DCT and lossy compression

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One-dimensional discrete cosine transform is defined by

$$X_{\mathrm{DFT}}(k) = \begin{cases} \frac{1}{\sqrt{N}} \sum_{n=0}^{N-1} x(n) & k = 0 \\ \sqrt{\frac{2}{N}} \sum_{n=0}^{N-1} x(n) \cos \frac{\pi k(2n+1)}{2N} & k = 1, \ldots, N-1 \end{cases}$$

Two-dimensional DFT is defined by

$$X(p,q) = \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} x(m,n) e^{-j\frac{2\pi}{M}pm} e^{-j\frac{2\pi}{M}qn} ,$$

while two-dimensional DCT is

$$X_{\mathrm{DCT}}(p,q) sum_{m=0}^{M-1} sum_{n=0}^{N-1} x(m,n) \cos \frac{\pi(2m+1)p}{2M} \cos \frac{\pi(2n+1)q}{2N}$$

Task 1

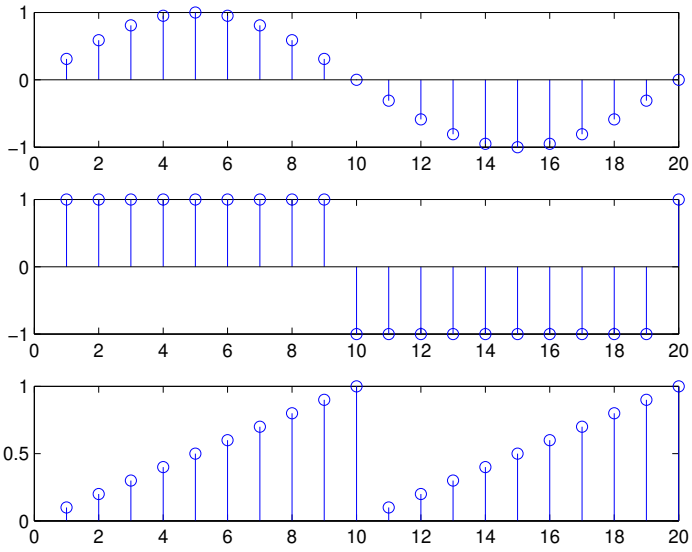
Using script `labptssi5_1.m` generate the following signals:

- sine,
- square,
- sawtooth.

as shown in the figure. Compute FFT and DCT for these signals. Check how changing coefficients of these signals to zeros affects reconstructions (obtained using IFFT and IDCT) of these signals.

Task 2

Test demonstration `dctdemo`. How many DCT coefficients is needed (in your opinion) to maintain acceptable quality.



Task 3

Run the following procedure, which processes Lena image

```
load lena512;
I=uint8(lena512);
I = im2double(I);
T = dctmtx(8);
B = blkproc(I,[8 8],'P1*x*P2',T,T');
mask = [1 1 1 1 0 0 0 0
1 1 1 0 0 0 0 0
1 1 0 0 0 0 0 0
1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0];
B2 = blkproc(B,[8 8],'P1.*x',mask);
I2 = blkproc(B2,[8 8],'P1*x*P2',T',T);
imshow(I), figure, imshow(I2)
pause
close all
```

Answer the questions below

- What is function `blkproc` doing?

- Why matrix `mask` has non-zero values in the upper-left corner.
- Change values in matrix `mask`. What happened?

Task 4

Using script `labptssi5_4.m` save an image to various formats using `imwrite`.

- To which lossless and lossy compression formats this function can save an image?
- Save image `lena512` to BMP, TIFF and JPEG. Explain why files have different sizes.
- Perform histogram equalization using `lena512eq=histeq(uint8(lena512))`. Does it affect sizes of BMP, TIFF, and JPG files? Why?

Information about a graphic file can be obtained using `imfinfo`.