

Implementation and Comparative Study of Image Fusion Algorithms

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ABSTRACT

Image Fusion is a process of combining the relevant information from a set of images, into a single image, wherein the resultant fused image will be more informative and complete than any of the input images. This paper discusses the implementation of three categories of image fusion algorithms – the basic fusion algorithms, the pyramid based algorithms and the basic DWT algorithms, developed as an Image Fusion Toolkit - *ImFus*, using Visual C++ 6.0. The objective of the paper is to assess the wide range of algorithms together, which is not found in the literature. The fused images were assessed using Structural Similarity Image Metric (SSIM) [10], Laplacian Mean Squared Error along with seven other simple image quality metrics that helped us measure the various image features; which were also implemented as part of the toolkit. The readings produced by the image quality metrics, based on the image quality of the fused images, were used to assess the algorithms. We used Pareto Optimization method to figure out the algorithm that consistently had the image quality metrics produce the best readings. An assessment of the quality of the fused images was additionally performed with the help of ten respondents based on their visual perception, to verify the results produced by the metric based assessment. Coincidentally, both the assessment methods matched in their ranking of the algorithms. The Pareto Optimization method picked DWT with Haar fusion method as the one with the best image quality metrics readings. The result here was substantiated by the visual perception based method where it was inferred that fused images produced by DWT with Haar fusion method was marked the best 63.33% of times which was far better than any other algorithm. Both the methods also matched in assessing Morphological Pyramid method as producing fused images of inferior quality.

Keywords

Image Fusion, Principal Component Analysis, Pyramid Methods, Discrete Wavelet Transform, Image Quality Metrics, Pareto Optimality.

1. INTRODUCTION

Any piece of information makes sense only when it is able to convey the content across. The clarity of information is important. Image Fusion is a mechanism to improve the quality of information from a set of images. By the process of image fusion the good information from each of the given images is fused together to form a resultant image whose quality is superior to any of the input images.

This is achieved by applying a sequence of operators on the images that would make the good information in each of the image prominent. The resultant image is formed by combining such magnified information from the input images into a single image.

1.1 Evolution of fusion techniques

The evolution of the research work into the field of image fusion [9] [17] [24] [25] [26] can be broadly put into the following three stages.

- Simple Image Fusion
- Pyramid Decomposition based fusion
- Discrete Wavelet transform based fusion

The eleven algorithms implemented and discussed here are such that all the three of the above categories are covered for assessment.

The primitive fusion schemes [9] perform the fusion right on the source images. This would include operations like averaging, addition, subtraction/omission of the pixel intensities of the input images to be fused. These methods often have serious side effects such as reducing the contrast of the image as a whole. But these methods do prove good for certain particular cases wherein the input images have an overall high brightness and high contrast. The primitive fusion methods considered were

- Averaging Method
- Select Maximum
- Select Minimum

With the introduction of pyramid transform [2] [3] [4] [5] [6] [9] in mid-80's, some sophisticated approaches began to emerge. People found that it would be better to perform the fusion in the transform domain. Pyramid transform appears to be very useful for this purpose. The basic idea is to construct the pyramid transform of the fused image from the pyramid transforms of the source images, and then the fused image is obtained by taking inverse pyramid transform. Pyramid transform could provide information on the sharp contrast changes, to which the human visual system is particularly sensitive to and it could also provide both spatial and frequency domain localization. The pyramid fusion methods considered here were

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Lauren Gardner



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Table of Contents Implementation And Comparative Study Of Image Fusion

1. Understanding the eBook Implementation And Comparative Study Of Image Fusion
 - The Rise of Digital Reading Implementation And Comparative Study Of Image Fusion
 - Advantages of eBooks Over Traditional Books
2. Identifying Implementation And Comparative Study Of Image Fusion
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Implementation And Comparative Study Of Image Fusion
 - User-Friendly Interface
4. Exploring eBook Recommendations from Implementation And Comparative Study Of Image Fusion
 - Personalized Recommendations
 - Implementation And Comparative Study Of Image Fusion User Reviews and Ratings
 - Implementation And Comparative Study Of Image Fusion and Bestseller Lists
5. Accessing Implementation And Comparative Study Of Image Fusion Free and Paid eBooks
 - Implementation And Comparative Study Of Image Fusion Public Domain eBooks
 - Implementation And Comparative Study Of Image Fusion eBook Subscription Services

- Implementation And Comparative Study Of Image Fusion Budget-Friendly Options
- 6. Navigating Implementation And Comparative Study Of Image Fusion eBook Formats
 - ePub, PDF, MOBI, and More
 - Implementation And Comparative Study Of Image Fusion Compatibility with Devices
 - Implementation And Comparative Study Of Image Fusion Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Implementation And Comparative Study Of Image Fusion
 - Highlighting and Note-Taking Implementation And Comparative Study Of Image Fusion
 - Interactive Elements Implementation And Comparative Study Of Image Fusion
- 8. Staying Engaged with Implementation And Comparative Study Of Image Fusion
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Implementation And Comparative Study Of Image Fusion
- 9. Balancing eBooks and Physical Books Implementation And Comparative Study Of Image Fusion
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Implementation And Comparative Study Of Image Fusion
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Implementation And Comparative Study Of Image Fusion
 - Setting Reading Goals Implementation And Comparative Study Of Image Fusion
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Implementation And Comparative Study Of Image Fusion
 - Fact-Checking eBook Content of Implementation And Comparative Study Of Image Fusion
 - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
- 14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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