COMPARATIVE STUDY ON DIFFERENT IMAGE ENHANCEMENT TECHNIQUES WITH BRAIN TUMOUR IMAGES.

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I. ABSTRACT:

Image processing is a rapidly growing field that involves the manipulation of digital images using algorithms and computer programs. One of the fundamental tasks in image processing is to extract useful information from images, which can be challenging due to noise, lighting conditions, and other factors that can affect the quality of the image. In this article, we shall be talking about the different Image Enhancement Techniques and we shall apply these techniques to the Brain Tumour Images.

II. INTRODUCTION:

Image processing is a rapidly growing field that involves the manipulation of digital images using algorithms and computer programs. One of the fundamental tasks in image processing is to extract useful information from images, which can be challenging due to noise, lighting conditions, and other factors that can affect the quality of the image.

One of the most useful techniques in image processing is image enhancement. Image enhancement is a critical step in image processing that aims to improve the quality, clarity, and visual appearance of digital images. It involves the use of a variety of techniques and algorithms that can modify an image's attributes, such as brightness, contrast, sharpness, color balance, and spatial resolution. The process of image enhancement is an essential step in several fields, such as medical imaging, remote sensing, digital photography, and computer vision.

The quality of the images captured in different applications can vary due to various factors such as noise, blur, low contrast, and inadequate lighting. These factors can affect the readability, accuracy, and usefulness of the images. Image enhancement techniques help to overcome these limitations by modifying the pixel values of the image to

improve its visual appearance and make it more useful for analysis and interpretation.

The purpose of image enhancement is to make the images more visually appealing, informative, and useful for various applications. In medical imaging, image enhancement techniques can help in improving the clarity of the images and identifying diseases or abnormalities in the human body. In remote sensing, image enhancement techniques can help in improving the quality of satellite images, which can aid in detecting changes in land use and monitoring natural disasters. In digital photography, image enhancement techniques can help in correcting the color balance and removing unwanted objects from the image.

Image enhancement techniques can be broadly categorized into two types: point processing and spatial processing. Point processing techniques involve modifying the individual pixel values of an image based on a predefined mathematical function. Spatial processing techniques involve the manipulation of the entire image using convolution operations or filtering techniques.

Overall, image enhancement is an essential step in image processing that plays a crucial role in improving the quality, clarity, and visual appearance of digital images. It has a significant impact on various fields, from medical imaging to digital photography, and continues to be an active area of research and development.

Fig 1 : Deblurring images using a Wiener filter.

III. LITERATURE REVIEW:

Image enhancement is one of the most important techniques in image processing that are widely used for various applications. Here is a more detailed literature review of some recent studies on these techniques:

[1] Removal of the Noise & Blurriness using Global & Local Image Enhancement Equalization Techniques :

The research paper uses both a global and local approach methodology to extract the noise and blurriness factors. Analyze an image after receiving it. Depending on the number of sources, divide an image (in case of local approach only). Then, apply the relevant systematic model, which includes the median filter techniques by parts along with equalisation and concatenation of all images. Confirm on the basis of assumptions for noise test cases whether the same noise is added in the entire image, the same noise with different values, or even different noise of different values. For the blur test cases in both local and global methodologies, the same system models will be deployed (using Weiner & other blur removal Filters). The histogram, PDF, and probabilities are described.

[2] U-shape Transformer for Underwater Image Enhancement:

Poor underwater imaging quality is caused by the scattering and absorption of light by underwater impurities. Lack of a large dataset with a variety of underwater scenes and high-fidelity reference images is a problem for the current data-driven based underwater image enhancement (UIE) techniques. Additionally, the inconsistent attenuation in various colour channels and space regions is not fully taken into account for enhanced boost. In this study, we built a dataset of 4279 image pairs called the Large-Scale Underwater Image (LSUI) and reported a U-shape Transformer network, which is the first time the transformer model has been applied to the UIE task. A channel-wise multi-scale feature fusion transformer (CMSFFT) module and a spatial-wise global feature modelling transformer (SGFMT) module are integrated into the U-shape Transformer, which strengthens the network's focus.

[3] Comparison of GAN Deep Learning Methods for Underwater Optical Image Enhancement :

When compared to optical images taken in our atmosphere, underwater optical images are subject to a number of restrictions that reduce the image quality. Low contrast, blurry clarity, and colour degradation are caused by attenuation according to the light's wavelength and reflection by very small floating objects in underwater images. In this paper they created the image data of the Korean Sea and improved it by teaching CycleGAN (cycle-consistent adversarial network), UGAN (underwater GAN), and FUnIE-GAN the characteristics of underwater images (fast underwater image enhancement GAN). Additionally, the underwater optical image was improved using the Image Fusion image processing method. UIQM (underwater image quality measure), which assesses the performance of the enhancement in terms of colour, sharpness, and contrast, and UCIQE (underwater image quality evaluation) is used to make a quantitative performance comparison.

[4] Exploring the effect of image enhancement techniques on COVID-19 detection using chest X-ray images :

In order to stop the virus from spreading during the pandemic and lessen the strain on the healthcare system, computer-aided diagnosis for the accurate and quick detection of corona virus disease (COVID-19) has become essential. Compared to other imaging and detection methods, chest X-ray imaging (CXR) has a number of benefits. However, in this paper numerous CXR enhancement techniques' effects on the classification of plain and segmented CXR images have been thoroughly investigated.

The results of this study is validated using an image visualization technique to support the deep network findings. The results of COVID-19 detection is then improved by the use of enhancement techniques, transfer learning, and lung segmentation.

[5] Image enhancement with naturalness preservation :

There are many methods in the literature for improving images with poor lighting. The majority of these techniques are based on retinex theory, which only takes into account the image's reflectance component while ignoring its illumination. However, achieving a pleasing perceptual quality in an image depends heavily on illumination. Additionally, illumination must be preserved for an image to retain its naturalness. The image enhancement method suggested in this paper preserves the good illumination already present in the image while enhancing the details. To improve the perceptual quality and naturalness of images with poor illumination, they recommend adding a suitable amount of brightness to low-lit areas of the image. This work primarily makes two contributions. It first suggests a poor illumination. Second, it suggests using an adaptive logarithm transformation to add the necessary brightness to the image's poorly lit areas.

In recent years, deep learning-based techniques have shown promising results in image enhancement. These techniques have the potential to learn complex image features and can be trained on large datasets to improve the quality and appearance of images. Further research is required to explore the potential of these techniques in different applications and to develop new algorithms that can address the challenges posed by various applications.

IV. METHODOLOGY:

Image enhancement techniques in image processing are a set of algorithms or methods that aim to improve the quality, clarity, and visual appearance of digital images. There are many different techniques used in image enhancement.

First, obtain an MRI image of the brain and then perform image enhancement techniques on it.

1.1. Contrast Stretching :

This technique is used to improve the contrast of an image. It stretches the pixel values in the image such that the minimum and maximum values cover the entire range of intensities.

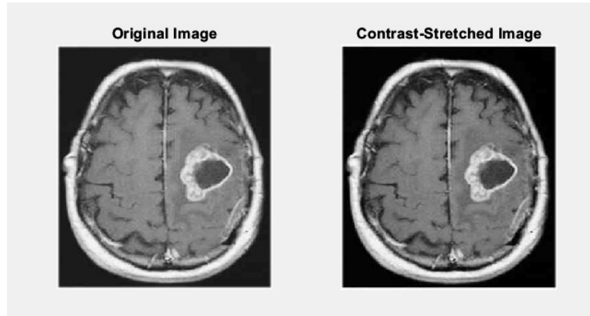

Fig 2 : The original and Contrast - Stretched Image of a Brain MRI image.

1.2. Histogram Equalization:

It is one of the pixel brightness transformation techniques. This technique is used to redistribute the pixel intensities in an image to make the image look brighter or darker. It aims to achieve a uniform distribution of pixel intensities.

The mathematical calculation part of histogram equalization involves computing a cumulative distribution function (CDF) of the input image and then mapping the pixel intensities to a new distribution using the CDF.

The mathematical formula for the transformation function is given by:

s = T(r) = (L-1) * sum(p_i), for i = 0 to r

where s is the new intensity value after equalization, T(r) is the transformation function for input intensity value r, L is the maximum intensity level (typically 256 for an 8-bit image), and p_i is the normalized histogram value for intensity value i.

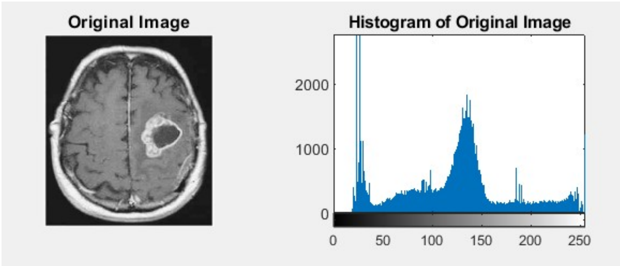

Fig 3 : The histogram distribution of pixel values of the original image

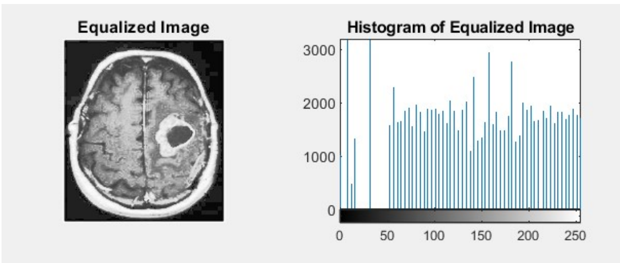

Fig 4 : The histogram distribution of pixel values of the transformed/equalized image.

1.3. Image Sharpening:

This method is applied to improve the edges and fine details of an image. By subtracting a blurred copy of the image from the original image, it emphasizes on the high-frequency elements of the image.

Using a high-pass filter to separate the high-frequency components of the image and combining them with the original image to enhance the edges and details is the mathematical idea behind image sharpening.

The high-pass filter used for image sharpening is typically a Laplacian filter or a derivative filter, which emphasizes the high-frequency components of the image by subtracting the local average value from each pixel. The Laplacian filter is a second-order derivative filter that highlights the edges in an image by detecting the zero-crossings in the filtered image. The derivative filter, on the other hand, is a first-order filter that amplifies the gradients in the image to enhance the edges.

The mathematical formula for the Laplacian filter is given by:

L(x,y) = ∑_i, j h(i,j) [f(x+i,y+j) - f(x,y)]

where L(x,y) is the filtered image, h(i,j) is the Laplacian kernel, f(x,y) is the original image, and i and j are the coordinates of the kernel.

The mathematical formula for the derivative filter is given by:

D(x,y) = ∑_i, j h(i,j) [f(x+i,y+j) - f(x,y)]

where D(x,y) is the filtered image, h(i,j) is the derivative kernel, f(x,y) is the original image, and i and j are the coordinates of the kernel.

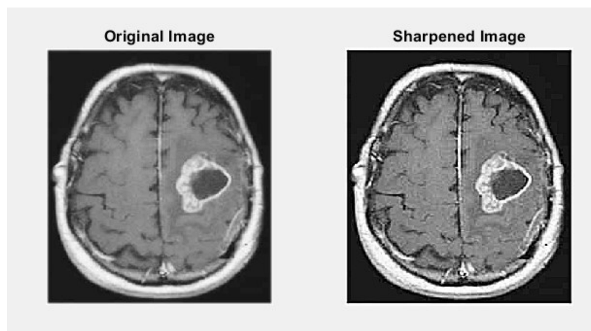

Fig 5 : The original and Sharpened Image of a Brain MRI image.

1.4. Noise Reduction :

Noise reduction is a process of removing or reducing unwanted or random variations in an image, known as noise, to improve its quality and visual appearance. Noise can arise due to various reasons such as sensor limitations, low-light conditions, signal interference, or transmission errors. Noise reduction techniques aim to minimize the impact of noise on the image without significantly affecting its underlying details.

There are various types of noise reduction techniques used in image processing. Some of the commonly used techniques include:

- Spatial Filtering
- Frequency Domain Filtering
- Wavelet - Based denoising
- Non - local based filtering
- Deep - Learning based denoising

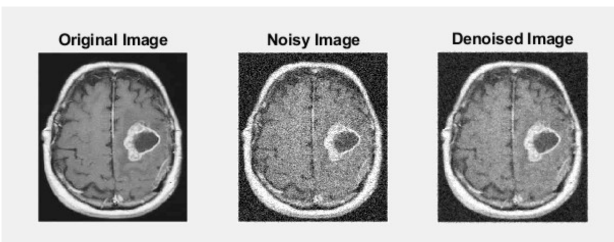

Fig 6 : The original, Noisy and Denoised Image of a Brain MRI image.

1.5. Image Resizing:

Image resizing is a process of changing the size of an image while maintaining its aspect ratio. The process involves adjusting the number of pixels in the image to either increase or decrease its dimensions. Image resizing can be done for various reasons such as fitting an image to a specific output device, reducing the image file size for faster loading, or enlarging a small image to a larger size for printing.

The most common techniques used for image resizing include:

- Nearest Neighbour Interpolation
- Bilinear Interpolation
- Bicubic Interpolation

Image resizing can be performed using image editing software, such as Adobe Photo shop, or through programming languages such as MATLAB or Python. The choice of resizing technique depends on the specific application and the desired output quality. However, it is important to note that resizing an image to a larger size can result in loss of image quality and resolution, while resizing an image to a smaller size can result in loss of image details.

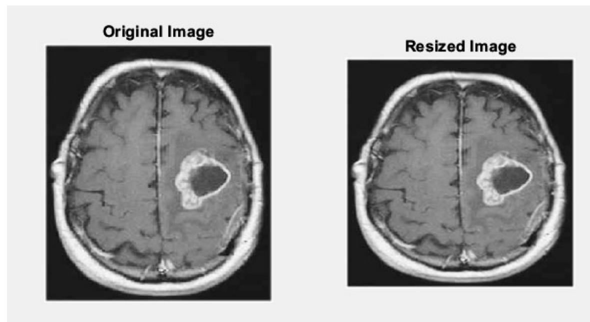

Fig 7 : The original and resized Image of a Brain MRI image.

1.6. Image Restoration :

Image restoration is a process of improving the visual quality of an image that has been degraded by various factors such as blur, noise, or distortion. The goal of image restoration is to recover the original image as much as possible by removing or minimizing the effects of the degradation.

Image restoration techniques can be classified into two categories: spatial domain and frequency domain techniques. Spatial domain techniques operate directly on the pixel values of an image, while frequency domain techniques transform the image into the frequency domain using techniques such as Fourier transforms or wavelet transforms.

The most common techniques used for image restoration include:

- Weiner Filter
- Richardson - Lucy De convolution
- Total Variation Regularization
- Wavelet - based techniques

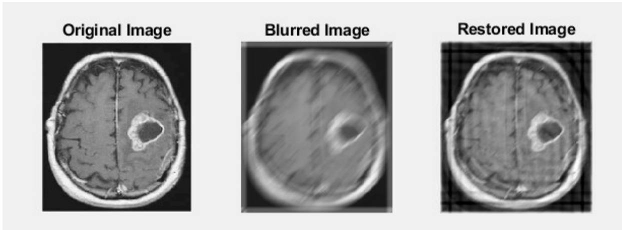

Fig 8 : The Original, Blurred and Restored Images of a Brain MRI image.

V. INFERENCE :

Comparative analysis of image enhancement methods reveals the benefits and drawbacks of each method as well as their suitability for various tasks. One can determine the trade-offs between the quality of the enhanced image, computational complexity, and processing time by contrasting various techniques.

The comparative study's findings can be used to help determine which image enhancement method is best for a given application. For instance, if the goal is to enhance an image's visual quality, a method that preserves fine details and creates an image that looks natural might be preferred. On the other hand, a method that is robust to noise and creates a smoother image may be preferred if the goal is to reduce the noise in an image.

VI. CONCLUSION :

In conclusion, image enhancement techniques are an essential part of image processing and play a critical role in improving the visual quality of images for various applications. There are many different techniques available, each with its strengths and limitations, and the choice of technique depends on the specific requirements of the application. Histogram equalisation, image sharpening, noise reduction, and colour correction are some of the most popular methods for improving images. These methods are widely used in remote sensing, computer vision, and medical imaging.

The best technique to use for a given application can be chosen by comparing various image enhancement methods in order to better understand their advantages and disadvantages. Additionally, it can be useful in pointing out the shortcomings of the existing approaches and pinpointing areas that require more study.

In summary, methods for improving images are still developing, and new methods are being created in response to the problems presented by various kinds of images and applications. The significance of image enhancement techniques is likely to increase as technology develops, and they will continue to be an essential tool for enhancing the quality of images for a variety of applications.

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