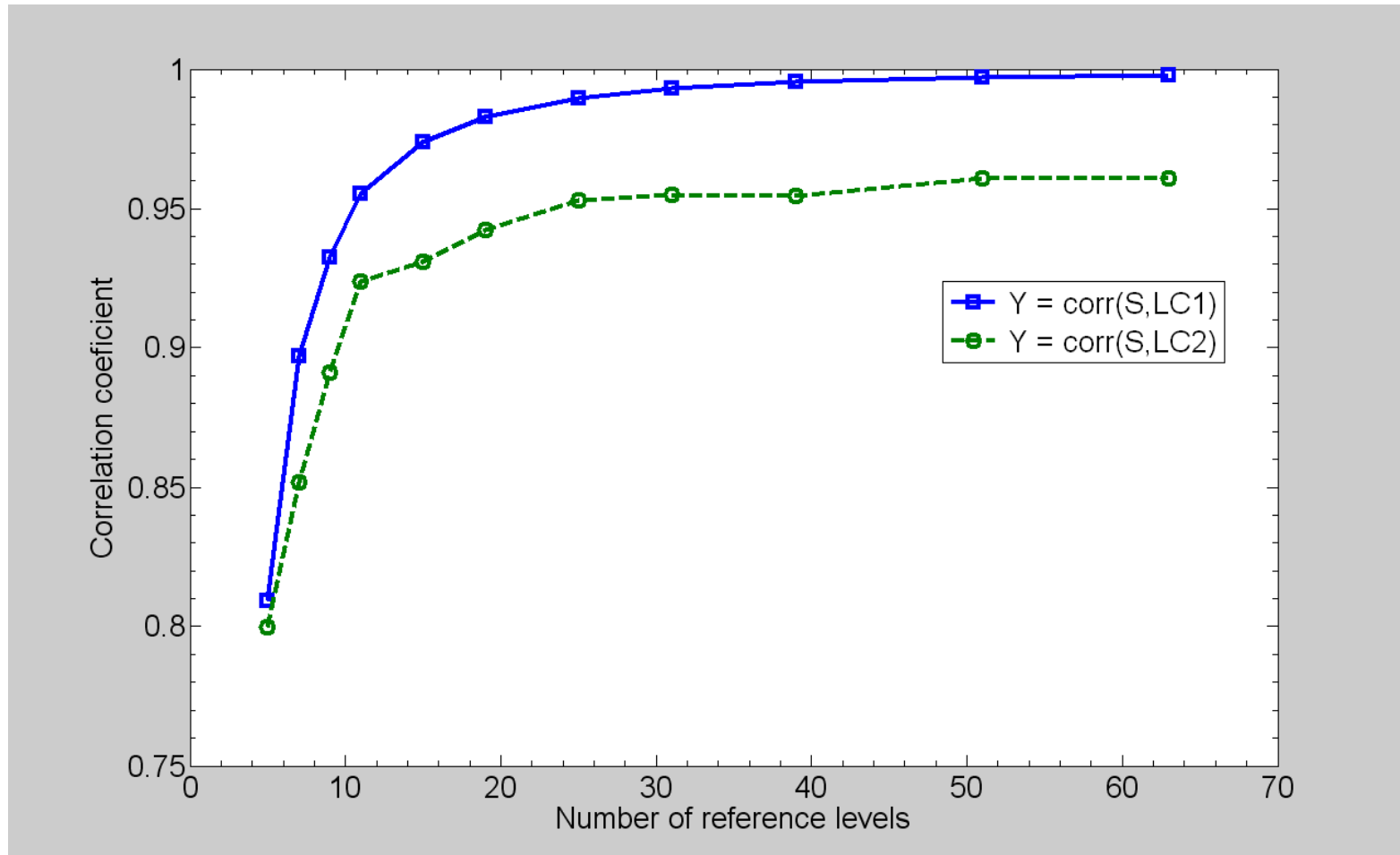
SIGNAL COMPRESSION CALCULATIONS

- $CR1 = N_s/N_{LC1}$; $CR2 = N_s/N_{LC2}$
- N_s – number of samples of uniformly sampled data
- N_{LC1} - number of samples of non-uniformly sampled data using sampling approach LC1
- N_{LC2} - number of samples of non-uniformly sampled data using sampling approach LC2
- $K = CR2/CR1$

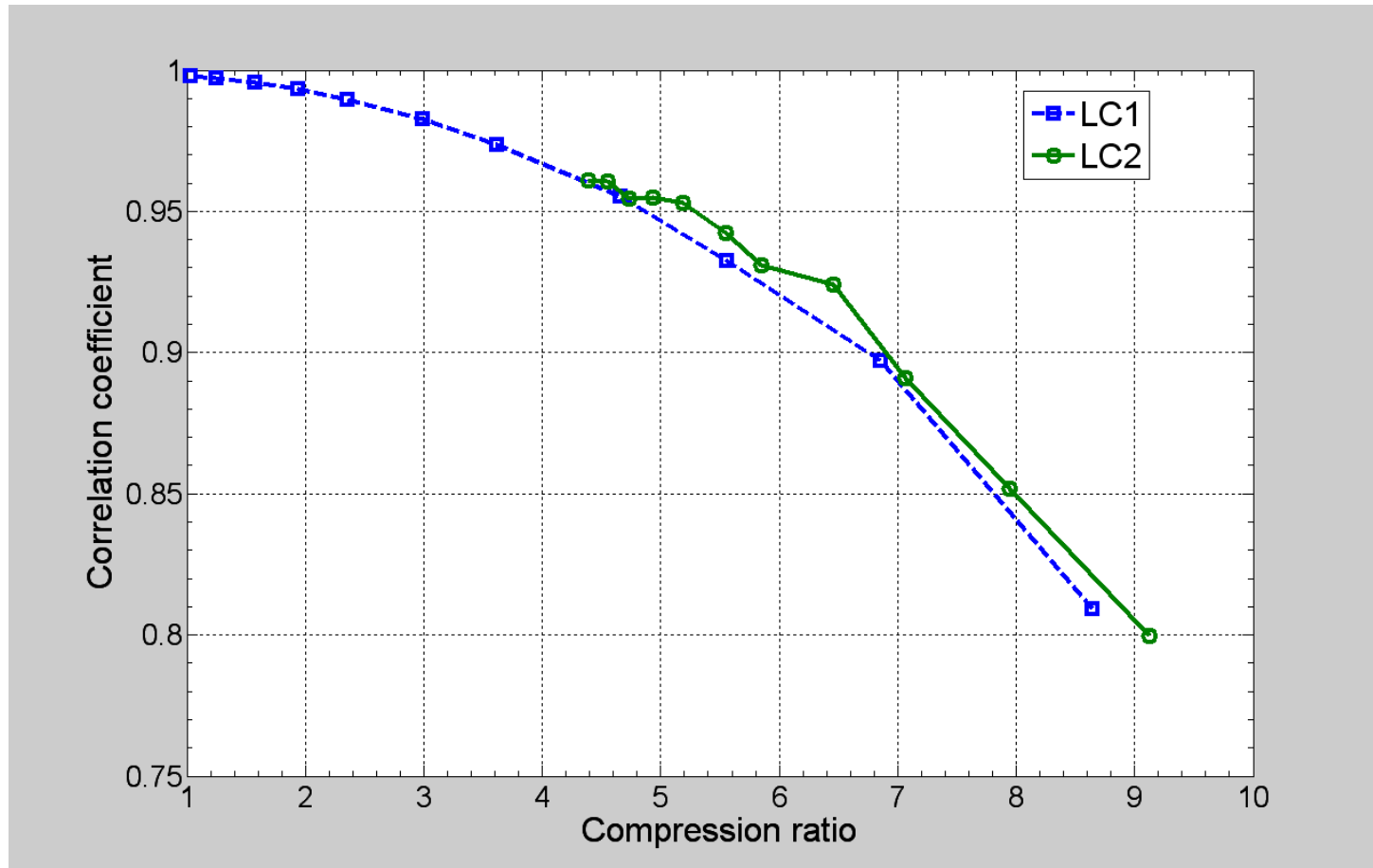
SPEECH SIGNAL COMPRESSION RATIO



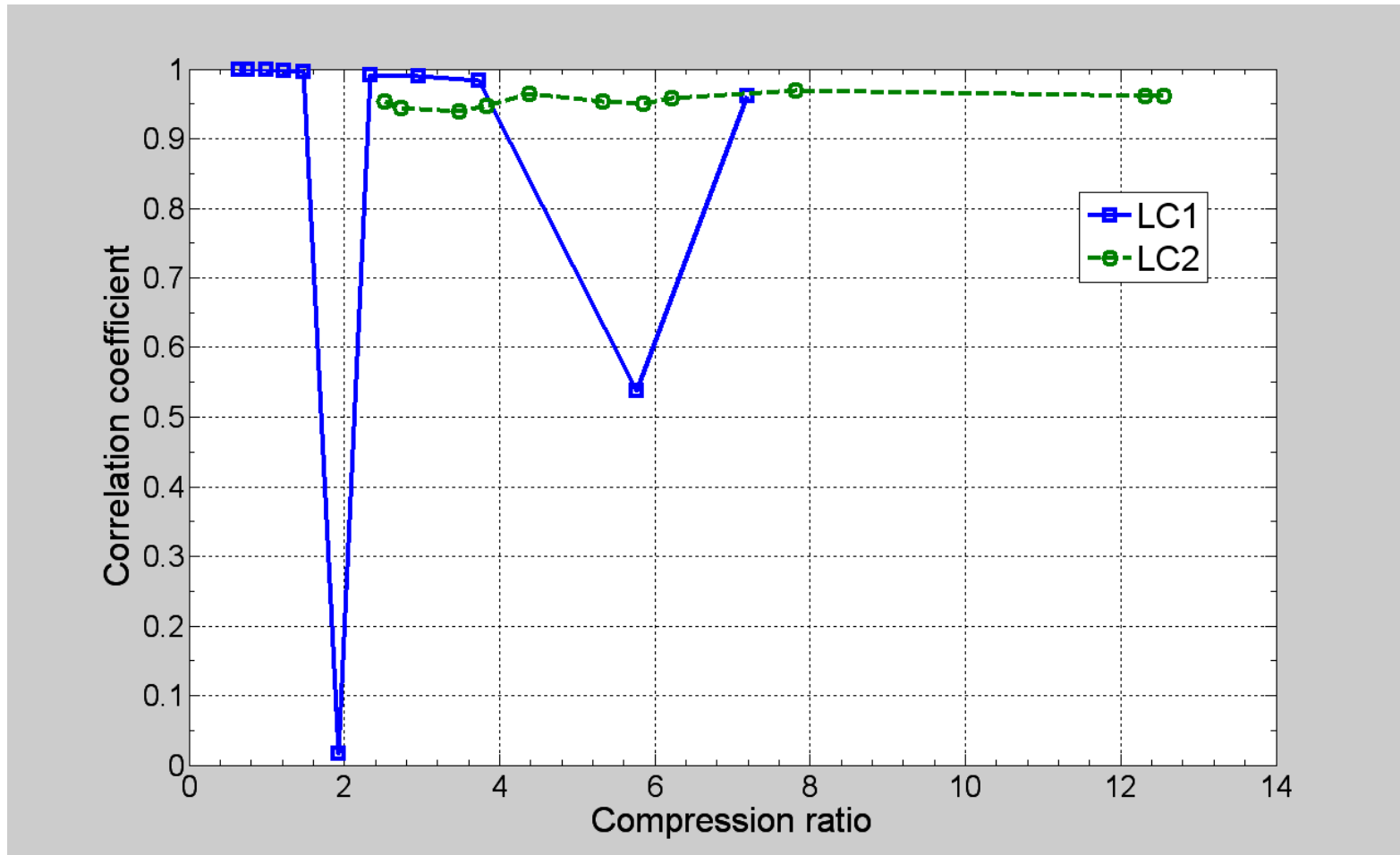
SPEECH SIGNAL CORRELATION COEFFICIENTS



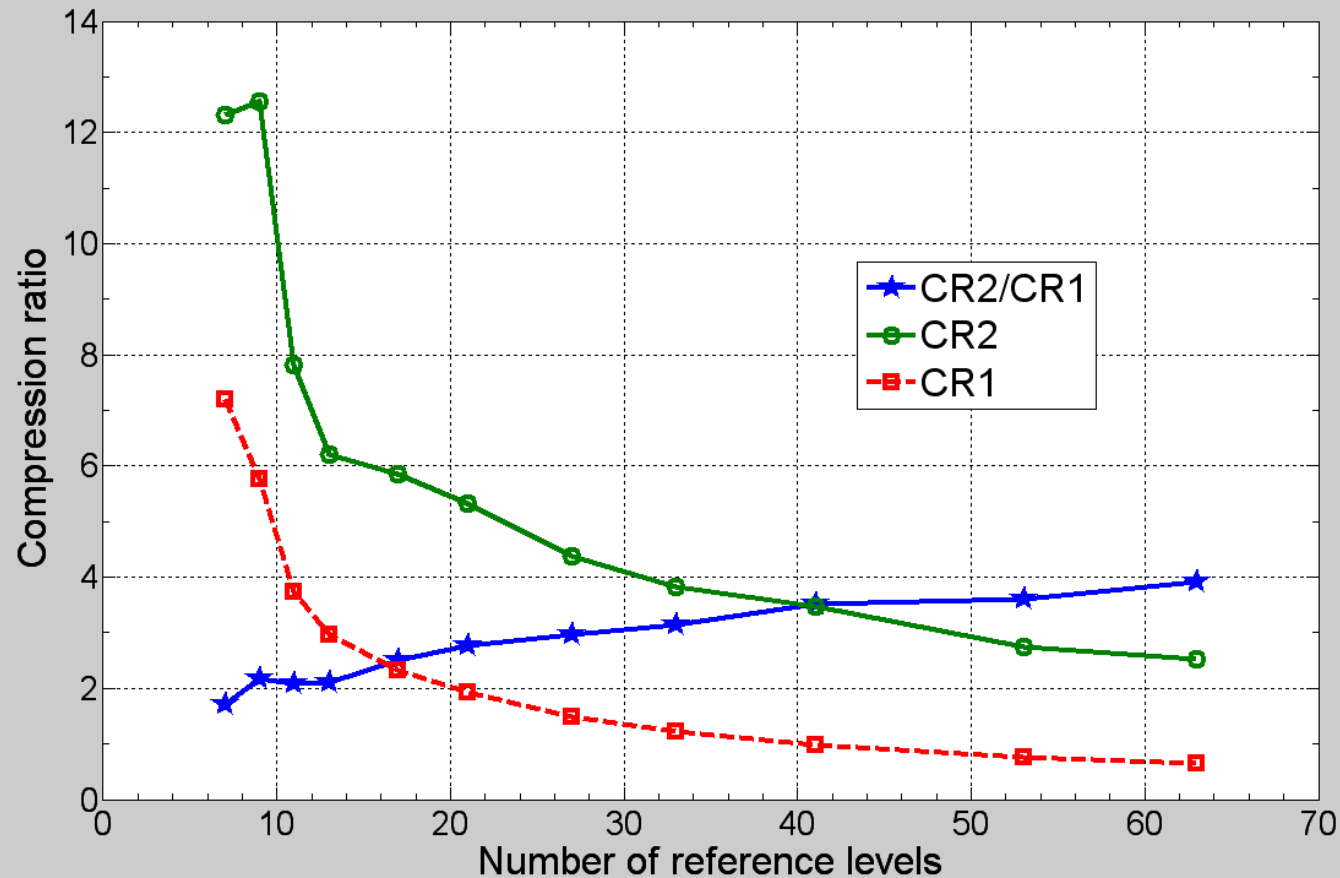
SPEECH SIGNAL CORRELATION VS COMPRESSION



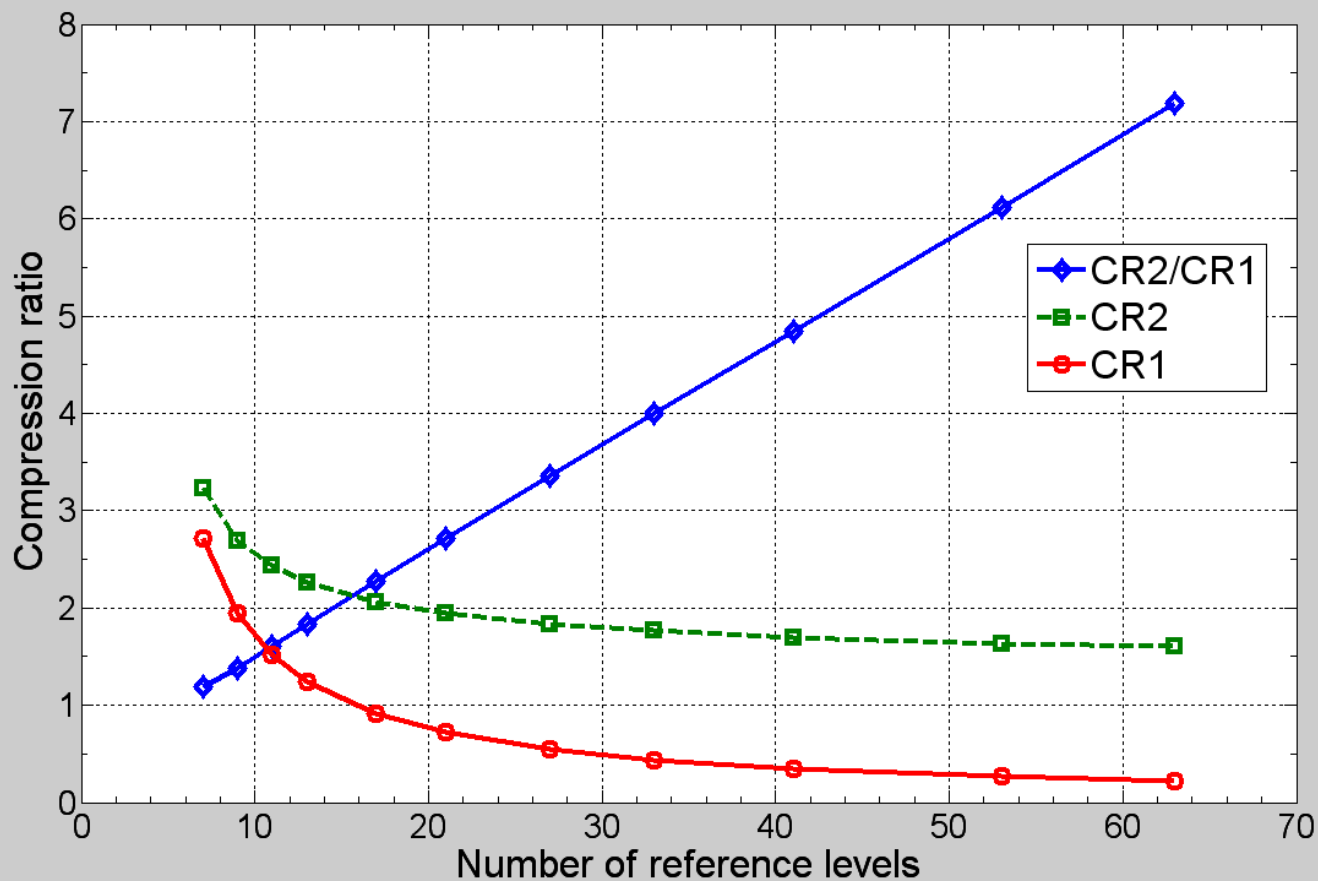
ECG SIGNAL CORRELATION VS COMPRESSION



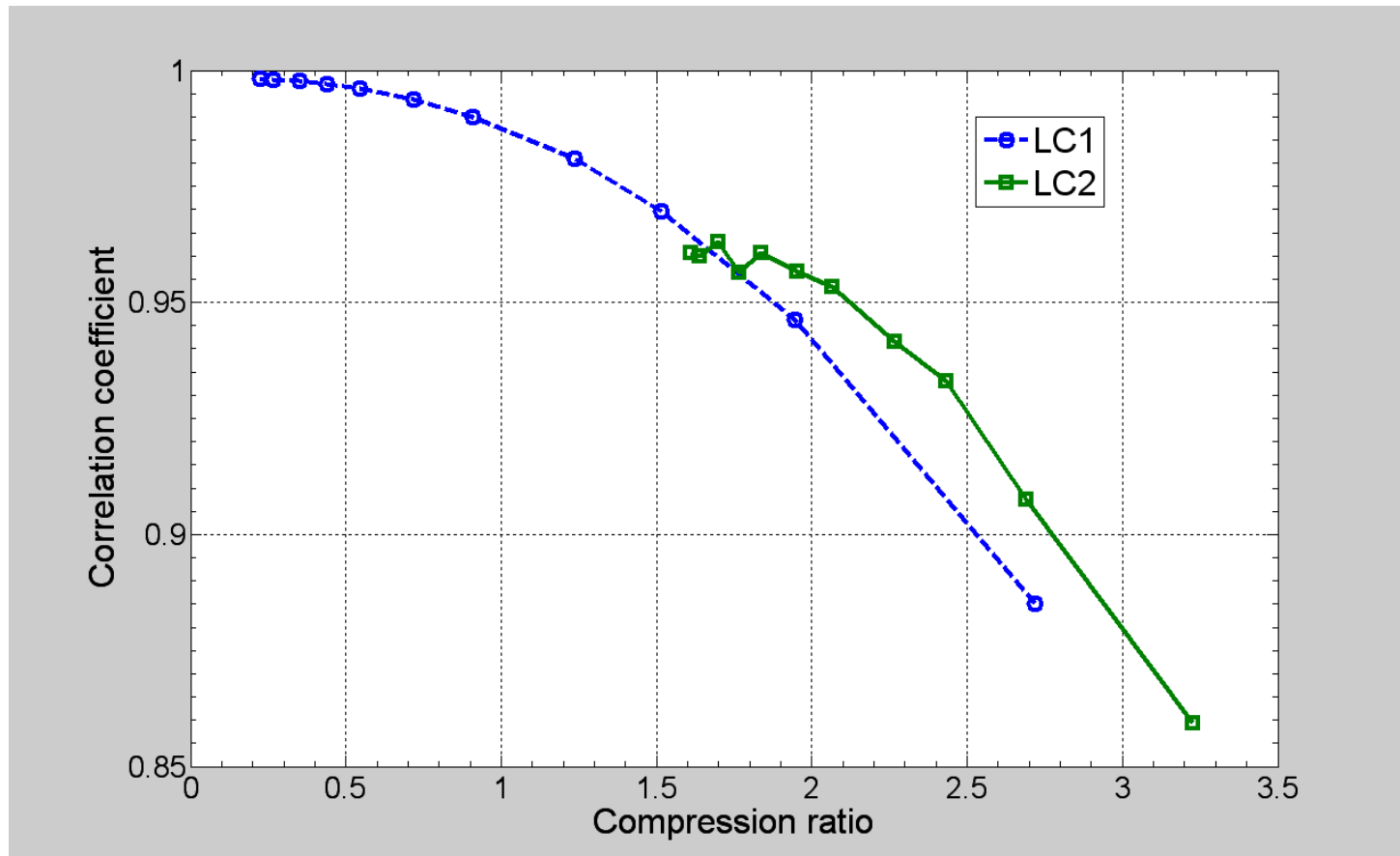
ECG SIGNAL COMPRESSION RATIO



NOISE SIGNAL COMPRESSION RATIO



NOISE SIGNAL CORRELATION VS COMPRESSION



CONCLUSIONS

- Depending from the input signal adaptive compressive sensing is compressing data up to 12x
- Maximum compression occurs at small numbers of reference levels
- Modified level crossing approach is more preferable for ECG

QUESTIONS

Thank You!