Image Quality Evaluation

To know after this part

How to evaluate image quality using PSNR and WPSNR

Quality Assessment

Key component to assess the quality of a processed multimedia signal (coding, transmission, watermarking, etc.)

"Objective", "computed" measures : easy computation but can be unreliable.

"Subjective" measures: complex and more oriented on the Human Visual System.

Subjective measures

Subjective assessment: visual quality is judged by human observers: observers are request to rate the quality of the watermarked image to different quality scale

Disadvantages:

expensive, non-repeatable

hard to distinguish very small difference between original image and altered image

We need objective measures

imperceptible	excellent
perceptible, not annoying	good
slightly annoying	fair
annoying	poor
very annoying	bad

Objective measures

Mean Absolute Difference

$$MAD = \frac{1}{N}\sum_{k}\sum_{m,n}\left|V_1(m,n,k) - V_2(m,n,k)\right|$$

Mean Square Error

$$MSE = \frac{1}{N}\sum_{k}\sum_{m,n}\left(V_1(m,n,k) - V_2(m,n,k)\right)^2$$

Peak SNR

$$PSNR = 10\log_{10}\frac{V_{\max}^2}{MSE}$$

Objective measures

On average they are good and reliable metrics

All of them measure the difference w.r.t. the original

Different artifacts have the same weight

The analysis is carried out on a pixel basis

There is no context/content-related analysis

A shift of the image by a few pixels would probably return a very low score

Original Image

What's wrong here?

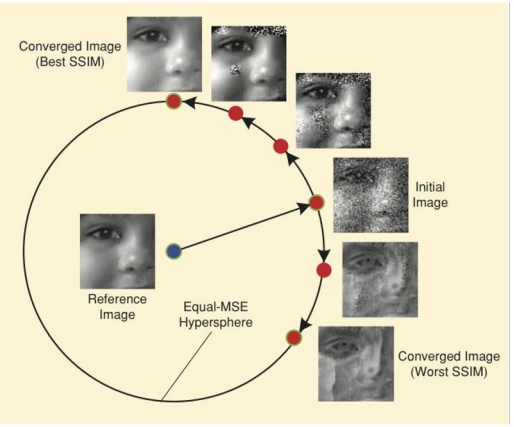
Traditional objective metrics have some implicit assumptions:

Signal fidelity is independent of the signs of the error signal samples.

All signal samples are equally important to signal fidelity

If the noise, or the error, is randomly placed in the picture, the metric does not care

We can find an equal-MSE hypersphere where the perceptual quality is clearly very different among the pictures



What's wrong here?

Disadvantages

- Ignore the fact that judging the perceptual quality of image significantly depends on the human observers
- Don't take into account the effect of HVS

Ideally the improved methods are ought to combine merits of the two types of assessments

- Automated objective measure
- Consider Human Visual System

Weighted PSNR (WPSNR)

PSNR 24.6dB
wPSNR 26.4dB

PSNR 24.6dB
wPSNR 27.9dB

PSNR 24.6dB
wPSNR 29.3dB

Weighted PSNR (WPSNR)

Based on the fact that human eye is less sensitive to changes in textured areas than in smooth areas

WPSNR uses an additional parameter called Noise Visibility Function (NVF), a texture masking function, as a weight factor

$$WPSNR_{dB} = 10 \log_{10} \left(\frac{255^2}{MSE \cdot NVF^2} \right)$$

Any NVF<1, WPSNR will be slightly higher than PSNR

Weighted PSNR (WPSNR)

NVF uses a Gaussian model to estimate how much texture exists in any area of an image

Flat regions NVF->1

Edge and texture regions NVF->0

$$NVF = NORM\left\{\frac{1}{1+\delta^2_{block}}\right\} \in [0,1]$$

Normalization function

Luminance variance for the block of pixel

Weighted PSNR (WPSNR)

For texture images we can increase more watermark energy without sacrificing perceptual quality

Baboon has higher perceptual capacity

WPSNR is more effective and precise in evaluating the perceptual quality of an image

Quality Evaluation

Exercises:

Edit the image in the spatial or transform domain and see how the quality is affected