A NOVEL APPROACH TO FACE RECOGNITION BASED ON THERMAL IMAGING

MG Sanjith Kumar[1], D Saravanan[2]

[1]*Department of Computer Application,* [2]*Asst. Professor, MCA, Sathyabama University, Chennai-600119*

Abstract

A novel approach to face recognition system based on thermal image is presented. The thermal images are captured using Thermal Mid Wave Infrared (MWIR) camera system at various temperature to take into consideration of subtle variations that may occur over time. The vasculature information from the image is extracted and used for matching process. Four images are used for registration process. The image registration is done with the Rigid Body Image Registration tool. Before registering Gabor filter is applied to the images and then filtered images are fused and registered. Face segmentation is done by localized region based active counters. The anisotropic diffusion filter is applied to an image and fused with the segmented image. The signature is then generated from the segmented image. Then templates are generated and stored for matching purpose. To perform authenticate the signatures are generated first and matched with the templates stored in the system

***Keywords –** Thermal image**,** Mid Wave Infrared (MWIR) camera, Rigid Body Image Registration tool, Parona-malik anisotrophic filter, Face segmentation.*

---***---

1. INTRODUCTION

The identification systems are mainly based on three key elements
1) Attribute identifiers 2) Biographical identifiers and 3) Biometric identifiers.

It is easy to falsify the recognition system based on attribute and biographical identifiers for an individual when tries with random or by hacking information regarding an individual's as the hacking techniques have emerged a lot. But the biometric identification depends upon the physical characteristics of an individual, its quiet hard to falsify this system.

Even though the Biometric identification system is reliable, it also holds its hardest part. It mainly depends upon the physical characteristics which is its striking feature and also have some flaws as the physical characteristics of an individual may not be accurate always it may have some minor variations from time to time. This may occur due to the light variations and facial disguises.

The images captured using Thermal mid wave infrared (MWIR) can be used to overcome this problem of light variations. As the images are captured as electronic spectrum of waves. These cameras are now mainly used for industrial purpose to identify the machinery parts which may be overheated due to continuous running.

In recent years research has be done on the MWIR spectrum and the researchers have realized the potential of MWIR images. They identified that the images captured using MWIR system can be used for face recognition based on the vain structure of the human body.

2. MATERIALS AND METHODS

The work presented here consists of four modules: 1) Image Registration 2) Signature Generation 3) Template generation and 4) Matching.

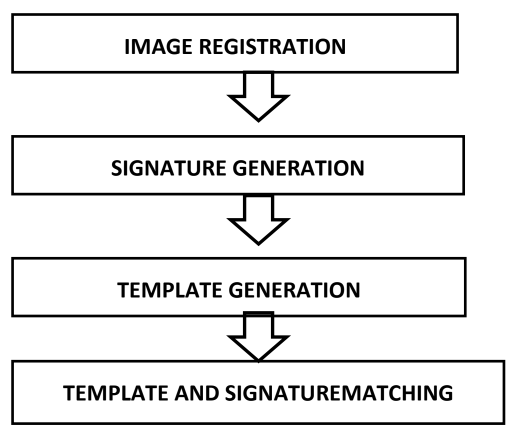


Fig. 1 Flow diagram of Thermal Image based Recognition system.

2.1 Image Registration:

Image registration is the challenging task in image processing system. The Thermal images of the object is used for the registration process. The thermal images are captured with the help of MWIR (Mid Wave Infrared) Cameras which captures the heat contents in the object.

Fig.2 Sample MWIR Thermal Images

These cameras are widely used in industries to identify the overheated parts due to continuous running or malfunctioning in machineries. The images are captured at various temperature conditions in order to overcome the subtle variations due to light. The images are registered using the Rigid Body Image registration tool. A set of four images are taken. The images are converted into grey scale image and then Gabor filter is applied to the images.

The filtered images are then fused by using the Wavelet fusion tool.

2.2 Signature Generation:

After registering the thermal images for each subject, the extraction of vasculature information from image is carried out. The vasculature extraction process has four main sections: face segmentation, noise removal, image morphology, and blood vessel segmentation post processing.

2.2.1 Face Segmentation:

The face of the subject was segmented from the rest of the image. The segmentation process was achieved by implementing the technique of localizing region based active contours in which typical region-based active contour energies are localized in order to handle images with non-homogeneous foregrounds and backgrounds.

Fig. 3 Face segmented Image

Let$\Psi = \{x|\Phi(x) = 0\}$be a closed contour of interest. The interior of the closed contour Ψ is expressed in terms of the smoothed approximation of the signed distance

Function given as

$$\Phi(x) = \begin{cases} 1, & \Phi(x) < -\varepsilon \\ 0, & \Phi(x) > \varepsilon \\ \frac{1}{2}\left\{1 + \frac{\Phi}{\varepsilon} + \frac{1}{\pi}\sin\frac{\pi\Phi(\mathrm{x})}{\varepsilon}\right\}, & \text{otherwise} \end{cases}$$

Where $\Phi(x)$ is a smoothed initial contour and $[-\varepsilon, \varepsilon]$ represents the boundary of the Heaviside function.

2.2.2 Noise Removal:

After the face was segmented from the rest of the body, segmented face is applied with perona-malik anisotropic diffusion filter to remove the speckle and spurious noise in order to perform further processing. The anisotropic diffusion filter enhance the edge information in the segmented face for extracting the thermal signature. During the diffusion the filter considers eight regions (east, west, north, south, northeast, northwest, southeast and southwest) is considered for diffusion conduction. The conduction coefficient function is given by

$$c(x, y, t) = \frac{1}{1 + (\frac{\|\nabla I\|}{K})^2}$$

Where ∇I is calculated for eight directions and K is the gradient modulus threshold that controls the blurring of facial features.

2.2.3 Image Morphology:

Image morphology is the way of analysing the shapes. Here we consider the blood vessel as a tubule like structure that runs along the length of face. The operation carried out in this section is opening and top-hat segmentation. In this there are two versions of top-hat segmentation and we consider the white top-hat segmentation which is used to enhance the bright objects in the image. The opening operation is used to preserve the foreground regions.

The opening of an image can be mathematically described as

$$I_{open}=(I \ominus S)\oplus S$$

Where I and I_{open} face segmented and the output of opened image. The $\ominus$ and $\oplus$ are the morphological erosion and dilation operators.

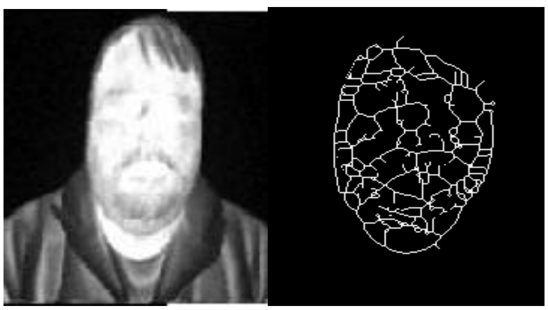
The top hat segmented image is given by the mathematical equation

$$I_{top} = I - I_{open}$$

2.2.4 Postprocessing:

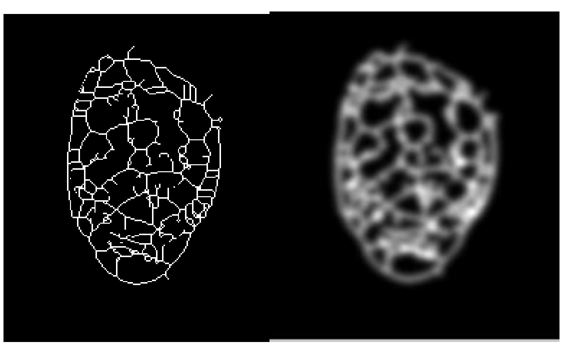
After obtaining the maxima in the image, skeletonization process is carried out. The technique used in this step is morphological thinning. Morphological thinning is defined as hit or miss transformation.

$$I_{skel} = I_{top} | (I_{top} \underline{x}^{\wedge} L_i)$$



(a) (b)

Fig. 4 Result of signature extraction. (a) Original thermal image (b) Thermal signature



(a) (b)

Fig. 5 (a)Thermal signature and (b)Result of applying anisotropic diffusion on summary image

2.3 Template Generation:

The generation of thermal template consist of taking the thermal signature of each subject and fuse then together by wavelet fusion technique. The resultant image is the addition of four thermal signatures. We apply anisotropic diffusion filter to the added thermal signature in order to fuse the predominant features.

Fig. 6 Illustrative thermal template overlaid on the thermal image of the subject

2.4 Matching:

The thermal template and thermal signature are matched by means of similarity measures. Here we make use of this technique as we are attempting to find the thermal infrared template similar to the queried thermal infrared signature. The similarity measure is calculated by using formula

$$S(A \rightarrow B) = \sum_{i=1}^{h} \frac{1}{h(D_i + 1)}$$

Where l/h is the weight associated with the matching.

3. CONCLUSIONS

This paper has presented a novel approach to biometric face recognition system based on thermal infrared images. The approach make use of rigid body image registration and localized-contouring algorithms to segment the subject's face. Morphological techniques are used to segment the subject's face and to generate the thermal signature by make use of top-hat and hit or miss techniques. The results that we obtained clearly showed that the usage of this unique technique has generated better results than the existing technique. The accuracy results obtained in this process clearly demonstrated the ability of thermal infrared system and in future it can be used on other thermal infrared systems and data base.

REFERENCES

[1]. W. Zhao, R. Chellappa, P. J. Phillips, and A. Rosenfeld, "Face recognition: A literature survey," ACM Comput. Surv., vol. 35, pp. 399–459, 2003.

[2]. F. W. Prior, B. Brunsden, C. Hildebolt, T. S. Nolan, M. Pringle, S. N. Vaishnavi, and L. J. Larson-Prior, "Facial recognition from volume- rendered magnetic resonance imaging data," IEEE Trans. Inf. Technol. Biomed., vol. 13, no. 1, pp. 5–9, Jan. 2009.

[3]. D.Saravanan, Dr.S.Srinivasan, "Data Mining Framework for Video Data", In the Proc.of International Conference on Recent Advances in Space Technology Services & Climate Change (RSTS&CC-2010), held at Sathyabama University, Chennai, November 13-15, 2010.Pages 196-198.

[4]. Y. Adini, Y. Moses, and S. Ullman, "Face recognition: The problem of compensating for changes in illumination direction," IEEE Trans. Pattern Anal. Mach. Intell., vol. 19, no. 7, pp. 721–732, Jul. 1997.

[5]. C. L. Lin and K. C. Fan, "Biometric verification using thermal images of palm-dorsa vein patterns," IEEE Trans. Circuits Syst. Video Technol., vol. 14, no. 2, pp. 199–213, Feb. 2004.

[6]. D.Saravanan, Dr.S.Srinivasan, "Matrix Based Indexing Technique for Video Data ", International journal of Computer Science", 9 (5): 534-542, 2013,pp 534-542.

[7]. S. K. Im, H. S. Choi, and S. W. Kim, "A direction-based vascular pat- tern extraction algorithm for hand vascular pattern verification," Etri. J., vol. 25, pp. 101–108, 2003.

[8]. T.ShimookaandK.Shimizu, "Artificial immune system for personal identification with finger vein pattern," Lect. Notes Comput. Sci., vol. 3214, pp. 511–518, 2004.

[9]. S. Gundimada and V. K. Asari, "Facial recognition using multisensor images based on localized kernel eigen spaces," IEEE Trans. Image Process., vol. 18, no. 6, pp. 1314–1325, Jun. 2009.

[10]. D.Saravanan, Dr.S.Srinivasan, "Video Image Retrieval Using Data Mining Techniques "Journal of Computer Applications, Volume V, Issue No.1. Jan-Mar 2012. Pages39-42. ISSN: 0974-1925.

[11]. D.Saravanan, Dr.S.Srinivasan, " A proposed New Algorithm for Hierarchical Clustering suitable for Video Data mining.", International journal of Data Mining and Knowledge Engineering", Volume 3, Number 9, July 2011.Pages 569

[12]. I. Pavlidis, P. Tsiamyrtzis, P. Buddhraju, and C. Manohar, "Biometrics: Face recognition in thermal infrared," in Biomedical Engineering Hand- book, J. Bronzino, Ed. Boca Raton, FL: CRC Press, 2006.

[13]. M. Khader and A. Ben Hamza, "Nonrigid image registration using an entropic similarity," IEEE Trans. Inf. Technol. Biomed., vol. 15, no. 5, pp. 681–690, Sep. 2011.

[14]. N. Miura, A. Nagasaka, and T. Miyatake, "Feature extraction offinger-veinpatternsbasedonrepeatedlinetrackinganditsapplicationtopersonal identification," Mach. Vision Appl., vol. 15, pp. 194–203, 2004.

[15]. P.Buddharaju, I.T.Pavlidis, P.Tsiamyrtzis, andM.Bazakos,"Physiology- based face recognition in the thermal infrared spectrum," IEEE Trans. Pattern Anal., vol. 29, no. 4, pp. 613–626, Apr. 2007.

[16]. B. R. Nhan and T. Chau, "Classifying affective states using thermal in- frared imaging of the human face," IEEE Trans. Biomed. Eng., vol. 57, no. 4, pp. 979–987, Apr. 2010.