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Fusion Of Medical Images By Using Artificial Intelligence Models

Ashu Nayak[1], Dr. F Rahman[2], Harish Kumar[3]
[1]Assistant Professor, Department of CS & IT, Kalinga University, Raipur, India.
ku.ashunayak@kalingauniversity.ac.in, 0009-0002-8371-7324
[2]Assistant Professor, Department of CS & IT, Kalinga University, Raipur, India.
ku.frahman@kalingauniversity.ac.in, 0009-0007-7167-188X
[3]Assistant Professor, New Delhi Institute of Management, New Delhi, India., E-mail: harish.kumar@ndimdelhi.org, https://orcid.org/0009-0006-8553-4096

Abstract
As a result of two distinct modalities employed in the image acquisition, patient posture and resolution of two images can differ. This causes misalignment of two images while fusing. Hence, image registration is a necessary pre-processing step prior to image fusion. Multimodal image registration avoids or reduces the above-mentioned disadvantages and enhances fusion quality. Image registration superimposes PET and MR images into one coordinate system so that the data from the same physical objects are combined together. Medical imaging is the method of visual representation of body parts of the human body. Medical imaging is carried out with the assistance of scanning modalities which are classified broadly as functional and anatomical modalities. The key aim of this thesis is to construct effective medical image fusion techniques to deliver valuable clinical information to support the medical professionals. Such techniques must fulfill some requirements. The first is to transfer the essential information contained in the input images into the fused image without losing any of it. Second requirement is to remove artifacts in the fused image. We suggest methods by taking these requirements into account as well as taking the other constraints within literature into account. The most important thing when devising our methods is to leverage the adaptive image processing algorithms. The adaptive idea ensures low information loss and small artifacts.
Keywords: *Fusion, medical, images, MRI, PET.*

1. INTRODUCTION

Human beings rely greatly on their sense organs to perceive the outside world. The data received from multiple sensors must be integrated properly through the brain in order to take any sensible decision. Touch, smell, sound, taste and vision are essential to make an intelligent estimate about any phenomenon. Even in today's world, the information received from many sources through multiple channels has to be fused and this phenomenon is collectively known as data fusion [1]. Data fusion also addresses the case of fusing data from various sensors to get an accurate and meaningful information about a situation of interest. Sensor data consists of different types of signals such as speech, image, thermal radiation etc. We are interested in pictures more specially with medical purposes [2]. In the bygone era, the medical expert's sensitivity alone is utilized for the diagnosis of any abnormality in the normal functioning. With technology, different instruments began to assist them with the information necessary for precise diagnosis. But it was difficult to understand the internal organs and their functioning. In the medical sector, most interest is in the sensors that can deliver representative information regarding the organs of concern. In ancient times, invasive methods are the major diagnostic instruments for doctors [9]. In the invasive technique, the condition of the organ is tracked by placing the instruments within the body by piercing or cutting the skin. These methods need the utmost care and due precautions during use. But this kind of practice results in some negative outcomes mostly. Later on, Rontgen discovered X-rays in 1895, a great revolution in the field of medicine. This process records the inner organ structures in the form of images by passing X-rays through the body. The primary benefit of this method is not to carry out this invasive practice to know about the internal structure of the human body. Because the medical imaging is so important in health screening [3].

2. LITERATURE REVIEW

The effectiveness of actual applications of computer vision and image understanding highly relies on the effectiveness of low-level operations engaged. Edge detection and medical image segmentation are two such crucial low-level operations [4]. Thus, numerous researchers have tried to form varied methods for these operations and the history linked to them is incredibly rich. To surpass the drawback of the above-listed techniques, various metaheuristic algorithms have been created to use in edge detection and medical image segmentation. There exist a few forms of bacterial foraging algorithm [13] that have been evolved to use in edge detection to optimize the traditional bacterial foraging algorithm and to detect the edges effectively. Another algorithm, inspired by nature, called differential evolution algorithm, has also been used in the edge detection problem. This algorithm has been tried on two images fused with remote sensed data and has proven effective in this application. Little has been established to date that applies particle swarm optimization techniques in order to find continuous edges of noisy images [5]. The disadvantage of the method is that it is unable to find edges of images distorted with high-density impulse noise.

3. METHODOLOGIES

Fusion of medical images has held a prominent place in many tasks such as observation of the disease condition, treatment planning, identification of the precise location etc. The images derived from different modalities hold a key role by giving necessary information regarding different organs and tissues, thus supports the professionals in taking thoughtful decisions (El-Gamal et al. 2016a). As explained in the last chapter, imaging methods commonly employed are: CT, MRI, PET, SPECT, etc. We can remember the information regarding bones and other dense tissue that can be extracted from CT images. This modality fails to capture very fine variation in the tissue detail [6]. A high-resolution information regarding soft tissue is provided by MRI. But the functional information along with structural details of hard are not achieved here. The functional information in terms of the blood flow is achievable from PET as well as SPECT. For a significant diagnosis, we require both the spatial and structural information MRI/CT along with functional information from PET/SPECT [11]. The ultimate aim is to achieve clean details of an organ or tissue in order to facilitate clinical guidance. The limits of the filters employed in the analysis of source images are chosen based on the details of the spectrum.

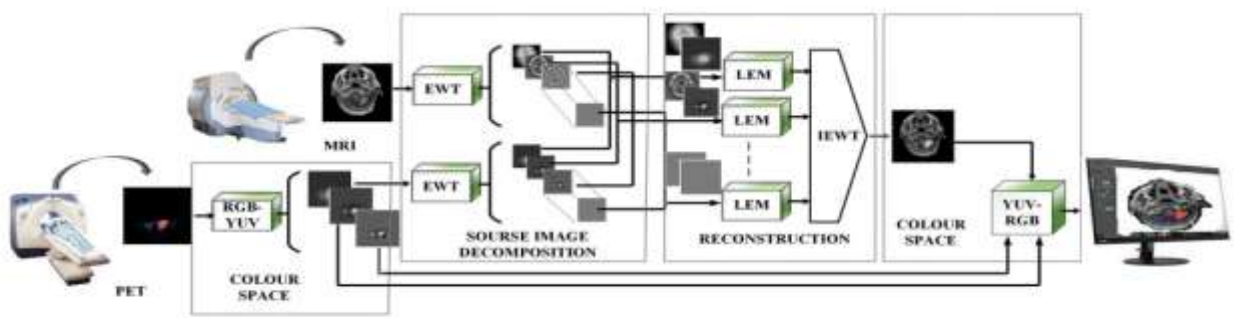

Figure 1: Proposed fusion

The filters aim to extract various bands of input images primarily based on the frequency characteristics [10]. As images are real valued data, the frequency domain information within the default limits 0 and π is taken into consideration. In the spectrum, maxima peaks are detected first. Filters need to extract sub bands such that these maxima points are included.

4. RESULTS

While taking discussions with the neuro-radiologists and neurosurgeons it was noticed that they use the PET image in addition to MR image for finding the location of biopsy or for finding the appropriate location of cut in the bone so that the related disease like tumor can be excised from the brain. MR images are usually examined by the radiologists to find out the diseases of a soft tissue area of the brain. In some situations, it is necessary to gather the entire information of the organ for correct diagnosis. But it is a laborious process for a clinician to examine this with separate images. Furthermore, there is also a possibility of losing some crucial information while examining these various images. Hence, image fusion is a trusted method that gives us the complementary data of two or more images within a single image with respectable resolution [7].

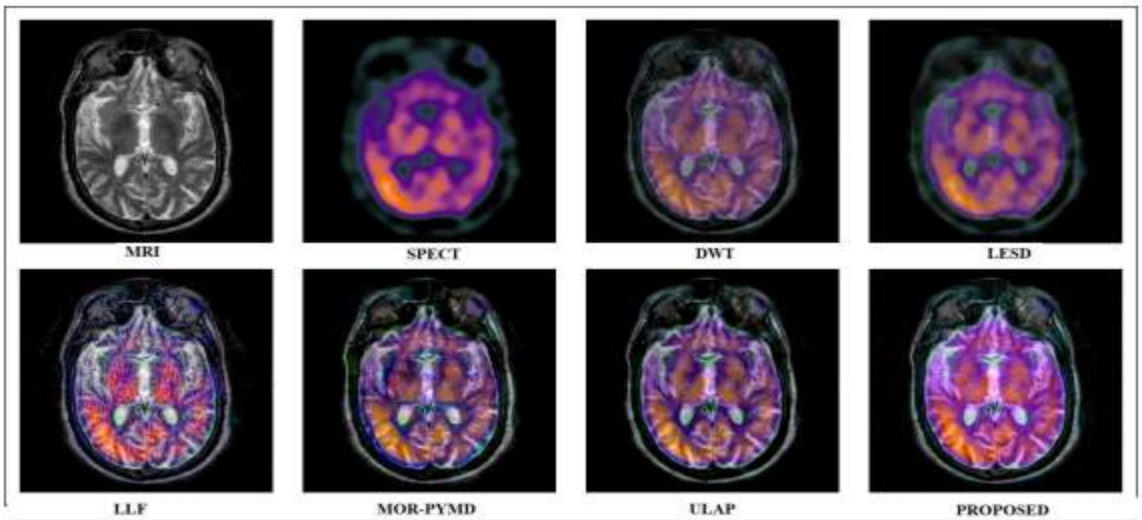

Figure 2: Visual quality analysis

It is hard to spot the precise position and size of skull bone and other hard tissues by interpreting an MR image and the approximated guess of the experts on MRI based on PET image may differ from individual to individual [8]. The manual process of finding the precise position and size of bone on the MR image is quite subjective and based on the experience of radiologists [12].

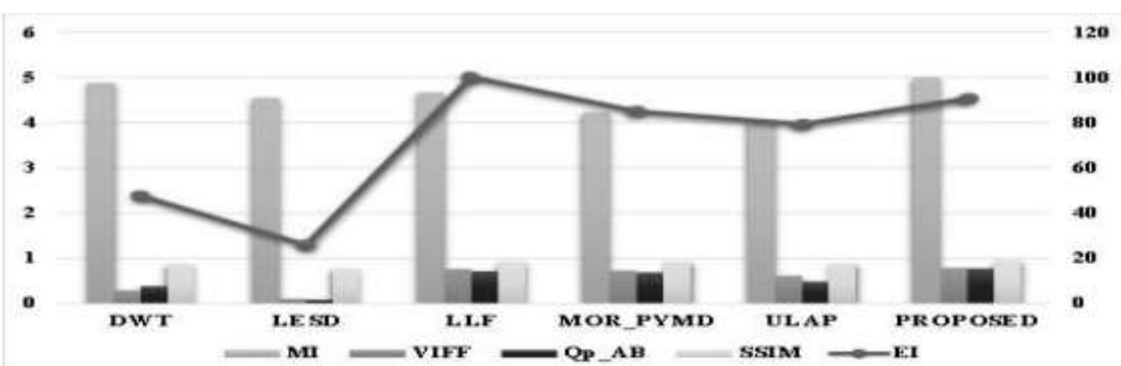

Figure 3: Graphical representation of the image fusion metrics of MRI-PET.

The primary strength of this method is to minimize the amount of work done manually by huge information investigation and lag. Thus, medical image fusion is a potential method in providing more meaningful information as single image. Medical image fusion gained a lot of attention in the field of medicine since the previous decade [14]. It is because various tools in the field of signal processing and digital image processing have got improved. The prime motive of medical image fusion is to create one image by merging the different images of different scanners appropriately without diminishing the quality of the image. The independent analysis of PET and MRI for disease identification and surgeries is not fast due to the time consumed by the manual way of visualization. Accordingly, there arises the necessity for a blending of PET and MR images with assistance from computer science so that this process assists radiologists in reaching conclusions. Combining MRI information and PET scans is referred to as fusion[15].

5. CONCLUSION

With the help of medical image scanners, we can get various kinds of information regarding a single organ. But we cannot get full knowledge of an organ by using a single imaging method. It is due to the fact that the human body consists of an enormous number of cells. The collection of similar cells constitutes a tissue. Any organ consists of two or more tissues that carry out some specific functions. Thus, the organ's structure and its function based on the tissues give us crucial information. The general division of tissues is: Hard and soft. Hard tissue is also referred to as calcified tissue, contains a number of minerals in it. Bones, enamel of teeth, etc. are examples of hard tissue. Conversely, soft tissue is opposite to hard tissue, such as skin, flesh, muscles, blood vessels, and nerves. Thus, the aforementioned medical imaging methods have limitations to obtain certain information and not total information. For example, X-ray and CT scan are applied to take hard tissue information such as bone structure within the body. These methods assist in identifying bone fractures. In addition, MRI scanning assists in creating detailed pictures of soft tissues. To identify tumors within soft organs such as brain, breast etc., are favored. Also, it is a great diagnostic tool for heart problems. On the other hand, the PET and SPECT imaging methods give functional information including blood flow and measures of metabolism. Thus, to capture all the above-mentioned information, we require more than one imaging sensor.

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