Artificial & Computational Intelligence / Published Online : June 2020
https://acors.org/ijacoi/VOL1_ISSUE3_11.pdf

Artificial & Computational Intelligence

A Review on Medical Image Fusion

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Abstract

Image fusion is the procedure of merging of intended information or feature from a collection of relevant images into single one that will be more informative than individual images. In other words, image fusion is the combination of interested feature from a series of interested images without distortion of relevant information .In case of medical image , it is the method of collecting feature of multiple medical images from single or distinct resources to get more informative image to increase analysis capabilities and estimation of medical problems. In present scenario, it is a more powerful tool to diagnosis disease more accurately. Image fusion applicable in various applications like satellite imaging for remote sensing, medical diagnosis, Military and civilian surveillance etc. In this review paper various medical image fusion techniques are discussed along with their merit and demerit.

Keywords: Modalities, Fusion, wavelet transform, CT, MRI, PET, SPECT

1. Introduction

Multimodal medical image fusion is emerging explore field in medical imaging [1][2]. In this, interested features from dissimilar medical modalities image into a single one which would be more informative in order to finding medical disease. CT, MRI, PET and SPECT are various modalities used for image fusion. By using appropriate algorithm for image decomposition the resultant low and high frequency component are obtained .The course of action is used to join together more than features fetched from low and high frequency components into sub – images at different resolution. The more useful image is regenerated from fused sub images by means of different image reconstruction algorithms. The purpose of image fusion is cut down amount of data, hold important features, eliminate artifacts and provide a resultant image that is more informative for interpretation.

2. Medical Image Fusion Classification and Techniques

In Medical Image fusion, different modality are used to fuse image to find missing information. Different modalities like CT, MRI, and PECT, PET, TRUS etc. are used to find relevant information. In morphology based fusion CT and MR images can be used [3][4][5][6] ..

2.1. Pixel Level Medical Image Fusion: In this case, fusion is used to enlarge the intended information related with every pixel in an image produced through a collection of multiple images [7].

2.2. Feature Level Image Fusion: fusion is generally obtained using a region-based fusion approach and is confirmed to be more robust in adapting to smart fusion rules than pixel based procedure.

2.3. Decision Level Image Fusion: Combine the information at a higher level of generalization and merge the results from a set of algorithms to put down a final fused decision [18].

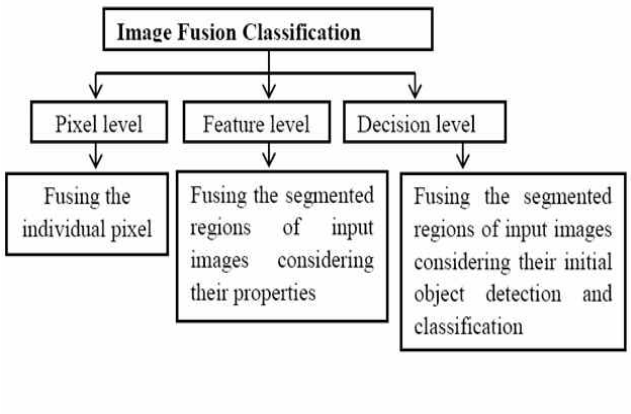

Figure 1.1 Image fusion classifications

3. Different Modalities Used In Medical Image Fusion:

The modalities can be CT, MRI, PET, SPECT etc. CT is used in a variety of medical field under clinical purpose [9]. CT is one of the important modalities along MRI-CT-PET-SPECT-DSA-MEG[10], MRI-CT, SPECT-CT, MRI-CT-PET, CT-FOCAL, ultrasound-CT, FDG-CT, MRI-CT-SPECT etc.

MRI is used for brain tumors detection. The MRI provides high definition and high contrast between soft tissues. Several studies shows the MRI can be used with other modalities are EEG-MRI [11], MRI-Mammogram [12], and MRI-SPECT-PET etc. The most well-known grouping is the MRI-CT.

PET can detect the activity at cellular level and the images can help in distinguish between cancerous tissue and healthy ones. PET produce high resolution images to analysis metabolic process etc.

To investigate the working of some of internal organs SPECT is used. It is a kind of nuclear imaging test.

In case of Ultrasound imaging, it can be used for conformal radiation therapy, prostate cancer treatment, liver tumor diagnosis, breast cancer detection etc.

Breast cancer detection can also be detected by use of Infrared as a modality [13]. Oral cancer detection [14] and prostate brachy therapy and treatment can be performed with the help of Fluorescent imaging [15].

Microwave imaging is used in breast cancer detection [16] and tumor identification .

Mammography is broadly used for breast cancer estimation & when use with other modalities, fusion can much improve the finding accuracies of problems. MRI-mammogram is used for better performance.

3.1. Different Modalities Based On Organs:

Organs	Modalities used
Brain	CT, MRI, DSA, PET, SPECT, MEG, EEG, Molecular and DTI.
Breast	Mammogram, MRI,CT,PET
Prostate	Ultrasound, X-rays, CT, MRI, Uroscopic, FMRI, PECT, PET.
Lungs	SPECT , PET-CT , FDG-PET , CT , PET and FDG.

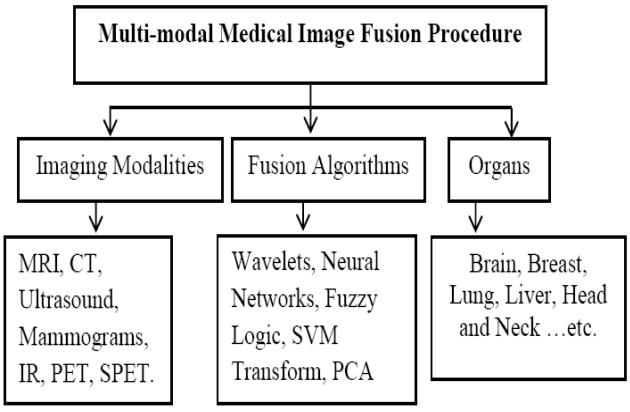

Figure 1.2 Multi modal medical image fusion procedure based on modality, techniques and Organs

As per the nature of the images, the fusion can also be categorized into multi-view fusion, multi-temporal fusion, multi-focus fusion and multimodal fusion [17][18].

4. Comparison of Medical Image Fusion Techniques:

Table 1 shows the comparisons of medical image fusion techniques.

5. Conclusion:

Image fusion can improve reliability and capability by paired information, the fused image will be more suitable for identification and recognition, fused image reduces storage space and time for transmission. apart from advantages there are some hurdles in image fusion like noise can affect the fused results, Some color artifacts can be introduced in fusion process, different illumination of images ,processing is time consuming when image are fused and more than one modality is required for fusion.

Table 1 shows the comparisons of medical image fusion techniques.

Research/Work	Fusion Technique	Modality Used	Remarks/Advantage/Disadvantage
"Find out or fetching of brain regions affected by Alzheimer disease via fusion of brain multi spectral MRI". [19]	DTWT	MRI	Proposed a method for finding affected region by Alzheimer.
"Multimodal M. image fusion using modified fusion rules and guided filters". [20]	Gaussian decomposition, Guided filters, modified saliency and weight maps	MRI	Proposed rules decrease the contrast reduction and halo artifacts.
"multi modal & Multi focus image fusion using wavelet transform".[21]	DT-DWT	MRI ,CT	Proposed fusion technique based on DT-DWT, applied fuzzy logic clustering for segmentation that assist in tumor identification.
"Anisotropic diffusion by heat guided low rank structural analysis".[22]	Anisotropic heat diffusion	MRI,PET	Shows better performance. Fail in case of massive noise.
"Fusion via DWT".[23]	DWT	MRI ,PET	Retain spectral and anatomical information but noisy fused image.
" Image fusion framework based on new contrast"[24]	NSCT	MRI , CT	Preserve spatial feature and functional information.
"Fusion using WT and HVS".[25]	WT	MRI,CT	Algorithm proposed better visual quality.
"Fusion via improved gradient exposure bracketed pairs"[26]	Gradient orientation bracketed pairs	MRI, CT	Use luminance and gradient level.
"Fusion based on HIS and PCA"[27]	HIS and PCA	MRI,PET	Preserve functional information and more spatial features. Color alteration observed.

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