E-ISSN No : 2581-6195 | Volume : 7 | Issue : 1 | Jan 2024

IMAGE ENHANCEMENT COMPARISON USING HISTOGRAM EQUALIZATION AND FUZZY LOGIC TECHNIQUES

Shefali Dhingra[1], Shikha Bhardwaj[2]

ABSTRACT

Image enhancement is a method of improving the quality of an image and contrast is a major aspect. Traditional methods of contrast enhancement like histogram equalization results in over/under enhancement of the image especially a lower resolution one. We aim at developing a new Fuzzy Inference System to enhance the contrast of the low resolution images overcoming the shortcomings of the traditional methods. Results obtained using both the approaches are compared.

1. INTRODUCTION

A. Image Enhancement

Image enhancement is simply a technique which improves the quality of the image, increases the perceptibility of the image which is quintessential in the fields such as medical imaging, surveillance, remote sensing etc. Further this acts as a preprocessing for applications like segmentation, recognition etc[1].

B. Histogram

Histogram is important in image processing as it acts as a graphical representation of the tonal distribution in a digital image. It is a graph showing the number of pixels in an image at each different intensity value found in that image [2].

C. Fuzzy Logic

Human brain is capable of making excellent decisions using imprecise & incomplete sensory information provided by the perceptive organs. Fuzzy theory provides a systematic calculus to deal with such information linguistically and perform numerical computations using linguistic labels in the form of membership functions. Fuzzy inference system (FIS) when selected properly can effectively model the human expertise in the specific application. Figure 1shows the fuzzy system [3].

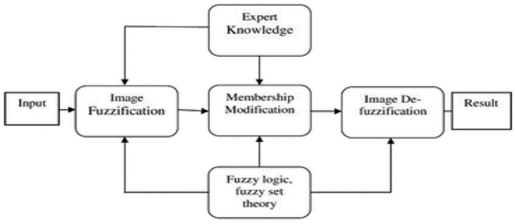

Fig. 1 Fuzzy System

2. METHODOLOGY

The basic steps are as follows:

2.1 Dataset:

- Selection: Choose a diverse dataset containing images with varying content, resolutions, and quality to ensure comprehensive testing.
- Preprocessing: Normalize images, handle outliers, and address any inconsistencies in the dataset.

2.2 Fuzzy Logic Image Enhancement:

- Fuzzy Logic System Design:
- Define linguistic variables (e.g., brightness, contrast) and associated fuzzy sets.
- Construct rule-based systems to map input image characteristics to enhancement parameters [4].
- Membership Functions:
- Design appropriate membership functions to capture the linguistic terms used in the fuzzy logic system.
- Experiment with different shapes and parameters to observe their impact on the enhancement process.
- Implementation in Python:
- Utilize a fuzzy logic library in Python (e.g., scikit-fuzzy) to implement the designed fuzzy logic system.
- Develop functions or modules for fuzzification, rule evaluation, and defuzzification.

2.3 Histogram Equalization:

- Global Histogram Equalization:
- Implement the standard global histogram equalization algorithm to enhance the overall image contrast.
- Optimize the implementation for efficiency and compatibility with various image formats.

[1] Assistant Professor, ECE Department, University Institute of Engineering and Technology, Kurukshetra University, Haryana, India
[2] Assistant Professor, ECE Department, University Institute of Engineering and Technology, Kurukshetra University, Haryana, India

HOW TO CITE THIS ARTICLE:
Shefali Dhingra, Shikha Bhardwaj (2024). Image Enhancement Comparison Using Histogram Equalization and Fuzzy Logic Techniques, International Educational Journal of Science and Engineering (IEJSE), Vol: 7, Issue: 1, 13-14

Research Paper

- Local Histogram Equalization (CLAHE):
- Extend the implementation to include Contrast Limited Adaptive Histogram Equalization (CLAHE) for better handling of localized contrast enhancement.
- Experiment with different block sizes and clip limits.
- Implementation in Python:
- Leverage Python libraries such as OpenCV or NumPy for efficient implementation.
- Provide functions for global and local histogram equalization.

2.4 Experimental Setup:

- Evaluation Metrics:
- Choose appropriate metrics for performance evaluation, such as Peak Signal-to-Noise Ratio (PSNR), Structural Similarity Index (SSIM), and subjective visual assessment.
- Parameter Configuration:
- Define a set of parameters for both fuzzy logic and histogram equalization methods (e.g., fuzzification parameters, block size for histogram equalization).
- Establish a rationale for selecting these parameters.
- Validation and Cross-Validation:
- Split the dataset into training and testing sets to validate the models.
- Implement cross-validation to ensure robustness of the results.

2.5 Implementation Notes:

- Programming Environment:
- Specify the programming environment used (e.g., Python version, libraries).
- Reproducibility:
- Document the codebase, version control, and dependencies to ensure reproducibility of the experiments.

3. RESULTS

The images enhanced by both the techniques i.e. by fuzzy logic and histogram are obtained and compared which are shown in Figure 2 and Figure 3 respectively.

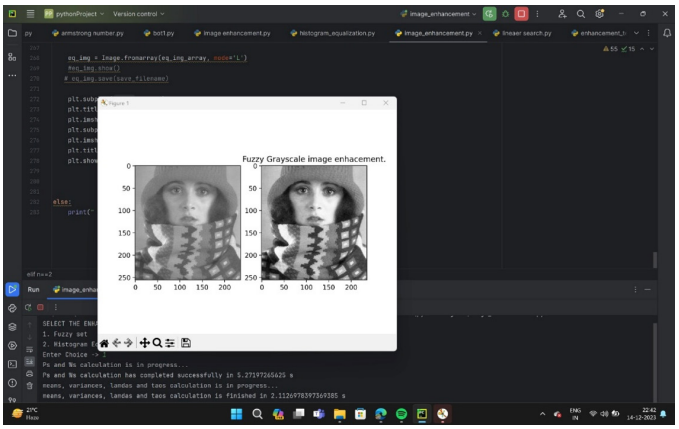

Fig. 2 Image enhancement using fuzzy technique

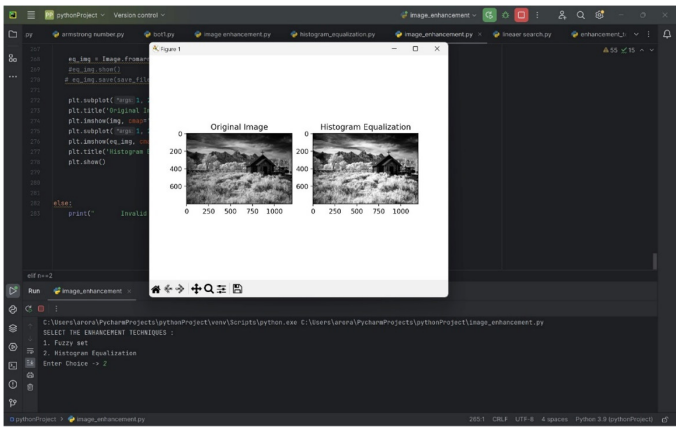

Fig. 3 Image enhancement using Histogram Equalization

4. CONCLUSION & FUTURE SCOPE

Here, in this article image is enhanced by two techniques and the results obtained prove that the enhancement is more accurate with Fuzzy technique as it is more précised and provides a systematic calculus to deal with such information linguistically. Future can be explored by the possibility of combining fuzzy logic and histogram equalization in a hybrid approach. Investigate how the strengths of both methods can be leveraged to achieve even better image enhancement results.

REFERENCE

1. S.D. Chen, & A. R. Ramli, 2003, 'Contrast enhancement using Recursive Mean-separate Histogram Equalization for scalable brightness preservation', IEEE Transactions on Consumer Electronics, Vol. 49, No. 4, pp.1301-1309.
2. H. Ibrahim, & N.S.P. Kong, 2007, 'Brightness preserving dynamic histogram equalization for image contrast enhancement', IEEE Trans. Consum. Electron. Vol.53, pp.1752–1758
3. Yen-Ching Chang & Chun-Ming Chang, 2010, 'A Simple Histogram Modification Scheme for Contrast Enhancement', IEEE Transactions on Consumer Electronics, Vol. 56, No. 2.
4. V. Magudeeswaran and C. G. Ravichandran, "Fuzzy Logic-Based Histogram Equalization for Image Contrast Enhancement," Mathematical Problems in Engineering, vol. 2013,