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Comparative study of loss in precision of DCT coefficient when representing in fixed and floating-point method

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Abstract
Representing the numbers in digital makes the design and storage easier and increases the precision. In digital world representation of number in binary form is most popular and appropriate method. DCT co-efficient are real numbers representing the coefficients in hardware is done using fixed and floating point method. JPEG, MPEG, ITU.T are standards in image compression and DCT is used to transform from spatial domain to frequency domain.[2]

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I. Introduction

DCT is the transform used to convert the image to frequency domain from time domain, it is one of standard used in JPEG for image compression.
Real numbers are stored in two ways fixed and floating method. Format followed for fixed point representation is shown below [1]

Integer	Fraction

Sign	Integer	Fraction

In arithmetic operations representation the number in 2's compliment is desirable with definite property with increase in performance and limiting the range. Precise DCT's computation are very close to theoretical computation with increase in complexity. Approximate DCT's is an alternative to reduce the computational complexity. Energy compaction property of DCT shown in the figure contributes for reducing the complexity in computation.[5]

Fig:1 Energy concentrated in left corner shows the compaction property of DCT

II. Results and discussion:

Representing the DCT coefficients approximately or exactly affects the quality of the image.

GUIDE: Graphical user interface development environment is used to demonstrate the difference between computing of DCT coefficients in MATLAB and in Verilog which is a hardware description language. GUIDE supports to create push buttons, Pop-up menus for interfacing. Objective criteria use metrics like peak noise to signal ratio to measure the performance of the method used for compressing the image.

Tabulation shows the number of digits after decimal point and relationship between DCT coefficient, PSNR and compression ratio.

Table: 1 DCT coefficient Representation

Slno	Digits after decimal point	Image-1 Psnr	Co-efficient	Image-2 Psnr	Co-efficient
1	0.99999999	83.36	15782	82.46	19578
2	0.999999	63.3694	13595	65.9066	162364
3	0.999	33.3718	1138	35.6714	12407

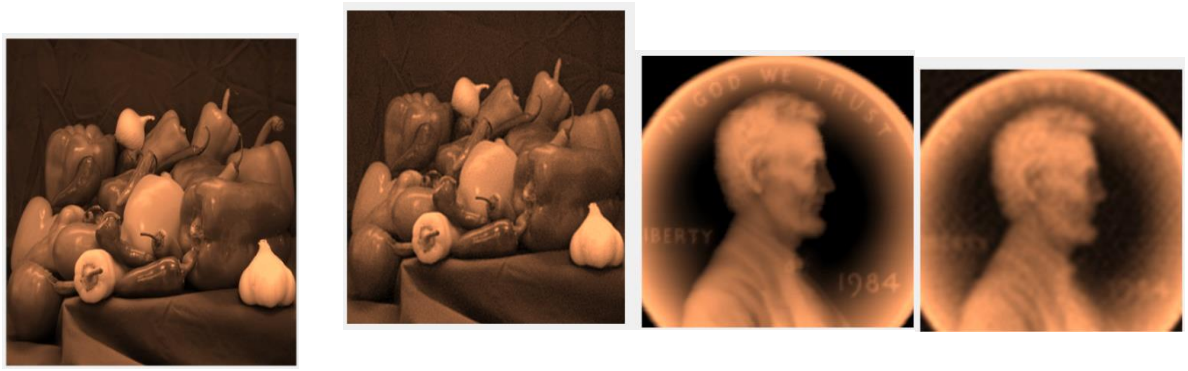

Fig: 2 PSNR=83.36 PSNR=63.36 PSNR=82.46 PSNR=65.90

Figure 2 shows the degradation in the quality of image for change in the number of digits after decimal point. Two images are considered whose DCT coefficients are normalized by varying the digits after decimal point and its effect on PSNR ratio and the quality of image is shown in the table 1 and figure 1. The number of DCT coefficient required for representing the two images decreases as the PSNR ratio decreases with degrading the quality of image.

Graphical User Interface: Figure 3 shows the precision loss in computing DCT using fixed and floating point in Verilog and matlab. The graph shows the difference in DCT coefficients calculated in MATLAB using double precision floating point method and in Verilog fixed point is used to compute DCT coefficients.

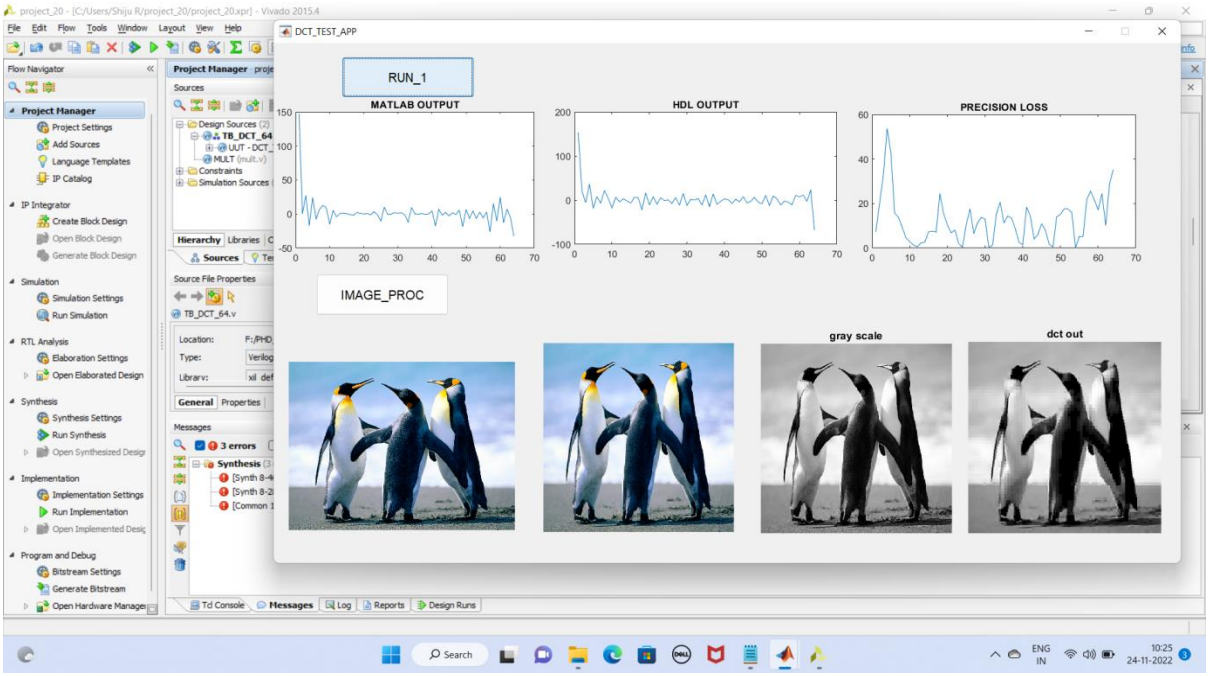

Fig:3 Computation of DCT in MATLAB and verilog

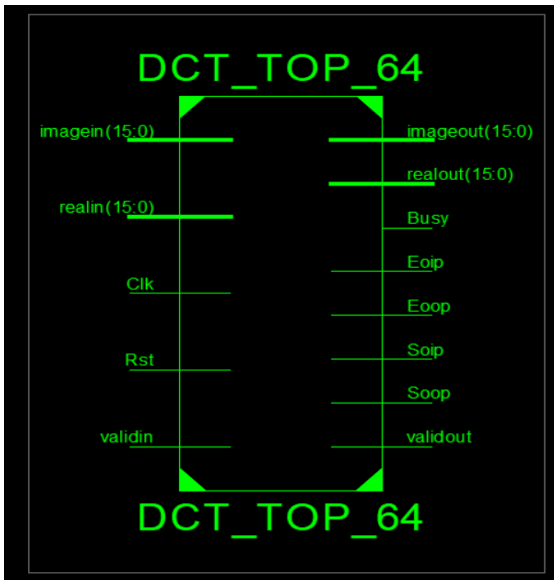

Fig: 4 shows the Top level schematic of DCT in verilog.

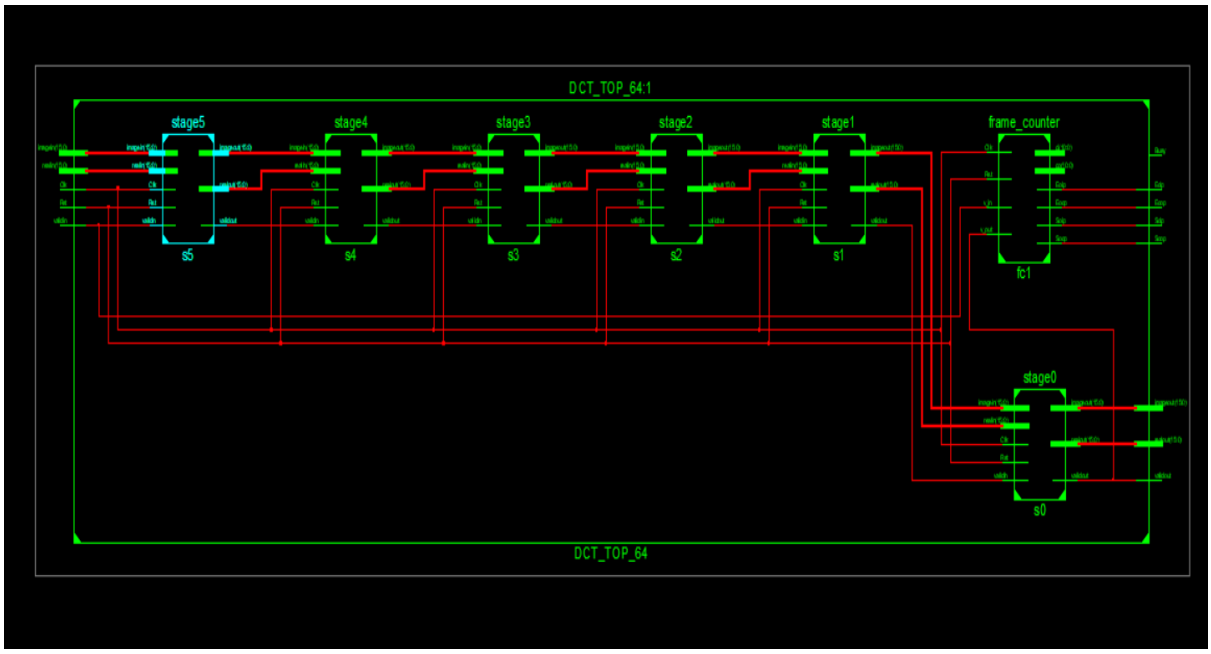

Fig: 5 DCT in Verilog and its internal structure.

III. Conclusion:

The fixed and floating-point representation of DCT coefficients have an effect on the quality of the image. An Optimization path can be adopted depending on the application and precision can be compromised with trade-off between performance and cost.

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