MULTIMODAL IMAGE FUSION TECHNIQUE FOR BRAIN IMAGES

1. INTRODUCTION

In medical image processing MRI image, PET image, X- Ray image, CT-Scan image, etc. are the different modalities. Each and every modality has its own advantages and disadvantages. When the advantages of different modalities are combined, it will help the physicians for accurate diagnosis and treatment of the patient. **Image fusion** is an approach which is used to amalgamate the corresponding features of input images in a sequence, integrate and add the geometric detail of a **high-resolution panchromatic (Pan) image** and the color information of a **low-resolution multispectral (MS) image** for the production of a high-resolution MS image. Image fusion is also known as **pan sharpening**. The purpose of image fusion is to combine information from multiple images so that resulting fused image will be thus more suitable for human and machine perception or for further image processing tasks.The multimodality medical image fusion plays an important role in clinical applications which can support more accurate information for physicians to diagnosis diseases.

2. LITERATURE REVIEW

1. Padmavathi, K., Asha, C. S., & Maya, V. K, " **A novel medical image fusion by combining TV-LI decomposed textures based on adaptive weighting scheme".** Engineering Science and Technology, an International Journal, **(2020).**

The most recent MRI-PET fusion model TV-Lland Particle Swarm Optimization (PSO) is used. This model decomposes the source images and their differences into cartoon and texture components and performs fusion as a weighted summation of these components. This fusion model is superior compared with approaches based on wavelet transforms, Laplace transforms, sparse representation, curvelet, NCST fusion .**Drawback- PSO considerably increases the computational time compared to spatial and transform domain approaches.**

2 . Shahdoosti, H. R., &Tabatabaei, Z., "**MRI and PET/SPECT image fusion at feature level using ant colony based segmentation. Biomedical Signal Processing and Control**" , International Journal of Imaging Systems and Technology(2019).
Ensemble Empirical Mode Decomposition (EEMD) and Ant Colony Optimization (ACC)) for adaptive fusion is proposed. This transform decomposes an image into a set of Intrinsic Mode Function (IMF) components, where each component is an ensemble of the signal and a white noise with finite amplitude. In order to eliminate noise pixel wise fusion methods constructs a segmentation map using ACO from the PET images. These maps are fused applying the majority voting rule to construct the fused image.

3. Tang, L, Qian, J., Li, L, Flu, J., & Wu, X**. , "Multimodal medical image fusion based on discrete Tchebichef moments and pulse coupled neural network",** International Journal of Imaging Systems and Technology, **(2017).**

A multi modal fusion model based on discrete Tchebichef Moment (TM) and Pulse Coupled Neural Network (PCNN) proposed in this paper. It exhibits superior performance in MRI-PET fusion clearly depicting the fine textures and functional information in the fused image.

4. He, K., Zhang, X., Ren, S., & Sun, J**, "Deep residual learning for image recognition" in** Proceedings of the IEEE conference on computer vision and pattern recognition**. (2016).**

In this paper, perceptual quality of fused images are improved with deep CNN learning based fusion models, their accuracy tends to decrease due to the vanishing gradient problems. **Drawback-the weights are not updated at the deeper layers.**

5. Liu, Y., Chen, X., Wang, Z, Wang, Z J., Ward, R. K., & Wang, X **, "Deep learning for pixel-level image fusion",** Recent advances and future prospects. Information Fusion (**2018).**

In this paper, a complete review on the conventional image fusion approaches which can be overcome with deep learning based fusion method is used. **Drawbacks-**image representation approaches, image transforms and **the ability of the models to capture significant details from the source images are identified as the major drawbacks of the transform based fusion approaches.**

6. Kim, L, Kwon Lee, J., & Mu Lee, K. "**Accurate image super-resolution using very deep convolutional networks**", in Proceedings of the IEEE conference on computer vision and pattern recognition, **(2016).**

The Very Deep Super Resolution (VDSR) networks for enhancing the resolution of images are realized in this paper. The resolution of the low resolution PET images by are done by residual learning. **Drawbacks- well-defined mathematical transforms are not implemented.**

7. Liu, Y., Chen, X., Peng, H., & Wang, Z. , "**Multi-focus image fusion with a deep convolutional neural network", Information Fusion** (**2017).**

This network designed with two branches of identical sub networks models image fusion as a classification problem. The deep learning based multi focus and the multi spectral image fusion models are based on this network.
Drawback- The weight map is further decomposed into Gaussian pyramid do not guides fusion process at each level of the pyramid.

8. Amini, N., Fatemizadeh, E, & Behnam, H**, "MRI-PET image fusion based on NSCT transform using local energy and local variance fusion rules",** Journal of medical engineering & technology, **(2014).**

The authors have employed the **Non-Subsampled Contourlet Transform (NSCT)** featuring **multi directionality and shift invariance for MRI-PET fusion**. This approach separates the source images into low and high frequency bands and fuses the coefficients of these bands applying the maximal variance fusion rules respectively. **Drawback- The NSCT transform domain requires the maximum energy for fine edges and contours in the fused images.**

3. RESEARCH PROBLEM

From the above literature survey the following problems are identified.

1. There is no exclusive adaptive model for different image modality and fusion with design considerations on resolution, texture and spectral components of source images.
2. Different subsystems for different component of images are limited.
3. Optimization of penalty parameters for image decomposition is difficult.

4. OBJECTIVES OF THE WORK

Based on the problem identified from the literature survey the following objectives are framed.

The highlights of this research proposal are:

l. The deliverable of this research is an exclusive adaptive model for MRI-PET fusion with design considerations on **resolution, texture and spectral components of source images.**

2. Image decomposition is performed with self adaptive TV minimization **optimized with adaptive penalty parameters.**

3. Separate subsystems are designed for fusion of structure and texture component

5. CONTRIBUTIONS

In this research work, a new fusion scheme to fuse high resolution**Magnetic Resonance Images (MRI)** and **low resolutionPositron Emission Tomography (PET)**

images based on **Deep Residual Learning (DRL)** framework and **Self Adaptive Total Variation (SATV)** is proposed. Residual learning model is suitable for super resolving an image and the SATV decomposes an image into structural and textural components.PET/MRI medical image fusion has important clinical significance. MRI isa predominant modality in medical image fusion due to its proliferating usage in the diagnosis and treatment protocols of several pathologies concerned with abdomen, liver, brain. PET is efficient in capturing the internal functions of internal organs and in therapeutic treatment of lesions, metastases, tumours, Alzheimer. The proposed model is Implemented with Matlab 2017b software in an i7-7700K processor with 32GB DDR4 RAM equipped with a NVIDIA GeForce GTX1060 3GB Graphics card.

Finally, the proposed research work of image fusion is an **integral model encompassing super resolution and fusion operations which has not been attempted so far in any of the research papers**. Also in this research paper, proficiently integrated and adapted prospective_mathematical approaches such as **ADMM, TV, SFN, RAP and PReLU will be used in this flexible fusion model.**

Mrs.N.Thenmoezhi