School of Computer Science & Engineering

BCSE403L – Digital Image Processing – E1 Slot – WIN 2023 -24

Project Report

DA-1

Project Title : Histogram Equalization for Poor Contrast Images

GitHub Link : https://github.com/Tanmay0448/Histogram-Equalization-for-Poor-Contrast-Images

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I. Introduction

In the realm of digital image processing, the quality and clarity of an image play a pivotal role in its interpretation and analysis. However, images with poor contrast often pose significant challenges, hindering effective visualization and analysis. Histogram equalization emerges as a fundamental technique to address such shortcomings, providing a means to enhance the contrast of images by redistributing pixel intensities.

This project delves into the application of histogram equalization specifically tailored for images suffering from poor contrast. The primary objective is to develop a robust algorithm capable of transforming low-contrast images into visually enriched representations, thereby facilitating improved interpretation and analysis.

II. Literature Review

A novel technique for analysing histogram equalized medical images using superpixels

Superpixel segmentation is introduced as a crucial component of the proposed technique. The authors specifically focus on the SLIC (simple linear iterative clustering) algorithm, which allows for the generation of superpixels with control over their compactness and number. This algorithm is well-suited for analyzing grayscale images before and after histogram equalization.

The proposed technique combines histogram equalization and superpixel segmentation to determine whether an image is histogram equalized or not. By utilizing SLIC superpixels, the authors demonstrate the ability to effectively distinguish between original images and their histogram equalized versions. This distinction is not observed with other superpixel segmentation algorithms, highlighting the superiority of SLIC in this context.

To evaluate the proposed technique, the authors conduct experiments using various medical images. They compare the results of SLIC superpixels with three other superpixel segmentation algorithms: quick shift, watersheds, and Felzenszwalb's segmentation algorithm. The results consistently show that SLIC superpixels provide compact and uniform segmentation for histogram equalized images, further validating the effectiveness of the proposed method.

The document concludes by discussing the potential applications of the proposed technique in medical image analysis. Accurately distinguishing between original and enhanced images is crucial in medical imaging, where precise analysis plays a vital role. The proposed technique offers a promising solution to this challenge, providing a novel approach to analyze histogram equalized medical images using superpixels.

"A novel technique for analysing histogram equalized medical images using superpixels" presents a valuable contribution to the field of medical image analysis. The combination of histogram equalization and superpixel segmentation, specifically utilizing the SLIC algorithm, offers a novel and effective approach to distinguish between original and histogram equalized images. The document provides insights into the effectiveness of different superpixel segmentation algorithms and their application in medical image analysis. Further research can be conducted to explore the full potential of this technique and its implications in the medical field.

Automatic Contrast Enhancement of Brain MR Images Using Histogram Equalization

The study titled "Automatic Contrast Enhancement of Brain MR Images Using Histogram Equalization" proposes a method for enhancing the contrast of brain MR images using hierarchical correlation histogram analysis [1].

The method aims to improve adaptive contrast enhancement for specific objects, such as abnormal cell regions. The results demonstrate that the proposed method outperforms existing techniques in terms of image quality and accuracy. This approach has potential applications in computer-aided diagnosis systems, particularly for diseases like Parkinson's disease.

The study highlights the importance of contrast enhancement in brain MR images for accurate diagnosis and evaluation of diseases. By applying histogram equalization techniques, the proposed method effectively enhances the visibility of abnormal cell regions, aiding medical professionals in disease assessment.

Experimental and Numerical Research of Paved Microcrack Detection

The paper proposes a method that combines image segmentation and feature extraction techniques for detecting and analyzing microcracks in asphalt pavement. While the article mentions other methods such as ultrasonic testing and infrared detection, histogram equalization is highlighted as a technique for enhancing the efficiency and accuracy of crack detection.

The study emphasizes the significance of accurate crack detection in road maintenance and proposes a method that utilizes histogram equalization to enhance the visibility of microcracks. By applying histogram equalization techniques, the proposed method improves the efficiency and accuracy of crack detection, contributing to effective road maintenance and damage evaluation.
Overall, histogram equalization plays a crucial role in image enhancement by improving the visibility of image features and enhancing the overall quality of images. Its application extends beyond brain MR images to various domains, including pavement crack detection. The studies mentioned above demonstrate the effectiveness of histogram equalization in enhancing image contrast and improving the accuracy of feature detection.

Application of Histogram Equalization for Image Enhancement in Corrosion Areas

Histogram equalization is a technique that redistributes the pixel intensities in an image to enhance its contrast and improve overall image quality. In the context of corrosion areas, several studies have investigated the application of histogram equalization and its impact on image enhancement.

One study by Lu et al. (2019) focused on the estimation of defect size from magnetic flux leakage (MFL) images using a visual transformation convolutional neural network. They utilized histogram equalization as a preprocessing step to enhance image quality and improve defect detection accuracy. The results demonstrated that histogram equalization effectively improved the visibility of corrosion areas and facilitated accurate defect detection. Ham et al. (2018) developed a robust guided image filtering technique using nonconvex potentials. They applied histogram equalization to enhance contrast and details in the image, particularly in shadow areas. The study showed that histogram equalization significantly improved image quality and enhanced the identification of corrosion regions.

In another study by Pidaparti et al. (2013), the authors evaluated corrosion growth on SS304 based on textural and color features from image analysis. They employed histogram equalization to enhance image contrast and improve the visibility of corrosion areas. The results demonstrated that histogram equalization effectively enhanced the visibility of corrosion regions, enabling accurate analysis and detection.

Roberge (2007) discussed corrosion inspection and monitoring techniques, including image analysis. The author emphasized the importance of image enhancement methods, such as histogram equalization, in improving the visibility of corrosion areas and facilitating accurate analysis. Histogram equalization was highlighted as a valuable tool for enhancing image quality and aiding in corrosion detection and monitoring.

Histogram equalization techniques for enhancement of low radiance

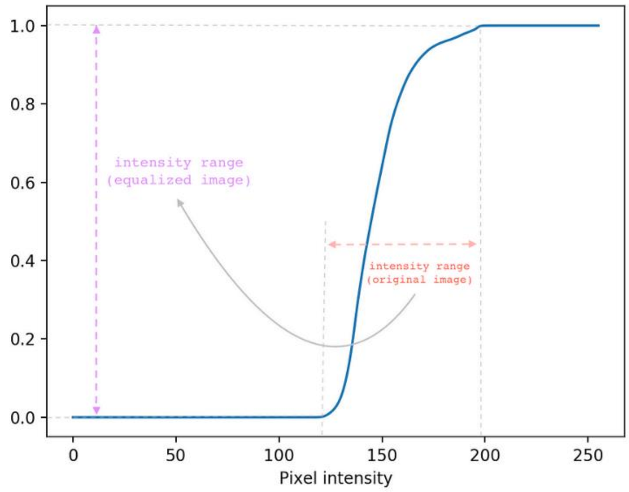
Discusses the use of histogram equalization techniques to enhance low radiance retinal images for early detection of diabetic retinopathy. The proposed techniques, RIHE-RVE and RIHE-RRVE, address the problem of low light radiance by separating the histogram into sub-histograms and performing equalization. The methods are evaluated using various metrics and compared to state-of-the-art techniques. The results show that the proposed techniques outperform existing methods, especially in low radiance images. The importance of retinal imaging in diagnosing various diseases, such as diabetic retinopathy, macular degeneration, diabetes mellitus, hypertension, and stroke, is also highlighted.

The article also discusses the datasets used for evaluation, including the DRIVE, STARE, CHASE_DB1, and OASIS databases. The average results for each database are presented in tables, showing the performance of different techniques in terms of entropy, SSIM, PSNR, and Euclidean distance.

III. Proposed Method

Step 1: Calculate normalized cumulative histogram

First, we calculate the normalized histogram of the image. Normalization is performed by dividing the frequency of each bin by the total number of pixels in the image. As a result, the maximum value of the cumulative histogram is 1. The following figure shows the normalized cumulative histogram a poor contrast image.



Normalized cumulative histogram is used as the transformation function in histogram equalization. It maps the narrow pixel intensity range to the full range.

Step 2: Derive intensity-mapping lookup table

Next, we derive a lookup table which maps the pixel intensities to achieve an equalized histogram characteristic. Recall that the equalized cumulative histogram is linearly increasing across the full range of intensity. For each discrete intensity level i, the mapped pixel value is calculated from the normalized cumulative histogram according to:

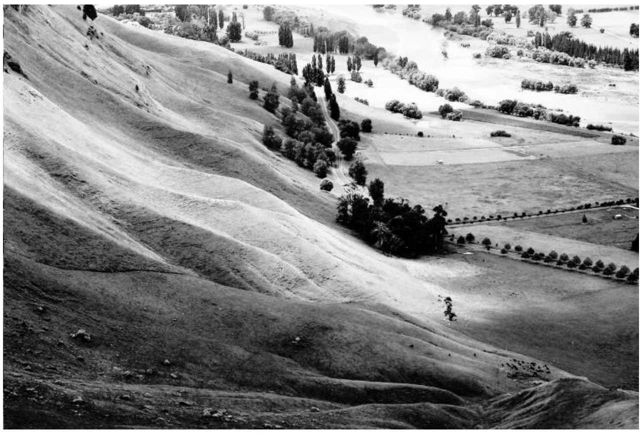
mapped_pixel_value(i) = (L-1) *normalized_cumulative_histogram(i)

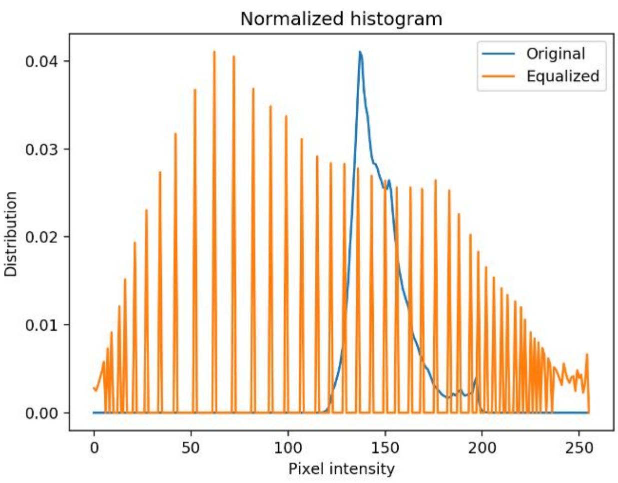
where L = 256 for a typical 8-bit unsigned integer representation of pixel intensity.

As an intuition into how the mapping works, let’s refer to the normalized cumulative histogram shown in the figure above. The minimum pixel intensity value of 125 is transformed to 0.0. The maximum pixel intensity value of 200 is transformed to 1.0. All the values in between are mapped accordingly between these two values. Once multiplied by the maximum possible intensity value (255), the resulting pixel intensities are now distributed across the full intensity range.

Step 3: Transform pixel intensity of the original image with the lookup table

Once the lookup table is derived, intensity of all pixels in the image are mapped to the new values. The result is an equalized image.





IV. Dataset Description

A dataset of low contrast images used in histogram equalization typically consists of images that suffer from poor contrast, meaning they have a narrow or compressed range of pixel intensity values. Here is a description of such a dataset:

1. **Image Samples**: The dataset comprises a collection of images that exhibit low contrast. These images can be of various types such as natural scenes, medical images, aerial photographs, or any other domain where contrast enhancement is necessary for better visualization or analysis.

2. **Resolution**: Images in the dataset may vary in resolution, but they typically have a resolution suitable for analysis and processing, which could range from low-resolution images to high-definition images.

3. **Variety**: The dataset contains images with diverse content and scenes to ensure that the algorithm's performance is robust across different types of images.

Image 1

Image 2

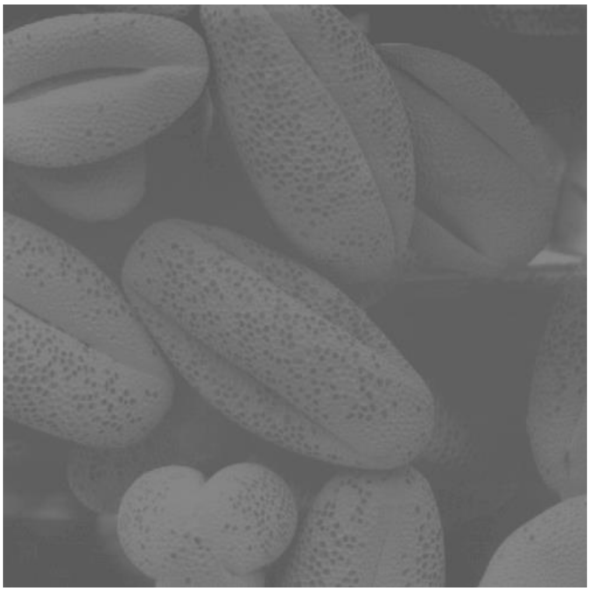


Image 3

Image 4

Image 5

Overall, the dataset of low contrast images serves as a benchmark for developing and evaluating histogram equalization algorithms aimed at improving image contrast for various applications.

V. References

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