**CRIMINAL IDENTIFICATION IN COLOR SKIN IMAGES USING SKIN MARKS DETECTION AND FUSION WITH INFERRED VEIN PATTERNS**

**ABSTRACT**

Skin texture without obvious features is different from other hard biometrics on the skin, such as fingerprints and palmprints. Relatively Permanent Pigmented or Vascular Skin Marks (RPPVSM) were recently introduced as a biometric trait for identification in cases where the evidence images show only the non-facial body parts of the criminals or victims, such as in child sexual abuse and riots. As manual RPPVSM identification is tiring and time consuming, an automated criminal identification system is proposed in this paper. The system is comprised of skin image enhancement, skin segmentation, vein pattern extraction and matching algorithms. Various number of algorithms are used in different stages of our proposed work. The system was evaluated on back images collected from different subjects in varying pose and viewpoint conditions. The proposed algorithm is computationally efficient and consistent in skin segmentation. To the best of our knowledge, this is the first work on automated identification in color skin images based on non-facial skin marks and fusion with inferred vein patterns in forensic settings.

**OBJECTIVES**

* To propose an automated people identification system based on back skin images as a biometric trait for identification of the criminals and victims.
* To enhance and segment the skin region.
* To extract the blood vessels and vein patterns of the skin images.

**EXISTING SYSTEM**

* Several skin mark detection and matching methods have been proposed in literature for face recognition systems, where skin marks are used as additional discriminative features (e.g., to discriminate monozygotic twins) or alternative identification features when face recognition fails.
* Zhang et al. detected facial marks in a semi-automated fashion by manually labeling seed pixels of facial marks and using region growing operations to grow the seeds of the selected facial marks from one pixel into a group of pixels with similar intensity.
* Park and Jain introduced facial marks together with gender and ethnicity as soft biometric traits to improve the performance of face matching and retrieval.
* Srinivas et al. used facial marks as a standalone biometric for identifying monozygotic twins.

**EXISTING DRAWBACKS**

* RPPVSM are different from facial marks since they are not specific to the face and only skin marks which are stable for six months or longer are considered as RPPVSM.
* RPPVSM are also different from birthmarks since birthmarks are congenital (i.e., appear at birth or shortly after birth) but RPPVSM can be congenital or acquired.
* Gunmen, terrorists, and rioters often cover their faces with masks or clothing, making face recognition impossible.
* The same challenges are encountered in the cases of child sexual abuse (e.g., child pornography), where pedophiles’ faces and tattoos are rarely visible in the evidence images or purposely blurred to avoid recognition
* Skin portions are not segmented properly
* Image quality is Poor.
* Computational Complexity is high.

**PROPOSED SYSTEM**

While it is rare to observe the criminals’ faces in the evidence images of child sexual abuse, masked gunmen, and riots, their non-facial body parts are often visible. To identify the criminals in these skin images, in this paper we propose an automated criminal identification system, which is comprised of skin image enhancement, skin segmentation, RPPVSM detection, and vein pattern matching algorithms. The RGB image can be converted into Red channel, Green channel and Blue channel and YCbCr color space model. Luminance (Y) channel, Chrominance (Cb) channel and Chrominance (Cr) channel. We Apply Gray world algorithm to the YCbCr output image in order to enhance the image. Mean/Average Filter is applied to all the three channels in the YCbCr image and Mean filtered normalized RGB image is obtained. Fuzzy C-Means (FCM) Segmentation algorithm is used to segment the backskin images from the background. Masking is applied and the color skin segmentation is done. Further to enhance the image, Contrast Limited Adaptive Histogram Equalization (CLAHE) is applied. Gabor Filter is used for extracting the vein pattern. Local Binary Patterns (LBP) is also used for extracting the texture feature extracted image. Shape Features are measured for all the registered criminals and the new testing image and it is classified using Multisvm algorithm. If it is matched, then it results as Registered Criminals. If it is not matched, it results as unregistered and new one.

**PROPOSED SYSTEM TECHNIQUE**

* Channel conversion RGB,YcbCr
* Image Normalization
* Histogram Analysis
* Fuzzy C-Means (FCM) Segmentation algorithm
* Homomorphic filtering (Preprocessing)
* Multiscale filtering and Thresholding (Candidate Extraction)
* Contrast Limited Adaptive Histogram Equalization (CLAHE) (Image Enhancement)
* Local Binary Pattern (LBP) (Feature Extraction)
* Gabor Filter (Vein Pattern Extraction)
* Shape feature extraction
* MultiSVM (Classification)

**PROPOSED SYSTEM BLOCK DIAGRAM**

**VEIN MATCHING**

**VEIN PATTERN EXTRACTION**

**IMAGE ENHANCEMENT**

**CRIME SCENERGB IMAGE**

**BACKSKIN IMAGE SEGMENTATION**

**IMAGE NORMALIZATION**

**TESTING FEATURE VALUES**

**VEIN PATTERN EXTRACTION**

**IMAGE ENHANCEMENT**

**(DATA-BASE)**

**RGB IMAGE**

**BACKSKIN IMAGE SEGMENTATION**

**IMAGE NORMALIZATION**

**CLASSIFICATION/ MATCHING**

**TRAINED FEATURE VALUES**

**RECOGNIZED**

**NOT RECOGNIZED**

**UNREGISTERED CRIMINAL**

**REGISTERED CRIMINAL**

**PROPOSED SYSTEM ADVANTAGES**

* This is the Novel approach and the first systematic study on non-facial skin marks
* This work is the first systematic study on non-facial skin marks and their fusion with vein patterns for automated criminal identification in color skin images in forensic settings..
* High accuracy in vein identification
* Segmentation Accuracy is high.
* The proposed system is robust and very effective.

**APPLICATIONS**

* Can be used for identification of criminals involved in theft,etc.,
* Both the RPPVSM identification and the fusion results demonstrate the practical use of applying RPPVSM in forensic investigation.

**SOFTWARE REQUIREMENTS**

* MATLAB 8.3 Version R2014a

**MATLAB**

The MATLAB high-performance language for technical computing integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation.

* Data Exploration ,Acquisition, Analyzing &Visualization
* Engineering drawing and Scientific graphics
* Analyzing of algorithmic designing and development
* Mathematical functions and Computational functions
* Simulating problems prototyping and modeling
* Application development programming using GUI building environment.

Using MATLAB, you can solve technical computing problems faster than with traditional programming languages, such as C, C++, and Fortran.

**REFERENCES**

[1] A. Nurhudatiana, A.W.-K. Kong, K. Matinpour, D. Chon, L. Altieri, S.Y. Cho, and N. Craft, “The Individuality of Relatively Permanent Pigmented or Vascular Skin Marks (RPPVSM) in Independently and Uniformly Distributed Patterns,” *IEEE TIFS*, vol. 8, no. 6, pp. 998-1012, 2013.

[2] D. Lin and X. Tang, “Recognize High Resolution Faces: From Macrocosm to Microcosm,” in *Proc. IEEE CVPR*, pp. 1355-1362, 2006.

[3] J.S. Pierrard and T. Vetter, “Skin Detail Analysis for Face Recognition,” in *Proc. CVPR*, pp. 1-8, 2007.

[4] Z. Zhang, S. Tulyakov, and V. Govindaraju, “Combining Facial Skin Mark and Eigenfaces for Face Recognition,” in *Proc. ICB*, pp. 424-433, 2009.

[5] U. Park and A.K. Jain, “Face Matching and Retrieval Using Soft Biometrics,” *IEEE TIFS*, vol. 5, no. 3, pp. 406-415, 2010.

[6] N. Srinivas, G. Aggarwal, P.J. Flynn, and R.W.V. Bruegge, “Analysis of Facial Marks to Distinguish Between Identical Twins,” *IEEE TIFS*, vol. 7, no. 5, pp. 1536-1550, 2012.

[7] D.G. Lowe, “Distinctive Image Features from Scale Invariant Keypoints,” *IJCV*, vol. 60, no. 2, pp. 91-110, 2004.

[8] P.F. Felzenszwalb and D.P. Huttenlocher, “Pictorial Structures for Object Recognition,” *IJCV*, vol. 61, no. 1, pp. 55-79, 2005.

[9] V. Blanz and T. Vetter, “A Morphable Model for the Synthesis of 3D Faces,” in *SIGGRAPH ’99 Proc. 26th Annual Conf. Computer Graphics and Interactive Techniques*, pp. 187-194, Los Angeles, 1999.

[10] T.F. Cootes, G.J. Edwards, and C.J. Taylor, “Active Appearance Models,” in *Proc. ECCV*, vol. 2, pp. 484-498, 1998.

[11] D. Ziou and S. Tabbone, "Edge Detection Techniques: An Overview," *IJPRAI*, vol. 8, no. 4, pp. 537–559, 1998.

[12] A.K. Jain, K. Nandakumar, and A. Ross, “Score Normalization in Multimodal Biometric Systems,” *Pattern Recognition*, vol. 38, no. 12, pp. 2270-2285, 2005.

[13] T.F. Cootes, C.J. Taylor, D.H. Cooper, and J. Graham, “Active Shape Models-Their Training and Application,” *Computer Vision and Image Understanding*, vol. 61, no. 1, pp. 38-59, 1995.

[14] G. Loy and A. Zelinsky, “Fast Radial Symmetry for Detecting Points of Interest,” *IEEE TPAMI*, vol. 25, no. 8, pp. 959-973, 2003.

[15] P. Burt and E. Adelson, “The Laplacian Pyramid as a Compact Image Code,” *IEEE Trans. Communication*, vol. 31, no. 4, pp. 532-540, 1983.

[16] C. Bradley, *The Algebra of Geometry: Cartesian, Areal and Projective Co-Ordinates*, Bath: Highperception, 2007.

[17] S. Milborrow and F. Nicolls, “Locating Facial Features with an Extended Active Shape Model,” in *Proc. ECCV*, pp. 504-513, 2008.

[18] R. Friedman, D. Rigel, and A. Kopf, “Early Detection of Malignant Melanoma: The Role of Physician Examination and Self-Examination of the Skin,” *CA: A Cancer Journal for Clinicians*, vol. 35, no. 3, pp. 130-151, 1985.

[19] T.S. Cho, W.T. Freeman, and H. Tsao, “A Reliable Skin Mole Localization Scheme,” in *Proc. ICCV*, pp. 1-8, 2007.

[20] T.K. Lee, M.S. Atkins, M.A. King, S. Lau, and D.I. McLean, “Counting Moles Automatically From Back Images,” *IEEE Trans. Biomedical Engineering*, vol. 52, no. 11, pp. 1966-1969, 2005.