Chapter 12
Enhancing Medical Diagnosis Through Multimodal Medical Image Fusion

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ABSTRACT

In the medical domain, multimodal image fusion has emerged as a powerful technique aiming to enhance diagnostic accuracy and clinical decision-making. Image fusion technique combines two or more images from the different imaging modalities to enhance image detail and preserve information. However, single modality imaging fails to provide accurate information necessary for precise analysis and diagnosis. This chapter introduces a flask-based application that integrates multiple medical images, merging brain CT scans and MRI through landmark-based image registration. Then wavelet transform-based fusion techniques combine the registered images, providing a comprehensive view of the brain's neural structure and functions. A CNN model is then employed to identify brain tumors in the fused multimodal images. Following tumor detection, the model categorizes tumors as glioma, meningioma, or pituitary tumor. Through the incorporation of these methodologies, the application supports medical imaging and diagnosis by enhancing accuracy, efficiency, and clinical outcomes.

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1. INTRODUCTION

In the modern era of image processing the image fusion plays an important role in the diagnosis and treatment (Bindu & Swamy, 2014). The technique known as "medical image fusion" involves registering and merging multiple images from one or more imaging modalities in order to enhance imaging quality and decrease redundancy and randomness. This increases the clinical applicability of medical images for the diagnosis and evaluation of medical issues (Li et al., 2019). Magnetic Resonance image (MRI) is supplying soft tissue information of brain but lacks in generating cross-sectional image of brain which can be generated by Computed tomography (CT). Every modality image has its own limitation for providing clinical information because each image taken with diverse radiation power. Tumor detection becomes more difficult when trying to obtain spatial clinical information based on single-channel images. Overcoming the limitations of utilizing a single imaging modality is possible with the help of medical image fusion (IF). Information from many sources can be combined to maximize the distinct benefits of each source while eliminating elements that would otherwise be hidden or difficult to recognize. The selection of fusion method depends on unique features of tumor and chosen imaging modalities. Different fusion techniques have been developed to address the challenges of tumor identification across multiple imaging modalities which include wavelet, (Qiguang, & Baoshu, 2006). Contourlet transform, deep learning-based fusion, multiscale fusion, and (Li et al., 2017) pixel (Malik, Shivprasad, & Maruthi, 2013), feature, and decision-level fusion methods where each fusion technique leverages the strengths of multiple imaging modalities to provide a more accurate representation of tumors than individual modalities alone (Rani & Lalithakumari, 2020). V. A. Rani The proposed hybrid image fusion algorithm consists of two main components: Empirical mode decomposition (EMD) and discrete wavelet transform (DWT) that fuses functional and structural information from MRI and CT images of the brain, enhancing accuracy through a hybrid fusion method based on empirical mode decomposition and discrete wavelet transform. The hybrid algorithm employing EMD and DWT for multimodal brain image fusion enhances accuracy but faces challenges related to input quality sensitivity and computational complexity, requiring further validation for real-world applicability. On the other hand M. B. Abdulkareem's (2018) study aims to enhance the quality of medical images for clinical diagnosis by using image fusion techniques. This includes preprocessing, decomposition, fusion, inversion, and post-processing. The workflow includes Gaussian filters, DWT, weighted average method, IDWT, and color dilation. DWT significantly improves image quality, achieving 90-95% accuracy. However, it may introduce artifacts and distortions in the processed images. The proposed system contains a multifaceted approach to brain tumor diagnosis and analysis, integrating advanced techniques in medical imaging and artificial intelligence to enhance accuracy and efficiency in detecting and classifying brain tumors. The following are the contributions of this paper:(i) A discrete wavelet transform image fusion technique has been presented for merging multimodal images (ii) The effectiveness of the suggested technique has been assessed (iii)In comparison to previous approaches, it offered more edge information and had a higher level of content visibility. (iv) Extracting features from various modalities that are typically not visible in a single image is another useful application of it. The rest of this paper will explore the theoretical basis, methodological specifics, experimental architecture, and results obtained from the implementation of the proposed approach.