# **Comparative Study of Different Image Enhancement Methods**

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Abstract— Images are being used in many fields of research. Image enhancement methods and techniques have been studied for more than 40 years, and during this time a vast number of methods have been developed. At first, methods were more concentrated in improving the quality of gray-level images. In this paper, present a categorization of a number of methods and techniques that can be used for image enhancement and also its comparing different methods. This comparison is useful for selecting suitable enhancement method for particular application.

Index Terms— Histogram Equalization(HE), Partially Overlapped Sub-block HE (POSHE), Non-Overlapped Sub-blocks and local Histogram Projection(NOSHP), Discrete Wavelet Transform (DWT), Short Time Fourier Transform(STFT),Contrast Enhancement.

# Introduction

Image processing is the system of mathematically transforming an image, generally to change some characteristics. This includes many applications such as image edge enhancement. detection. object recognition, and noise reduction. Providing digital images with good contrast and detail is required for many important areas such as vision, remote sensing, dynamic scene analysis, autonomous navigation, and biomedical image analysis.

Because some features are hardly detectable by eye in an image, we often transform images before display. Producing visually natural images or modifying an image to better show the visual information contained within the image is a requirement for nearly all vision and image processing methods. Methods for obtaining such images from lower quality images are called image enhancement techniques. Much effort has been spent extracting information from properly enhanced images.

Image enhancement is a visually appealing area of image processing and enjoys much attention in a wide range of applications. There is no general theory of image enhancement. When an image is processed for interpretation, the viewer is the ultimate judge of how well enhancement method works. Image Enhancement improves the quality (clarity) of images for human viewing. Removing blurring and noise, increasing contrast, and revealing details are examples of enhancement operations.

The ultimate receiver of the image is the human; thus the purpose of image enhancement is to improve interpretability or perceptibility of information contained in the image for the human visual system (HVS). An important piece of information is image structure, i.e. the objects composing the image and the textures of the objects. Generally, a perceptually good image features clear-cut borders between different objects and homogeneous textures within objects.

The purpose of image enhancement is to improve the perceptibility of information

contained in an image. Since the human visual system tends to extract image structure, enhancing the structural features can improve perceived image quality.

## Background

The principal objective of image enhancement is to process an image so that the result is more suitable than the original image for a specific application.

Mathematical morphology is a relatively new approach to image processing and analysis. This approach is based on set-theoretic concepts of shape. In morphology objects present in an image are treated as sets. As the identification of objects and object features directly depend on their shape, mathematical morphology is becoming an obvious approach for various machine vision and recognition processes.

The term morphology means form and structure of an object. Sometimes it refers to the arrangements and inter-relationships between the parts of an object. Morphology is related to the shapes and digital morphology is a way to describe and analyze the shape of a digital object. Morphological opening is a name specific technology that creates an output image such that value of each pixel in the output image is based on a comparison of the corresponding pixel in the input image with its neighbors. By choosing the size and shape of the neighborhood, one can construct а morphological operation that is sensitive to specific shapes the input in image. Morphological functions could be used to perform common image processing tasks, such as contrast enhancement, noise removal, filling and segmentation. The image enhancement

problem in digital images can be approached from various methodologies.

Conventional image enhancement techniques are broadly classified into two categories: the spatial domain techniques and the frequency domain techniques. Spatial domain techniques are more popular than the frequency based methods, because they are based on direct manipulation of pixels in an image. Myriad spatial domain methods have been developed for visualizing the effect. Some of these methods uses simple linear or non-linear intensity level transformation functions, whereas others use complex analysis of different image features such as the edge and connected component information.

Histogram is defined as the statistic probabilistic distribution of each gray level in a digital image. It can give us a general overview of an image such as gray scale, gray level distribution and its density, the average luminance of an image, image contrast, and SO on. Histogram equalization is one the most well-known methods for contrast enhancement. Such an approach is generally useful for images with poor intensity distribution. Since edges play a fundamental role in image understanding, one good way to enhance the contrast is to enhance the edges.

Numerous image enhancement methods have been proposed. In general, they can be classified into two broad categories: global methods and local methods. Global methods build enhancement transformations on the basis of the global gray-level distribution of the entire image. Common global methods include global equalization (GHE) and global histogram contrast stretching. Global histogram

equalization attempts to spread the histogram of an image to closely match a uniform distribution covering the entire gray scale. Global contrast stretching uses the logarithmic, power-law or piecewise-linear transformation to rescale (expand or compress) the dark, bright or any range of gray levels in an image.

These global methods are suitable for overall enhancement, but not adequate for local enhancement because the local gray-level distribution varies from region to region in an image and does not necessarily coincide with the global one. Take global histogram equalization for example. It may hardly enhance or even retain details over small areas in an image if the numbers of pixels in these areas have negligible influence on the computation of the cumulative distribution function (CDF) that is used for global transformation.

To overcome the shortcoming of global methods mentioned above, a large number of local methods have been proposed, which devise enhancement transformations based on the local gray-level distribution (or other local properties) in the regions of the image. Local methods generally involve some form of image segmentation followed by various enhancement transformations applied on the segments. The procedure can be performed in the spatial or frequency domain.

One of the most common degradations in the recorded image is its poor contrast. The contrast of an image may roughly be defined as the difference between its highest and lowest intensity values. Contrast enhancement increases the total contrast of an image by making light colors lighter and dark colors darker at the same time. The problem of poor contrast in the degraded image is usually solved by histogram stretching or by histogram equalization technique. Contrast stretching methods using local statistics are also reported, have devised a variational approach to local contrast enhancement through a suitable optimization of some desirable characteristics of graylevel histogram of output image.

# **Image enhancement methods**

In this section, present a categorization of a number of methods and techniques that can be used for image enhancement. The first attempt to categorize image enhancement methods was made in the early eighties. Since 1983, the methods used for image enhancement became much more sophisticated, but their basic structure remained the same. For this reason, their classification scheme is still useful to have a broad view of the type of methods existent in the literature and their characteristics.

Image processing is a vast and challenging domain with its applications in fields like medical, aerial and satellite images, industrial applications, law enforcement, and science. Often the quality of an image is more often linked to its contrast and brightness levels enhancing these parameters will certainly give us the best result. HE is an image enhancement method that allocates the pixel values evenly, thus developing a better picture. Image Enhancement majorly involves four key parameters :

1. brightness –Brightness can be modified by increasing "gamma". Gamma is a non-linear form of increase in brightness.

- 2. contrast- It is the separation between the dark and bright areas of an image. Thus, increasing contrast increases darkness in dark areas and brightnes in bright areas.
- 3. Saturation- Saturation is increasing the separation between the shadows and highlights.
- Sharpness- It is related to edges, the contrast along the edges of a photo. Using histogram equalization contrast can be enhanced. It is a straightforward and Invertible operator.

There are various histogram equalization techniques with their own advantages and disadvantages.

## 2. HISTOGRAM EQUALIZATION TECHNIQUES

There are numerous methods by which Histogram of an image can be equalized. Depending upon the area of Application, we can choose the different histogram equalization techniques. Here, five types of Histogram Equalization methods in detail:

- 2.1 Classical Histogram Equalization (CHE)
- 2.2 Adaptive Histogram Equalization (AHE)
- 2.3 Bi-Histogram Equalization (BHE)
- 2.4 Recursive Mean Separate Histogram

Equalization (RMSHE)

2.5Multi-Decomposition Histogram Equalization (MDHE)

### 2.1 Classical Histogram Equalization

CHE is the fundamental technique for image processing, especially when gray level images are considered. The aim of this method is to distribute the given number of gray levels over a range uniformly, thus enhancing its contrast. The cumulative density function (CDF) is formulated by the below mentioned expression:

$$C_{l}^{o[l_{s},l_{f}]} = \sum_{i=l_{s}}^{l_{f}} P_{i}^{I[l_{s},l_{f}]} = \frac{i-l_{s}+1}{(l_{f}-l_{s}+1)},$$

The CHE tries to produce an output image with a flattened histogram, means a uniform distribution. An image is formed by the dynamic range of values of gray levels. Basically, the entire gray levels are denoted as 0 to L-1.





#### Disadvantage

- 1. A disadvantage of this method is that it is undifferentiating between the various pixels, that is, while increasing the contrast of its background, the signal gets distorted.
- 2. Histogram equalization often produces unrealistic and unlikely effects in photographs.

### 2.2 Adaptive Histogram Equalization

Adaptive Histogram Equalization (AHE) is used to improve contrast in images. It computes many ordinary histograms, each one analogous with a section of the image. Thus, the output results in each to redistributing the lightness values. It is appropriate to adjust the local contrast and to fetch clear details.

On the other hand, AHE is responsible for overamplifying noise in some homogeneous regions of an image. To avoid this drawback, an advanced version of AHE, called Contrast Limited Adaptive Histogram Equalization (CLAHE) is introduced.





Fig 2.2 : (a) Histogram after AHE (b) Image after AHE

#### Disadvantage

- 1. AHE has a behavior of amplifying noise, thus limiting its use for homogeneous figures.
- 2. Its advanced form is contrast limited adaptive histogram equalization (CLAHE) that eliminated the above problem.
- 3. It also fails to retain the brightness with respect to the input image.

### 2.3 Bi-Histogram Equalization

The major basis of origination of this method is to overcome the drawback introduced by CHE. Here, the original image is segmented twice i.e. into two sub-sections. This is done by dividing the mean gray level and then applying CHE method on each of the two sub-sectioned image. Its objective is to produce method suitable for real-time applications. But again this method has the same disadvantage as CHE by inputting unwanted signals.



Fig 2.3 : (a) Histogram after BHE (b) Image after BHE

# 2.4 Recursive Mean Separate Histogram Decomposition

An extended version of the BHE method proposed before, and named as recursive mean-separate HE(RMSHE), proposes the following. Instead of decomposing the image only once, the RMSHE method offers to perform image decomposition recursively, up to a scale r, generating 2r sub-images. After, each one of these sub-images is independently enhanced using the CHE method. Note that, computationally speaking, this method presents a problem: the number of decomposed subhistograms is a power of two.



(a)



# 2.5 Multi-Decomposition Histogram Equalization

All the HE methods that we have covered prior to this, enhances the contrast of an image but are unable to preserve its brightness. As a result, these methods can generate unnatural and nonexisting objects in the processed image. To eliminate these limitations, MDHE comes up with a novel technique by decomposing the image into various small images. Then the image contrast enhancement provided by CHE in each sub-image is less concentrated, leading the output image to have a more likely and acceptable look. There are two types of MHE method, MWCVMHE (Minimum within class variance MHE) and MMLSEMHE ( Minimum middle level squared error MHE).





Fig 2.5 : (a) Histogram after MDHE (b) Image after MDHE

Method	Brightness	Contrast
Original	139.20	29.70
HE	133.94	75.47
BBHE	162.78	70.09
DSIHE	131.66	75.42
RMSHE $(r = 2)$	139.77	37.81
MMBEBHE	144.97	68.70

#### 2.6 Comparison

HE	Advantages	Disadvantages
Tech		
niqu		
es		
CHE	Flattened	Undifferentiating
	histogram	between various pixels.
	Uniform	Unrealistic and unlikely
	distribution	effects in photographs.
	Simple	Washout effect.
	Fast	CE power is relatively low.
AHE	Improve contrast.	Amplifying noise, thus
	Good results in	limiting its use for
	medical imaging.	homogeneous figures.
		Fails to retain the
		brightness.
		Images with noise artifacts,
		false or over-enhanced
		shadows.
		Computational complexity.
		Blocking effect.
CLA	An advanced	Fails to retain the
HE	version of AHE.	brightness.
	Avoid noise	Unnatural processed image.
	amplification.	Computational complexity.
	CT image	
DUE	Suitable for real	Concrete unnetural and
вне	time applications	non existing objects
	time applications	non-existing objects.

		Inputting unwanted signals.
RMS HE	An extended version of the BHE. Recursive algorithm of BBHE. (b) Brightness preserving.	Equalization effect was reduced. Cannot solve over- equalization effect in specific images.
MD HE	A more likely and acceptable look.	Time consumption.

## **3. Block based techniques**

To overcome GHE limitation, a local histogramequalization method has been developed, which can also be termed block-overlapped histogram equalization. In the spatial domain, the simplest way is to define the overlapped or nonoverlapped rectangular blocks in the image, and carry out the enhancement transformation, such as local histogram equalization (LHE) or various sharpening spatial filtering , on the blocks.

In this block based techniques, a rectangular sub-block of the input image is first defined, a histogram of that region is obtained, and then its histogram-equalization function is determined. Thereafter, the center pixel of the region is histogram equalized using this function. The center of the rectangular region is then moved to the adjacent pixel and the histogram equalization is repeated. This procedure is repeated pixel by pixel for all input pixels. This method allows each pixel to adapt to its neighboring region, so that high contrast can be obtained for all locations in the image. However, since local histogram equalization must be performed for all pixels in the entire image frame, the computation complexity is very high. For example, for a  $640 \times 480$  pixel image, the histogram equalization must be performed maximally 307 200 times.

To reduce this computation complexity and obtain the advantage of local adaptability of block-overlapped histogram equalization, subblock nonoverlapped histogram equalization can be used. Even so, this nonoverlapped method will sometimes suffer from blocking effects.

These block-based techniques can enhance contrast at all locations in an image. But because they cannot discriminate between edge and noise in a block, they usually produce unnatural results due to excessive noise amplification especially in smooth areas.

## **3.1 Partially Overlapped Sub-block Histogram Equalization (POSHE)[3]**

Based on the requirement of real-time processing, Kim et al proposed a contrast enhancement using partially overlapped subblock histogram equalization (POSHE) to deal with both the contrast enhancement and blocking effect. POSHE is derived from local histogram equalization, but it is more effective and much faster compared to HE methods. The effectiveness results from its local adaptability, and its speed from the partial overlapping feature. The most important feature of POSHE is a low-pass filter shaped mask that obtains a sub-region probability density function, and the fact that the mask size can be varied to achieve quality improvements at the expense of calculation complexity. POSHE gives large contrast enhancements which global histogramequalization methods cannot achieve, and proves to be simpler than local histogram equalization without incurring any blocking effects. POSHE can be realized in simple hardware and processed in real-time.

In this algorithm, it partitions the original image into numbers of sub-blocks, and then equalizes them in terms of partially overlapped manner, and finally averages the result based on certain weights. POSHE could be considered as a special version of LHE, thus it has all the features belonging to LHE besides its own. Namely it could well strengthen the local details as well as decrease the wash-out effect and blocking effect. Moreover, it is capable of accelerating the processing to achieve the real-time applications. However, if we inspect the results carefully, slight blocking effect still exists in the images though blocking effect reduction filter (BERF) operation suggested by Kim is already conducted.

## 3.2 Non-Overlapped Sub-blocks and local Histogram Projection(NOSHP)[5]

Bin Liu, Weigi Jin, Yan Chen and Chongliang Liu presented a non-overlapped sub-blocks and local histogram projection based contrast enhancement (NOSHP).HE based algorithms are not the optimal choices for contrast enhancement, especially when dim texture and tiny targets are what we concern most. Different from HE process, HP based algorithms work on the fact that zero-PDF grayscales sometimes exist in the original histogram, and they can enhance the contrast by redistributing the original grayscales uniformly onto the full grayscale range. They could preserve the image brightness as far as possible, and avoid the annoying washout effect as well. First, the original image is segmented into numbers of non-overlapped sub-blocks where the histogram projection (HP) is then executed individually. Subsequently, each sub-block is related to its adjacent three ones by certain

weights, so that the integral image and local details can be both enhanced. It is indeed better than those traditional ones, but the non-linear mapping curve is not easily and automatically acquired in practical uses. In order to appropriately enhance the contrast and highly decrease the time consumption and complexity, in this paper presents the NOSHP to deal with these problems. It not only has efficient performance similar to the global methods like GHE and HP, but also owns detail enhancement of perfect visual perception similar to the LHE and POSHE.

NOSHP can effectively enhance the local details as well as properly preserve the image brightness to avoid the annoying blocking effect and wash-out effect. Moreover, this algorithm can dramatically reduce the time consumption in practical use, leading to a useful real-time processing method well suited to the consumer electronic products.

#### 3.3 Comparison

Title	Author	Features
POSHE POSHE CMBFHE : a Novel Contrast Enhancem ent Technique based on Cascaded Multistep Binomial Filtering HE	Joung- Youn Kim, Lee-Sup Kim, and Seung- Ho Hwang Fabrizio Lamberti, Bartolom eo Montrucc hio, and Andrea Sanna	<ul> <li>Reduce the computation complexity.</li> <li>Blocking effects eliminated.</li> <li>POSHE requires a slightly larger number of divisions and shifts, but this is two order of magnitude smaller than the number of additions.</li> <li>Real time processing.</li> <li>Simple hardware.</li> <li>Approximately 4 and 17 times faster than POSHE</li> <li>Suitable solution in all those consumer electronics.</li> <li>Efficient filtering techniques,</li> <li>Exactly the same results of POSHE, With a reduced computational complexity.</li> </ul>
NOSHP	Bin Liu, Weiqi Jin, Yan Chen, and Li Li	<ul> <li>Avoid blocking effect and wash-out effect</li> <li>Brightness preserving.</li> <li>Real time processing.</li> <li>Reduce time consumption</li> </ul>

# 4. Multiscale mathematical morphology

#### 4.1 Multiscale tophat transformation[6]

Susanta Mukhopadhyay and Bhabatosh Chanda developed a multi-scale morphological approach. According to their approach, the scale-specific features of an image are firstly multi-scale extracted using tophat transformation, then separately amplified, and finally combined to reconstruct a locally enhanced image. About their approach, there is a point worthy of notice: the scale-specific features, to be enhanced, are defined not only depending on the shape of the image structure but also depending on the shape and size of multiscale structuring elements used for tophat transformation. Thus the approach usually gives rise to false contouring artifacts. The same problem also happens to other multi-scale techniques using anisotropic diffusion. nonlinear pyramid recombination, and so on.

# **5.** Multiresolution Methods

Multiresolution methods or hierarchical approaches attempt to find a specific frequency at a specific location, which is the main shortcoming of Fourier Transform (FT) and Short Time Fourier Transform(STFT). However, it is not possible to find a specific frequency at a specific location simultaneously. Therefore, as a tradeoff between time frequency representations, multiresolution methods are created. Multiresolution methods are designed to obtain a good time resolution but less accurate frequency resolution at high frequencies and a good frequency resolution but less accurate time resolution at low frequencies (Fig 5.1(a)). This approach is useful when the signal contains high frequency components for short durations and low frequency components for long duration. Usually, 2-D images follow frequency pattern. This effectively this overcomes the window size problem of STFT (Fig 5.1(b)).

Therefore, multiresolution approaches are more effective in image analysis and they

overcome the limitations of frequency and location resolutions found in FT and STFT.



Figure 5.1: Time frequency tiling using wavelet

A set of coefficients are obtained from a multiresolution transform. These coefficients corresponds to the frequency information at a different resolution, location and sometimes the orientation of the image. In multiresolution approaches, such as discrete wavelet, gabor filters and discrete curvelet transforms, the frequency information at different scales, orientations and locations are obtained.

The multiresolution method is similar to image zooming process. When image is zoomed out, we get a global view of the image. Whereas, a detailed view of the image is obtained when it zoomed in. Using the multiresolution approach, we can get a complete picture of the image consisting of its low frequency components. Meanwhile, high frequency components of the image at low scales provide the detailed and discriminatory structures of the image, which is important when using content based image retrieval based on texture features. In the following, we describe the two maior multiresolution approaches from the literature, namely, Gabor filters transform and the discrete wavelet transform.

Local methods in the frequency domain (often referred to as multi-resolution

techniques), by and large, consist of following steps: first, transform the image into frequency domain using discrete cosine transform, Fourier transform, wavelet transform, or curvelet transform, etc; then, modify the frequency components using various sharpening frequency filters or based on the human contrast sensitivity;finally, reconstruct the image from the modified frequency components using the corresponding inverse transform. A major drawback of multi-resolution techniques is that they usually suffer from ringing or blocking artifacts caused by altering the frequency components.

#### 5.1 Discrete Wavelet Transform

Wavelet transform is introduced with the advancement in multiresolution transform research. Discrete wavelet transform is one of the most promising multiresolution approaches. It has the advantage of a time-frequency representation of signals where Fourier transform is only frequency localized. The location, at which a frequency component of an image exists, is important as it draws the discrimination line between images. Given an image f(x; y), its continuous wavelet transform [7].

$$WT_{\psi}(a_1, a_2, b_1, b_2) = \int_R \int_R f(x, y) \overline{\psi_{a_1, a_2, b_1, b_2}(x, y)} dx dy$$

Unlike the FT and STFT, the window size varies at each resolution level when the wavelet transform is applied to an image. In discrete wavelet trans- form, the original image is highpass filtered yielding three detail images, de- scribing the local changes in horizontal, vertical and diagonal direction of the original image. The image is then lowpass filtered yielding an approximation image which is again filtered in the same manner to generate high and low frequency subbands at the next lower resolution level (Fig. 5.2). This process is continued until the whole image is processed or a level is determined as the lowest to stop decomposition.

This continuing decomposition process is known as down sampling and shown in Fig. 5.2.



Figure 5.2: DWT decomposition tree

The whole decomposition process provides us with an array of DWT coefficients obtained from each subbands at each scale. These coefficients can then be used to analyze the texture patterns of an image. Wavelet subbands obtained from the Lena image using 4 decomposition levels are shown in Fig. 5.3



Figure 5.3: A 512\_512 Lena image (left) and its DWT transform (right).

Though wavelet transform has been widely accepted, it has several prob- lems which results in a poor outcome for content based image retrieval. In two dimensional 2-D(2D) space, wavelets can not capture highly anisotropic elements like the curves of an image effectively as wavelets are not effective at representing line singularities. Images with a dense composition of highly anisotropic elements such as curves may not be well represented using wavelet texture representation. Besides. discrete wavelet transform only uses 3 directional wavelets; horizontal, vertical and diagonal to capture the im- age texture information. Images containing a high level of directionality will not be well by wavelet spectral represented domain. Because of the above mentioned flaws of discrete wavelet transform, researchers have been trying to introduce spectral approaches which involve more directional information in an image for texture representation. Discrete curvelet transform is the result of this endeavor. Discrete curvelet transform consists of more scales and orientations in the frequency domain than the Gabor filters and completely covers the spectral plane. The Gabor filters transform has less number of orientations at every scale whereas, in the curvelet transform, the number of orientations increases as the level of resolution increases so that more directional information from high frequency components can be captured.

## 6. Contrast Enhancement

Contrast enhancement has an important role in image processing applications. Contrast enhancement is acquiring clear image through brightness intensity value redistribution. In other words, that is enhancing features as stretching interval between dark and brightness area. Enhanced image which was result of contrast enhancement processing in preprocessing stage will provide clear image to eyes or assist feature extraction processing in computer vision system.

#### 6.1 Gray-Level Grouping (GLG)- Part 1[2]

Conventional contrast enhancement techniques either often fail to produce satisfactory results for a broad variety of lowcontrast images, or cannot be automatically applied to different images, because their parameters must be specified manually to produce a satisfactory result for a given image. This paper describes a new automatic method for contrast enhancement. The basic procedure is to first group the histogram components of a low-contrast image into a proper number of bins to a selected criterion. according then redistribute these bins uniformly over the grayscale, and finally ungroup the previously grouped gray-levels. Accordingly, this new technique is named gray-level grouping (GLG), ZhiYu Chen, Besma proposed by R. Abidi, David L. Page, and Mongi A. Abidi. GLG only produces not results superior to conventional contrast enhancement techniques, but is also fully automatic at fast speeds in most circumstances, and is applicable to a broad variety of images. The benchmark image quality measure, Tenengrad criterion, indicates that the GLG results are superior to the conventional techniques. The optimized GLG algorithm generally can process an image within a few seconds on a personal com- puter (PC), and the FGLG algorithm can process an image on the time scale of millisecond on a PC. The basic GLG method also provides a platform for various extensions of this technique, such as selective gray-level grouping (SGLG), (S)GLG with pre- processing steps for eliminating image background noises, (S)GLG on color images, and so on.

#### 6.2 Gray-Level Grouping (GLG)- Part II[4]

This is Part II of the paper, Gray-Level Grouping (GLG): an Automatic Method for Optimized Image Contrast Enhancement. Part I of this paper introduced a new automatic contrast enhancement technique: gray-level grouping (GLG). GLG is a general and powerful technique, which can be conve- niently applied to a broad variety of low-contrast images and outperforms conventional contrast enhancement techniques. However, the basic GLG method still has limitations and cannot enhance certain classes of low-contrast images well, e.g., images with a noisy background. The basic GLG also cannot fulfill certain special application purposes, e.g., enhancing only part of an image which corresponds to a certain segment of the image histogram. In order to break through these limitations, this paper introduces an extension of the basic GLG algorithm, selective gray-level grouping (SGLG), which groups the histogram components in different segments of the grayscale using different criteria and, hence, is able to enhance different parts of the histogram to various extents. This paper also introduces two new preprocessing methods to eliminate background noise in noisy lowcontrast images so that such images can be properly enhanced by the (S)GLG technique. The extension of (S)GLG to color images is also discussed. SGLG and its variations extend the capability of the basic GLG to a larger variety of low-contrast images, and can fulfill special application requirements.

## 7. Conclusion

Here different image enhancement methods are discussed. Each of these methods has advantages, but suffered from some drawbacks. Depending on the application we can choose suitable image enhancement method.

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#### Profile



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