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Selecting a Suitable Gamma Value for Bone Scan Image Enhancement using Gamma Correction Method

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Abstract

Bone scan is one of the most important tests in nuclear medicine used to identify abnormalities in the bone. The bone image produced by gamma camera in nuclear medicine is very noisy image. Thus image enhancement is very important for accurate diagnosis. There are different methods used for image enhancement in this work we want to use a gamma correction method to enhance the image and then select a best gamma value, which is gives better image. The result shows that the best bone image enhanced with gamma correction methods when gamma value was 0.6 ($\lambda = 0.6$). The result was judged by expertise.

Keywords: Bone Scan; Enhancement; Gamma Camera; Gamma Correction; Nuclear Medicine

Introduction

The nuclear medicine imaging system used to provide information on a wide range of disease after injecting the patient with a very small amount of radionuclide. The radionuclide imaging is one of the most important applications of radioactivity in nuclear medicine. It used to obtain a picture of the distribution of a radioactivity within the body [1]. The importance of nuclear medicine imaging lies in its ability to provide an exquisitely sensitive measure of a wide range of biologic processes in the body [1].

Image enhancement is one of the most important tools used in image process to modify the original image so the resulting image is more suitable for specific application [2, 3]. In medical imaging, many images

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suffer from noise and low contrast, there for its necessary to enhance the image before displaying for visual, detail worth full and accurate diagnosis.

Various image enhancement techniques have been proposed for enhancing the contrast of an image [4, 5(16)- 8(19)]. Histogram equalization (HE) is a technique used widely for image contrast enhancement [2]. However, HE technique cause loss of contrast during enhancing gray level images [7]. In order to overcome the problem of brightness in the images, preserving bi-histogram equalization [8], and dualistic sub-image histogram equalization [9] have been proposed. In this technique, however, desired improvement may not always be achieved, and the difference between input and output image is minimal.

Some other methods have been proposed for medical image enhancement and noise removal such as log transform, gamma correction, pixel contextual information [10], etc.

In general, most of the contrast enhancement techniques proposed to produce noiseless and high contrast images. In this work we will concentrate on gamma correction transform techniques. Gamma correction is one of the most important pre-processing steps in medical image processing methods.

Bone Scan: A bone scan is one of the most important exams used for diagnosing patient in a nuclear medicine department. For a bone scan the patient injected with Tc^{99m} and is sent to the waiting room for about three hours, then transferred to the gamma camera for imaging the total time for images is about 15 min. The gamma used to perform this work was Sprit Nucline dual head gamma camera from Mediso with resolution 256 x 1024 pixels. Four pair images of patient with metastases were used to perform this work

The quality of the enhanced image with gamma correction technique depends on the gamma values; the image contrast increased and decreased a cording to the gamma value. In this work we want to select

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a suitable gamma value for gamma enhancement method, which is gives an image with noise free and high contrasts.

Materials and methods

Gamma Correction technique is a nonlinear operation used to encode and decode images. Gamma correction is, in the simplest cases, defined by the following power law expression. When the gamma value is less than one ($\gamma < 1$) the expression sometimes called an encoding gamma, and the process of encoding with this compressive power-law nonlinearity is called gamma compression; conversely a gamma value greater than one ($\gamma > 1$) is called a decoding gamma and the application of the expansive power-law nonlinearity is called gamma expansion. The concept of gamma correction can be applied to any nonlinear relationship. The gamma correction can be expressed as follows:

$$S = Cr^{\gamma} \qquad (1)$$

Where C and λ are positive constant, r is the value of input pixel and S is the corresponding value of the output pixel.

The gamma correction technique is very important tools for enhancing images and better visualization, the quality of the image depends on the gamma value.

The quality of resulting image was evaluated by using the entropy performance measure. Image entropy is a quantity which is used to describe the amount of information which must be coded in the image. The image with less entropy is the best.

The resulting images enhanced with gamma correction methods using different gamma values were validated by nuclear medicine expertise.

Result and Discussion

The bone image enhanced with a gamma correction technique using different gamma values for better visualization. Matlab program was used to read and enhanced the images. Two different images were used and gamma value between 0.3 - 4 were tested.

Figure 1 shows the result of the first image enhanced with gamma correction technique, the image enhanced

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and the amount of noise was reduced, when $\gamma = 0.6$. Image enhanced with $\gamma = 3$ was very noisy and the metastases was not clear and it's very difficult to be diagnosed with the nuclear medicine physician. However, with gamma, lower than 0.6 some legions can't be seen and some details removed from the image.

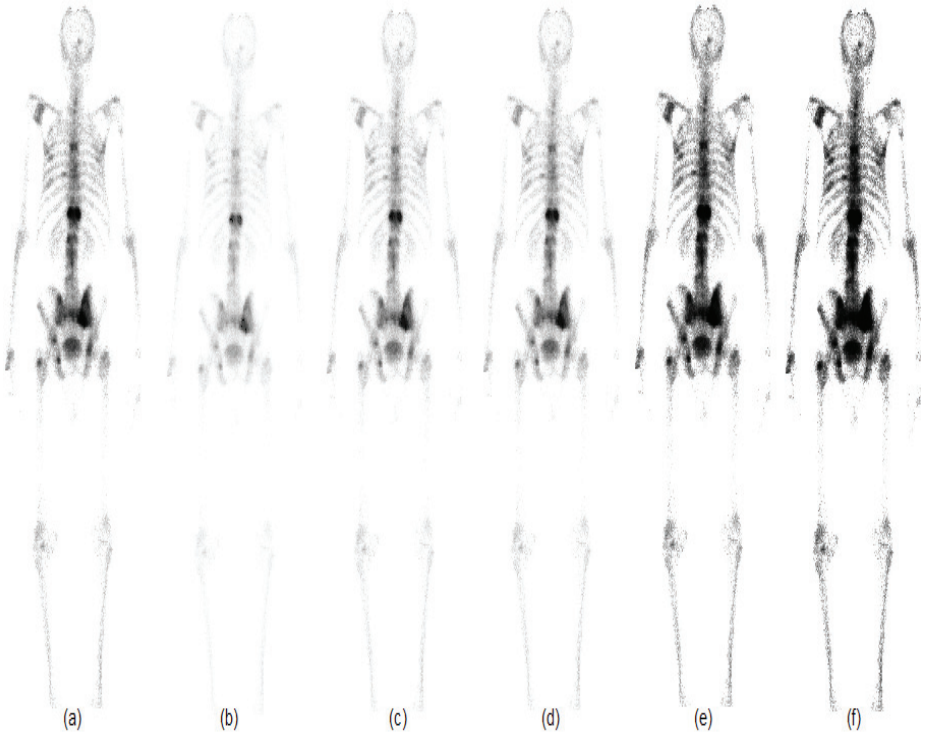

Figure 1: thin patient (a) original image (b) enhanced image with $\gamma = 0.3$ (c) enhanced image with $\gamma = 0.6$ (d) enhanced image with $\gamma = 0.7$ (e) enhanced image with $\gamma = 2$ (f) enhanced image with $\gamma = 3$.

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Figure 2 shows images of second patient enhanced with gamma correction, the best image was obtained with $\gamma = 0.5$, lower gamma values can remove some important details from the image and higher value gives noisy image.

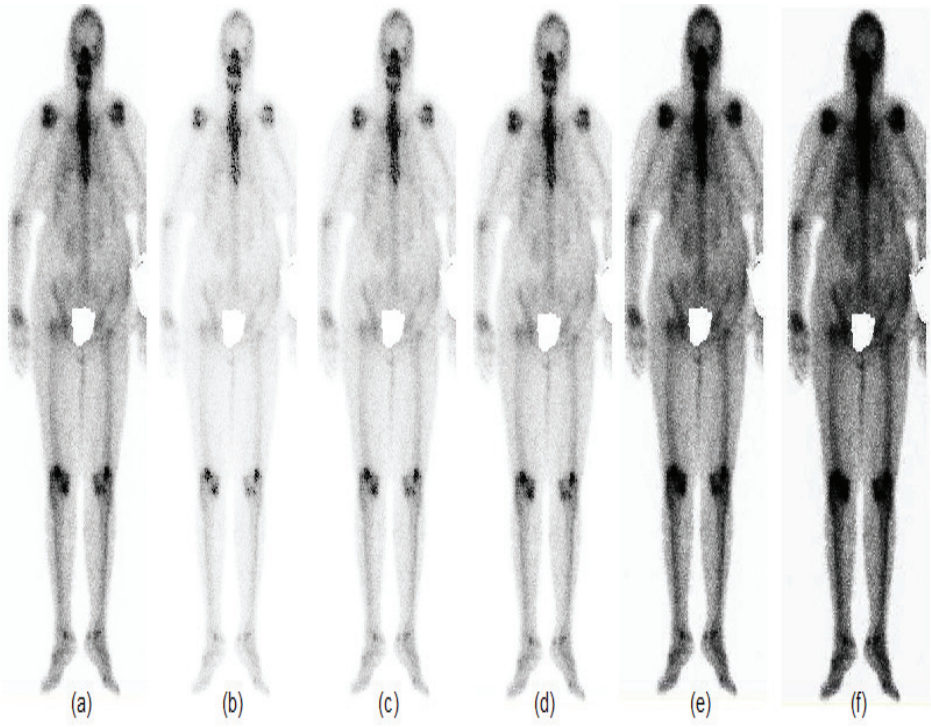

Figure 2: healthy patient (a) original image (b) enhanced image with $\gamma = 0.3$ (c) enhanced image with $\gamma = 0.5$ (d) enhanced image with $\gamma = 0.7$ (e) enhanced image with $\gamma = 2$ (f) enhanced image with $\gamma = 3$.

Thus the gamma values depend on the patient shape (body) the healthy patient image can be enhanced by lower gamma value and the thin patient enhanced with higher value.

The enhanced image was evaluated with entropy, the result shows that for the first group, image enhanced with $\gamma = 0.6$ was the best and for the second group image enhanced with $\gamma = 0.5$ was the best.

Conclusion

The whole body bone scan image was successfully generated by gam

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ma camera and enhanced for better visualization. Bone scans image can be enhanced with gamma correction technique and gives an image with noise free. Images of two patients were selected and enhanced with gamma correction the result shows that the selection of gamma value to enhance image depend on the patient size. For the two patients selected the gamma values was 0.5 and 0.6 respectively. We can conclude that the gamma value effect on the quality of the image and suitable gamma value can give pest image.

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