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# Enhancement of Images using Optimized Gamma Correction with Weighted Distribution via Differential Evolution Algorithm

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**Abstract-** When an acquired image has flaws such as poor visual appearance to the eyes, noise, or low quality. To increase the visual appearance, image enhancement should be used. The primary goal of image enhancement is to suppress blemishes in an image while retaining useful information. Many researchers suggested different kinds of enhancement processes that produced positive results. In this algorithm, we developed a novel hybrid algorithm called Optimized Gamma Correction with Weighted Distribution (OGCWD), which combines the Differential Evolution algorithm and Adaptive Gamma Correction with Weighted Distribution. The proposed method is an automated transformation process that aims in improving the brightness of a lowered image. The proposed OGCWD algorithm out performs state-of-the-art image enhancement techniques in terms of structural Similarity Index (SSIM), Mean Square Error (MSE), and Peak Signal to Noise Ratio (PSNR).

**Keywords:**Image Enhancement, Adaptive gamma correction weighted distribution (AGCWD), Differential Evolution (DE).

## I. Introduction

For video monitoring, remote sensing tracking, industrial production, military applications, and other purposes, digital image processing systems are often utilized in daily life. There are a few uncontrolled things that are viewed as flaws while processing a image. These are because the image was taken in dimly lit environments, such as at night, on a cloudy day, inside, or with little light reflecting off the object's surface; as a result, the image quality worsened and was deemed a fault. Thus, we employ image enhancing techniques to fix these problems. Image enhancement is one of the most fundamental components of image processing. In order for the image to look uniform, the goal is to bring attention to the image and its features. Often seen image. Most often, a transform function will be used to do spatial domain image improvement. It creates a new intensity of the input image for each pixel to create the amended image. If the pixel values' spatial connection is changed, the augmented image is also changed. The subjective character of the image quality evaluation approach suggests that human involvement and discretion are needed. Yet, this system must be made objective in order to eliminate the need for human intervention in order to advance. So, it is required to construct a function to assist in evaluating a image by numerically determining the quality of the improvement. Hence, it is crucial to find a fitness function that may assist in evaluating a image by a numerical assessment of the quality of the Using the differential evolution algorithm, a method to boost image contrast. The natural-inspired optimization technique known as the differential evolution algorithm plays a dynamic role in the processing of images. Moreover, it improves image enhancement, restoration, segmentation, detection, formation of image fusion, image pattern recognition, image threshold, and other processes. Moreover, it reduces image noise and fuzziness. The DE seeks to maximize the fitness function by modifying the intensity change function variables. When evaluated critically and subjectively, enhanced imaging outperforms other techniques in our DE-based technology. The Differential evolutionary method was created to handle numerical optimization problems that are intended to be practical. It is a mathematically sound, effective, and widely used evolutionary computation technique. DE is reliable and manageable.

## II. LITERATURE SURVEY

Patel S., Bharath K.P., Balaji S., Muthu R.K. (2020) Comparative Study on Histogram Equalization Techniques for Medical Image Enhancement. In: Das K., Bansal J., Deep K., Nagar A., Pathipooranam P., Naidu R. (eds) Soft Computing for Problem Solving. Advances in Intelligent Systems and Computing, vol 1048. Springer, Singapore The traditional methods of the Histogram Equalization technique possess certain limitations and fail in certain circumstances. Therefore there is a need to

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turn to various other modified methods for the Histogram Equalization technique. The modern versions of Histogram Equalization techniques. The histogram shows that in the initial image the number of the pixels on the gray scale are close together without spreading over the entire range of the gray scale after Histogram Equalization.[1]

S. H. Gangolli, A. Johnson Luke Fonseca and R. Sonkusare, "Image Enhancement using Various Histogram Equalization Techniques," 2019 Global Conference for Advancement in Technology (GCAT), BANGALURU, This paper focused on studying Image Enhancement performed using Histogram Equalization Technique. It was performed on an input image using MATLAB (R2014a) software. The comparisons of the images show that the image after Histogram Equalization is of somewhat higher contrast as compared to the initial image which has a lower contrast. The histogram shows that in the initial image the number of the pixels on the gray scale are close together without spreading over the entire range of the gray scale. After Histogram Equalization it is clearly seen that the histogram gets distributed entirely over the spectrum of the gray scale, with the number of pixels on each value of the spectrum increasing resulting in the increase in the brightness and the contrast [2].

Chenigaram Kalyani, Kama Ramudu, Ganta Raghotham Reddy,"Enhancement and Segmentation of Medical Images Using AGCWD and ORACM". The proposed method of Image Contrast Improvement and the image segmentation is discussed in this section. An algorithm is planned to progress the contrast efficiently and sustain the brightness of input images. Segmentation is performed on the enhanced AGCWD image [3].

Vijay A. Kotkar, Sanjay S. Gharde, "Review of Various Image Contrast Enhancement Techniques," International Journal of Innovative Research in Science, Engineering and Technology Vol. 2, Issue 7, July 2013 Henan, Wu et al. in 2011 presented an enhancement algorithm predicated on multi-scale Retinex to be able to improve the potency of remote sensing image enhancement. The principle and recognition types of multi- scale Retinex and wavelet were calculated. The research of panchromatic and multicolor remote sensing image enhancement were agreed out on the basis of the two methods, the end result showed that the mean valve of enhanced image by this algorithm is all about 125, the entropy and definition might be improved by 5% and 25% in contrast to wavelet algorithm, and remote sensing images might acquire better enhancement quality, so multi-scale Retinex is a superior method for sensing image enhancement.

## III.EXISTING METHODS

This section primarily focuses on a detailed discussion of the suggested optimized Gamma Correction with Weighing Distribution (OGCWD) method and the currently used augmentation strategies.

### 3.1 Existing Image Enhancement Methods

During the decade, several researchers have developed a variety of augmentation approaches to shape an image's visual according to the user's viewpoint. Hence, two approaches for image enhancement have been employed and described in this paper. The two approaches of improvement are

- Adaptive gamma correction with weighted distribution (AGCWD)
- Image enhancement using Differential Evolution.(DE)

#### 3.1.1Adaptive gamma correction with weighted distribution (AGCWD):

The proposed method of Image Contrast Improvement and the image segmentation is discussed in this section. An algorithm is planned to progress the contrast efficiently and sustain the brightness of input images. Segmentation is performed on the enhanced AGCWD image. The suggested process consists of phases which are shown in the flowchart. An adaptive gamma correction method is proposed to improve the contrast of the image where the appropriate gamma value is set automatically based on the statistics extracted from images, As we know that power -law transformation method which main drawback is to give the value of gamma manually for image enhancement. This problem solved by the adaptive gamma correction weighted distribution method. In which the value of gamma is find out automatically with the help of weighted distribution function gamma correction techniques make up a family of general techniques obtained simply by using a varying adaptive parameter. The simple form of the transform-based gamma correction is derived. Adaptive gamma correction via weighted distribution: Rendering to AGCWD process, an expression for adaptive gamma correction is expressed as below.

#### 3.1.2 Image enhancement using Differential Evolution (DE):

Method to increase the image contrast with the algorithm of differential evolution. Differential evolution algorithm is a nature inspired optimization method plays a dynamic role in processing of an image. It also enhances the enhancement/restoration/segmentation of images/image detection / generation of image fusion/image pattern recognition/image threshold and etc. It also helps to minimize noise and blurriness of images. The DE aims to adjust the intensity change function variables in order to optimize the fitness function. Enhanced imaging is subjectively and critically assessed, showing a higher performance than other methods in our DE based technology. The Differential evolutionary algorithm is a mathematical, efficient and commonly used Evolutionary computation algorithm built to address numerical optimization issues that are supposed to be practical. DE is stable, it is relatively easy to implement and has a basic structure. DE is used to address the problem type's uni modal, multimodal, and hybrid. In the field of image processing, natural optimization techniques are crucial. It also helps to improve images by reducing noise and blurriness from photos. So far, many optimization techniques for a variety of image processing systems have been developed. This article presents a short review of nature inspired optimization algorithm which is Differential Evolution algorithm. In the year 1995, storn and price, introduced an optimization algorithm called Differential Evolution which has become a successful population-depended approach.

**Calculation of Optimum weights using Differential Evolution Algorithm**:

The use of natural optimization approaches is essential in the field of image processing. The noise and blurriness in shots is also reduced, which enhances the quality of the images. Many optimization methods have so far been developed for a wide range of image processing systems. The Differential Evolution method, which was inspired by nature, is briefly reviewed in this paper. Differential Evolution, an effective population-dependent optimization technique, was first described in 1995 by Storn and Price. This method makes use of the well-known concepts of mutation, fusion, and selection. The tuning control parameters are the population size, mutation scaling factor, and crossover rate. Several DE variations have been created in the past ten years to boost production. Considering the increased global convergence and

**Mutation Operation:** A person may be produced using the following formula

$$X_{r1,G+1} = X_{r1,G+1} + F * (X_{r2,G} - X_{r3,G}) \quad (5)$$

In the preceding equation (14), r1, r2, and r3 are represented as random integers, and the variance factor F is a real value between 0 and 2 that regulates the degree of amplification of the differential variable.

$$X_{r2,G} - X_{r3,G}$$

**Crossover Operation**: The interoperability of the differential evolution algorithm is extended to the diversity of the new population. According to the crossover approach, old and new persons exchange a portion of their code to generate a new person. New citizens are classified as follows:

$$X_{i,G+1} = (x_{1i,G+1}, x_{2i,G+1}, x_{3i,G+1}, \ldots . x_{ni,G+1}) \quad i=1,2,3\ldots$$

Where,

$$X_{ji,G+1} = \begin{cases} V_{ji.G+1}, \\ if\ (\text{randb(j)} \le \text{CR})\ \text{or}(\text{j=mbr(i)}), \end{cases}$$

(j=1,2,3,....n), (7)

According to the preceding equation (7), ran db (j) is distributed uniformly within the interval [0,1], and the crossing probability is denoted as CR. M br I is a random number between [0, 1]

**Selection Operation**: Because the true candidate's commodity is all mutations and crossings, this is a greedy strategy.

$$X_{ji,G+1} = \{U_{i,G} if\ (\text{f}(U_{i,G}) > \text{f}(x_{i,G+1}))$$

$$\text{,if} \quad X_{ji,G+1} = \{x_{i,G+1}, if\ (\text{f}(U_{i,G}) \le \text{f}(x_{i,G+1})) \quad (8)$$

At which, *f* is the fitness function.

**Stages need to be followed to perform Differential evolution Algorithm:**

Stage 1 Begin by entering the population number NP, the average number of evolution Max inner, the scale factor, and the cross factor.

Stage 2 Pop population is being created.

Stage 3 Follow the DE/ rand/1/bin policy Compliance choices to produce a new generation of people.

Stage 4 Mutation Stage.

Stage 5 Crossover process.

Stage 6 Selection process.

Stage 7 Before it meets the termination requirements.

## IV.PROPOSED METHODS:

### 4.1 Optimized Gamma Correction process for Image Enhancement Gamma Corrections:

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which combines the Differential Evolution algorithm and Adaptive Gamma Correction with Weighted Distribution. The proposed method is an automated transformation process that aims in improving the brightness of a lowered image. The proposed OGCWD algorithm out performs state-of-the-art image enhancement techniques in terms of structural Similarity Index (SSIM), Mean Square Error (MSE), and Peak Signal to Noise Ratio (PSNR) is optimized using hybrid histogram modification. It combines classic histogram equalization with transform based improved gamma correction. This is an algorithmic transformation procedure that improves the gamma correction and likelihood distribution in darkened image brightness. The gamma value is calculated using an optimum.

$$T(\mathrm{I}) = \mathrm{I}_{MAX}(\mathrm{I}/\mathrm{I}_{MAX})^{\gamma_{optimized}} \quad (9)$$

The maximal intensity of input is. T transforms the intensity I of each pixel in the input image I. Different images may cause the parameter set to modify its intensity if a contrast is modified manually or immediately via a gamma adjustment. The probability density function is defined as follows:

$$pdf(\mathrm{I}) = \mathrm{n}_I/(\mathrm{MN}) \quad (10)$$

The number of l-intensity pixels is represented by nI. MN is the total number of pixels in a image. The probability density function is used to generate the cumulative distribution function, which is as follows:

$$cdf(\mathrm{I}_{opt}) = \sum_{k=0} pdf(\mathrm{k}) \quad (11)$$

The traditional HE approach employs the cumulative distribution function (cdf) directly as,

$$T(1) = \mathrm{cdf}(\mathrm{I})\,\mathrm{I}_{\max} \quad (12)$$

Formulated proposed optimized gamma correction is given as,

$$T(\mathrm{I}_{opt}) = I_{MAX}(\mathrm{I}/\mathrm{I}_{MAX})^{\gamma_{optimized}} = I_{MAX}(\mathrm{I}/\mathrm{I}_{MAX})^{1-CDF(\mathrm{I}_{opt})}$$

(13)

The suggested optimal gamma correction formula is presented as, The weighted distribution function formula is expressed as,

$$pdf_w(\mathrm{I}_{opt}) = \mathrm{pdf}_{\max}\left(\frac{pdf(\mathrm{I}_{opt}) - \mathrm{pdf}_{\min}}{\mathrm{pdf}_{\max} - pdf_{\min}}\right)^{\alpha_{opt}}$$

(14)

According to equation (9), opt is an adjusted parameter; is for the highest pdf of a statistical histogram; and is for the least pdf. As a result, the reformed cdf is estimated as follows:

$$cdf_w(\mathrm{I}_{opt}) = \sum_{I=0}^{I_{\max}} \frac{pdf_w(\mathrm{I}_{opt})}{\sum pdf_w}$$

(15)

The sum of is seen as,

$$\sum pdfw = \sum_{I=0}^{1_{\max}} Pdfw(1) \quad (16)$$

Finally, the optimized gamma parameter, which is based on the cumulative distribution function (cdf) in equation (8), is enhanced as follows:

$$\gamma = 1 - cdf_w(\mathrm{I}_{optimum}) \quad (17)$$

As a result, the following equation (17) provides us with an optimum Gamma Correction while also improving the darker and aerial regions of an input image.

**V.SIMULATION RESULTS:**

This section discusses the simulation findings as well as current and planned augmentation strategies. Figure 1 compares the simulation results of the suggested technique termed optimal Gamma Correction with Weighted Distribution (OGCWD) to those of state-of-the-art enhancement methods such as Histogram Equalization (HE) and Adaptive Gamma Correction with Weighted Distribution (AGCWD). We generated and compared the metrics structural Similarity Index (SSIM), Mean Square Error (MSE), and Peak Signal to Noise Ratio (PSNR) for both approaches. The proposed enhancement method outperforms the currently available enhancement techniques. The SSIM values range from 0 to 1, with higher values indicating greater performance and lower values indicating poor enhanced outcomes. Likewise, MSE and PSNR.
This segment describes the simulation results and discussions of existing and proposed enhancement methods. The simulation results of the proposed algorithm named optimized Gamma Correction with Weighted Distribution (OGCWD) are compared to those of state-of-the-art enhancement methods such as Histogram Equalization (HE) and Adaptive Gamma Correction with Weighted Distribution (AGCWD) as shown in figure 1. Peak Signal to Noise Ratio (PSNR) and analyzed the performances. The proposed enhancement method is outperforming the existing enhancement techniques. The SSIM values within the range of 0 to 1, higher the values of SSIM gives superior performance and lower the values leads the worst enhancement results. Similarly, MSE and PSNR for good enhancement results are low and very high

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values respectively and higher MSE and Lower PSNR values leads the worst enhancement results. Table 1 clearly shows that the proposed method evaluation parameters give superior performance over existing AGCWD Method. The evaluation parameters indicated in the table 1 such as SSIM, MSE and PSNR directly calculated based on MATLAB commands

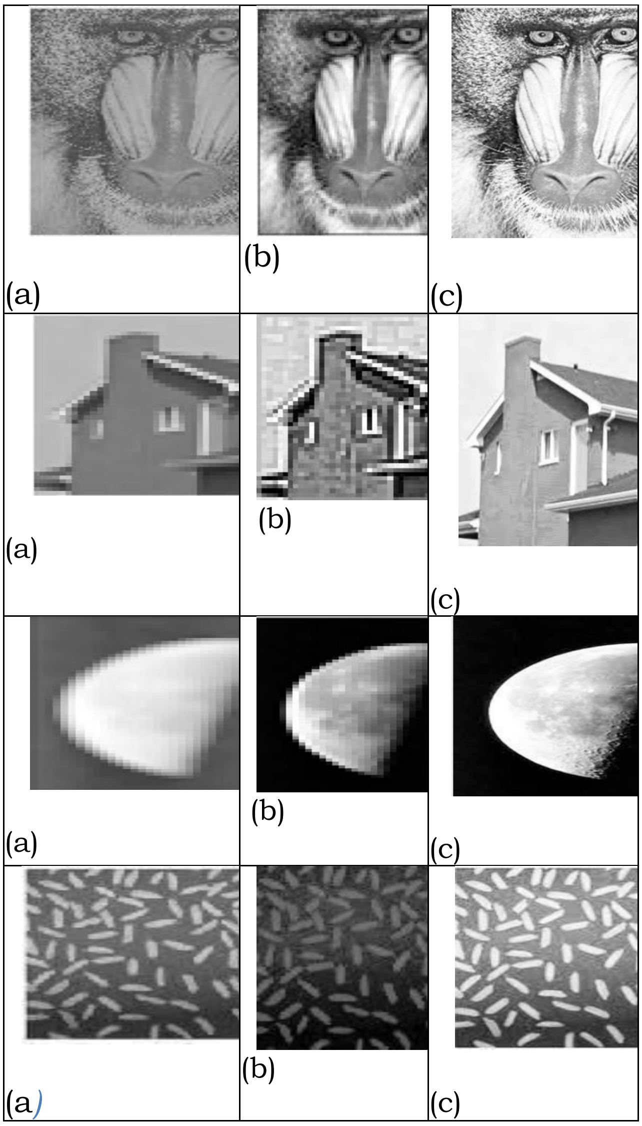


Fig:1 depicts the simulation results of existing AGCWD methods as well as proposed OGCWD.column 1(a) Shows the original input images, column 2(b) Shows the enhanced output images using AGCWD methods respectively, column 3(c) optimized gamma correction with weighted distribution output images.

## VI.CONCLUSION

The Opimal Gamma Correction with Weighted Distribution (OGCWD) approach suggested in this research is an unique hybrid method that includes the differences between gamma correction and weighted distribution. This method was invented by us. A computer-assisted transformation process is proposed for improving contrast and brightness in low-quality images. In terms of SSIM, MSE, and PSNR values, the proposed OGCWD procedure outperforms state-of-the-art image enhancement techniques. Similarly, the average values of the current AGCWD method results are 0.6781, 2.1608, and 13.2356. Finally, we can conclude that the proposed method outperforms the existing method in terms f average PSNR value, resulting in good enhancement results

| Parameters | AGCWD Method | | | | | Proposed Optimized Gamma Correction with Weighted Distribution (OGCWD) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Image 1 | Image 2 | Image 3 | Image 4 | Average Value | Image 1 | Image 2 | Image 3 | Image 4 | Average Value |
| SSIM | 0.8795 | 0.5319 | 0.2747 | 0.6484 | 0.6781 | 0.9621 | 0.8099 | 0.8652 | 0.9519 | 0.8972 |
| MSE | 2.7628 | 2.3270 | 1.8279 | 1.7258 | 2.1608 | 0.0075 | 0.0245 | 0.1238 | 0.0270 | 0.0457 |
| PSNR | 13.7174 | 14.4628 | 9.0745 | 15.6877 | 13.2356 | 21.2518 | 16.1059 | 19.6052 | 19.4225 | 19.0963 |

## VII ACKNOWLEDGEMENT

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