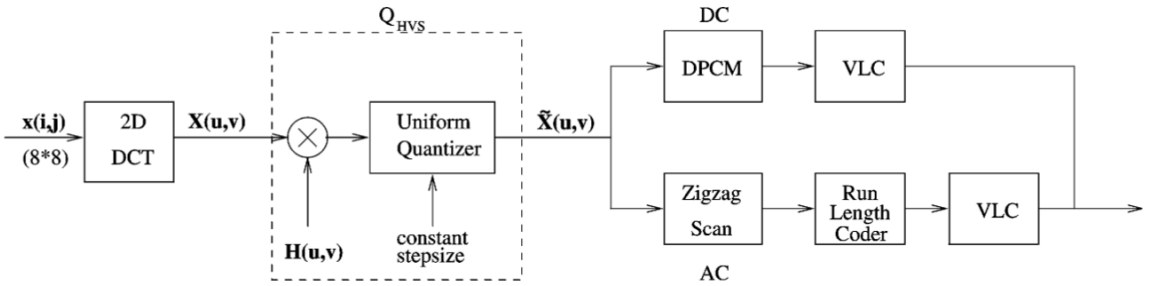
JPEG quantization tables based on human visual system(HVS)[1]

1. Human Visual System: a nonlinear point transformation --> the modulation transfer function(MTF)

$$H(u,v) = \begin{cases} 2.2(0.192+0.114f(u,v))\exp(-(0.114f(u,v))1.1) & \text{if } f(u,v)>f_{max} \\ 1.0 & \text{otherwise} \end{cases}$$

--> weighting matrix H(u, v)

2. DCT-based encoder:



$$X'(u,v) = \text{Round}\left[\frac{X(u,v)}{Q_{HVS}(u,v)}\right], \text{ where } Q_{HVS}(u,v)=\frac{q}{H(u,v)}, \text{ for } u,v \in [0,8)$$

3. HVS-based luminance quantization table: obtain better performance in rate-distortion
*under the assumed viewing conditions (about 0.5 m viewing distance and 100 dots per inch (dpi) resolution)

Reference: [1] C. Y. Wang, “Designing JPEG quantization tables based on human visual system”

Details of implementation

1. Obtain difference image between original and reconstruction image (SSD.m & SSD_rec.m)

2. Difference image will be simulated through E-4-1 Milestone.
   -->Train the block (IntraEncode.m & IntraDecode.m)
      --> DCT8x8; Quant8x8; ZigZag8x8; ZeroRunEnc_EoB; Then inverse.
         --> Quant8x8:
            · Luminance Table: Abovementioned table[1] ; A Novel Deblocking Quantization Table[2] ; Quantization Table generated from psycho-visual error threshold for DCT basis functions[3] ; Quantization Table employed by the JPEG encoder on the Apple iPhone 4/4S models[4] ;
            · Chrominance Table: The standard chrominance table[5] .

3. Respectively combine the bitrate and the predicted frame
4. Calculate bitrate and the corresponding PSNR

Reference: [2] Fu, Qiming, "A novel deblocking quantization table for luminance component in baseline JPEG." [3] N. A. Abu, “A generic psychovisual error threshold for the quantization table generation on JPEG image compression.” [4] C. Sun, “An efficient DCT-based image compression system based on Laplacian transparent composite model.” [5] https://imagemagick.org/discourse-server/viewtopic.php?f=22&t=20427

Plot RD-Function

Advantage:

· Obvious improvements in PSNR
· Suitable for still image and video
· No extra time cost
· Not increase any complexity in either encoder or decoder

Disadvantage:

· Can‘t ensure suitable for all sequences
· Nearly no improvement at low bpp