Section A -Research paper
ISSN 2063-5346

Quality Enhancement of Medical Images Using DICOM

Mrs Monika [1] , Dr. Chandan Kumar [2]
Department of Computer Science
[1]Research Scholar , *Career Point University, Hamirpur, H.P.*
[2] *Professor, Career Point University, Hamirpur, H.P.*
**Corresponding author E-mail: kundimonika@gmail.com,*
2 Email:- chandansharmahmr@gmail.com

DOI: 10.48047/ecb/2023.12.si4.1671

Abstract: The process of working with a picture to produce a result that is superior to the original image in terms of its suitability for a certain application is referred to as image enhancement. It offers a variety of options that may be used within the context of digital image enhancement methods, with the goal of improving the perceptible look of photographs. The imaging approach, the job at hand, and the settings under which one is seeing all play a significant role in determining the relevant possibilities for such procedures. This study will provide an overview of several techniques that are often used for the improvement of medical images. The purpose of this research is to give an analysis of the numerous methods that may be used to improve medical images. The analysis that is presented in the research helps to identify a picture of high quality, which is significant for the preparation of medical imaging applications. In addition to this, it offers an analysis of DICOM, which is a standard that is used in almost every device used for radiology, cardiology imaging, and radiotherapy, as well as in an increasing number of devices used for achieving good image quality in other medical specialties, such as ophthalmology and dentistry. In this work, we also studied previous research, and we came to the conclusion that the use of watermarking as a security measure has yielded the most encouraging results in the case of medical photographs. As a result, we have made the decision to use watermarking strategies in order to provide protection for medical photographs.

Keywords: Medical image, Medical image enhancement, Digital Imaging and Communications in Medicine (DICOM).

1. INTRODUCTION

The appearance of a photograph may be enhanced by the use of a number of image enhancement techniques. An image's spatial information may be retrieved by enhancing its visual quality and appeal. Photos taken with a smartphone or mobile phone often have poor contrast. As a consequence, algorithms will be required to improve the contrast in these images. [19,24,26] The basic goal of image enhancement [2,5,22] is to improve the amount of information in the picture that the human eye can discern. Since each pixel is altered, the outcome is an image that looks better than the original. Many sectors benefit from image enhancement, including medical imaging and remote sensing, HDTV, HDR, X-ray, microscopic, and many more. Image enhancement is one of the most fundamental digital image processing approaches. For the greatest results, several of these tactics call for the utilization of interactive processes. Because of the growing use of digital imaging technologies in medical diagnosis, digital image processing is needed in health care. Digital sensors are also employed in endoscopy and radiography, in addition to completely digital imaging modalities like CT or MRI. Thanks to the tiny pixel size, digital photos allow for precise control over lighting and contrast. Using particular communication networks and protocols, they may be handled with efficiently and accurately [21,22]. The improvement of biomedical images is essential for the detection and evaluation of the human body's functioning. An important aspect of image processing, this approach boosts the visual impact of a photograph. By decreasing noise, fine-tuning contrast, and improving brightness for analysis, this strategy aims to improve the image's special qualities.

Figure 1: Showing the effect of Image Enhancement [43]

1.1 Medical Image Enhancement

Pre-processing of medical images is essential for detecting human organs such the lungs and ribs [4,34,26]. Enhancing medical images is an important step in this process. Medical image segmentation is the context for this project. The effort made to boost contrast ultimately determines the result of image processing. The Sobel method, the Prewitt algorithm, and the Laplacian of Gaussian operator [25] are three of the most often used techniques for edge identification. Medical picture edge detection cannot make use of techniques that belong to the high pass filtering family because of the noise in these images. This is because both noise and edge are classified as having a high resonant frequency. Image noise and object boundaries are common in medical images used for real-world applications. As a consequence, it may be difficult to tell the exact edge apart from the background noise or from unimportant geometric features. "Medical imaging" is a term used to describe the process and practice of creating visual representations of a patient's internal organs for the purposes of clinical analysis and medical intervention. Medical imaging is used to find out what is concealed under the skin and bones. Anomalies may also be detected with more ease thanks to this technology. A wide range of imaging modalities and processes are referred to as "medical imaging" in order to provide pictures of the human body in order to aid in diagnosis and therapy. Thus, medical imaging has a significant role to play in efforts to enhance overall health for all populations. It is vital in all three levels of health care: primary, secondary, and tertiary. All aspects of health care, including public health and preventative medicine, need accurate diagnoses in order to make informed decisions. Picture enhancing is a technique that focuses on processing images in such a way that the enhanced version of the picture is more suited to the specific application than the original version of the image was. Using the word "specific" is critical in this circumstance. Such an operation raises a red signal since their effects are very dependent on the exact environment in which they are used. An image enhancement technique that works well on X-ray topography images may not work as well on MR images, to put it another way.

There are two basic categories of picture enhancement techniques: those that work in the frequency domain and those that act in the spatial domain. There are several methods that belong within this category, and they all revolve upon manipulating individual pixels on the picture plane. Changing an image's Fourier transform is the underlying principle of frequency domain processing operations.. Using this equation, the process may be explained. If the input image is represented by f(x, y), then the processed image is represented by g(x, y), and the operator T is defined over some neighborhood of the input image, then (x, y). Creating a neighborhood around a point (x, y) is easiest when you use a rectangle or square subimage area with the point (x, y) in its center (x, y). The center of the subimage is moved from pixel to pixel starting at the top left corner of the subimage. The output, g, generated by the operator T at each location (x, y) is unique to that location. Only the pixels in the area covered by the neighborhood are utilized during the process. There are several ways to improve a medical image using wavelet transformation [29]. Using the Haar wavelet technique, high-frequency pictures may be decomposed into subimages. As a result, high-frequency subband noise will be reduced by applying soft-thresholding. In the end, the process of inverse wavelet transformation produces the better image. Another common method of enhancing the quality of medical photographs is histogram equalization [38]. Dispersion of gray levels is increased in this method to increase contrast in the image. Increasing contrast has the potential to harm both the image and the surrounding areas, therefore this method cannot be relied upon to provide consistently outstanding results across the board. As a consequence, many variations on this strategy have been devised in order to improve its efficacy [31,32]. In order to improve abdominal ultrasound images, a method based on a combination of histogram equalization and wavelet modification is proposed in the publication [37]. Abdominal wall boundaries and surrounding areas are enhanced by this algorithm, and it is able to handle changing conditions. Another strategy for improving medical photos is gamma correction [27]. To get locally ideal Gamma values for each every pixel, this approach requires reducing the original image's homogeneity of co-occurrence matrix. By boosting the dynamic range using the Gamma correction, the picture's quality may be improved. Medical images are sharpened using morphological filters [33]. An advanced class of morphological filters is used to further sharpen the edges that have previously been detected using gradient-based operators. There's no doubt about it: Morphological operators play an important part in the detection process for many types and sizes a broad range of items that are already present inside images. Edge-detection methods such as Canny and Sobel [35] are comparable in performance to morphological gradients, which are used to find picture edges.

1.2 Image Enhancement Methods

The enhancement methods can broadly be divided in to the following two categories:

- *A approach called spatial domain methods [18,28] deals directly with the pixels of a picture. The pixel values are altered to produce the desired effect. First, the picture is transformed into a frequency domain representation using algorithms that operate in the frequency domain. So, the first step is to calculate the image's Fourier Transform (Fourier TT). The Fourier transform of the picture is used for all image enhancing processes, and the Inverse Fourier transform is used to produce the final image. The brightness, contrast, and gray level distribution of a picture may all be altered using these image enhancement techniques. Consequently, the pixel values (intensities) of the output picture will be altered as a result of the transformation function applied to the input values.*

Frequency Domain Methods: In the frequency domain, image enhancement is simple. A filter (rather than a spatial convolution) is used to improve a picture instead of convolution in the spatial domain. An image's high frequency components may be reduced or increased in amplitude to blur or sharpen a picture, respectively. This is a simple concept to grasp. Convolutions by modest spatial filters in the spatial domain, on the other hand, are more computationally efficient. Frequency-domain approaches may lead to new ideas that were not possible if just spatial considerations were taken into account.

Every sector in which pictures need to be interpreted and evaluated makes use of image enhancing techniques. For instance, medical picture analysis, satellite image analysis, and so on. Simply said, image enhancement is the process of changing a picture f into an image g using T (where T is the transformation. r and s represent the pixel values in pictures f and g, respectively. The phrase, as previously stated, connects the pixel values r and s.

$$S = T(r) \dots\dots\dots\dots\dots\dots\dots..(1)$$

A pixel value r is transformed into a pixel value s via the transformation T. When working with grayscale photos, the results of this transformation are mapped to the grayscale range. There are k bits in the picture, and hence results are mapped back into the range [0–L-1], where L=, k. So, for example, an 8-bit picture will have a pixel range of [0, 255].

1.2.1 Point Processing Operation

- When the neighborhood is only the pixel itself, the simplest operations in the spatial domain are possible. The term "grey level transformation" or "point processing procedure" is used here to describe T. Equation depicts the shape that point processing procedures take (1). It is possible to change in three different ways [44].
- An identity shift and a shift from positivity to negativity are part of the linear metamorphosis.
- • Logarithmic: Dark pixels are extended in comparison to higher pixel values when log transformation is performed. Higher-resolution images are compressed through logarithmic transformations.
- Figure 1 depicts the nth power transformation and the nth root transformation as two different forms of Power Law Transformation..

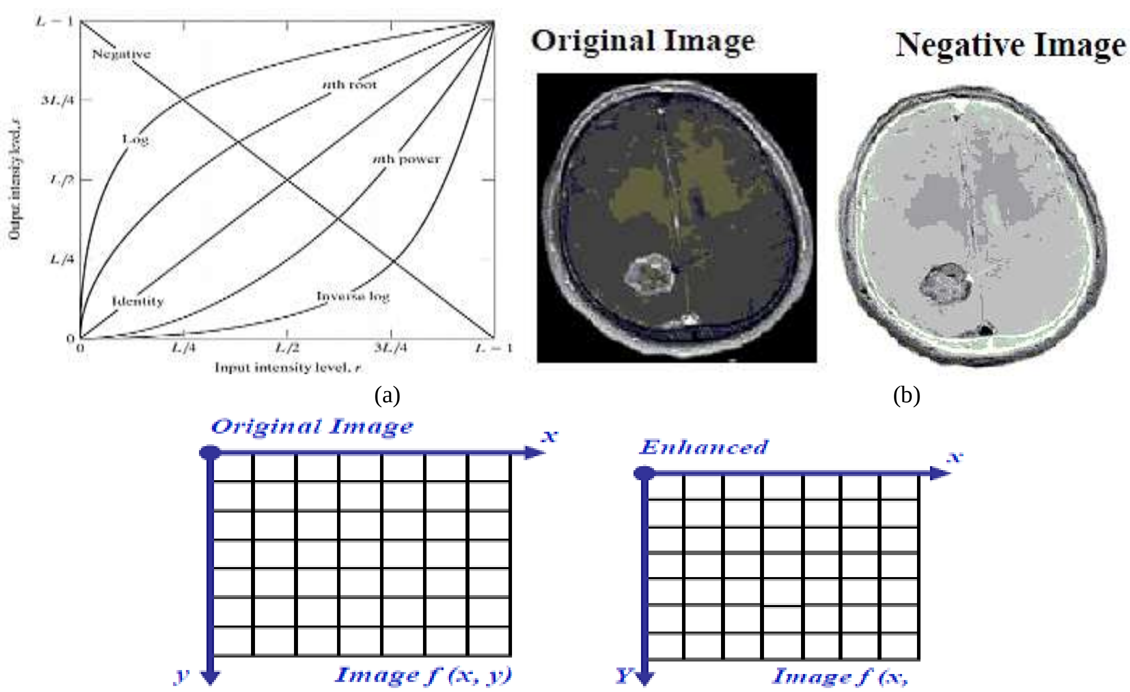


Figure 1: (a) Basic grey level transformations [44]; (b) Negative of Brain tumor image [28]

a. *Negative Image:* Calculating an image's negative is the first step in this procedure [1]. The pixel intensity standards are reversed to compute an image's negative. To illustrate this, a picture of dimensions R x C, where R represents the number of rows and C represents the number of columns, is indicated using the suffix "I." (r,c). Calculate the image's negative, denoted by N(r, c), using the following equations:

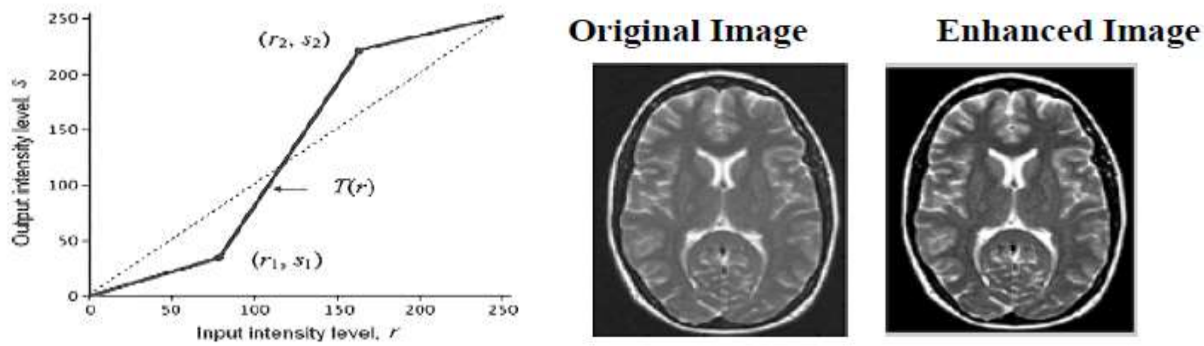
$$N(r, c) = 255 - I(r, c) \ldots\ldots\ldots\ldots\ldots..(2)$$

Assume R and C are both equal to zero. Each pixel value in the original picture is subtracted from the value 255 in this example. Afterwards, we create a retouched negative. To bring out the white or grey elements in the shadows, negative photos might be helpful.

b. *Contrast stretching:* Image sensors without dynamic series or lens apertures adjusted incorrectly during the acquisition phase result in pictures with limited contrast. Contrast stretching [8,12,16,17] enlarges the image's sequence of gray points, extending the device's or medium's whole range of gray levels in the process. Contrast in the photos may be boosted by making the darker and brighter areas darker and lighter. In order to achieve a contrast stretching approach in a picture, we convert the image as shown in Equation 3 and Figure 2(a). Low contrast photos are caused by insufficient light, such as a misaligned lens aperture during image capture or a lack of dynamic series on the image sensor. As a result of contrast stretching, the complete range of grey levels on the presentation device or recording medium may be extended, making images seem more realistic. Contrast in the photos may be boosted by making the darker and brighter areas darker and lighter. Figure 2(a) demonstrates the transformation needed to achieve contrast stretching in a picture, as shown in Equation 3 and Figure 2(a).

$$s = \begin{cases} l * r & 0 \le r < a \\ m * (r - a) + v & a \le r < b \\ n * (r - b) + w & b \le r < L - 1 \end{cases} \quad \ldots\ldots\ldots\ldots\ldots (3)$$

The slopes are represented by I, m, and n. Figure 2 clearly illustrates this point (a). For example, in equation 3, the dark gray levels are made darker by assigning a slope of less than one (between (0, 0), as well as between and the L-1,L-1 range), while the bright intensity levels are made brighter by allocating a slope of more than one (between and the L-1,L-1 range). The dynamic range of the upgraded picture will increase as a result of the contrast stretching process.



(a) (b)

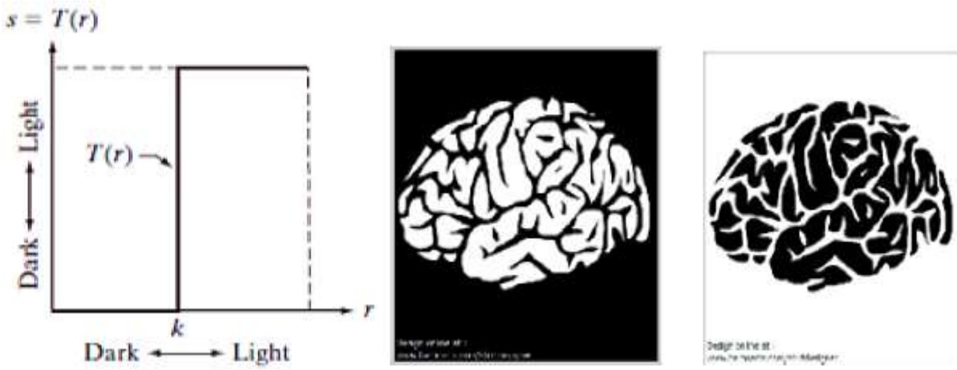
Figure 2: (a) Contrast Stretching Graph; (b) Enhancement of Brain tumor image after Contrast stretching [13]

Different slopes might be made to the original picture depending on the application for which it is to be utilized. No combination of slope values yielded the desired result, while we discovered that picture enhancement is a one-off operation. The contrast stretching transformation increases the dynamic range of the rebuilt picture. Figure 2 (a) shows that the area of the points and) controls the contour of the transformation function from the supplied graph. There are no changes in gray levels between the two transformations (and vice versa).

c. Thresholding: In the case when (r 1= r 2), s 1=0, and s 2=L-1 are all true, then the transformation yields a threshold function, as previously explained. A dualistic picture is produced by the threshold function, as may be seen in the following figure 3. (a). It's common to see this equation used to calculate the threshold image::

$$\begin{cases} 0 & r \le a \\ L - 1 & r > a \end{cases} \quad \ldots\ldots\ldots\ldots\ldots (4)$$

Figures 3 (a) and 3 (b) show the threshold function [28] diagram and output image, respectively. For a thresholding picture, the output will always be black, which is represented by a pixel value of 0, and white, which is represented by a pixel value of 255.



(a) (b)

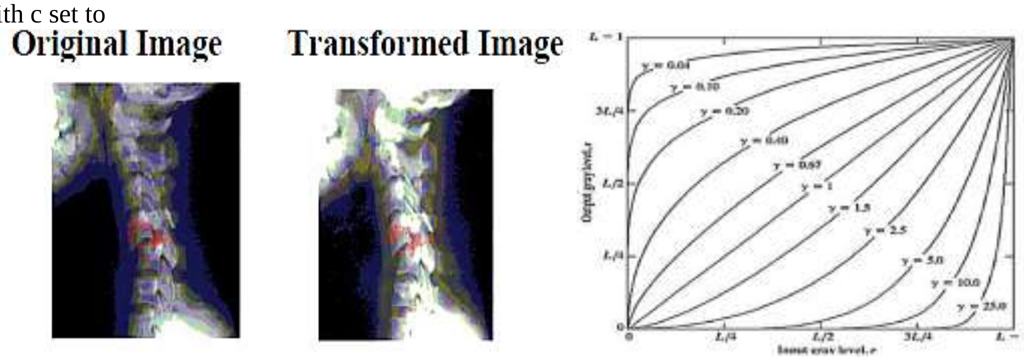
Figure 3: (a) Thresholding function; (b) Thresholding function applied on brain image [13]

d. Log transformation: The log transformation in general form is given as :

$$s = c * log\,(1 + r) \ldots\ldots\ldots\ldots\ldots (5)$$

The log transformation combines a limited set of input intensity level measurements with a larger set of output measurement results. The inverse log transformation is the opposite transformation of log transformation [28]. [28] The Log functions are in handy when the input gray level evaluations have an extremely wide range of assessments. A log transform is used here in order to enhance the image's detail. The gray levels should be in the range [0.0, 1.0] with c set to

1.



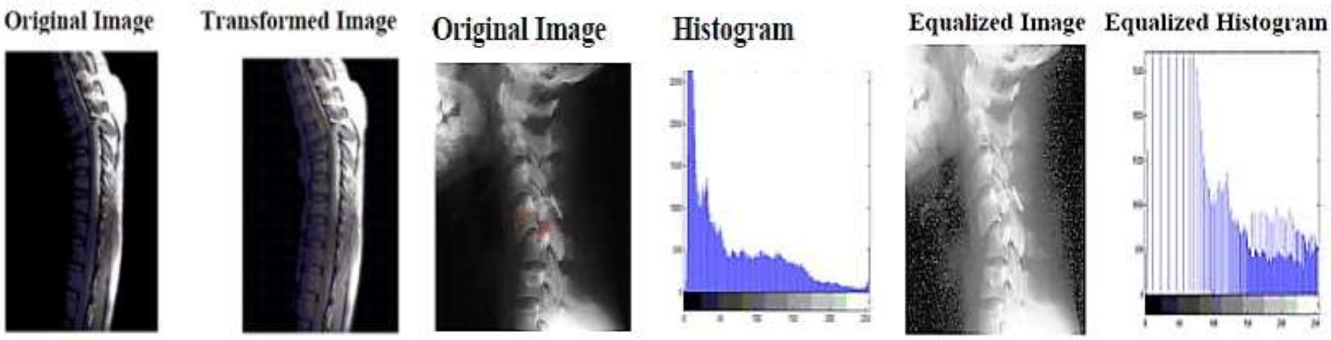
(a) (b)

Figure 4: (a) Log transformation function applied onto the cervical spine fractured image; (b) The plot of Power law transformation [13]

e. Power law transformation: In order to maintain the image's quality after a power-law transformation, the exponent appearing in the function must be selected. Equation 6's nth power and nth root curves are shown in Figure 4 (b):

$$s = cr^{\gamma} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Where, s and r are the intensity points of pixels in the input and output pictures and c remains constant. Depending on the gamma value, several phases of improvement may be achieved. For various values of s other than constant as c = 1, the plots in figure 4(b) below show how power law transformation curves work with input intensity level 'r,' along the x-axis, and the output intensity level "s,' along the y-axis. The gamma parameter may be varied to provide a wide variety of plausible transformation curves.



(a) (b) (c)

Figure 5: (a) Enhancement of MRI of fractured human Spine by power law transformation by varying Gamma; (b) ; The original image with its histogram; (c) the equalized versions by histogram equalization [13]

f. Histogram Equalization: An image contrast enhancement technique known as Histogram Equalization (HE) [15,39] equalizes the histogram in such a manner that the picture is improved. It's a discrete job to generate a digital picture histogram with intensity points in the range [0, L-1].

$$h(r_k) = n_k \dots \dots \dots \dots \dots \dots \dots \dots (7)$$

The overall amount of pixels present in an image is repeatedly normalized in histogram. Considering M x N as an image, a stabilized histogram is allied to the likelihood of happening of r_k in the image.

$$p(r_k) = \frac{n_k}{MN} \quad K = 0,1,2, \dots \dots , L-1 \dots \dots . (8)$$

Histogram equalization, also known as collective method, is used to improve the appearance of photographs on the outside. Histograms are more likely to favor the darker end of the spectrum if the picture is largely dark. Every pixel in the picture will be pushed to the histogram's darker periphery as a result. Our picture will evolve more smoothly if we distribute the intensity values towards the darker end of the histogram.

1.3 Applications of Medical Imaging

To improve the quality of photographs, image enhancement is used. Aerial imaging, satellite imaging, medical imaging, digital camera application, and remote sensing are the most common uses of image enhancement. Forensics, astronomy, and fingerprint matching are just a few of the numerous fields that make use of image enhancement methods. Clear pictures may be achieved by the use of such methods as color contrast improvement, sharpening, and brightness. This is used in medical imaging to enhance the image's visual representation by decreasing noise and sharpening features. This necessitates the use of image augmentation in MRI and ultrasound to examine atomic regions. An image's quality may be improved to aid in the identification of criminals and the protection of victims using fingerprint recognition, security video analysis, and crime scene investigations.

1.4 DICOM

After the introduction of digital medical image sources in the 1970s and the use of computers in the processing of these images after their acquisition, the National Electrical Manufacturers Association (NEMA) and the American College of Radiology (ACR) came together to form a joint committee with the goal of developing a standard method for the transmission of medical images and the information that is associated with them. The ACR-NEMA Standards Publication No. 300-1985 was issued the next year by this committee, which was formed in 1983. The bulk of devices used proprietary formats to store and subsequently transmit data in order to communicate images, either over a network or onto portable storage. Version 2.0 of the ACR-NEMA initiative was released in 1988, but the bulk of the promise of a standard means of exchanging digital image information was not achieved until the publication of version 3.0 of the Standard in 1993.. ACR-original NEMA's efforts to standardize nomenclature, arrange information, and unofficially encode files were to blame. With the release of version 3.0, a number of improvements were made that delivered on the promise of standardized communication under the new moniker of

Digital Imaging and Communications in Medicine (DICOM). DICOM's network protocol currently uses TCP/IP, and it also defines the functioning of Service Classes beyond basic data transmission, as well as producing an identification method for reliably identifying Information Objects over the network [40,41]. The DICOM standard was meant to be a multi-part document to make it easy to add new functionality. To go along with the standardization of image files, DICOM also created Information Objects to bring together data about patients, studies, reports, and other sources. The DICOM (Version 3.0) enhancements make it possible for the Standard to live up to its promise. This promise encompassed not only the capacity to transport medical pictures in a multi-vendor environment, but also the ease of the construction and extension of picture archiving and communication systems (PACS) and the interface with medical information systems. The time has come to make good on this commitment.

DICOM is employed or will soon be utilised by about every medical profession that makes use of photographs during the healthcare company [3,6,11,20]. This is because DICOM was established for use in diverse medical picture investigations. A wide range of medical specialties are represented in this category: cardiology; dentistry; endoscopy; mammography; orthopaedics; pathology; pediatrics; radiation therapy; radiology; surgery; and more. Even in veterinary medical imaging applications, DICOM is used. DICOM also supports the incorporation of patient EHR data generated by a wide range of specialty applications into the DICOM repository (EHR). Network and media interchange services that EHR systems may employ to store and retrieve DICOM objects are outlined in this document The best approach to use your DICOM medical imaging knowledge in the real world is to get your hands dirty. The first thing you should do is download and install a DICOM application that is appropriate for your needs. You may learn a lot for free, thanks to a variety of programs that are readily accessible. These formats include PostDICOM, Horos, RadiANT, Miele LXIV, and Navegatium.

MEDICAL IMAGE WATER MARKING

The ultrasound pictures have been processed using the technique developed by Zasni Jain [45]. She has obtained the ultrasound picture, then segmented it into the ROI and RONI areas of the image. The watermark is then embedded into the medical picture with the help of the mod function. This ensures that the watermark may be equally challenged over the whole image. This will prevent unauthorized individuals from cropping the medical picture, so ensuring its safety. Again, before the watermark is added, the hash values are generated, and then with the help of a technique called the message digest, these hash values and the watermarked information are added to the picture. A. Giakoumaki Algorithm [46]: They start by separating the medical picture into two parts: the area of interest, and the region that is not of interest. After that, they use a method called fragile watermarking to authenticate the medical image by introducing text messages into the piece that is not of interest. Birgit et al: Birgit [49] has segmented the picture into multiple parts and identified the features of each segment, such as the intensity or the visual quality of each segment individually. On the basis of these characteristics, a choice on the insertion of the watermark is made. For instance, the area with the lowest visibility might have its watermark reversed by using more rigorous procedures than the regions with the most visibility. Because it includes more specific information about the body part, the area that has extremely excellent visibility will not have a watermark placed on it. This approach incorporates both the method fragile and the method robust for the insertion of the additional information in the form of watermarking. In this manner, the method encompasses both ways. algorithm developed by Wang and Rao) [48]: The fact that this approach was created for real-time diagnostics meant that the algorithm for this fragile method was beneficial. During the diagnosing process, following the use of the medical picture information of embedding, information leaks with the individuals. Therefore, when watermarking the information, the same chaotic sequence of the watermark information will be automatically formed. Additionally, the picture will be automatically watermarked after it has been used. In this approach, a technique that is normally fragile will be able to function in a manner that is analogous to one that is robust. Sunita V. Dhavale [47] explains that the DCT technique and the hospital logo have both been utilized as a watermark for the purposes of fragile watermarking verification. Malay. They worked on fragile watermarking in the spatial domain, as mentioned by Kumar Kundu [54]. For this purpose, they made advantage of the gray scale characteristic. Calculations of PSNR were carried out in order to measure the overall MSE. Taha Jassim [48]: This is the first time that attempts have been made to implement watermarking for mobile phones. For the purpose of watermarking, this technique took into account both the restricted bandwidth and the limited storage.

1.4.1 DICOM's added capabilities

More than merely viewing DICOM pictures, today's DICOM medical imaging viewers may do a variety of other functions as well. It is possible to enhance picture quality and produce extra data from photographs captured by certain programs, making them useful for diagnosis. In addition to merely looking at the picture, you may do the following: [42]*Increasing or decreasing the brightness of the picture is one method for improving the image's overall quality. Altering the contrast of an image allows for improved differentiation between radiodense and radiolucent portions of the picture. You also have the option to zoom in on the region of interest. Maximum and minimum intensity projections are an innovative approach that may be used to significantly enhance the picture quality in the region of interest. This helps to differentiate between locations that have received the most or the least radiation from the surrounding areas. It also helps to separate areas that have absorbed the most or the least radiation.*

Making measurements:

Certain medical DICOM viewers provide the user the ability to measure anatomical features in a linear or even volumetric fashion. This may be helpful in both the planning of therapy and the evaluation of how well the treatment is working. For instance, planning orbital reconstruction after a traumatic damage to the bony orbit might benefit from volumetric analysis as well as a comparison of the afflicted orbit with the unaffected one.

The process of reconstructing images:

The first DICOM data set is comprised of a collection of two-dimensional pictures that have been obtained in each of the three planes: axial, coronal, and sagittal. These pictures may be rebuilt in such a way as to provide a view of the anatomical region in three dimensions. This technique is known as 3D rendering. Making new slices from the reconstructed 3D pictures is the focus of yet another method, which is referred to as Multiplanar Reconstruction, or MPR for short. Because of this, the radiologist is able to observe various anatomical levels or angulations from the slices that were initially obtained.

Comparing and merging medical pictures: DICOM medical applications provide the radiologist the ability to look at two separate images at the same time so that they may determine which one is more accurate. When attempting to evaluate the effectiveness of a therapy or the progression of a condition over a period of time, this might be helpful. Using certain DICOM applications, it is also possible to merge two distinct imaging modalities that are used in medical diagnosis. For example, merging PET and CT scans helps guarantee that regions of high metabolic activity (identified by PET) are mapped to particular anatomical places. This can be accomplished in a number of different ways (using CT scan). Because of this, the doctor is able to reap the benefits of both kinds of imaging modalities at the same time, which is really beneficial.

2. RELATED WORK

This section highlights the literature survey of various approaches and techniques in table I used by different researchers in the field of image enhancement of medical images.

Table I. Literature Survey

S.No	Author	Method/Technique	Proposed Work	Finding	Limitation
1.	Subramani & Veluchamy	Exposure based contrast limited bi-histogram equalization method	Meant to improve the visual quality of medical images	The proposed algorithm improves contrast while preserving brightness and visual quality	Sometimes the contrast in the image cannot be equally enhanced.
2.	Fajar, A., et.al	3D images based on medical images	Propose an algorithm for reconstructing 3D images based on medical images in the DICOM format	Experimental results show that the proposed method can handle various DICOM files and correctly project annotations onto the resized image.	These metadata of different DICOM files may involve divergences if the images are taken without supervision.
3.	Islam & Mondal	Laplacian, Sobel operator, addition operation, filter, product operation and power law transformation techniques	The developed method is tested on low contrast medical images to improve image contrast.	With the help of the technologies used, it is possible to get the details which are kept hidden as well as to improve the image contrast.	The edges and borders on image are not as clear as expected due to interference and low intensity in images.
4.	Dawood & Abood	Exponential and logarithm equations	To improve the illumination and contrast of medical images.	The statistical results of PSNR, MSE and RMSE showed the efficiency of the equations in improving the illumination and contrast of medical images, especially for CT images.	Low contrast, speckle noise, having signal dropouts and complex anatomical structures may create difficuilty.
5.	Dorgham, O., et.al	Hybrid encryption algorithms	Enhancing the security of exchanging and storing DICOM medical images on the cloud	The results of the analyses showed that for a DICOM file with size 12.5 Mb, 2.957 minutes was required to complete the process.	Security issues due to attack
6.	Perumal & Velmurugan	Filtering techniques	Preprocessing by contrast enhancement techniques for medical images.	The research work focuses on preprocessing lung images.	Time factor is the main drawback of this research technique.
7.	Kaur, R., et.al	Contrast enhancement techniques: INT operator, Type-1 Fuzzy and Type-2 Fuzzy. Fuzzy hyperbolisation technique	Comparative analysis of contrast enhancement techniques for medical images	INT Operator is better than other techniques to increase the contrast of the images without edge detection.	-
8.	Pandey, P., et.al	Kalman filter	Enhancement of medical images using Kalman filter.	The proposed technique will help the doctors and physicians to analyze the medical images more accurately	The medical images commonly include the issues of noise, bad quality and low intensity.
9.	Firoz, R., et.al	Morphological transform operation	Medical image enhancement using morphological transformation.	The results indicate that this method improves the contrast of medical images and can help with better diagnosis.	Noise issue can occur
10.	Nithyananda & Ramachandra	Histogram equalization	Histogram equalization method-based image enhancement techniques.	Histogram equalization using different types are briefly explained and placed in chronological order for comparison purpose.	The images resulted by quality measures made by hardware and software may not be always good and are not having natural look.

Section A -Research paper
ISSN 2063-5346

3. CONCLUSION

The term "image enhancement" refers to a wide range of sophisticated techniques that may be applied to photos in order to make them more appealing to the human eye. The choice of method is determined by the specific job at hand, such as the composition of the picture, the characteristics of the observer, and the viewing circumstances. The point processing methods are the image processing activities that are the most straightforward but are still required. This is so that the pictures' contrast may be improved. It is the Image Negative that is responsible for bringing out the white elements in the areas that are mostly dark. The field of medical imaging is another area where it may be used. Transformations based on power laws are helpful for contrast modification in general purpose situations. Spreading of intensity levels may be accomplished effectively by the use of a power-law transformation for dark pictures that has a fractional exponent. Log transformation is effective when it comes to boosting the data in the darker sections of the picture at the expense of fine points in the brighter parts of the image. When applying a power-law transformation to any picture that has a desiccated appearance, a firmness of gray levels may be created when the value of is larger than 1. The histogram of an image gives the key information that one needs to know about the contrast of a picture. Histogram equalization is the process of taking the contrast and stretching it out by reordering the values of the different intensity levels in a consistent manner. Nevertheless, the computational cost of improvement techniques is an important factor to consider when choosing a procedure for usage in real-time applications. Instead of doing each technique alone, a person in training has to construct a combination of such ways to get extra efficacy in the medical image improvement. This is required in order to meet the requirements of the training. In addition to the hundreds of thousands of medical imaging enhancement methods that are now in use, DICOM is also regarded to be one of the most extensively implemented healthcare messaging Standards in the whole globe. DICOM has made it possible for more sophisticated medical imaging applications, which have "transformed the way clinical medicine is practiced." DICOM is the standard that makes medical imaging function for both patients and their treating physicians. It is used everywhere from the emergency room to the testing of heart stress to the diagnosis of breast cancer.

ACKNOWLEDGMENT

REFERENCES

[1] Woods, R. E., & Gonzalez, R. C. (2021). Digital image processing third edition.
[2] Subramani, B., & Veluchamy, M. (2020). A fast and effective method for enhancement of contrast resolution properties in medical images. *Multimedia Tools and Applications*, *79*(11), 7837-7855.
[3] Fajar, A., Sarno, R., Fatichah, C., & Fahmi, A. (2020). Reconstructing and resizing 3D images from DICOM files. *Journal of King Saud University-Computer and Information Sciences*.
[4] Islam, S. M., & Mondal, H. S. (2019, July). Image Enhancement Based Medical Image Analysis. In *2019 10th International Conference on Computing, Communication and Networking Technologies (ICCCNT)* (pp. 1-5). IEEE.
[5] Dawood, F. A., & Abood, Z. M. (2018). The Importance of Contrast Enhancement in Medical Images Analysis and Diagnosis. *International Journal of Engineering Research & Technology (IJERT),* Vol. 7, no.12.
[6] Dorgham, O., Al-Rahamneh, B., Almomani, A., & Khatatneh, K. F. (2018). Enhancing the security of exchanging and storing DICOM medical images on the cloud. *International Journal of Cloud Applications and Computing (IJCAC)*, *8*(1), 154-172.
[7] Perumal, S., & Velmurugan, T. (2018). Preprocessing by contrast enhancement techniques for medical images. *International Journal of Pure and Applied Mathematics*, *118*(18), 3681-3688.
[8] Kaur, R., Chawla, M., Khiva, N. K., & Ansari, M. D. (2018). Comparative analysis of contrast enhancement techniques for medical images. *Pertanika J Sci Technol*, *26*(3), 965-78.

[9] Abdoon, R. S., & Khudair, O. S. (2018). Employing Histogram Equalization Enhancement Technique to Segment Different Medical Images of Three Organs. *Journal of Advanced Microscopy Research*, *13*(4), 494-502.

[10] Pandey, P., Jain, S., & Khatri, S. K. (2017, September). Enhancement of medical images using Kalman filter. In *2017 6th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO)* (pp. 619-623). IEEE.

[11] Monteiro, E., Costa, C., & Oliveira, J. L. (2017). A de-identification pipeline for ultrasound medical images in DICOM format. *Journal of medical systems*, *41*(5), 1-16.

[12] Kaur, R., Chawla, M., Khiva, N. K., & Ansari, M. D. (2017). On contrast enhancement techniques for medical images with edge detection: a comparative analysis. *Journal of Telecommunication, Electronic and Computer Engineering (JTEC)*, *9*(3-6), 35-40.

[13] Shweta, K. V. (2017). A Review of Enhancement Techniques on Medical Images. *IJACET*, *4*(3).

[14] Firoz, R., Ali, M. S., Khan, M. N. U., Hossain, M. K., Islam, M. K., & Shahinuzzaman, M. (2016). Medical image enhancement using morphological transformation. *Journal of Data Analysis and Information Processing*, *4*(1), 1-12.

[15] Nithyananda, C. R., & Ramachandra, A. C. (2016). Histogram equalization method-based image enhancement techniques. Department of ECE.

[16] Tiwari, M., & Gupta, B. (2016, March). Brightness preserving contrast enhancement of medical images using adaptive gamma correction and homomorphic filtering. In *2016 IEEE Students' Conference on Electrical, Electronics and Computer Science (SCEECS)* (pp. 1-4). IEEE

[17] Singh, S., & Pal, P. (2016). Contrast Enhancement of Medical Images.

[18] Kokate, R. M., & Shandilya, V. K. (2016). Enhancement techniques of medical images-a review. *International Journal of Advanced Research in Computer and Communication Engineering*, *5*(2), 533-535.

[19] Janani, P., Premaladha, J., & Ravichandran, K. S. (2015). Image enhancement techniques: A study. *Indian Journal of Science and Technology*, *8*(22), 1-12.

[20] Alagdar, M. A., Morsy, M. E., & Elzalabany, M. M. (2015). MATLAB techniques for enhancement of liver DICOM images. *International Journal for Research in Applied Science & Engineering Technology (IJRASET)*, *3*(XII).

[21] Wu, H. T., Huang, J., & Shi, Y. Q. (2015). A reversible data hiding method with contrast enhancement for medical images. *Journal of Visual Communication and Image Representation*, *31*, 146-153.

[22] Rana, S. B., & Rana, S. B. (2015). A review of medical image enhancement techniques for image processing. *International Journal of Current Engineering and Technology*, *5*(2), 1282-1286.

[23] Gorai, A., & Ghosh, A. (2011, September). Hue-preserving color image enhancement using particle swarm optimization. In *2011 IEEE Recent Advances in Intelligent Computational Systems* (pp. 563-568). IEEE.

[24] Ahmed, H. S., & Nordin, M. J. (2011). Improving diagnostic viewing of medical images using enhancement algorithms. *Journal of Computer Science*, *7*(12), 1831.

[25] Singh, G., & Singh, S. (2013). Medical Images Edge Detection Using Mathematical Based Morphology.". *Apeejay Journal of Computer Science and Applications*, *1*, 1-4.

[26] Mohanapriya, N., & Kalaavathi, B. (2013). Comparative study of different enhancement techniques for medical images. *International Journal of Computer Applications*, *61*(20).

[27] Amiri, S. A., & Hassanpour, H. (2012). A preprocessing approach for image analysis using gamma correction. *International Journal of Computer Applications*, *38*(12), 38-46.

[28] Maini, R., & Aggarwal, H. (2010). A comprehensive review of image enhancement techniques. *arXiv preprint arXiv:1003.4053*.

[29] Yang, Y., Su, Z., & Sun, L. (2010). Medical image enhancement algorithm based on wavelet transform. *Electronics letters*, *46*(2), 120-121.

[30] Sawant, H. K., & Deore, M. (2010). A comprehensive review of image enhancement techniques. *International Journal of Computer Technology and Electronics Engineering (IJCTEE)*, *1*(2), 39-44.

[31] Sengee, N., Bazarragchaa, B., Kim, T. Y., & Choi, H. K. (2009, June). Weight clustering histogram equalization for medical image enhancement. In *2009 IEEE International Conference on Communications Workshops* (pp. 1-5). IEEE.

[32] Wang, Q., Chen, L., & Shen, D. (2008, August). Fast histogram equalization for medical image enhancement. In *2008 30th Annual International Conference of the IEEE Engineering in Medicine and Biology Society* (pp. 2217-2220). IEEE.

[33] Mahmoud, T. A., & Marshall, S. (2008, August). Medical image enhancement using threshold decomposition driven adaptive morphological filter. In *2008 16th European Signal Processing Conference* (pp. 1-5). IEEE.

[34] Rajab, M. I., Woolfson, M. S., & Morgan, S. P. (2004). Application of region-based segmentation and neural network edge detection to skin lesions. *Computerized Medical Imaging and Graphics*, *28*(1-2), 61-68.

[35] Chen, T., Wu, Q. H., Rahmani-Torkaman, R., & Hughes, J. (2002). A pseudo top-hat mathematical morphological approach to edge detection in dark regions. *Pattern Recognition*, *35*(1), 199-210.

[36] Tang, H., Wu, E. X., Ma, Q. Y., Gallagher, D., Perera, G. M., & Zhuang, T. (2000). MRI brain image segmentation by multi-resolution edge detection and region selection. *Computerized Medical Imaging and Graphics*, *24*(6), 349-357.

[37] Fu, J. C., Lien, H., & Wong, S. T. C. (2000). Wavelet-based histogram equalization enhancement of gastric sonogram images. *Computerized medical imaging and graphics*, *24*(2), 59-68.

[38] Moore, C. J. (1986). Medical image processing: the characterization of display changes using histogram entropy. *Image and Vision Computing*, *4*(4), 197-202.

[39] Hummel, R. A. (1975). Histogram modification techniques. *Computer Graphics and Image Processing*, *4*(3), 209-224.

[40] DICOM. Online available at: https://www.dicomstandard.org/about

[41] DICOM. Online available at: http://dicom.nema.org/dicom/geninfo/strategy.pdf

[42] A Crash Course on Handling DICOM Medical Imaging Data. Online available at: https://www.postdicom.com/en/blog/handling-dicom-medical-imaging-data

[43] Radiography software GOPView® XR2Plus .Online available at: https://www.medicalexpo.com/prod/contextvision/product-100514-787184.html

[44] Gray Level Transformation. Online available at: https://www.javatpoint.com/dip-gray-level-transformation

[45] Jasni Mohamad Zain, Malcolm Clarke, “Reversible Region of Non-Interest (RONI) Watermarking for Authentication of DICOM Images”, IJCSNS International Journal of Computer Science and Network Security, VOL.7 No.9, September 2007.

[46] Anastassios Tagaris, Aggeliki Giakoumaki, “Watermarking SDK Implementation to Facilitate Integration in a Secure Healthcare Environment”, EMBS Annual International Conference USA, Aug 30-Sept 3, 2006.

[47] Sunita V. Dhavale; Rajendra S. Deodhar; Debasish Pradhan; L. M. Patnaik, “Robust multiple stereo audio watermarking for copyright protection and integrity checking”, Third International Conference on Computational Intelligence and Information Technology (CIIT 2013) Pages: 9 - 16, DOI: 10.1049/cp.2013.2567,2013.

[48] Taha. Jassim; Raed Abd-Alhameed; Hussain Al-Ahmad, “New Robust and Fragile Watermarking Scheme for Colour Images Captured by Mobile Phone Cameras”, UKSim 15th International Conference on Computer Modelling and Simulation, ,Pages: 465 – 469, 2013..

[49] P. Wang, ”A Public Key Watermark for Image Verification and Authentication”, Proceedings of International Conference on Image Processing (ICIP’98), pp. 425-429, 1998.

Section A -Research paper
ISSN 2063-5346

[50] J. A. Bloom, I. J. Cox, T. Kalker, J.-P. M. G. Linnartiz, M. L. Miller, C. B. S. Traw, ”Copy Protection for DVD Video”, Proceedings of IEEE, Vol. 8, No. 7, pp. 1627-1276, July 1999

[51] .B. M. Plantiz, A. J. Maeder, ”A Study of Block-Based Medical Image Watermarking Using a Perceptual Similarity Metric”, Proceedings of the Digital Imaging Computing: Techniques and Applications (DICTA 2005), 2005.