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Bio-Medical Image Enhancement using Counter Let Transformation & Bacterial Foraging Optimization

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Abstract: Medical imaging is the technique and process of creating visual representations of the interior of a body for clinical analysis and medical intervention. This transformation use different decomposition filters and reconstruction filters for the process of image enhancement. Contour let transformation & BFOA Algorithm is used in this work. The contour let transformation has been used for the process of image enhancement. The contour let utilize LP and FB decomposition filter to divide the image into different segments. These segments have been enhanced independently using different contour let transformation equations. After the implementation of contour let transformation the BFO algorithm is implemented for optimization process.

Keywords: Medical Image Enhancement, Counter let Transformation, BFOA, PSNR, MSE, EPI, Co-relation.

I. INTRODUCTION

A. Medical Images

Medical imaging is the technique and process of creating visual representations of the interior of a body for clinical analysis and medical intervention. Medical imaging seeks to reveal internal structures hidden by the skin and bones as well as to diagnose and treat disease. Although imaging of removed organs and tissues can be performed for medical reasons.

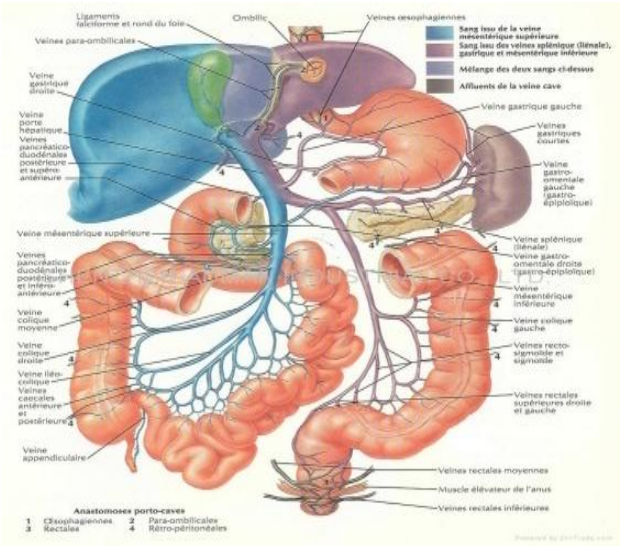

Fig 1: Medical Image

As a discipline and in its widest sense, it is part of biological imaging and incorporates radiology which uses the imaging technologies of X-ray radiography, magnetic resonance imaging, medical ultrasonography or ultrasound, endoscopy, elastograph, tactile imaging, thermography, medical photography and nuclear medicine functional imaging techniques as positron emission tomography. Measurement and recording techniques which are not primarily designed to produce images, such as electroencephalography (EEG), magneto encephalography (MEG), electrocardiography (ECG), and others represent other technologies which produce data susceptible to representation as a parameter graph vs. time or maps which contain information about the measurement locations.

B. Methods of Enhancement

1) Spatial domain enhancement methods:

Spatial domain techniques are performed to the image plane itself and they are based on direct manipulation of pixels in an image. The operation can be formulated as $g(x, y) = T [f(x, y)]$, where g is the output, f is the input image and T is an operation on f defined over some neighborhood of (x, y).

2) Frequency domain enhancement methods:

These methods improve a picture f (x, y) by convoluting the picture with a direct, position invariant operator. The 2D convolution is performed in recurrence space with DFT.

Spatial area: $g (x, y) = f (x, y) * h (x, y)$

Frequency domain area: $G (w1, w 2) = F (w1, w 2) H (w1, w 2)$.

C. Image enhancement techniques

- Adaptive Median Filter: The main idea of the median filter is to run through the image pixel by pixel, replacing each pixel with the median of neighboring pixels. The pattern of neighbors is called the "window", which slides, pixel by pixel, over the entire signal.
- Histogram Equalization: This technique when applied on an image, adjust the contrast of the image using the image's histogram. The method usually increases the global contrast of images, especially when the usable data of the image is represented by close contrast values. This allows

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for areas of lower local contrast to gain a higher contrast. Histogram equalization accomplishes this by effectively spreading out the most frequent intensity values.

1) Histogram Modified Local contrast Enhancement
HE consistently disperses the yield histogram by utilizing cumulated histogram as its mapping capacity. Be that as it may it creates over improvement in the yield picture which prompts loss of more neighborhood data in the first mammogram. One more issue with HE is its vast retrogressive contrast benefits of mapping capacities and the complexity upgrade potential ought to be advanced without the fine subtle elements in the mammogram picture.

2) Contrast Limited Adaptive Histogram Equalization (CLAHE)
CLAHE is a strategy utilized especially to enhance differentiate as a part of pictures. It varies from standard histogram leveling in the admiration that the versatile technique figures a few histograms, every relating to a different segment of the picture, and uses them to redistribute the daintiness estimations of the picture. It is in this manner suitable for enhancing the neighborhood difference of mammogram pictures and bringing out more detail to the consideration of specialists.

- Fuzzy Contrast Enhancement: Fluffy image enhancement is in light of dark level mapping into a fluffy plane, utilizing a participation change capacity. The point is to produce a picture of higher difference than the first picture by giving a bigger weight to the dark levels that are closer to the mean dim level of the picture than to those that are more distant from the mean. We attempted to execute a fascinating work which utilizes the same idea for upgrading the difference of mammograms, yet lamentably because of constrained time, we were not ready to completely actualize this calculation and incorporate its last result in this report.

D. Approaches Used

1) Counter let Transformation
The Contour let transform uses a double filter bank structure to get the smooth contours of images. In this double filter bank, the Laplacian pyramid (LP) is first used to capture the point discontinuities, and then a directional filter bank (DFB) is used to form those point discontinuities into linear structures. The Laplacian pyramid (LP) decomposition only produces one band-pass image in a multidimensional signal processing that can avoid frequency scrambling. And directional filter bank (DFB) is only fit for high frequency since it will leak the low frequency of signals in its directional sub-bands. This is the reason to combine DFB with LP, which is multi-scale decomposition and remove the low frequency. Therefore, image signals pass through LP sub-bands to get band-pass signals and pass those signals through DFB to capture the directional information of image.

2) BFO (Bacterial Foraging Optimization)
Bacterial foraging optimization algorithm (BFOA) has been widely accepted as a global optimization algorithm of current interest for distributed optimization and control. BFOA is inspired by the social foraging behavior of Escherichia coli. BFOA has already drawn the attention of researchers because of its efficiency in solving real-world optimization problems arising in several application domains. The underlying biology behind the foraging strategy of E coli is emulated in an extraordinary manner and used as a simple optimization algorithm. This chapter starts with a lucid outline of the classical BFOA. It then analyses the dynamics of the simulated chemo taxis step in BFOA with the help of a simple mathematical model. Taking a cue from the analysis.

II. RELATED WORK

Abishek Gupta et al [1] "Evolutionary Approach and Spline Interpolation for Contrast Enhancement" In this paper, image contrast enhancement strategies are investigated and two novel methodologies are proposed. The principal methodology utilizes a Super Resolution based Convolution bit in Lab shading space which is improved utilizing Genetic Calculations, for the transformative era of the piece values. The utilized wellness capacity has a tendency to give a harmony between difference and characteristic of pictures. The second approach is called Spline Interpolation which meets expectations by fitting a persistent three dimensional bend through (0, 0, 0), the current pixel's RGB esteem and (255,255,255).

Janani, V. et al [2] "Infrared image enhancement techniques A review", From the earliest starting point of the idea of picture transforming, the analysts took the test of picture upgrade transform as an essential center since upgrading a picture would bring about change in the picture quality. Picture must be upgraded preceding any specified handling. An ideal Enhancement procedure ought to upgrade both excellent and low quality pictures, and ought to highlight even little points of interest covered up in the picture.

Bhattacharya, S [3] "Localized image enhancement", Picture improvement is an entrenched field in picture handling. The principle goal of picture improvement is to expand the perceptual data contained in a picture for better representation utilizing some transitional steps, in the same way as, complexity upgrade, de-blurring, de-noising and so on. Among them, differentiate improvement is particularly essential as human eyes are more touchy to luminance than the chrominance segments of a picture. The greater part of the differentiation improvement calculations proposed till now are worldwide routines.

Suprijanto [4] "Image contrast enhancement for film-based dental panoramic radiography", The dental surrounding radiography is one of dental imaging that used to picture the whole of the maxilla and mandible jaws on the one picture planes. In spite of the fact that the immediate computerized surrounding radiography has been accessible, however film-based surrounding radiography is still utilized on the generally dental center and lab in Indonesia. The nature of film-based picture has noteworthy impediment because of compound handling and picture

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upgrade isn't possible if needed. In this way, digitized film-based picture to computerized picture was obliged to permit picture improvements so as to enhance the interpretability nature of data in the picture.

III. METHODOLOGY

First, Medical images that have been used in the various diagnosis procedures have been developed in dark rooms. These noise removal filters extract the noise from the image and the transformation equation computes the image coefficients that have been replaced by the higher pixel value with higher or enhanced image coefficients. In the image after the rearrangement of the coefficients the image components have to be re construct using the LP and DFB reconstruction filters. After the contourlet transformation the image coefficients have to be optimizing using various optimization approaches. In the purposed work bacterial forging optimization (BFO) has been used for optimization process. Bacterial forging optimization is a nature inspired approach that use different number of bacteria's on the image coefficients. These bacteria's have been initialized and the elimination dispersal loop is started. In the BFO chemotactic steps have been initialized and after these steps the reproduction loop has to be initializing that use different number of parameters. Fitness function has been used in BFO as the health evaluation function, on the basis of the fitness the reproduction or elimination dispersal of a bacteria take place. After this various parameters that have been evaluated for performance evaluation of purposed work. In the purposed work PSNR, EME, EPI, Co-relation and SSIM have been measured.

A. Parameters Used

1) Peak signal-to-noise ratio

The term peak signal-to-noise ratio (PSNR) is an expression for the ratio between the maximum possible value of a signal and the power of distorting noise that affects the quality of its representation. Because many signals have a very wide dynamic range, (ratio between the largest and smallest possible values of a changeable quantity) the PSNR is usually expressed in terms of the logarithmic decibel scale. Image enhancement or improving the visual quality of a digital image can be subjective. Saying that one method provides a better quality image could vary from person to person.

2) Enhanced Measurement (EME)

Enhanced measurement (EME) of an estimator measures the average of the squares of the "errors", that is, the difference between the estimator and what is estimated. EME is a risk function, corresponding to the expected value of the squared error loss or quadratic loss. The difference occurs because of randomness or because the estimator doesn't account for information that could produce a more accurate estimate. The EME is the second moment (about the origin) of the error, and thus incorporates both the variance of the estimator and its bias. For an unbiased estimator, the EME is the variance of the estimator.

3) Structural Similarity (SSIM)

The structural similarity (SSIM) index is a method for measuring the similarity between two images. The SSIM index is a full reference metric; in other words, the measuring of image quality based on an initial uncompressed or distortion-free image as reference. SSIM is designed to improve on traditional methods like peak signal-to-noise ratio (PSNR) and mean squared error (MSE), which have proven to be inconsistent with human eye perception. The difference with respect to other techniques mentioned previously such as EME or PSNR is that these approaches estimate perceived errors; on the other hand, SSIM considers image degradation as perceived change in structural information. Structural information is the idea that the pixels have strong inter-dependencies especially when they are spatially close.

4) Correlation

Correlation refers to any of a broad class of statistical relationships involving dependence. Familiar examples of dependent phenomena include the correlation between the physical statures of parents and their offspring, and the correlation between the demand for a product and its price. Correlations are useful because they can indicate a predictive relationship that can be exploited in practice. For example, an electrical utility may produce less power on a mild day based on the correlation between electricity demand and weather.

5) Enhanced publications Integration (EPI)

Enhanced publications are a form of electronic publishing for the dissemination and sharing of research outcomes. As many forms of digital publications, they typically feature a unique identifier and descriptive metadata information. Unlike traditional digital publications, enhanced publications are often tailored to serve specific scientific domains and are generally constituted by a set of interconnected parts corresponding to research assets of several kinds and to textual descriptions of the research. The nature and format of such parts and of the relationships between them, depends on the application domain and may largely vary from case to case.

IV. RESULT AND DISCUSSION

The medical images have been enhanced by using the contourlet transformation. This transformation use different decomposition filters and reconstruction filters for the process of image enhancement. The image enhancement process has been optimized by using different approaches that has been used for evolution on the basis of fitness function. The fitness function use different parameters for evaluation bacteria's health contain reproduction step and elimination dispersal.

Fig. 1 represents the graphic user interface that has been designed for various operations that have to be performed on the basis of different computational steps. This user interface has different buttons and edits boxes, axes. These axes have been used for image representation, the button have been used for performing various operation that has been assigned behind their callbacks.

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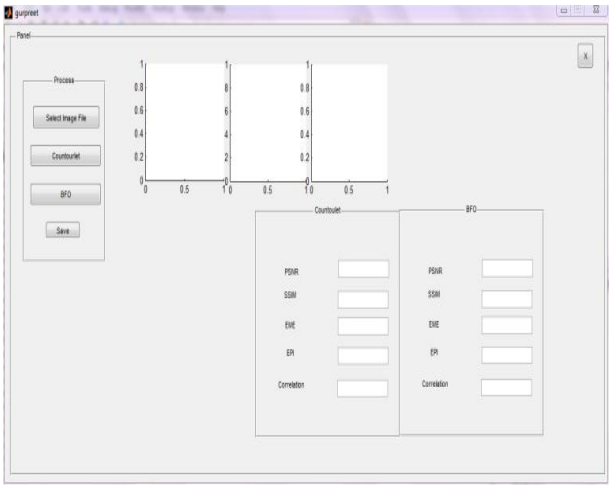

Fig 1 GUI for Image enhancement using contourlet and BFO

Fig. 2 represents the input image that has been selected for image enhancement. 5the input image features cannot be easily seen by using naked eyes. Different noise intensities has been available in the input image to enhance the image these intensities have to be removed.

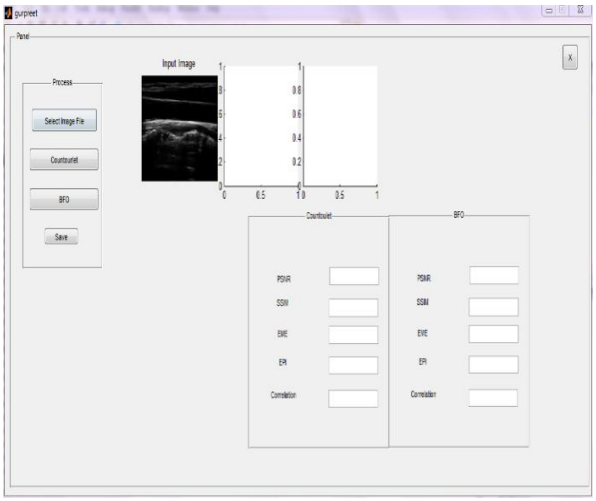

Fig 2 Input Image for image enhancement

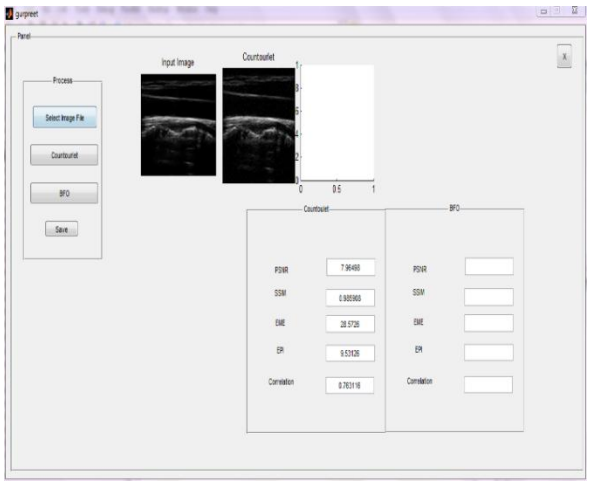

Fig 3 contourlet transformation for image enhancement

Fig. 3 represents that image that has been enhanced by using contoulet transformation. This operation use different decomposition filters that divide the image into different segments. In this process different approaches have been used for enhancement of the image the noise removal filter removes the noise from the image and after this reconstruction filters have been implemented to reconstruct the image.

Fig 4 BFO optimization for image enhancement

Fig. 4 represents the image that has been enhanced by using the BFO algorithm. The bacterial have been initialized and the parameters have been defined for BFO. The chemo-tactic steps have been started for image optimization. These steps that have been started for image optimization use the health function for fitness evaluation of the image coefficients. These image coefficients that have been used for image enhancement measure the elimination dispersal loop and reproduction loop for optimization of the parameters.

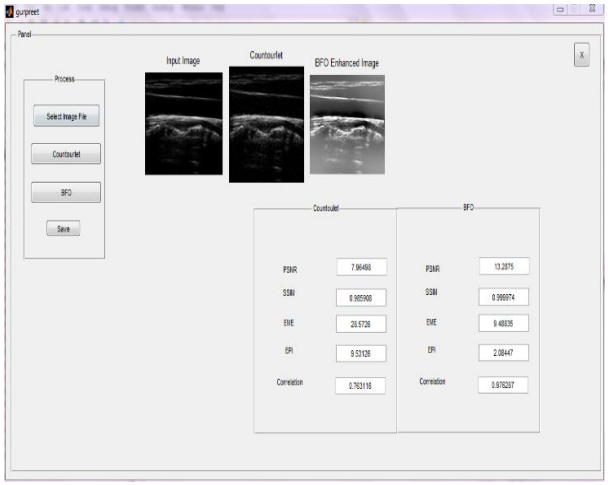

Fig 5 Parameter evaluation for image enhancement

Fig. 5 represents the evaluation of various parameters for comparison of the purposed work with previous approaches. In this evaluation of parameters different parameters like PSNR, EME, SSIM, EPI and Co-relation have been measured for performance evolution of image by using contourlet transformation and BFO algorithm.

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V. CONCLUSION

Medical imaging is the technique and process of creating visual representations of the interior of a body for clinical analysis and medical intervention.. These approaches utilize different filters for removal of noise from these images. The noises available in the images have been reduced using different noise removal filters. On the basis of these filter the noise has been reduced. The contour let utilize LP and FB decomposition filter to divide the image into different segments. After the implementation of convolution theorem the reconstruction filters have been implement that reconstruct the image into its original format. After the implementation of contour let transformation the BFO algorithm is implemented for optimization process. This is a nature inspired approach that have been used or optimization on the basis of bacteria's. After these steps various parameters have been analyzed for validation of purposed work. Different parameters are introduced & on the basis of these parameters our system gives us better results.

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