CHAPTER 3

ENHANCEMENT OF IMAGE CONTRAST BASED ON
INTENSITY HISTOGRAM EQUALIZATION METHOD

3.1 INTRODUCTION

Enhancement of the overall image contrast and the sharpness of the image are the associated tasks to be performed. The Intensity Histogram Equalization (IHE) method is employed to preprocess the image to remove noise and enhance the image contrast for disparity enhancement and in that way introduces intensity to improve the brightness. The preprocessing in IHE method follows the mask production, enlightenment equalization, and color normalization for efficient analysis of the different chosen design parameters. Mask production labels the pixels, and Region-of-Interest (ROI) in the entire image excludes the background of the image to generate a binary image for each band. The histogram threshold rate was mechanically calculated using pixel value statistics for exact relationship maintenance on gradient flow.

An efficient minimization algorithm based upon graph fails to have the exact relationship on gradient flow. The existing Nonlinear Dynamic Range Adjustment (NDRA) method combines and updates existing processing blocks but a comprehensive and efficient analysis of the different chosen design parameters are not performed. The effective optimization technique does not implement the pre-processing steps to reduce the number of instructions, noise and improve the quality. In order to overcome the ambiguity of existing NDRA method, IHE method was developed and efficiently performed the preprocessing task which is used to achieve the better enhanced contrast of image with minimal noise. The experimental performance of IHE method is precise in terms of noise
removal ratio, brightness quality efficiency, Max-flow computational intricacy, and false positive error. The noise removal ratio is approximately 11% improved when compared with the existing Variation-HOD method.

3.2 IMAGE CONTRAST DEVELOPMENT AND DENOISING APPROACHES

Image Contrast development plays a special role in the image processing applications. The image processing application encloses natural digital image photography, remote sensing, and LCD display based images. Exiting techniques have the several reasons for the images in the poor contrasts. The poor contrast of images lacks in providing the expert result while performing operation on it. The imaging device is of adverse form at the time of acquisition. The curvature based image denoising and energy based on curvature of images are discussed in the following sections.

3.2.1 Curvature Based Image Denoising

Egil Bae et al. (2011) designed Curvature based on Higher Order Derivatives (Variation-HOD) minimizes the curvature of all level lines in the image. An efficient minimization algorithm based on graph cuts not succeeds to have the accurate connection on gradient flow. Euler’s Elastica model has relations to the gradient flow of the energy function, and joins to a least point. Themodel can also protect discontinuities. Euler’s Elastica model shortens the problem by solving a series of graph represent able problems.

Total Variation (TV) algorithms and graph representable for minimizing higher order Markov Random Field (MRF). A minimization algorithm supported on the graphcuts curvature method used for basically reducing the energy in the Euler’s elastic model. In the distinct location; Euler’s model has the structure of a higher order MRF. A graph cut of images has been used in vision problems for a long time. In addition, this type of concept can also
be used to solve binary problems of the form which represented on a graph and minimized by max-flow/min-cut algorithms.

3.2.1.1 Minimization of higher order energy based on curvature of images

The higher order model that reduces several functional of the curvature of the image is essential. Euler’s elastica is an important such curvature based model which introduced in image processing. In image processing, the model can be created as the minimization of Euler’s elastica of all stage curves of the image.

Euler’s elastica on image denoising; in which the complete energy functional can be decreases to the standard TV denoising model, which is also reduces the total length of all the level lines in the image. Euler’s elastica is consequently more difficult than TV, as the resulting level lines will have a more natural appearance. In general, minimization concerned in graph cut curvature is based on answering their corresponding Euler-Lagrange equations. Therefore, the curvature based models does not robust for the development of max flow computation into the framework.

3.2.2 Fingerprint Image Enhancement with Significance on Preprocessing

Josef Strom Bartunek et al. (2013) developed a Nonlinear Dynamic Range Adjustment (NDRA) method as combines and keep informed the processing blocks. The processing blocks does not have a comprehensive and efficient analysis of the different chosen design parameters. The NDRA method consists of four processing blocks for development of finger print images are, preprocessing, global analysis, local analysis and matched filtering.
A nonlinear dynamic range adjustment method is only used for pre-processing and local analysis blocks. The different shape of order statistical filters is applied in global analysis and corresponding filtering blocks. Besides, pre-processing block using non-linear SMQT dynamic range tuning method is used to increase the global contrast of the fingerprint image for additional processing. The fingerprint has circular structure branch which is same spatial frequency throughout the image but varying local orientation. Hence, circular structure in the magnitude spectrum has been utilized for calculating the quality of fingerprint image.

The local analysis is determined by a local dynamic range adjustment which is used for applying to each local area. A local area that includes a fingerprint image pattern is extremely periodic and it creates a strong central peak. So, the segmentation of the fingerprint image is performed by assigning a binary mask to the fingerprint image. The segmentation method used the estimated spectral features from the local analysis are create the binary mask. Another post processing is used to eliminate incorrectly segmented structured background from the binary mask. But, the effective optimization technique does not implement the pre-processing steps to reduce the number of instructions, noise and improve the quality.

3.2.3 Different Methods used for Image Contrast Enhancement

Framework for Total Variation (TV) as described in imprints sphere. The sphere shaped TV methods turn into the in-painting problem which computationally practicable at high-resolution. An extremely accepted method for contrast enhancement of images is defined as the Histogram Equalization (HE). HE is the most normally used method due to its ease and reasonably better performance on almost all types of images. HE carries out the procedure on digital images by remapping the gray levels of the image based on the likelihood allocation of the input gray levels. The group HE methods is group into two
standard forms such as global and local histogram equalization method. Global Histogram Equalization (GHE) occupies the histogram information of the complete input image for its alteration function.

In GHE remaps the gray levels in the form that the contrast stretching becomes imperfect in several dominating gray levels. The grey level has larger image histogram components and source important disparity loss for other minute ones. Local Histogram Equalization (LHE) uses a minute slide window through each pixel of the photo image. The every pixel in the photo image consecutively falls in the window which is taken into account of HE method. The gray level mapping for improvement is completed only for the center pixel of that window. Conversely, LHE requires high computational cost and sometimes cause over-enhancement in some portion of the image. Another complexity is that LHE improve the noise level in the input photo image all the length of image features.

Image enhancement via optimal contrast-tone mapping as illustrated the primary departure of histogram equalization. Optimal contrast-tone mapping maximizes predictable difference and gain subject to an upper limit on tone distortion and optionally to other constraints. The minimization of the useful is explicitly acquired with the B-spline coefficients. The each step of minimization is expressed during a convolution procedure. The color feature is one of the most broadly used image objects in image retrieval. It is relatively robust to backdrop complexity and self-governing of image size and direction.

An object illustration by sparse coding and multi-scale max pooling as demonstrated to symbolize a linear classifier to differentiate the objective from the background. The background image description for target and backdrop are measured on variations over time. The non-orthogonal, over-complete lexicon learned from local patches build visual prior more capable for object
description. Max-margin learning algorithm as developed to attains more effectual training of a huge number of inter-related classifiers for multi-label picture annotation application. Max-margin learning algorithm fails to enlarge cluster-based parallel computing stage for inter-related classifier. It is also not very attractive to consider higher order nearest neighbors in inter-related classifier process.

PCA algorithm as described based on Maximum Correntropy Criterion (MCC). MCC is a functional dimension to hold nonzero form and non-Gaussian noise with large outliers. PCA replaces MSE criterion by MCC rotationally invariant and vigorous to outliers. A solution provided to the all critical cases by by adapting generic detectors and encodes a priori knowledge in the form of selected features and weak classifier weighting. Boosted Detectors towards Viewpoint fails to prepare the system by integrating online updating ability into parameterized CovBoost.

Gaussian Mixture Modeling (GMM) as offered suffers from a tradeoff between robustness to background image modification and compassion to foreground abnormalities. GMM is inefficient in running and providing the solution for a variety of observation scenarios. GMM easily controlled by adaptive alteration for image pixels at dissimilar locations and of separate properties.

Arnold transforms and Random Strategies has two weaknesses. One is the periodicity measure and the other is that the higher redundancy rate while dividing the image into square forms. The random overlapping square blocks as presented to generate random iterative numbers, encryption order, and mixed up pixels of each block using Arnold transform. The periodicity makes it unsecure, while the requirement limits its applications. A Parametric Switching Chaotic System (PSCS) and its equivalent transforms for image encryption have a
straightforward structure. PSCS incorporate the Logistic, Sine and Tent maps into unique system. The PSCS shows more common properties, including the Sine and Tent maps as exacting instances but the periodicity is in higher ratio.

Least-Mean-Square (LMS) algorithm as expressed to establish an association linking the present processing location and its equivalent neighboring positions. The position in each type of halftone image includes shortest binary search and error diffusion. LMS fails to develop a hybrid method to fully take care of all the possible components.

Image contrasting using the Intensity Histogram Equalization (IHE) method remove the noise level on the preprocessing step. The preprocessing step follows the mask production, enlightenment equalization, and color normalization for efficient analysis. The brightness on the photo image is improved using the intensity factor in IHE method. The photo image uses the histogram threshold rate for exact association with gradient flow. IHE method improves the level of contrast enhancement and noise robustness.

3.3 INTENSITY HISTOGRAM EQUALIZATION METHOD DEVELOPMENT FOR IMAGE CONTRAST

Intensity Histogram Equalization (IHE) method create an easy and successful image contrast improvement technique. IHE method is to remove the noise level using the mask production, enlightenment equalization, and colour normalization. Mask production labels the pixels, Region-of-Interest (ROI), in the entire image, and exclude the background of the image to produce a binary image for every band. The binary outcome of all bands are merged by using Logical operators, identify the major general associated mask. The enlightenment equalization is used to calculate the mean intensity value.
Figure 3.1 shows the input image of Intensity Histogram Equalization. Color normalization is potentially constructive in classification and color capacity computation in images of significant differences. In order to constantly point out colored objects and lesions, color must transmit directly to the inherent properties of the imaged objects and be self-determining of imaging conditions to enhance the quality. Intensity Histogram Equalization (IHE) method is proposed for disparity enhancement and in that way introduces intensity to improve the brightness particularly to eradicate the noise level. IHE offer maximal brightness preservation using the intensity rate factor. After removing the noise level, the histogram threshold rate was mechanically calculated using pixel value statistics for each colour band.

Hence, IHE max-flow computation takes pixels that have some level of contrast with their neighbors. IHE method possible to relate practical approach with optimization based solutions for a successful contrast enhancement, brightness and for maintaining the histogram threshold rate. The architecture diagram of Intensity Histogram Equalization (IHE) method is shown in Figure 3.2.
Figure 3.2 Architecture diagram for IHE method

Figure 3.2, IHE method used for contrast enhancement which perform well on photo images taken for the experimental test. The computational complexity and controllability become an important goal to design a contrast enhancement algorithm. In order to achieve all these requirements, IHE presents a histogram threshold rate which aims to enhance and preserve the image quality with exact relationship maintenance on gradient flow. In summing up, IHE method goal is to obtain a visually agreeable image enhancement method that has low computational intricacy and works well with picture images.

3.3.1 Preprocessing on IHE method

IHE method first process is to remove the noise level using the Mask production, Enlightenment Equalization, and Color Normalization. The diagrammatic representation of preprocessing step is shown in Figure 3.3.
Figure 3.3 Diagrammatic representation of preprocessing step in IHE method

As shown in Figure 3.3, preprocessing is performed on three important steps. The first step is the mask generation which labels the pixels of the photo image. Region-of-Interest (ROI) in the entire photo image eliminates the background of the image.

Figure 3.4 Generation of binary image
Figure 3.4 is the generated binary images. IHE generated the masks automatically by simple threshold of the three color channel (i.e.,) R, G, B color bands. The color bands generate a binary image for each band. The threshold value was mechanically considered using pixel value statistics outside the ROI for each color band. Logical operators are then used to merge the binary outcome of all bands, and identify the major general associated mask for max flow computation.

The second step enlightenment equalization is non-uniform due to the variation of the photo image. To overcome the non-uniform illumination, each pixel is equalized using the following equation

\[ E_{\text{equalize}}(r_p, c_p) = E(r_p, c_p) + i - \bar{E}p(r_p, c_p) \]  

(3.1)

Enlightenment Equalization’ \( E_{\text{equalize}} \)’ measures the mean intensity value using the row pixel ‘rp’ and column pixel ‘cp’. ‘i’ is the desired average intensity and \( \bar{E}p(r_p, c_p) \) is the mean intensity value of pixels within a photo image ‘p’ of size N×N. IHE enlightenment equalization is used to calculate the mean intensity value, even though the resulting photo images look very similar.

The final (i.e.,) third step is potentially useful in classification of given photo images showed with significant differences. In order to consistently point out colored objects and lesions, color must relate directly to the inherent properties of the photo imaged objects and be autonomous of imaging conditions. Usually, imaging conditions such as lighting geometry and the imaging device scales pixel values in a photo image.

### 3.3.2 Intensity Histogram Equalization Function

Intensity Histogram based contrast enhancement method utilize the photo image histogram to obtain a distinct mapping \( D[n] \) to modify the pixel
values. In IHE method, mapping function is obtained from the histogram, respectively. IHE finds a mapping to obtain an image with a histogram that is as close as possible to a uniform distribution to fully exploit the dynamic range and to have a max-flow computation. An intensity histogram, IHE, D[n] is regarded as an intensity discrete probability mass function of the pixel intensities.

![Figure 3.5 Intensity Histogram Equalization Function](image)

Figure 3.5 explains about the intensity histogram i[n] of a photo image give the approximate Probability Density Function (PDF) of its pixel intensities. Then, the approximate Cumulative Distribution Function (CDF) c[n], is obtained from i[n]. The discrete mapping function is a leveled version of IHE which uses the image histogram to obtain the higher contrast. The discrete mapping function in the IHE discrete form is given as

$$D[n] = (2^f - 1) \sum_{j=0}^{n} i[j]$$  \hspace{1cm} (3.2)

where, f is the number of bits used to represent the pixel values, and n ∈ [0, 2^f - 1]. IHE of the processed photo image is uniform with the discrete nature pixel intensities. IHE is possible to enhance the contrast by stretching the
color of the photo image to makes pixels brighter. IHE produces more natural looking which enhances the contrast of the image by discrete mapping.

The main objective of IHE is to obtain a contrast image with denoising mode for the output photo image. The procedure to perform IHE techniques is as follows:

- Sum the histogram values found through execution on photo image.
- Mean Intensity value computes on sum values by dividing the total number of pixels.
- Multiply the Mean Intensity value by maximum contrast and round off to the nearest integer value.
- Map the contrast level values using a discrete mapping.

For a given photo image P (i,j) with ‘i’ pixels and a contrast level of [0,R-1]. The Probability Density Function (PDF) is given by

$$PDF(l_n) = \frac{V_n}{N} \quad (3.3)$$

$$l_n = 0, 1, \ldots \ldots , R-1. \ V_n \text{is the number of times level } 'l' \text{ appears in an photo image. The probability density function } \ PDF(l_n) \text{ is used to attain exact relationship on gradient flow. The Cumulative Density Function (CDF) of histogram intensity values in IHE is obtained by}$$

$$CDF(l_n) = \sum_{i=0}^{k} PDF (i) \quad (3.4)$$

The Cumulative Density Function (CDF) using equation (4) is used to attain exact relationship on gradient flow and for efficient analysis of the different chosen design parameters. Using the execution sum of histogram values, histogram equalization plots an input level $l_n$ into an output level $\tilde{l}_n$.

$$\tilde{l}_n = (R - 1) \ast CDF (l_n) \quad (3.5)$$
The above equation indicates the relationship between \( l_n \) and \( l_n + 1 \) which has direct relation with PDF of the input photo image. In the IHE, the pixel values are uniformly distributed with values across their range. IHE method enhances the background of the photo image and often produces the probable effects in the photo image. The original photo image and the equalized IHE photo image is clearly seen with the improve photo image enhancement by removing the noise.

### 3.3.3 IHE Algorithm

The below IHE algorithm illustrates the processing step one by one and it is shown below,

<table>
<thead>
<tr>
<th>Step 1: Read input image, perform preprocessing steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1.1: Mask Production generate binary image</td>
</tr>
<tr>
<td>Step 1.2: Enlightenment Equalization forms mean intensity value</td>
</tr>
<tr>
<td>Step 1.3: Color Normalization enhance image quality</td>
</tr>
<tr>
<td>Step 2: Perform the image contrast using a bitwise shift operation</td>
</tr>
<tr>
<td>Step 3: Calculate the histogram using pixels that has a magnitude larger than a given threshold</td>
</tr>
<tr>
<td>Step 4: Magnitude larger than a given threshold improves brightness</td>
</tr>
<tr>
<td>Step 5: Count the number of pixels included in the histogram threshold rate</td>
</tr>
<tr>
<td>Step 6: Calculate ( V_n ) in the discrete mapping function, resulting in increased utilization of active range</td>
</tr>
<tr>
<td>Step 7: Obtain enhanced contrast image with intensity value factor</td>
</tr>
</tbody>
</table>

End
The above algorithmic step of IHE method was adjusted depending on the photo input image’s contrast. Low contrast photo images have narrow histograms and with intensity histogram equalization, denoising is performed. The stretching IHE with histogram threshold rate improve the image quality with bitwise shift operation. Observation of these entire photo images shows that the IHE method outperforms well. However, it is usually desired to have some quantitative measures in addition to subjective assessment.

3.4 EXPERIMENTAL PERFORMANCE WITH VARYING PARAMETERS

Intensity Histogram Equalization (IHE method) for image contrast enhancement is implemented in MATLAB coding. For processing of IHE steps, Corel Image Features Data Set is used, which contain image features extracted from a Corel image collection. Corel Image Features Data Set holds 68,040 photo images from a mixture of categories. Four sets of features are accessible in Corel Image Features Data Set based on the color histogram, color histogram layout, color moments, and co-occurrences.

Each set of features in Corel Image Features Data Set is stored in a separate file and each line corresponds to a single image used for evaluating Intensity Histogram Equalization (IHE) method, (Variation-HOD) technique and Nonlinear Dynamic Range Adjustment (NDRA) method. The initial value in a line is the image ID and the succeeding standards are the feature vector (e.g. color histogram,) of the image. The similar image has the equivalent ID in all files but the image ID is not the same as the image filename in Corel Image Features Data Set.

Color Histogram and color histogram layout in Corel Image Features Data Set used for IHE method evaluation with 32 dimensions in which value of each dimension in a Color Histogram is the density of each color in the entire
image. Histogram intersection between Color Histograms of two images is used to determine the correspondence surrounded by two images. Color Moments contain 9 magnitudes and each one contains H, S, and V in HSV color space with mean, standard deviation, and skewness. Euclidean distance between Color Moments of two images is used to represent the dissimilarity (distance) between two images.

Co-occurrence Texture contains 16 dimensions (4 x 4) which are transformed to 16 gray-scale images. The co-occurrence in 4 directions is worked out horizontal, vertical, and two diagonal directions. The 16 values are Second Angular Moment, Contrast, Inverse Difference Moment, and Entropy. Euclidean distance between Color Moments in Corel Image Features Data Set of two images is used to calculate the divergence (distance) among two images. Experiments evaluation is conducted with the set of images with varying parametric metrics namely reliability, noise removal ratio, intensity percentage value, brightness quality efficiency, max-flow computational complexity, and false positive error.

3.5 RESULT ANALYSIS

Intensity Histogram Equalization (IHE method) for image contrast enhancement is compared against the existing variation models based upon Higher Order Derivatives (Variation-HOD) by Egil Bae et al. (2011) and Nonlinear Dynamic Range Adjustment (NDRA) method by Josef Strom Bartunek et al. (2013). The evaluation value through the graph describes the IHE method experimental result on using the Corel Image Features Data Set.

3.5.1 Measurement of Image Contrast Reliability

The reliability in IHE method is the ability of the photo image to improve the image contrast under the stated conditions for a specified period of time. Intensity Histogram Equalization (IHE method) for image contrast
enhancement is compared against the existing variation models based upon Higher Order Derivatives (Variation-HOD) by Egil Bae et al. (2011), and Nonlinear Dynamic Range Adjustment (NDRA) method by Josef Strom Bartunek et al. (2013).

![Image Contrast Reliability Chart]

**Figure 3.6 Measure of image contrast reliability**

Figure 3.6 shows the image contrast reliability of each technique and evaluates the system. From the figure, proposed IHE method recorded high Reliability Image Contrast. The Image Contrast Reliability is improved and measured in terms of percentage (%). The intensity histogram of a photo image gives the approximate Probability Density Function (PDF) of its pixel intensities to improve the reliability rate. With approximate Cumulative Distribution Function (CDF) $c[n]$ is attained from image $i[n]$, thus it improves the contrast reliability rate. The discrete mapping function is a leveled version of IHE which uses the image histogram to obtain the higher contrast. Therefore, output photo image is obtains a contrast image with de-noising mode and improves reliability rate. Hence, the reliability rate was improved 11 % when compared with the
Variation-HOD by Egil Bae et al. (2011) and 5 % when compared with the NDRA method by Josef Strom Bartunek et al. (2013).

3.5.2 Measurement of Noise Removal Rate

The noise level in the background of the photo image is measured and removes noise from that image using the IHE method. The Noise Removal Rate is measured in terms of Decibel (dB).

\[
\text{NoiseRemovalRate} = 10 \log_{10} (\text{Signal}_{dB} - \text{Noise}_{dB}) \quad (3.6)
\]

The signal dB and noise dB difference is computed with logarithmic form to easily compute the noise removal ratio.

Figure 3.7 depicts the noise removal rate of proposed IHE method when compared with the Variation-HOD by Egil Bae et al. (2011) and NDRA method by Josef Strom Bartunek et al. (2013). Hence, the proposed IHE method improved Noise Removal Rate compared to other existing methods. The cumulative density function (CDF) is used to attain exact relationship on gradient flow and for efficient analysis of the different chosen design parameters.

![Figure 3.7 Measure of noise removal rate](image-url)
Using the execution sum of histogram values, Histogram Equalization plots an input level $l_n$ into an output level $\bar{l}_n$ and reduces the noise rate. Intensity Histogram Equalization (IHE) method is designed for difference improvement and intensity is developed for improving the brightness predominantly to remove the noise level. The Mask production, Enlightenment Equalization and Color Normalization is used in IHE method for removing the noise level rate. Therefore, the noise removal rate is improved by 18.5 % in IHE method when compared with Variation-HOD by Egil Bae et al. (2011) and 10.5 % improved when compared with NDRA method by Josef Strom Bartunek et al. (2013).

### 3.5.3 Measurement of Brightness Quality Efficiency

The brightness quality defines the contrast quality enhancement on the photo image and measured in terms of the pixel rate. The existing variation models based upon Higher Order Derivatives (Variation-HOD) by Egil Bae et al. (2011) and Nonlinear Dynamic Range Adjustment (NDRA) method by Josef Strom Bartunek et al. (2013).

Figure 3.8 shows the measure of Brightness Quality Efficiency based on three techniques. From the figure, proposed IHE method evidenced better Brightness Quality Image.

**Figure 3.8 Brightness quality efficiency measure**
Figure 3.8 describes the brightness quality efficiency based on the PSNR value. The colored objects are related directly to the inherent properties of the photo imaged objects in IHE method. IHE method presents maximal brightness preservation of images using the intensity rate factor. After removing the noise level, the histogram threshold rate was automatically considered using pixel value statistics for each colour band. Lighting geometry and the imaging device are some of imaging conditions considered with pixel value of images to improve the quality ratio. Therefore, IHE method improves the brightness quality by 4.5 % when compared with the Variation-HOD by Egil Bae et al. (2011) and 13 % improved when compared with the NDRA method by Josef Strom Bartunek et al. (2013).

3.5.4 Measurement of Max-Flow Computational Complexity

Max-Flow Computational complexity in image contrast enhancement focuses on inherent difficulty, and relating those spatial frequency classes to each other. Max-Flow Computational complexity is measured in terms of percentage (%).

Figure 3.9 shows the experimental results of Max-Flow Computational Complexity based on Normalized Spatial Frequency. From the figure it is clear that the intensity Histogram Equalization method minimizes the computational complexity compared to other existing methods.
Figure 3.9 demonstrates the computational complexity based normalized spatial frequency. The complexity is reduced in IHE method using the distinct mapping $D[n]$ to modify the pixel values. With the application of mapping function in proposed IHE method, the computational complexity is detected. This mapping function is attained from the histogram and they perform identical distribution of images with their dynamic range. Hence, IHE max-flow computation takes image pixels with certain level of contrast for each color band. As a result, the computational complexity is improved 35.5% when compared with the Variation-HOD by Egil Bae et al. (2011) and 26% improved when compared with the NDRA method by Josef Strom Bartunek et al. (2013).

### 3.5.5 Measure of False Positive Error

False Positive Error (FPE) denotes the incorrectly identified paths on the photo image.

$$False\ Positive\ Error = \frac{\sum False\ Positive}{\sum Condition\ of\ false\ positive\ points}$$

(3.7)

The false positive error denotes the lesser pixel count. Always, the FPE is denoted on lesser value in IHE when compared with existing systems.
Figure 3.10 (a) FPE on existing system (b) FPE on IHE method

Figure 3.10 (a) and (b) denotes the FPE on the existing and proposed system, whereas the pixel count with errors is reduced in IHE method.

Figure 3.11 Measure of false positive error

Figure 3.11 describes the false positive error based on the number of features. The threshold value was considered using pixel value statistics outside the ROI for each color band. Initially, Region-of-Interest in proposed method is considered in entire photo image thus it eliminates the background of the images. Next, threshold value was considered using pixel value of ROI for each color bands. Then, Logical operators are used to merge the binary result of all bands, and identify the major general associated mask for reducing the false
positive error. Hence, the false positive error rate is reduced in IHE method by 23% when compared with the Variation-HOD by Egil Bae et al. (2011) and 17.5% when compared with the NDRA method by Josef Strom Bartunek et al. (2013).

3.5.6 Measurement for Intensity Percentage Value

Intensity of the photo image denotes the measurement of overall preprocessing, brightness and contrast histogram threshold rate.

The experimental result of Intensity Percentage Value shown in the figure 3.12 is based on the frame number ranges from the 50 to 350. As the frame number varies, the intensity value is improved and measured in terms of percentage (\%).

![Figure 3.12 Measure of intensity percentage value](image)

Figure 3.12 describes the intensity percentage value based on frame number. IHE method enlightenment equalization’ $E_{equalize}$’ measures the mean intensity value using the row pixel ‘rp’ and column pixel ‘cp’. $\bar{Ep}(rp,cp)$ Compute the mean intensity value of pixels within a photo image ‘p’ of size N×N to improves intensity level. The enlightenment equalization is used in
Intensity Histogram Equalization (IHE) method to compute the mean intensity value. Intensity Histogram Equalization method introduces the intensity level for improving the brightness and produces minimum noise level. Therefore, intensity level is improved by 10% when compared with the Variation-HOD by Egil Bae et al. (2011). IHE enlightenment equalization computes the mean intensity value and 4% improved when compared with NDRA method by Josef Strom Bartunek et al. (2013).

3.6 CONCLUSION

Intensity Histogram Equalization (IHE) method is developed for removing the noise defects and enhanced the image contrast. IHE method follows mask production, enlightenment equalization and color normalization for efficient analysis of particular selected parameters. Mask production makes the pixels and Region-of-Interest (ROI) in the complete photo image and rejects the backdrop of the image to generate a binary image. In addition, The IHE avoids the complex calculations and improve the max-flow computational operations are used for obtain real-time implementable algorithm. IHE finds a mapping to get hold of a photo image with an intensity histogram threshold, which is designed based on the pixel value of images to obtain the accurate information of gradient movement. The experimental results show the effectiveness in IHE algorithm when compared to conventional NDRA method algorithms. The noise removal ratio is averagely 11.798% improved in IHE method when evaluated on existing system. IHE offers a level of controllability and different levels of contrast enhancement with improved result in reliability, noise removal ratio and also provided the better intensity of quality images compared to state-of-art methods.