A Project report on

ECG COMPRESSION USING DCT

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CERTIFICATE

This is to certify that ***KRITHIK K(4NM20EC051), MANNA MOHAMMED ZISHAN(4NM20EC055), RAMEEZ JAMAN(4NM20EC086), MOHAMMED SADEED(4NM20EC151)*** *bonafide students of N.M.A.M. Institute of Technology, Nitte have submitted a project report entitled "****ECG COMPRESSION USING DCT****" as part of the Project based Digital Signal Processing Lab, in partial fulfillment of the requirements for the award of Bachelor of Engineering Degree in Electronics and Communication Engineering during the year 2021-2022.*

Name of the Examiner	**Signature with date**
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ABSTRACT

An electrocardiogram (ECG) is the graphical representation of electrical impulses due to ionic activity in the cardiac muscles of the human heart. The fundamental goal of data compression is efficient transmission or storage while preserving the significant diagnostic features.

There are three transformation techniques such as Fast Fourier Transform (FFT), Discrete Cosine Transform (DCT) and Discrete Wavelet Transform(DWT). These techniques are employed for ECG signal compression.

DCT has widely used for data compression. DCT gives the decomposed coefficient of the original signal. Applying DCT to the sampled ECG signal gives DCT coefficients, which give energy at each component of the signal. Based on the requirement of energy in the compressed signal, the unwanted components can be removed resulting in a compressed ECG signal which is storage efficient.

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Chapter 1

INTRODUCTION

ECG is an important physiological signal which is exploited to diagnose heart diseases because every arrhythmia in ECG signals can be relevant to heart disease. ECG signals are recorded from patients for both monitoring and diagnostic purposes. Therefore, the storage of computerized signals becomes necessary. However, the storage has limitations, making ECG data compression an important issue of research in biomedical signal processing. In addition to these, there are many advantages of ECG compression such as the transmission speed of real-time ECG signal is enhanced and is also economical.

This project employs the DCT method of compression. The DCT is the most widely used transformation technique in signal_processing and the most widely used linear transform in data_compression. DCT is preferred over DFT in compression because DCT is a real transformation that results in a single real number per data point, in contrast, a DFT results in a complex number (real and imaginary parts) which requires double the storage memory. DWT gives a better compression ratio without losing more information, but it needs more processing power, while DCT needs low power but it has some loss of information.

Chapter 2

DESIGN AND IMPLEMENTATION

2.1 BLOCK DIAGRAM

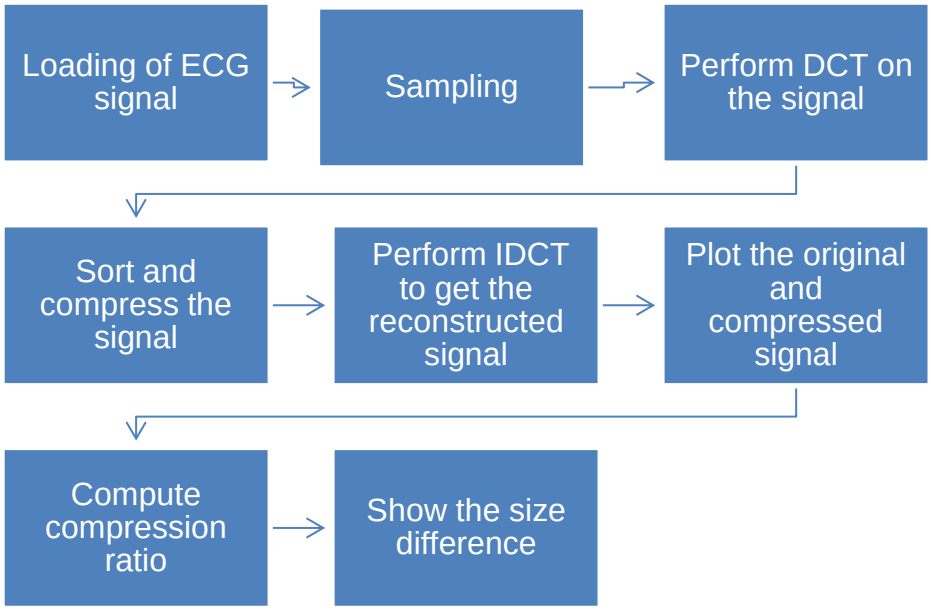

Figure 2.1 BLOCK DIAGRAM OF ECG COMPRESSION USING DCT

2.1.2 Code

ECG data

```
clear;
close all;
clc;
load('rec_1m (3).mat');
a=val;
T=1;
fs=1000;
N=length(a);
ts=1/fs;
t=(0:N-1)*ts;
```

DCT of the signal

```
dct_Sig=dct(a);
```

Sorting in descending order

```
[XX,ind] = sort(abs(dct_Sig),'descend');
```

98% of energy in the signal

```
need = 1;
while norm(dct_Sig(ind(1:need)))/norm(dct_Sig)<0.98
need = need+1;
end
c_r=N/need;
disp('compression ratio=');
disp(c_r);
```

Make other values 0

```
dct_Sig(ind(need+1:end)) = 0;
```

Perform IDCT

```
xx = idct(dct_Sig);
```

Plots

```
subplot(3,1,1);
plot(t,a);
title('Original signal');
xlabel('time');
ylabel('amplitude');
subplot(3,1,2);
plot(t,xx);
title('Reconstructed');
xlabel('time');
ylabel('amplitude');
subplot(3,1,3);
plot(t,a-xx);
title('Difference');
xlabel('time');
ylabel('amplitude');
legend([int2str(c_r) '% compression ratio']);
```

Energy

```
Eo=(norm(a));
disp('Energy of original signal=');
disp(Eo);
Er=(norm(xx));
disp('Energy of reconstructed signal=');
disp(Er);
```

Percentage

```
per=(Er/Eo)*100;
disp('Percentage of energy in reconstructed=');
disp(per);
```

Comparison

```
save('new.mat','xx');
save('old.mat','a');
z=dir('new.mat');
```

```
k=dir('old.mat');
size_a=k.bytes;
size_xx=z.bytes;
D= imabsdiff(size_a,size_xx);
disp('comparison');
disp(D);
```

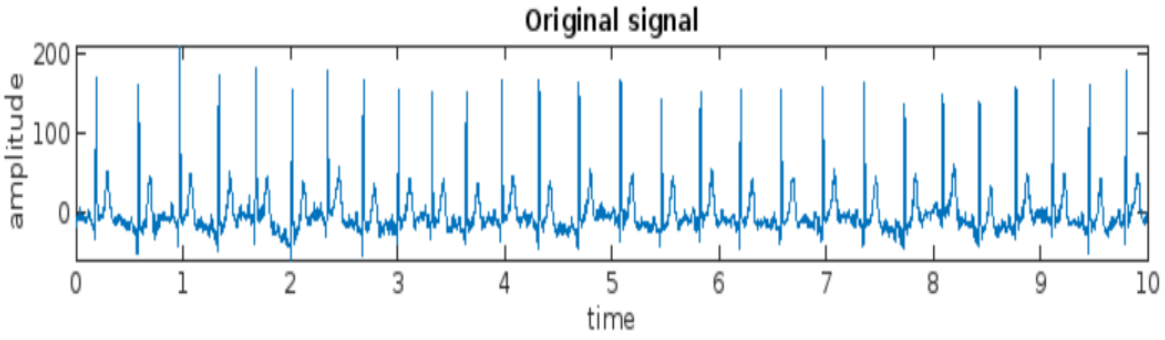

Figure (2.3.1) Original ECG signal

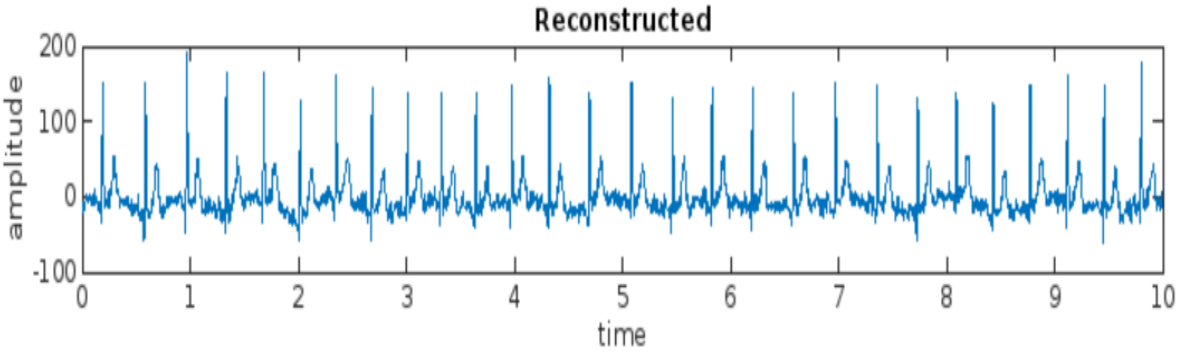

Figure (2.3.2) Reconstructed ECG signal

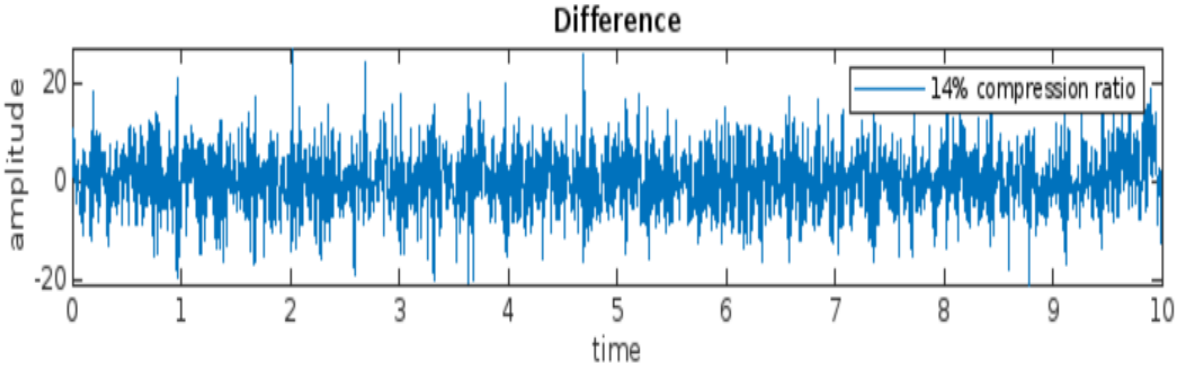

Figure (2.3.3) Difference signal

2.2 COMPONENTS USED

2.2.1 SOFTWARE

MATLAB online has been used to implement the program.

2.3 WORKING

Load a file containing the ECG signal. The original loaded ECG signal is as shown in Figure (2.3.1). Assign the values from the ECG MATFILE to a variable. The signals are sampled at a frequency fs. The sampling frequencies for a ECG signal should be more than 100 Hz and up to 500 Hz or in lab environment up to 1000 Hz. Perform discrete cosine transform on the loaded ECG signal using the MATLAB function (dct). The expansion coefficient is a measure of the energy stored in each of the components. Sort the coefficients in descending order in order to differentiate the signals that are having energy greater than 98% of the coefficients. Express the number as the percentage of total. Set the rest of the coefficients to zero.

Inverse Discrete Cosine Transform is applied on the sorted and zero padded signal to get the compressed signal. Reconstruct the signal from the compressed representation. Plot the Original signal, its reconstruction which is obtained as shown in Figure (2.3.2), and the difference between the two signal as shown in the Figure (2.3.3).

Compression ratio is defined as the ratio between the uncompressed size and compressed size. The compression ration is computed and the size comparison between the original and the reconstructed ECG signal is made in bytes.

Chapter 3

RESULT AND DISCUSSION

1)Electrocardiogram (ECG) signal compression could be achieved using methodologies based on different transforms such as Fast Fourier Transform (FFT), Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT).

2)The project has focused on compression of electrocardiogram (ECG) signal using Discrete Cosine Transform (DCT) technique and has calculated the compression coefficient.

2)The plot of the original signal, compressed signal and the difference signal is presented.

3)The compression in terms of memory consumption is showed as the difference between the size of original and compressed signal in terms of bytes.

4)The project is implemented on different ECG signal data. The plot gives further clarity on the signal compression.

5)Compression using DCT is efficient over techniques such as DFT and FFT because DCT is a real transform which results in a single real number per data point. Whereas DFT and FFT results in a complex number that is real and complex number per data point which requires double the memory for storage.

Chapter 4

CONCLUSION

In this project, a transform-based methodology is presented for ECG signal compression. DCT gives the high compression ratio. It is evident from the simulation results that these transforms can be effectively used for compression and analysis of ECG signal. DCT based compression allowed us to filter energy less than 98%. This is useful in the compression so that one can decide the energy of the compressed signal. DCT is preferred over other transform techniques such as DFT and FFT because DCT works with real time values only. This makes our compression faster and efficient. Compression efficiency is observed through compression coefficient and size difference. It is evident that compression has helped to reduce the memory size by a significant amount and achieved the aim of the project successfully.

REFERENCES

[1] https://in.mathworks.com/matlabcentral/fileexchange/49712-ecg-compression-based-on-dct-and-rleAmit Kumar Sharma, Ashok Kumar Sharma & Nidhi Vijay, “Unipolar and bipolar SPWM voltage modulation type inverter for improved switching frequencies”, International Journal of Engineering Sciences & Research Technology, Vol.3, pp 108-110, 2014.

[2] https://ieeexplore.ieee.org/document/269340M. Gopal, “Control Systems, Principles and Design”, 4th edition.

[3] Oppenheim & Schaffer Discrete Time Signal Processing

[4] S. K. Mitra, Digital Signal Processing