IR & IF for IoT Based Applications – A Survey

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Abstract –Present era is considered as internet of things and digital era, all type data (text, image and video) are stored in digital form. This data are retrieved from different sources (IoT, Cloud, so on) in various application fields medical, satellite to do analysis. To carry out analysis multiple views of object to be considered, Image Registration (IR) and Image Fusion (IF) are the process that can be initiated to do analysis. Image Registration (IR) is the process of combining two images taken at different views and Image Fusion (IF) is the process of combining multiple viewed images taken from different views. Internet of Things (IoT) is a system of inter-related devices having ability to compute and transfer the data over the network. IR and IF for IoT based applications is a challenging task and the combination of both is imaginary. This paper aims at studying the different methods in IR (like similarity methods, correlation methods, wavelet-based methods, soft computing methods and MI-based methods, etc.) and IF (like Principal component analysis, High pass filtering wavelet transforms, Artificial Neural Networks, and Discrete cosine transform) to produce better performance metrics - Peak Signal Noise Ratio (PSNR), Root Mean Square Error (RMSE), Entropy (E), and Mutual information (MI) by determining the best method for registration and fusion to improve the most important parameters like quality and accuracy which shall applicable for IoT based complex applications in the field of Image Processing (IP). Based on study still there is a need of using IR & IF methods to improve the quality of high resolution images and also to get better performance of space and time complexity.

Keywords- Image Registration (IR), Image Fusion (IF), Internet of Things (IoT), Image Processing (IP), Peak Signal Noise Ratio (PSNR), Root Mean Square Error (RMSE), Entropy (E), Mutual Information (MI).

I. INTRODUCTION

IoT is a system of interconnecting devices which collects and shares the information over the network. IoT gathers the information, by interconnecting things based on existing and growing technologies. To improve the quality of images, IoT and image processing are used based on particular domain to achieve various tasks accurately. This can be carried out by monitoring the distortions using an IoT networking sensing device. Sensors are positioned to capture the information, stores the image into database. Analysis is carried out to extract the features using registration and fusion algorithms to improve the performance and time complexity.

Image Registration (IR) is the process of aligning two or more images of same scene or different scene w.r.t a particular reference image (I_R). The images acquired from various sensors, different time, different viewpoints etc., can be registered with sensed image (I_S) by applying geometric transformations like rotation, translation & scaling to extract the information from two dissimilar sets for mapping the reference of same coordinate structure [1]. For automatic registration of images rapid changes, proliferating amount and mixture of images are acquired. Based on the domain, the reference and sensed images are registered particularly from multi-view, multi-temporal and multi-modal analysis to extract the features from individual images. As a result, image registration can be basically derived as an optimization problem using IOT [2]. The image registration process is shown in figure 1:

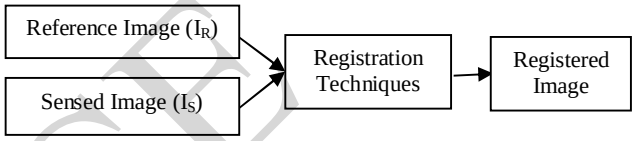

Fig. 1: Image Registration Process

Image Fusion (IF) is the process of combining multiple input images into a single output image which provides better results of same scene or different scene w.r.t a particular reference image (I_R).The fused image contains more information on the reference image than the sensed image (I_S) that is used in fusion process. Images to be fused can be acquired from single-model, multi-model imaging sensors or from same image sensors at different times [3]. Fusion merits, limitations and relationships between the wide variety of methods are discussed in this below chapters. A survey of traditional and up-to-date registration and fusion methods to exhibit their performance by practical experiments are discussed in this paper. The image fusion process is shown in figure 2:

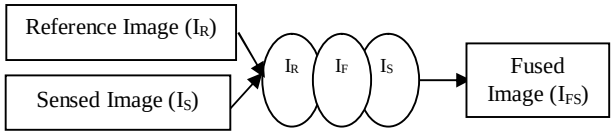

Fig. 2: Image Fusion Process

II. LITERATURE SURVEY

As there is lot of work carried out on image processing since 1980's, still there are few limitations. But to overcome limitations and to get the quality images, we use image registration techniques and image fusion techniques. The reference image can be extracted by considering the average of the gray-scale intensity values in image fusion. This method gives good results with the less contrast levels and

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also less cost. Depending upon the spatial and temporal distinctiveness, various methods can be relatively applicable to various sets of fusion images. For combining two sets of images, spatial domain and frequency domain techniques are applied to process image pixels to attain better results by applying Fourier transformation techniques to frequency domain which can transmit the reference image into frequency domain to acquire the registered image by applying inverse Fourier transform. Performance metrics like Peak Signal to noise ratio (PSNR), Root Mean Square Error (RMSE), Entropy, Mutual Information (MI), etc can be identified by applying image registration and image fusion methods using IoT security [11].

III. Image Registration Methods For IoT

Pre-processing of image registration is carried as shown in below figure 3 by considering the methods are discussed in this chapter.

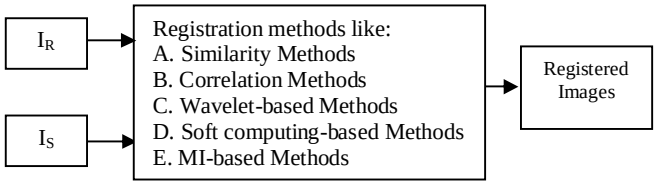

Fig. 3: Processing of image Registration

A. Similarity Methods:

Similarity methods are used for the establishment of various relative measures to increase the registration accuracy measures like Sum of Absolute Difference (SAD), Sum of Squared Difference (SSD) and Maximum Absolute Difference (MAD) [9], etc. For performing similarity measures [10], we basically need reference image (I_R) and sensed image (I_S) to obtain the target image or transformed image. For measuring similarity metrics based on time, and various other parameters can be observed by applying various techniques [4].

B. Correlation Methods:

Correlation methods find the reliance between the two random variables and find the relationship between the images. The statistical redundancy is applied to find the pixel intensities between the images reference image (I_R) and sensed image (I_S) during IR process. The result of correlation methods takes the values between 0 and 1. Based on various applications, correlation methods like Cross-Correlation (CC), Normal Cross Correlation (NCC), Entropy Correlation Coefficient (ECC) [5] etc., can be applied by using standard tool for evaluation various parameters and degree of measure and reliability between several images of similar object.

C. Wavelet-Based Methods:

Wavelet-based methods provide idea of images by using two important parameters - time and frequency. The wavelet-based IR is efficient by choosing wavelet coefficients using rules like maximum absolute wavelet coefficients for high-resolution images, partial wavelet coefficients for low-resolution images. Using intrinsic multi-resolution properties, we can apply different types of pyramidal approaches used for wavelet decomposition during IR process. Different types of wavelets like Haar, Symlet, Daubechies [6] and many techniques like normalized cross-correlation techniques and relaxation-based image matching techniques can be used by considering the control points to reduce the local degradations for IR.

D. Soft Computing-Based Methods:

Recent and advanced methods can be successfully applied to IR tasks. The methods like: Artificial Neural Networks (ANN), Fuzzy Sets, and several Optimization Techniques can be formulated based on various applications. Based on various biological neural networks applications, ANN is the best computational model for extracting required features. Also, can be viewed as non-linear statistical data to perform complex relationships between input images. Fuzzy sets are collection of elements having continuous sequence of grades and degrees. Fuzzy set allows properties like union, complement and intersection etc. It depends upon the intensity value belongs/doesn't belong to the image set. The elements in a fuzzy set lies between the interval [0, 1] to estimate the uncertainty or inaccuracies to enhance the extracted features by using IR techniques [7].

E. Mutual Information (MI)-Based Methods:

MI-based methods are calculated by taking the joint probabilities of intensity values of reference image (I_R) and sensed images (I_S) are measured. From the input images, various features can be performed efficiently based on mutual information measures. Using MI methods, like hierarchical search strategies, Powell's multi-dimensional direction set method etc can be employed to maximize mutual information [8].

IV. IF Methods For IoT

Pre-processing of image registration is carried as shown in below figure 4 by considering the methods are discussed in this chapter.

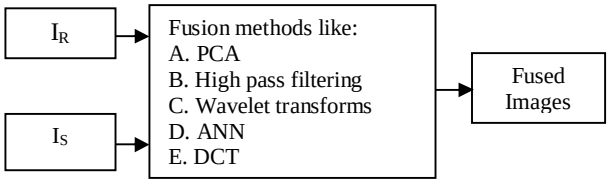

Fig. 4: Processing of image Fusion

A. Principal Component Analysis (PCA):

PCA is one of the best methods for image fusion as shown in figure 5. In PCA method, it mainly works on an arbitrary number of bands from fused images. PCA [14] method is applicable for low resolution multi-spectral images

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which has more inconsistency data for extracting features from panchromatic images. A high resolution fused image having similar discrepancy consisting of PAN component is extended to find various metrics based on various applications. Inverse PCA technique is used to perform high resolution multi-spectral images for fusion process [12].

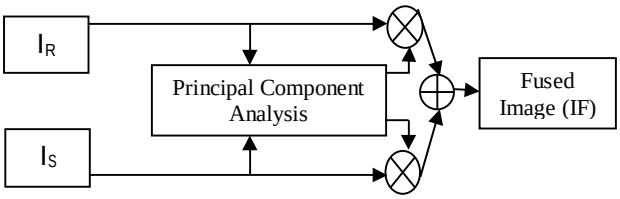

Fig. 5: Flow Diagram of image fusion using PCA method

B. High Pass Filtering:

By performing high pass filters, the high resolution multi-spectral images are obtained. The high frequency information of panchromatic image is extracted by applying high resolution image to low resolution multi-spectral image and the resultant image is obtained during fusion process. The spectral images can contain low frequency information. Panchromatic images can be extracted by performing high pass filters or by subtracting low pass filters.

C. Wavelet Transform:

Wavelet transforms is almost similar to Fourier transforms. The main advantage of wavelet transform is obtaining good quality resolution in time domain and also in frequency domain but on the other in Fourier transform it provides good quality resolution only in frequency domain. Using wavelet transform in image fusion, input images are decayed as informative or approximate coefficients using Discrete Wavelet Transformations (DWT) row wise and column wise as shown in below figure 6. But the fusion rule is applicable to combine the features like edges, lines [13] informative coefficients and by taking inverse wavelet transformation, the resultant or fused image is obtained.

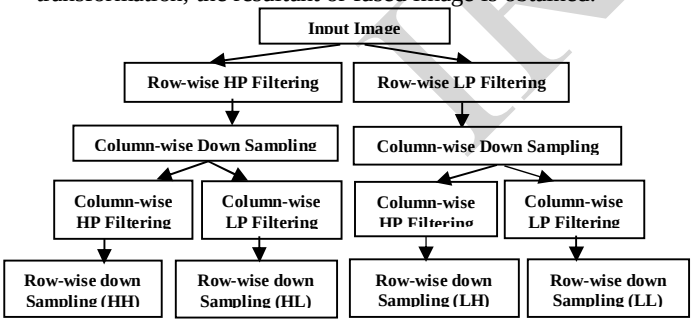

Fig. 6: Flow diagram of DWT

D. Artificial Neural Networks (ANN):

ANN plays very important role in pattern recognition and to extract various features it uses non-linear functions in fusion process. Mainly makes use of Pulse Coupled Neural Network (PCNN) which consists network instructions to identify matching pixel intensity values in input image.

E. Discrete Cosine Transform (DCT):

DCT have importance for compressing fused images by representing in various formats like MPEG, JPEG, JVT etc. The images are divided into three parts low, medium and high. The conversion of images from spatial domain image into frequency domain image is carried out by using DCT technique. The image is recognized as Red (R), Green (G), and Blue (B) which is divided into blocks with size 8 * 8 pixels and then transformed to the grey scale image.

Levels of Image Fusion are listed below:
Pixel Level - In image fusion, at lowest level the intensity values of two input images are based on its average pixel values which gives the single resultant image.
Feature Level – The features of reference image have indistinct feature with sensed image. In this level the features are easily extracted between two images and then after feature extraction, fusion algorithm gives resultant image [15].
Block or Region Based – According to the blocks or region based of the image, image fusion occurs accordingly. The image is split into blocks or region and its demonstration and metrics are identified according to the regions or blocks.

V. Conclusion

IR and IF methods are energetic field of research in image processing. Few methods are discussed in this paper but many methods can still be considered in general and in particular for analysis of providing better quality images. This paper presents a survey of registration and fusion methods for IoT related applications. Based on the need and the requirement in various fields, many algorithms and methods are validated correctly. In most of the cases, verification and validation methods laid for most of the applications and meticulous work was carried out also many techniques were involved due to its time/space complexity. IR and IF is most essential and there is lot of scope of image generation based on unimaginable applications and its uses to invent various methods from complex applications in the field of digital image processing (IP). Based on study still there is a need of using IR & IF techniques to improve the quality of high resolution images and also performance of space and time complexity can be improved. We further extend this work by implementing these methods using Matlab and identify best method by demonstrating the performance metrics.

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