LNMIIT
The LNM Institute of Information Technology
DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Experiment No. # 7
Discrete Cosine Transform Based Audio Compression

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1) **Objectives:**
   a) Discrete Cosine Transform and it's energy compaction property.
   b) Simulink based Audio compression.
2) **Software used:**
   a) MATLAB.

A. *Pre-Lab*

a) Read about Discrete Cosine tranform and compression.
b) practice simulink.

I. Discrete Cosine Transform (DCT)

A. *Theory*

1) J. Proakis and D. Manolakis, Digital signal processing: principles, algorithms, and applications

B. *Procedure*

1) Discrete Cosine Transform: Write a MATLAB code myCompression.m that takes the audio file as the input, find the one dimension DCT, store the significant transform domain coefficients and discards the nonsignificant coefficients, thus compress the original audio file in a compact form. Reconstruction of the audio file is done by following all the steps of compression in reverse manner.
2) **Steps :**
   a) Let x be the audio file of size $1 \times N$. The corresponding $1D$-Discrete Cosine Transfrom y is given by

$$y(k) = w(k) \sum_{n=1}^{N} x(n) \cos\left(\frac{\pi(2n-1)(k-1)}{2N}\right)$$

   where

$$w(k) = \frac{1}{\sqrt{N}}, \qquad k = 1$$
$$= \sqrt{\frac{2}{N}}, \qquad k > 1$$

   Also $n = 1, 2, \cdots N$.

   b) Use the above expression and write down the function for 1D-DCT for $N = 8, 16, ...256$.
   c) Divide the audio data into non-overlapping blocks of size 1×256. For each of them compute the 1D-DCT.

d) Now define two threshold value , Let's say
$Thresold_1 = 0.09$
$Thresold_2 = -0.09$
Keep the DCT coefficents available from above step whose value is greater than $Thresold_1$ and less than $Thresold_2$.
e) Take the 1D-IDCT using
f)

$$x_{idc}(n) = \sum_{k=1}^{N} w(k)y(k) \cos\left(\frac{\pi(2n-1)(k-1)}{2N}\right)$$

where

$$\begin{aligned} w(k) &= \frac{1}{\sqrt{N}}, && k = 1 \\ &= \sqrt{\frac{2}{N}}, && k > 1 \end{aligned}$$

Also $n = 1, 2, \cdots N$.

g) Repeat the above procedure for below cases.
Case 1: $Thresold_1 = 0.5$
$Thresold_2 = -0.5$
Case 2: $Thresold_1 = 0.01$
$Thresold_2 = -0.01$

h) Calculate the mean square error $\epsilon = |x - x_{idc}|^2$, where x_{idc} is a reconstructed approximation.
i) Calculate compression ratio for all cases.

3) **Observation:**
a) Use inbuilt DCT and IDCT function to compress and reconstruct any audio file.
b) Write down the myCompression.m and myDeCompression.m function using the expressions given and cross verify with the inbuilt DCT-IDCT function.
c) Divide the whole audio file in nonoverlapping blocks of size 1×256. Use above function to compress the whole audio file with coefficents saved according to the thresold values. Use myDeCompression.m function to reconstruct audio file, and write in "'outputcompression.wav"' file.
d) Repeat the above steps for given different thresold cases and make a table for mse and compression ratio for given thresold values.
e) Repeat the experiment in simulink.
f) **Conclusion:** Conclude the experiment.

II. Compression in Simulink

a) Open simulink and create a model file with .slx extension.
b) Transfer the audio data from command window to the above generated model file.
c) Write down or utilize myCompression.m in model file to compress and reconstruct the Audio.
d) Write a generalized model which takes thresold value as argument and and perform compression and reconstruction.

Well Done
