

Statistical Approach to Medical Image Errors Analysis

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Abstract: Medical imaging has been viewed as the window to the body, but, no window reveals everything. The process of medical image, as a means of pathological diagnoses, involves three major steps; image preparation, image viewing conditions, and the performance of the observer. To have quality in this process, the three stages of quality namely quality of organization, quality of process and quality of performance are the requirements. The quality of a medical image is determined by the imaging method, the characteristics of the equipment, and the imaging variables selected by the operator. Image quality is not a single factor but a composite of at least five factors: contrast, blur, noise, artifacts, and distortion, as shown above. The relationships between image quality factors and imaging system variables are complex and often confounded.⁽¹⁾

Contrast can be verbalized as the difference in light intensities, or colors in the image. It is considered the most fundamental characteristic of an image. An object within the body will be visible in an image only if it has sufficient physical contrast relative to the image surrounding background. Enumeration of contrast refers to the difference between two specific points or areas in an image, and in most cases the contrast between a specific structure or object in the image and its background is the purpose. Blurriness is related with the visibility of smaller objects and the details of the image. Image noise affects image texture and appearance. There are many systematic and random sources of error in image noise, and their amount depend on many factors including imaging method.^(1,2,3)

As a branch of graphic technique, diagnostic imaging shares image artifacts. Artifact does not significantly affect object visibility and diagnostic accuracy, but they can obscure a part of an image or may be interpreted as an anatomical feature. A variety of factors are associated with each imaging method that are causes of image artifacts. The known sources of errors and those that can be factorized are stochastic in nature and follow the rules of statistics and even could be simulated using Monte Carlo techniques. Using statistical approach, the root mean square of errors can be determined by computing the standard deviation for each factor in the parameters error space.

The image error then will be computed by^(1,2,3)
$$\text{Erms} = \left[\sum_{i=1}^n S_i^2 \right]^{1/2}$$

Ref: 1- <http://www.sprawls.org/ppmi2/> 2-<http://www.cambridgeincolour.com/tutorials/noise.htm>
Aceil, S. M. and Edwards, D. R. "Sensitivity Analysis of Thermal-Hydraulic Parameters and Probability Estimation of Boiling Transition in a Standard BWR/6". Nuclear Technology, Vol. 93 Feb 1991.