International Journal of Latest Technology in Engineering, Management & Applied Science (IJLTEMAS)
Volume V, Issue X, October 2016 | ISSN 2278-2540

# A Novel Technique for Fusion of IR and CCD Image Using Sift and WPT Algorithm

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***Abstract*— In this paper, we present a methodology for multispectral image registration. In the proposed method, both the input images are subjected to feature extraction using scale invariant fourier transform (SIFT). Image registration is done for one of the input image using affine transform. Image fusion of charge coupled device (CCD) image and Infrared image has become one of the most promising area of research in the field of multispectral image processing for both security as well as application specific requirement.One of the major applications of this idea is in the security domain such as border areas, Anti-poaching purposes. This approach is formulated using wavelet packet transformation (WPT), such that we estimate the parameters of a geometric transformation that aligns multispectral images. The basic concept is to create composite images and then match them by WPT Method. The goal of registration is to establish the correspondence between two images and determine a geometric transform that aligns one with the other which performs better quality prediction accuracy. Since EO and IR sensors are operated at different frequency bands, their images have different gray level characteristics. CCD camera captures visible spectrum of wavelength 300-600 nano meter and IR camera (Blind Image) captures long wavelength IR of 8-14 micro-meter.**

***Keywords*— Image Registration, WPT, Feature extraction**

## I. INTRODUCTION

It is highly desirable goal to enhance the information of output image citied when two images IR image and CCD image are fused together in many applications, especially in the field of security domain. Efficiently estimation of parallax points has been the most challenging aspect in the field of image processing. Image quality is affected by one or several particular kinds of distortions, such as blockiness [1], [2], ringing [3], blur [4], [5], or compression.

Multispectral is a technique of capturing images of the same object in a spatial region over different wavelengths[*9*]. Conventional cameras capture images in three components of light: red, green and blue (RGB images). Multispectral captures the images over a range of spectrum from ultraviolet to infrared and even x-ray range. In this proposed technology we capture a images, one from charged coupled camera and another image from IR camera which then are fused resulting in a parallex error which can be eliminated using image registration technique. Image fusion is a technique used to integrate the geometric detail of a high-resolution image and the color information of a low spatial resolution multispectral (MS) image to produce a high-resolution MS image [5].

Parallax error is the apparent displacement of target object as seen from two different positions and points of view. alternatively, it is the apparent shift of an object against a background due to change in observer position.

Image registration is an image processing technique used to overlay or align two or more images of the same scene. The images may differ by acquisition time, viewpoint or may be obtained using different sensors [6]. Image registration is used in medical, remote sensing and other image processing applications as the first step of image fusion procedures. When multiple views of the same scene have to be analyzed and the images differ by view angle and/or relative position of the subject, one of them is chosen as model image and all the other source images are aligned to it using geometric transforms computed by IR procedures. The geometric transform may be linear, rigid, affine or projective, respectively non-rigid or elastic in case when more capture devices are used and the geometric distortions are different.

Image fusion is a process of combining two or more different type of image attributes or objects, which is further incorporated into a resultant fused image. Hence, the resultant image will be more informative as compared to the input images. The process of image fusion includes various algorithms such as Genetic Algorithms, multispectral component analyzing, Neural Networks etc. Image fusion is highly desirable for enhancing the quality of input images thus the output image will be more suitable for understanding by human as well as computer-aided machines.

## II. PROPOSED METHODOLOGY

The proposed model aims to design a novel image fusion technique, in which the resultant image will be more informative as compared to the input images and intensifying the pixel attributes of an input image. The proposed system is designed integrating wavelet packet transform based image fusion. In case of WPT model the system takes a CCD and an IR camera captured image for further processing. SIFT algorithm is further enhanced to compute the match points of each image. It also shows the parallax points on image, therefore the geographic displacement of each and every pixel components are estimated acquiring the distance which is less than threshold value. The resultant registered image is then further process under the WPT where high frequency component fusion is performed to calculate the max fusion and mean fusion. The system design is shown in the figure 1.

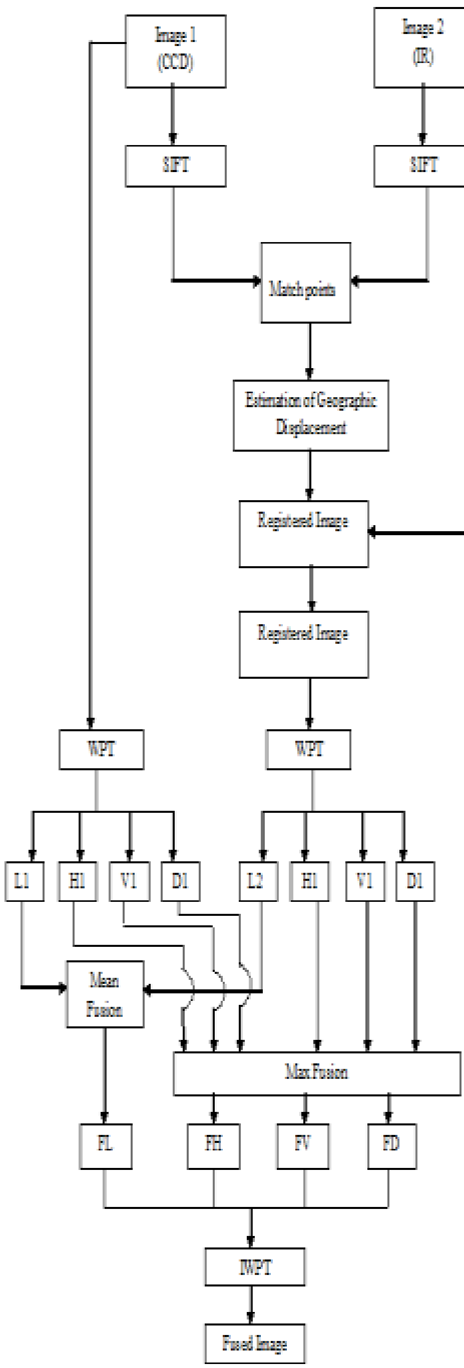


Fig 1: Block Diagram of the proposed method

*A. Feature extraction*

Feature extraction a type of dimensionality reduction that efficiently represents interesting parts of an image as a compact feature vector. This approach is useful when image sizes are large and a reduced feature representation is required to quickly complete tasks such as image matching and retrieval.

Feature extraction are Common, but distinctive objects are considered as features, such as points, edges, curves, lines, branches, and regions. Here features from ccd camera image and IR camera image are extracted.

Feature detection, feature extraction, and matching are often combined to solve common computer vision problems such as object detection and recognition, content-based image retrieval, face detection and recognition, and texture classification.

Features extraction from CCD camera image and IR camera Image Should satisfy the following

1. Presented in both sensor images;
2. Well distributed across the images;
3. Located in high contrast areas;
4. Unique in their surrounding areas.

Feature extraction involves evaluating the pixels of images depending on shape and size of the captured images from the cameras.

*B. Initial matching*

Using features from the previous step, the common features between both the images (IR and CCD image) are matched. Registration accuracy depends on the correctness of feature matching. To improve the matching quality, outlier removal techniques are normally integrated.

After feature detection a correspondence is established between image1and image2 .Various feature descriptors and some Spatial modulation are used with spatial relationships for this step between images. The feature descriptors should be capable enough to be distinguished among different features. The relevance between the features detected in image1 and image2 can be matched by means of the image intensity values in their feature spatial distribution and close neighbourhood regions. Sometimes, this step can be combined with feature detection apart from feature extraction.

*C. Consistence Checking*

Consistency checking is to construct a decision mask, which can be done with:

$$\textbf{Decision}=\textbf{abs}(L_1) > \textbf{abs}(L_2)$$

Here L1 and L2 are coefficients of source images. Decision is a matrix of the same size of L1 and L2, which contains 1's and 0's if the source selected to construct the fused level or not selected to construct fused level respectively. This binary map is subject to consistency verification. Result can be obtained after applying a two dimensional convolution between a padded version of the original decision mask and an averaging 3x3 or 5x5 template, followed by a rounding operation.

Checking the consistency of image databases is not a completely solved problem. To decide if an image has already been inserted into the database can only be checked by actually looking through the images, or using the textual descriptive keywords attached to the database items. Both the visual checking and the keyword search in a large image database may result in errors.

Consistency can be divided broadly into four parts such as spatial inconsistency, temporal inconsistency, attribute inconsistency and inconsistency among any combination of space, time and attribute. Spatial inconsistency is a process that cartographers must deal with on an operational basis. Map generalization is a major task of cartographers. It includes spatial displacement (a process of spatial error introduction), spatial simplification through selection, aggregation and smoothing, and attribute abstraction through classification. This process itself introduces a huge amount of error particularly on small scale maps. Traditional spatial analysis based on maps is restricted by map scale, as maps from different scales can not be overlaid with each other for multilayer (variable) analysis. In a GIS system, maps of the same spatial location can be enlarged or reduced to map with each other regardless their original scales. Spatial inconsistency could occur under this circumstance.

Mismatching could happen in both the initial matching and multiresolution transform-and-correct stages due to perspective deformation and feature inconsistency. Automatic exclusion of false matches is required and it is achieved by using three consistency tests .

1. *Distance Test:* The translation between the images captured should not be larger than a certain fraction of image size. A valid matching i should satisfy

$$dix = |X_{ir} - X_{ic}| \leq \lambda L_x$$
$$diy = |Y_{ir} - Y_{ic}| \leq \lambda L_y$$
$$|X_{ir} - X_{ic}| + |Y_{ir} - Y_{ic}| \leq k\max\{L_x, L_y\}$$

Where $L_x$ and $L_y$ are the image sizes along $x$ and y directions, respectively. $\lambda$ can be set at ½ and k can be taken as 3/2.

2. *Variation Test:* The translations of the correct matches should support each other such that

$$|d_i - \bar{d}| \leq \mu \sigma$$

where $d_i$ is the distance between the ith matched pair, and are the mean and standard deviation of thr distances for all the matched pairs, and is threshold.For the uniform distribution, can be set at .

3. *Outliers exclusion :* The matched pair should satisfy the image transformation model.Candidae matching pairs with large residual errors should be excluded.

The consistent checking scheme is implemented recursively.The most likely incorrect match, and so on and so forth.Extensive tests have shown that this method is very effective in removing inconsistent features while preserving the correct matches.

*D. Transform Parameters*

Parameters of the mapping function are estimated using the matched features, and the sensed image is then transformed using the estimated transformation.
Transformation parameters are estimated during this step for mapping functions to align IR and IS. Parameters of the mapping function are computed by means of the feature correspondence established. The mapping functions are chosen with prior knowledge about the acquisition process and expected degradation of sensed image. If there is no prior information then it modelled to handle all possible degradations which might appear.
These step involves determining a geometric transform between two images and resampling one image to align with another.The conformal camera projection model widely used in photogrammetric systems to describe the geometric relation between the images is used in our algorithm.Eight parameters are used to carried out the transform based on this model.Let the transform parameters be $a_i$ , i=1,….,8, the ground plane transform of image 1 to image 2 can be defined as

$$X_2 = \frac{a_3X_1 + a_5Y_1 + a_1}{-a_7X_1 + a_8Y_1 + 1}$$

$$Y_2 = \frac{a_4X_1 + a_6Y_1 + a_2}{-a_7X_1 + a_8Y_1 + 1}$$

These eight parameters are obtained by solving the following linear equations

$$a_1X_{1i}a_3 + Y_{1i}a_5 + X_{1i}X_{2i}a_7 + Y_{1i}X_{2i}a_8 = X_{2i}\ a_2X_{1i}a_4 + Y_{1i}a_6 + X_{1i}X_{2i}a_7 + Y_{1i}X_{2i}a_8 = Y_{2i}$$

*E. Transform and correct*

Based on the mapping function obtained in the previous step, the image2 is re-sampled to align with the image1. The importance of this step depends upon the trade-off between the demanded accuracy and the computational efficiency. Some interpolation techniques are used to compute the coordinates of pixels values in non-integer form.

*F. Image Registered*

The IR methodologies can be divided based on image acquisition and image correspondences.

1) Image acquisition: As per the image acquisition type, IR process can be divided into main three groups. They are different - viewpoints, sensors and times.

a) Different viewpoints*:* Images of the same scene are acquired from different viewpoints.
b) Different sensors: Images of the same scene are required to be acquired by different sensors. The aim is to integrate lot of information obtained from different sensors or same sensor at different times to gain detailed scene presentation.
c) Different times: Many times, it is required to acquire same scene at different times, often on regular basis, and possibly under different conditions.

2) Image correspondence*:* According to the type of methodology of image comparison for correspondences, IR process can be divided into three groups. They are intensity, area, and feature based.

a) Intensity based*:* These methods compare intensity patterns in images with CT. These methods register entire images or sub images. In sub-image registration the centre of the corresponding sub-image is treated as corresponding feature point.
b) Area based: Area based methods are also correlation like methods. These methods deal with CT without attempting to detect salient objects between IR and IS. A part of image or sub-images or entire image are used for the correspondence estimation.
c) Feature based*:* Significant regions (forests and fields),lines (region boundaries, coastlines (roads, rivers, lakes,mountains) or points (points or curves with high curvature, region corners, line intersections) are features considered for IR. They should be distinct and spread over the image and are efficiently detectable. The identified features are expected to be stable in time to stay at fixed positions during the IR process.

## III. WAVELET PACKET TRANSFORM (WPT)

The wavelet packet transform is an overview of the wavelet transforms. The wavelet transform is the one where the filtering of signal is carried out only in low frequency signal, since it understood that it is more significant than higher frequency signal . When compared with wavelet transform, the wavelet packets are different in their iteration. The iteration can be either in low-pass branch or high-pass branch providing a random tree structure with each tree corresponding to a wavelet packet basis. The frequency axis is separated in intervals with different sizes to form wavelet packet bases, these bases are used for decomposing signals having different actions in dissimilar frequency intervals.

The wavelet packet transform usually considers two different types of image which are Image 1 and Image 2 where Image 1 is a CCD camera captured image and Image 2 is Infrared Camera image which are subject to fusion.

All the resultant coefficients after the completion of WPT image processing are listed below.

*For high frequency component fusion*

H1 ← wpcoef ()
V1 ← wpcoef ()
D1 ← wpcoef ()
H2 ← wpcoef ()
V2 ← wpcoef ()
D2 ← wpcoef ()

*For low frequency component fusion*

L1 ← wpcoef ()
L1 ← wpcoef ()

The proposed model also computes the fuse coefficient FC using the above computed elements. It also computes the min fusion and max fusion. Inverse WPT is applied in the intermediate fused image and display the resultant fused image.

## IV. SOFTWARE REQUIREMENTS

In our proposed technology, for implementation of image registration, MATLAB R2014 is required.

The MATLAB application is built around the MATLAB scripting language. Common usage of the MATLAB application involves using the Command Window as an interactive mathematical shell or executing text files containing MATLAB code.

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning.It has powerful built-in routines that enable a very wide variety of computations. It also has easy to use graphics commands that make the visualization of results immediately available.

You can use MATLAB in a wide range of applications, including signal and image processing, communications, control design, test and measurement, financial modeling and analysis, and computational biology. For a million engineers and scientists in industry and academia, MATLAB is the language of technical computing.

MATLAB R2014 lies within Development Tools, more precisely IDE. The most frequent installation filenames for the software are: activate_matlab.exe,deactivate_matlab.exe, MATL AB R2014.exe and matlab.exe etc.

MATLAB has several advantages over other methods or languages:

- Its basic data element is the matrix. A simple integer is considered an matrix of one row and one column.

- Vectorized operations. Adding two arrays together needs only one command, instead of a for or while loop.
- The graphical output is optimized for interaction. You can plot your data very easily, and then change colors, sizes, scales, etc, by using the graphical interactive tools.
- Matlab's functionality can be greatly expanded by the addition of toolboxes.

## V. RESULTS

The proposed method is performed using WPT technique,with the images taken from CCD Camera and IR image. Images were digitized with image registration using Matlab software.The results of proposed method is shown .


Fig1 : Input1CCD Image


Fig2 : Input2 IR Image

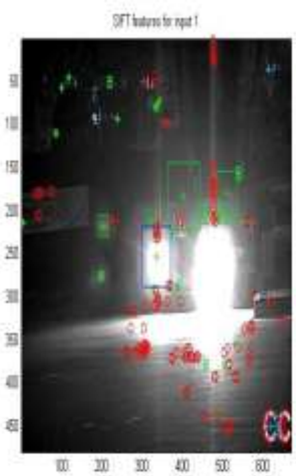

Fig3 : Feature extraction of Input1 CCD image

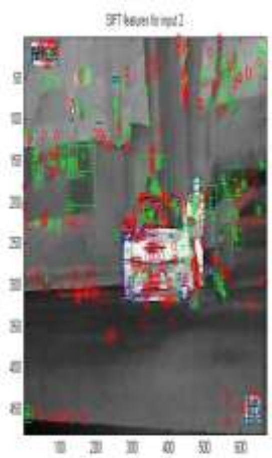

Fig4 : Feature extraction of Input2 IR image

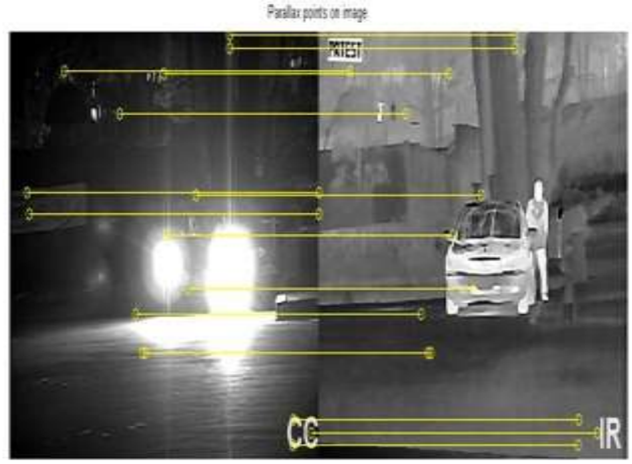


Fig5 : Parallax point estimation for both input1 and input 2 images.


Fig6 : Translated/ registered image

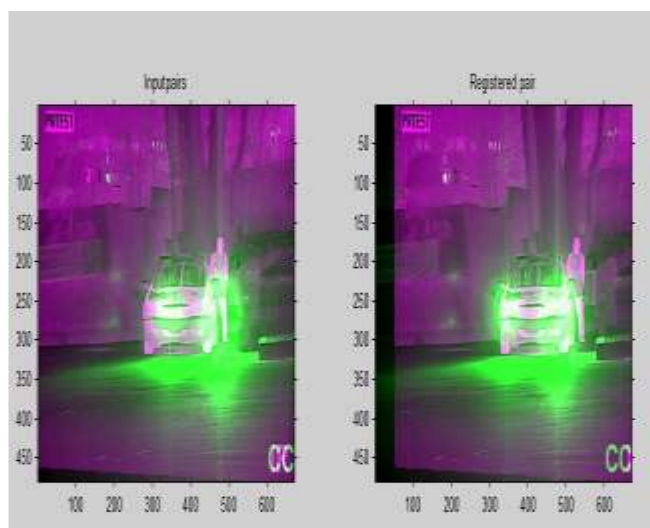


Fig7 : Comparative images of input pairs and registered pair

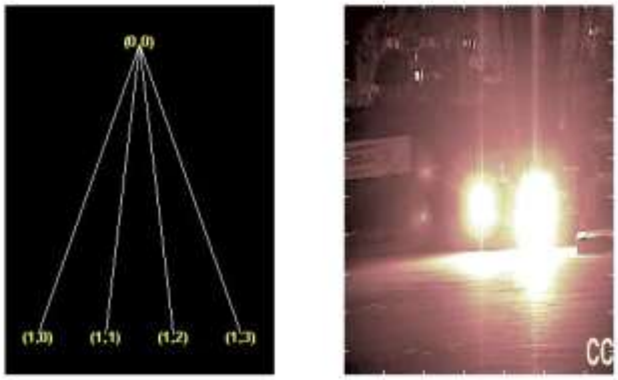


Fig8: High frequency component fusion

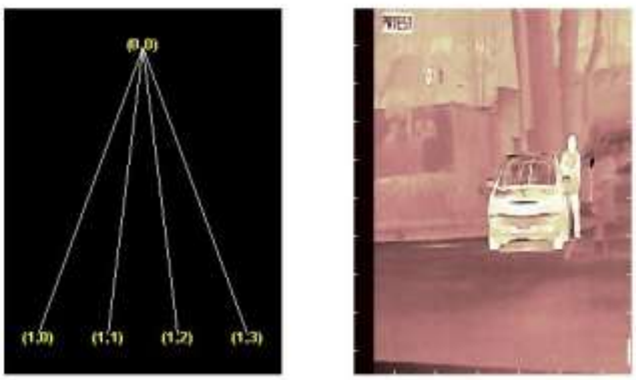


Fig9: Low frequency component fusion


Fig10 : Fused image output from input images

## VI. CONCLUSION

The proposed method estimates the parallax point by appending both input images and IR image is registered. Using a novel method based on techniques like wavelet packet transformation (WPT) model image fusion is performed considering analysis of input signal at different scale and resolution. In order to perform wavelet packet transformation where Fourier domains are incorporated with high and low band pass filter for estimating mean and maximum fusion values. And also we have done a comparative analysis for ensuring the effectiveness of the proposed system WPT. Our scheme developed to perform SIFT feature extraction as well as estimating parallax point, registration and finally fusion of images.

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