IR and VI Fusion using Hybrid VSM and Swarm Optimization

Vijayakumar. R, Karthikeyan. K

Abstract: ***In the current era, usage of Infrared (IR) sensors, in the real world has been increased because of decrease in their cost. Many recent applications of IR images are included in the field of defence, medicine, astronomy, meteorology, industry and science. One of the main applications in the field of defence is person detection. However, IR images have unique challenges. Image fusion based on DWT superior things because it is a multiresolution approach, it allows picture disintegration in various parameters and provides directional information. Most of the existing methods used two or three different quality measures to measure the performance of the fused system. The present study used the ten quality metrics on all derived approaches and noted down various qualitative conclusions. Proposed system the base layers obtained and Further the proposed work found that, the methods based on wavelet transforms have compactness, directional selectivity and orthogonality. Due to these, DWT based fusion methods are used in literature when compared to pyramid decomposition based fusion methods.***

Keywords: Visual Saliency Map, chicken swarm optimization, Multi-scale decomposition (MSD), Rolling-guidance-filter (RGF), fingerprint_iris, multi-biometric system, , match_level fusion.

I. INTRODUCTION

The rapid development taking place, has revolutionised the entire world today. Late, it has become inseparable in diverse areas of Physics, Medicine, Media and so on. The origin of digital images can be traced back to early 19th century in the newspaper industry. The visual quality of images, the requirement of high storage, the need for speedy processing and transmission posed great challenges to the scientific and research community. This paved the way for the development of DIP 1960s. But, the computing equipment available those days was not cost effective and could not meet the ever increasing demands of this field. This situation gradually changed in 1970s and till today, this field has witnessed an enormous and vigorous growth. This can be attributed to the development of computers which go hand in hand in developing the field of image processing. Several factors like declining cost of computer equipment and the emerging of new technologies promise a continued growth in the field. DIP percolated into all walks of life and is considered to be the most versatile technology that has ever been developed. Image blending is to play an better role in future due to availability inexpensive hardware. Better interpretation the captured scene. Therefore, diverse picture of the same scene received from dissimilar image sensors are fused into a composite image [1].

Revised Manuscript Received on October 05, 2019

Vijayakumar. R, Research scholar, Dr.SNS Rajalakshmi college of Arts and Science, Coimbatore ,Tamilnadu, India.

Dr.Karthikeyan. K, Assistant Professor & Head2 Government Arts and Science College, Palladam, Tamilnadu, India.

Image blending approach classified to the fp_data entering the blending and its reason [2].

- MSD of images: pictures appropriated from the equal modality and equal time but various focuspoints.
- Multi_temporal_fusion(MTF) of Pictures: Pictures appropriated at various periods and changes between them.
- Multi-focus-fusion (MFF) of Pictures: pictures of 3D appropriated videos repeatedly with different focal-ratios.
- Fusion-image-restoration: blending the pictures of the same scene and procedure, either obscure or boisterous, de-noised pictures. Multichannel de-convolution approach protracted to super-resolution-fusion.

In the proposed work, visible image (VI) and infrared (IR) images are considered for conducting experiments on the proposed methods and to evaluate the fusion result. Hence, the present study comes under multi modal fusion of images.

This paper is structured in the following manner: In section II, explain briefly about infrared images, visible images and key concepts related to . In section III, explain image fusion and related research work architecture. In section IV, explain the proposed system algorithms result and discussion. In Section V draws our conclusions from the study results.

There are various studies and approaches proposed in literature for multimodal biometric system and a comprehensive review is presented below. Integration of information takes place at different level and from different sources of information. The origin of image fusion can be traced back to early 1980's [3] and has started gaining momentum thereafter, with the application of wavelets making a breakthrough recently. Further, many applications demanding the fusion of images prompted a rapid growth in this area. For e.g., thermal, visual pictures for good interpretation of the scene [4] stands as a milestone for progress in this field. Importnt to merge visual data in robot exploration[5] and the possible trends in 3-D image fusion [6] also prompted further research field.

The simplest image blending technique started with the pixel averaging method. In this method, a linear-Weighted-Average (LWA) two source Pictures to be fused is considered. A pixel-level blending schemes in which the source images are prepared and blending on pixel basis or according to a neighbourhood pixel found in composition[7].] proposed facial picture of an personal gathered implemented a thermal IRcamera and a visible light camera in the context

of principal component analysis. It was shown that adding the information applied to these 2 picture (both at the rank-level and score-level) enhances matching accuracy. The combining process was done by logistic regression and fixed mean rule. They also showed principal component analysis recognition based on visible light camera outperformed recognition based on infrared camera [8] presented results of uni-modal/multi-modal facial authorization using three dimensional, two dimensional, IRpicture of the same objects.

Table 1 Differences between visible and infrared images

SUBJECTS	VISIBLE	INFRARED
Usage	Only day time	Any time
Channel sensation	Reflected solar radiation	Emitted radiation
Intensity depends on	Reflected light by objects	Temperature of objects
Presence of high clouds	Non distinguishable from low clouds	Bright white
Presence of low clouds	Non distinguishable from high clouds	Very dark
Presence of thin clouds	Milky White	Non distinguishable from Thick clouds
Presence of thick clouds	Bright white	Non distinguishable from Thin clouds
Resolution	High	Low

Each IRsensor captured various sorts of individual facial information, delineating emerge mirror from a IRcamera, heat emitted method. They used a database encompass a total of 142 picture and 297 expand timelapse picture. Using a PCA independently for 3Diamentional, 2Diamentional, IR picture, recognition rates were 90.6%, 91.9% and 71.0% respectively. Merged with every pair of procedure, recognition rate were 94.2, 95.3 and 97% for 3D/2D, IR/2D and 3D/IR individually. Combining all three modalities recognition rate was 100%. [9]. integrated information presented by two fingers at the match score level by probability proportion calculated nonparametric statistical estimates. It was found that multiple fingers improve the verification performance by 4%. [10]. Apart from this, classifier combination at decision level was also presented to improve accuracy of fingerprint verification system

Hence, wavelet based techniques are widely used in image processing applications.] come up with a mosaicking initialize a combination image conferred by various pictures of fingerprints. The proposed algorithm used simple affine transformation first to register the two picture of fingerprint. The achievement conferred mosaiced templates choose outperform personal fingerprint pictures by Graham [11]. integrated information presented by two fingers at the match score level by probability proportion calculated nonparametric statistical estimates. [12, 13] It was found that multiple fingers improve the verification performance by 4%. Apart from this, classifier combination at decision level was also presented to improve accuracy of fingerprint verification system [14]. Unfortunately, DWT is shift proportional and it lacks phase information. Only the magnitude information is available. Perfect reconstruction of the images is questionable [15]. This issue was addressed by Rockinger in 1997 and he came out with Shift Invariant DWT (SIDWT) [16] with reduced over- completeness which results in apparently better blending output. Price paid for this advantage is that it is computationally more expensive than DWT. This approach towards image fusion was achieved apparently by Beull et al (2002) using DTCWT [17]. proposed, fingerprint and iris modalities and own decision based[18], iris and fingerprint based on hammingdistance method. In their system they extracted minutiae code of fingerprint and iris code from individual fingerprint and iris classifier and fused them using simple accumulator based blending approach [6, 10, and 13] Final results of the proposed method higher accuracy, unimodal and the results comparable commensurate to conventional methods.

NN is one of the powerful tools which helps in solving the problems such as pattern classification, function approximation, etc. The fusion process considered in the present study can be considered as a classification problem. Classification is the important task of remote sensing applications because accuracy will improve the processing performance [18]. NN is one of the possible approaches to hyper-spectral- satellite pictures. In the present study, NN is trained using the block features of different pair of multimodal images. Once the classifier is obtained, it can be used for the fusion purpose. This approach has an advantage over the pixel based technique in circumventing the drawbacks of blurring effects.

fusion of visible, IR pictures using DTCWPT can easily extended colour and IR pictures blending. The colour pictures in an image and has been extensively researched. An improved Red Green Blue (RGB) colour fusion scheme with false colour mapping was proposed by Toet [16]. An advanced colour image fusion scheme for night vision applications capable of generating a three channel false colour image was developed by Waxman et al [24] which was found to be effective in fusing, This technique is effective in preserving the best features of the two input images in the fused output [17]. Contourlet revolutionize and wavelet transform have got their own advantages and disadvantages.

In the proposed work, wavelet based fusion using DTCWPT is considered region, pixel level colour image blending. Results obtained using DTCWPT were found to be better compared to that of pixel based scheme. The results are compared both qualitatively and quantitatively.

II. SYSTEM DESIGN

Unimodal biometric recognition cannot gather the performance needs in most of the applications. Simultaneously, the multimodal biometrics recognition symbolizes a promising trend in recent times. In our research work we present a novel approach of combining image level information of fingerprint and iris. The raw information or data is merged at pictures level or features. A particular feature initialized textural pattern based information of both 'IA' and ' IB' is given by,

$$Gauss = Gaussian(1, б_s) \quad \text{-------- (1)}$$

Equation 1 denotes Gaussian filtering with standard deviation for $б_s$. This step is an iteration function are recovered image J^t is updated and J^1 is the Gaussian-smooth pictures. The t^{th} updation expressed equ(2).

$$J^{t+1} = GuidedFilter(j^t, t, б_s, б_r^2) \quad \text{-------- (2)}$$

In our mechanism, $б_r$=0.05. RGFilter is expressed by combining Equation. 1 and 2,

$$u = RGFilter^{(1, б_s, б_r, T)} \quad \text{---------(3)}$$

Where,

T-filtering output.

Through the input IR picture I_1 disintegrate into the layer^{B1} and the detail-layers d_1^1 , d_1^2, d_1^3…. d_1^N. Figure 2 schematic diagrams for fusion framework. The main steps involved in region based fusion scheme (monochrome and IR image) are summarized as follows:

1. Read IR image and visible images.
2. Apply DWT at second level decomposition to both the images.
3. Consider the LL**2** component of IR and visible images
4. Partition LL**2** component of each image into non-overlapped blocks of size 4x4 or 8x8.
5. Extract statistical features such as contrast, dimensional -frequency, energy-gradient. features treated as feature vector Fi of IR image and feature vector F**2** of visible images.
6. Subtract the feature values of Fi and F**2** of each block. If the variance= 0 then denote=1 else=1.
7. Give Index vector to the classifier for classification which will be given as an input for the classifier.
8. Train the newly constructed swarm optimization randomly by simulating it.
9. If the simulated output > 1 then consider the corresponding block of IR image else consider the corresponding block of visible image.
10. Construct the fused image by selecting the appropriate block from step 9.

Figure 1 Pseudocodes for Proposed System IR, VI Fusion

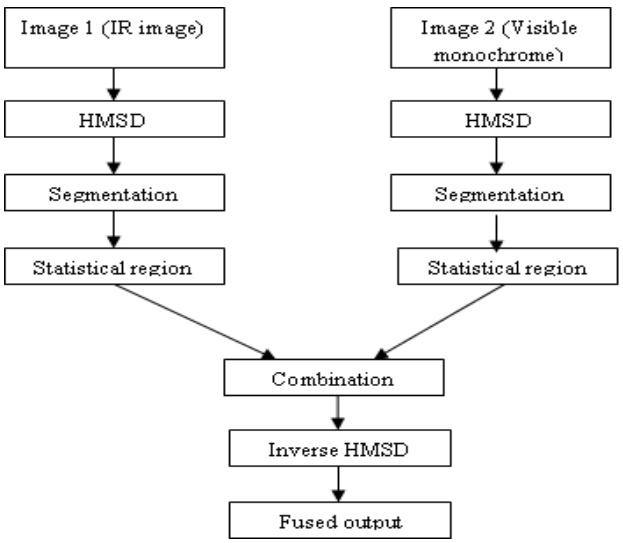


Figure 2 The block diagram proposed IR and visible image fusion

Accordingly, the proposed system RGFilter is formulated as follows:

$$u^j = \text{RGFilter}^{(uj-1\ ,\ бj\text{-}1s,\ бr,\ T\ )\ (j=1,2\ldots..\ N-1)} \quad \text{----- (4)}$$

$$d^j = u^{j-1} - u^j \ (j=1,2\ldots..\ N-1) \quad \text{----- (5)}$$

$$u^j = \text{Gaussian}(u^{j-1}\ ,\ б^{j-1}{}_{s,}\ )\ (J=N) \quad \text{----- (6)}$$

$$d^j = u^{j-1} - u^j \ (j=N) \quad \text{----- (7)}$$

Where.,

u^j- denotes the jth-level filtered pictures,

dj- jth-level-layer

N- decomposition-levels.

The average point is implemented to give a match average to decide the identity. The complete procedural analysis of the average point and the weighted average point are provided. Proposed method consist of two layers detail layers and base layers, , the input IR, VI pictures are disintegrate 2 layers based on RGF Gaussian filter Then, the base-layers merged using VSM, after that fused image applied that proposed optimization.

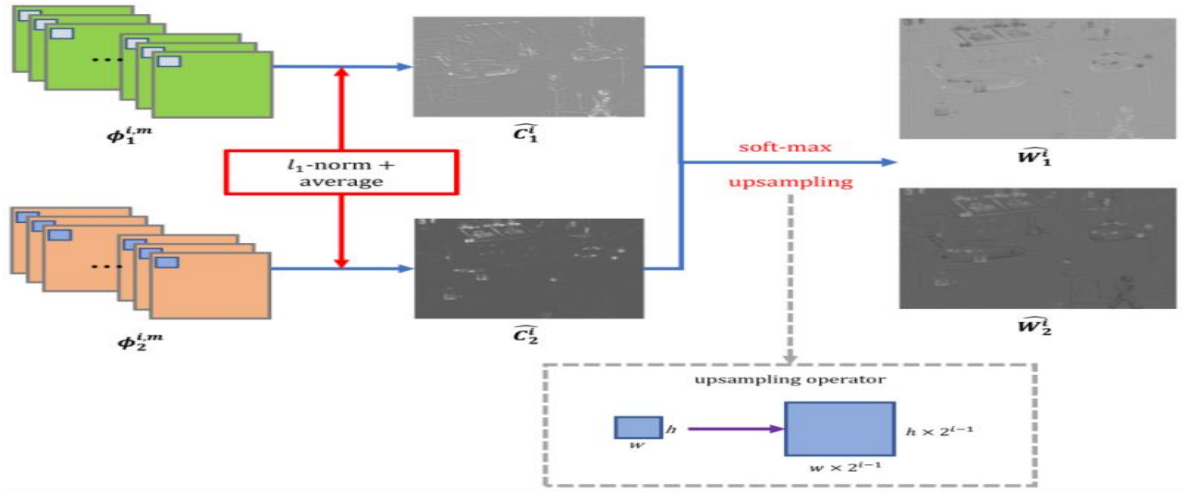


Figure 3 The proposed IR and visible image fusion

$$IF = (IA + IB) / 2 \quad \text{----- (8)}$$

Where,

I A - Image A

IB - Image B

The region entropy is used to compute the salient details from the almost images subsidize to the merged result. given by,

$$IF(r) = WA^{(r)}\ IA^{(r)} + WB^{(r)}\ IB^{(r)} \quad \text{--------- (9)}$$

$$WA^{(r)} = P\ A^{(r)} / P\ A^{(r)} + P\ B^{(r)} \quad \text{--------- (10)}$$

$$WB^{(r)} = 1\text{-}WA^{(r)} \quad \text{-------- (11)}$$

Where,

WA(r), WB(r) – Weighting factors

PA (r) - region entropy of source image IA

PB (r) - region entropy of source image IB

The two images are merged depends upon on region features in revolutionize domain. Finally, inverse transformation yields the fused output in spatial domain. Region based image merged using HMSD represented diagrammatically in Fig(3).

III. EXPERIMENTAL RESULTS AND COMPARISONS

This section, interpret the capability of proposed blending algorithm, different groups IR, VI images blending experiments interpret in this part. simulations performed MATrixLABOURATRY 2013a, on an Intel(R), i5-6400 @2.3GHz PC with 8GB -RAM.

Experimentation has been done by using 74 test cases of fingerprint and iris. 54 test cases were used to train the database and 10 test cases were kept out of the database to find false positives. iris database is obtained from consist of 5 test samples per IR with a resolution of 320*320. CASIA visible V5 database of Visible is obtained from which consist of 5 test samples of each fingerprint with the resolution of 320*320 in various orientation in each class. Only the class with the fingerprint samples of similar orientation were considered to meet the criteria texture based matching.

Example 1:

a) IR image b) visible image c) fusion image

Example 2:

a) IR image b) visible image c) fusion image

Example 3:

a) IR image b) visible image c) fusion image

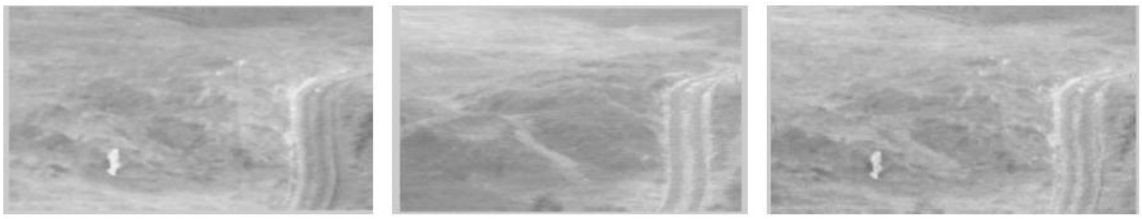
Example 4:

a) IR image b) visible image c) fusion image

Example 5:

a) IR image b) visible image c) fusion image

Example 6:



a) IR image b) visible image c) fusion image

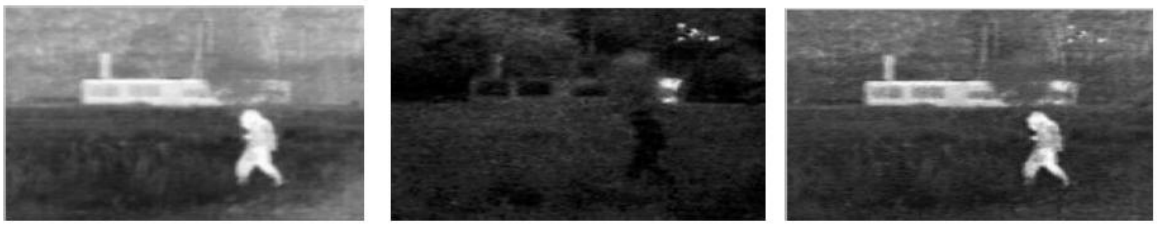
Example 7:

a) IR image b) visible image c) fusion image

Example 8:

a) IR image b) visible image c) fusion image

Example 9:



a) IR image b) visible image c) fusion image

Example 10:

a) IR image b) visible image c) fusion image

Figure 4 Hybrid multi-scale decomposition with chicken swarm optimization Based fusion image result

measuring different ER. Based on FAR and FRR. FAR is a measure of fraud genuine users and false (fraud) users. FRR used to total users rejected to false or frauds. The error rates is measured by recording a genuine and imposter (fraud) imposter of graph depending on their frequency. Figure 4, 5 and 6 explained input fingerprint and iris various process involved to final blending of combined fused result displayed.

In this example, an IR image shown in Figures (a) is considered which is to be fused with the visual image of Figures (b). HMSD is applied to this image which is then RGF and Gaussian filtered. It is also used to achieve excellent noise reduction capabilities with less blurring. Then, binary segmentation is carried out, filtered and binary segmented image. This step is followed by multiscale segmentation (the use of varying window sizes. Also output of HMSD seems to

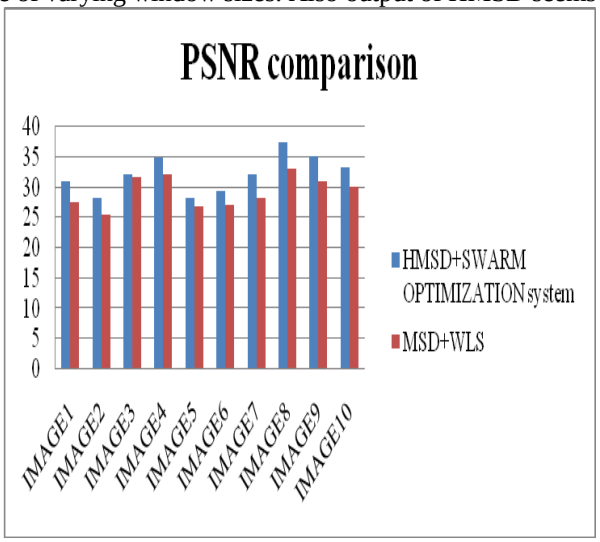


Figure 5 PSNR comparisons for proposed and existing system

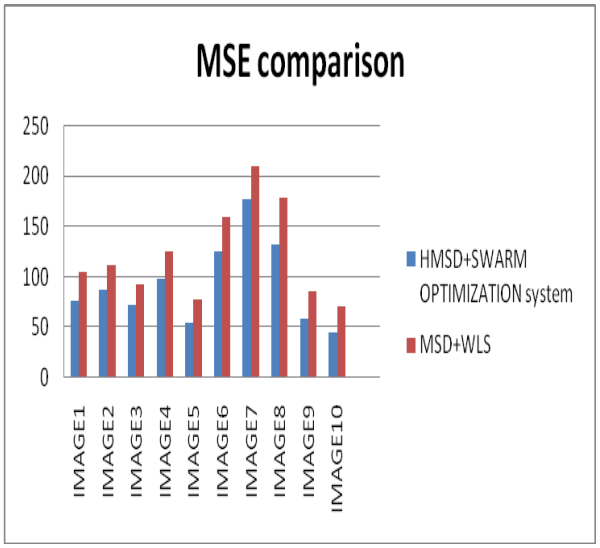


Figure 6 MSE comparisons for proposed and existing system

From the figure 5 and 6, it is inferred that proposed image fusion using chicken swarm optimization conveys higher average information content than existing based scheme. It is yet another validation of proposed scheme overriding the existing fusion.

be almost indistinguishable from existing system. It once again depends on the perception of the observer. Further, it would be highly difficult to differentiate the gray level variations, if the changes in gray levels are not distinct. Output fused images applied to chicken swarm optimization algorithm produce the optimized results. However, quantitative analysis establishes the superiority of HMSD in region based fusion over that existing system.

Quantitative performance comparison

Ten fused images are considered for performance comparisons in terms of PSNR and MSE using HMSD with chicken swarm optimization and MSD with weight least square optimization in image fusion approach. From the results, one can infer that image fusion employing HMSD with chicken swarm optimization outperforms the existing approach in yielding high PSNR values and low MSE values.

IV. CONCLUSION

In this proposed, scheme for fusion method achieved, score based and feature based. Proposed paper combines fingerprint and iris biometrics at confidence level to investigate and compare this multimodal biometric framework. Based on the simulation results, it is concluded that region based image fusion yields better results compared to that of the existing approach. It is effective in avoiding the problems such as RGF and Gaussian filter, reduced contrast and sensitivity to noise in the output fused images. Eventhough it is difficult to differentiate visually small variations in gray values between both the approaches, quantitative analysis proves that proposed approach performs well relatively. Segmentation plays an efficient role to achieve effective fusion. Since, colour conveys huge information and our eyes can discern even small variations in colour and can distinguish thousands of colours, next phase of the work is focussed on colour image fusion approach. It has been seen that min max and zscore normalization techniques are efficient and tanh normalization gives best result for open environment and these databases.

REFERENCES

1. JAN FLUSSER, FILIP SROUBEK, BARBARA ZITOVA, "IMAGE BLENDING : PRINCIPLES, METHODS, AND APPLICATIONS", TUTORIAL EUSIPCO LECTURE NOTES 2007.
2. J.J.LEWIS, J.O'CALLAGHAN, S.G.NIKOLOV, D.R.BULL, C.N.CANAGARAJAH, "REGION- BASED IMAGE BLENDING USING COMPLEX WAVELETS," PROCEEDINGS OF THE 7TH INTERNATIONAL CONFERENCE ON INFORMATION BLENDING, STOCKHOLM, SWEDEN, PP.555-562, 2004.
3. P.J.BURT, " THE PYRAMID AS A STRUCTURE FOR EFFICIENT COMPUTATION, MULTIRESOLUTION IMAGE PROCESSING AND ANALYSIS," SPRINGER-VERLAG, BERLIN, PP. 6-35, 1984.
4. N.NANDHAKUMAR AND J.K.AGARWAL ,"INTEGRATED ANALYSIS OF THERMAL AND VISUAL IMAGES FOR SCENE INTERPRETATION," IEEE TRANSACTIONS ON PATTERN ANALYSIS AND MACHINE INTELLIGENCE, VOL.10, NO.4, PP. 469- 481, 1988.
5. M.ABIDI AND R.GONZALEZ, " DATA BLENDING IN ROBOTICS AND MACHINE INTELLIGENCE," ACADEMIC PRESS, USA, 1992.
6. MORIA I.SMITH AND JAMIE P.HEAT ER, " REVIEW OF IMAGE BLENDING TECHNOLOGY IN 2005," PROCEEDDINGS ON DEFENCE AND SECURITY SYMPOSIUM, ORLANDO, PP. 39-45, MARCH 28- APRIL 1, 2005.

7. POHL.C AND GENDEREN , J.L , " MULTISENSOR IMAGE BLENDING IN REMOTE SENSING: CONCEPTS, METHODS AND APPLICATIONS ," INTERNATIONAL JOURNAL OF REMOTE SENSING, PP. 823-854, 1998.
8. RICHARDS, J.A. "THEMATIC MAPPING FROM MULTITEMPORAL IMAGE DATA USING THE PRINCIPAL COMPONENT INFORMATION," REMOTE SENSING OF ENVIRONMENT 16, PP. 36-46 , 1984.
9. J.ZENG, A. SAYEDALAHL, T.GILMORE, M.CHOUIKHA , "REVIEW OF IMAGE BLENDING ALGORITHMS FOR UNCONSTRAINED OUTDOOR SCENES," PROCEEDINGS OF THE IEEE INTERNATIONAL CONFERENCE ON SIGNAL PROCESSING, VOL.2,PP.16-20, 2006.
10. G.PIELLA, " A GENERAL FRAMEWORK FOR MULTIRESOLUTION IMAGE BLENDING FROM PIXELS TO REGIONS," REPORT ON PROBABILITY,NETWORKS AND ALGORITHMS-R0211,PP.1-47, MAY 31, 2002.
11. L.GRAHAM, JR., " COINCIDENT IMAGE BLENDING USING THE DISCRETE WAVELET TRANSFORM," A THESIS, UNIVERSITY OF ALABAMA IN HUNTSVILLE, 1994.
12. J.L.MOIGNE AND R.F. CROMP, " THE USE OF WAVELETS FOR REMOTE SENSING IMAGE REGISTRATION AND BLENDING," TECHNICAL REPORT TR-96- 171,NASA, 1996.
13. O.ROCKINGER, "PIXEL –LEVEL BLENDING OF IMAGE SEQUENCES USING WAVELET FRAMES,"PROCEEDINGS IN IMAGE BLENDING AND SHAPE VARIABILITY TECHNIQUES, PP. 149-154, UK, 1996.
14. G.HONG AND Y.ZHANG, " THE EFFECTS OF DIFFERENT TYPES OF WAVELETS ON IMAGE BLENDING," 20TH ISPRS CONGRESS, COMMISSION 4, INSTANBUL, TURKEY, PP. 1-6, 2004.
15. SHIVASUBRAMANI KRISHNAMOORTHY AND K.P.SOMAN, " IMPLEMENTATION AND COMPARATIVE STUDY OF IMAGE BLENDING ALGORITHMS," INTERNATIONAL JOURNAL OF COMPUTER APPLICATIONS, VOL.9 , NO:2, PP. 25-35, NOVEMBER,2010.
16. O.ROCKINGER,"IMAGE SEQUENCE BLENDING USING A SHIFT INVARIANT WAVELET TRANSFORM," IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL.3, PP.288- 291, 1997.
17. P.HILL, N. CANAGARAJAH, D.BULL, " IMAGE BLENDING USING COMPLEX WAVELETS", PROCEEDINGS OF THE 13TH BRITISH MACHINE VISION CONFERENCE, UNIVERSITY OF CARDIFF, PP. 487-497,2002.
18. N.G.KINGSBURY, " SHIFT INVARIANT PROPERTIES OF THE DUAL TREE COMPLEX WAVELET TRANSFORM," PROCEEDINGS OF ICASSP, PP.16-19, MARCH 1999.

AUTHORS PROFILE

R. Vijayakumar has over 14+ years of teaching experience. He is presently working as Assistant Professor in the PG&Research department of Computer Science at Pioneer College of Arts and Science, Coimbatore. He is a Ph.D. research scholar at Dr.SNS Rajalakshmi College of Arts and Science, Coimbatore and his research interest includes Image Processing, Data Mining and Web Designing. With 10 years of experience as NSS Programme Officer, he is continuing his community service by taking classes for Government School students in nearby schools in "Basics of Computer Science".

Dr. K. Karthikeyan obtained M.Sc., in Computer Science from Nehru Memorial College, Bharathidasan University, Tiruchirappalli, Tamil Nadu, in 1997, M.Phil., in Computer Science from Manonmaniam Sundaranar University, Thirunelveli, Tamil Nadu in 2003 and Ph.D. in Computer Science from Bharathiar University, Coimbatore in 2013. He is working as Assistant Professor, in Department of Computer Science, Government Arts and Science College, Palladam, Tamil Nadu. His specialization is Image Processing and research interest includes Computer Networks, Data Mining and Mobile Computing. He published 36 research papers in reputed Journals in National and International level, attended many seminars and conferences.