Encryption of Retinal Fundus Image using Digital Watermarking

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Abstract-Telemedicine is the approach towards implementing medical findings and diagnosis of various diseases and transmitting over public network or rather say go digital. This initiative was invented for the purpose of ease of access as well as quick diagnostic approach towards medical emergencies, although this has got majority of benefits but it has also got a highlighted limitations based on the security of the medical reports. This is the major obstacle to provide confidentiality, integrity, and authenticity for medical images or reports. Present work proposes a method for the authentication of medical images. This paper focuses on encryption of Fundus images based on a hybrid algorithm. Digital Retinal Fundus Images helps to detect various ophthalmic diseases by detecting morphological changes in optical cup, optical disc and macula [2].

Key words: Telemedicine, Retinal Fundus Image,

I. INTRODUCTION

The Healthcare institutions now a days are into the requirement of exchange of medical data or rather say medical findings for various purpose of diagnosis, medical emergencies, lack of specialists around patient for immediate treatment etc.. but above all these requirements and having an advantage of providing quick medical services Telemedicine also has drawback of secured data. Since Telemedicine is nothing but exchange of medical information over public network, the question of security will always be a concern.

The implementation in secured telemedicine application must provide three basic requirements. Confidentiality, integrity and authentication. Traditional method which was used was encryption, which is the process of encoding data and only authorized entity was having an access. Similar technique of Digital watermarking was developed and used for encryption or say for covered data. Digital Watermarking is the process of embedding a watermark in a multimedia object. Watermark can be considered as a kind of signature that reveals the owner of the multimedia object. Content providers want to embed watermarks in their digital content for several reasons like copyright protection, content authentication, tamper detection etc. [5]

Here we have suggested a combined technique which combines encryption and digital watermarking in order to provide the required authenticity and integrity [1]. The image or scan is divided into two regions: ROI i.e. Region of Interest and RONI i.e Region of not interest. Now ROI part is responsible for generating unique Hash value whereas RONI part is responsible for embedding the encrypted algorithm and water marking the image.

A cryptographic watermark and patient's medical information is embedded in the covered image before being transmitted over public network. On the receiver's side, this watermarked and encrypted image is sent for the exact reverse process of extraction in order to receive or capture original data. The proposed algorithm is implemented in frequency domain using Discrete Wavelet transform and Line tracking and vein segmentation algorithm is used for encryption.

This paper is organized as follows section I is brief description of Retinal Fundus Image and implementation of line tracking algorithm for vein segmentation is described. In section II Digital watermarking is described in section III Proposed algorithm is explained. In section IV Results and finally conclusion and references.

II. RETINAL FUNDUS IMAGE

The retinal images provide vital information about the health of the sensory part of the visual system. Retinal diseases, such as glaucoma, diabetic retinopathy, age-related macular degeneration, Stargardt's disease, and retinopathy of prematurity, can lead to blindness manifest as artefacts in the retinal image [17]. Fundus Imaging involves capturing images of the back of the eye i.e Fundus. Specialized cameras are used in such imaging. It mainly captures retina, optical disc and macula.

Here in this research where specifically retinal fundus images are encrypted, the coloured image is converted to green channel and then the encryption process is initiated. After conversion into green channel, the image needs to be classified into ROI and RONI region. ROI region is nothing

but finding the affected vein in the retinal image and this is achieved using line tracking algorithm.

Line tracking method used to trace a line on image with certain angular orientation and diameter. By utilizing the image histogram, the pixel area boundaries will be determined to be tracked by the threshold value corresponding to the frequency of intensity image [18]. Once the tracking area is fetched, the initialization process for pixel tracking starts by taking references for pixel neighbours with a direction and a predetermined diameter of a pixel. Now for tracking the vein, the pixel which have the highest weight and whose value will exceed a predetermined threshold weight will be selected. If it is not eligible than re initialization process starts for early pixels. If it meets the eligibility criteria, then the pixel is marked as a line.

III. DIGITAL WATERMARKING TECHNIQUE

The process of embedding a watermark in a multimedia object is termed as watermarking. Watermark can be considered as a kind of signature that reveals the owner of multimedia object. It is required for several purposes such as copyright protection, content authentication, tamper detection [5]. The digital watermarking implemented in the proposed algorithm provides authentication, integrity as well as tamper localization at different levels of DWT HL sub bands. Authentication watermark will embed patient's information in image. Unique computed has value from ROI is watermarked at level 2 DWT HL sub band and will provide Integrity. At level 1 sub band of DWT computed CRC -16 of ROI is watermarked for tamper localization. Finally all the three watermarked of an RONI image is combined with ROI and Watermarked image is created.

IV. PROPOSED ALGORITHM

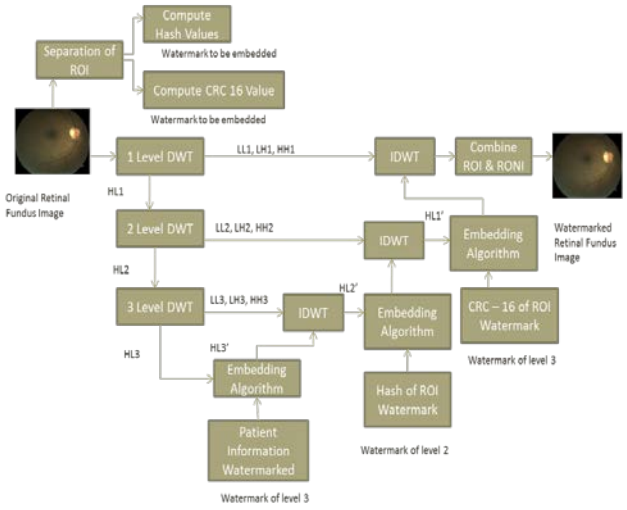


Fig. 1 Digital Watermark Embedding Process [1]

The proposed algorithm follows the separation of ROI and RONI region form the image. The image is sent for pre-processing and coloured image (RGB) is first filtered and converted to green channel image. Hash value is computed for the purpose of watermarking and to provide integrity to the image from ROI (Region of Interest) i.e. nothing but the affected area of the retina or rather say affected blood vessels are captured from ROI. Even CRC – 16 is calculated for the purpose of fetching the tamper localization watermarking.

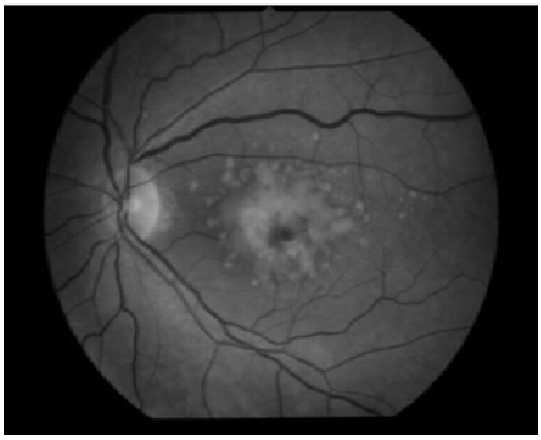
Now that the ROI is fetched and both the required data for encryption is calculated, the image is again passed through 3 level DWT (Discrete wavelet transform) for embedding different watermark into an RONI image for secured transmission. Every level of DWT will generate different multi resolution sub bands. HH, HL, LH and LL. Out of which Only HL band is sent for further decomposition and application of another level of DWT. And other sub bands are sent for embedding watermark at 3 different region as shown in figure. Finally Both ROI and RONI is combined to generate encrypted retinal fundus image.

V. EXPECTED RESULTS

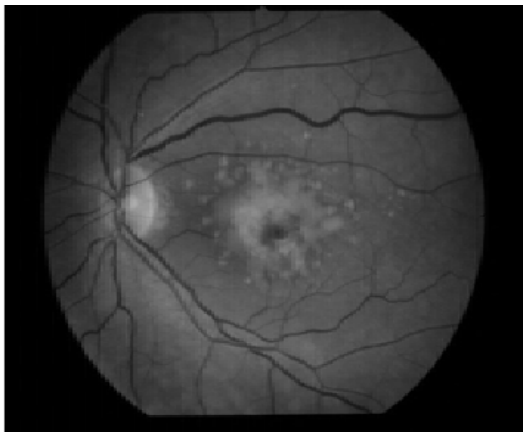
The proposed algorithm will be proving authentication, integrity, and security for Retinal Fundus Image by different level of watermarking techniques. Authentication is achieved by embedding patient's information watermark into HL3 sub band. Improved integrity and security will be provided by the proposed model as well as tamper localization will be much more accurate to find out the affected area of transmitted image. The imperceptibility and robustness can be achieved by higher PSNR (Peak Signal – to Noise Ratio) and Zero mean so the extracted watermarked image at receiving end will be same as original image.

a. Original Retinal Image

b. Pre processed Green channel Image



c. Watermarked Image



PSNR and SNR Values:

PSNR and SNR should range from 20 – 40db.

VI. CONCLUSION AND FUTURE SCOPE

The proposed research will be implemented and tested on Retinal Fundus image. The Retinal image is converted into green channel image and then it will be further processed for encryption and embedding watermarking. The same perspective can be implemented for all the medical images for secured transmission. The future scope for this is advancement can be made by using different error correcting codes such as hamming code, ECC code etc. another variation can be made by reversing the whole process i.e. instead of RONI embedding. ROI can be watermarked, exact reverse process of the proposed algorithm.

REFERENCES

[1] Ali AI-Haj, Noor Hussein, Gheith Abandah "Combining Cryptography and Digital Watermarking for Secured Transmission of Medical Images" 978-1-5090-1470-5 4/16/$31.00 ©2016 IEEE.

[2] Nilanjan Dey, Moumita Pal , Achintya Das "A Session Based Blind Watermarking Technique within the NROI of Retinal Fundus Images for Authentication Using DWT, Spread Spectrum and Harris Corner Detection" International Journal of Modern Engineering Research (IJMER) www.ijmer.com Vol.2, Issue.3, May-June 2012 pp-749-757 ISSN: 2249-6645.

[3] Ms. G. Rajeshwari, Dr. S. Subbaiah "Quality and Security Guaranteed Medical Image Transmission Framework for E-Health Services" International Journal On Engineering Technology and Sciences – IJETS™ ISSN(P): 2349-3968, ISSN (O): 2349-3976 Volume IV, Issue VI, June – 2017.

[4] John Craig and Victor Patterson "Introduction to the practice of telemedicine" Journal of Telemedicine and Telecare 2005; 11: 3-9.

[5] Vidyasagar M. Potdar, Song Han, Elizabeth Chang "A Survey of Digital Image Watermarking Techniques" 2005 3rd IEEE International Conference on Industrial Informatics (INDIN).

[6] R.C. Ashley, "Telemedicine: Legal, Ethical and Liability considerations." Journal of the American Dietetic Association. Vol 102, No.2, 2002.

[7] J. Katz and Y. Lindell Y, "Introduction to Modern Cryptography." CR C Press. ISBN 1-58488-551-3,2007.

[8] A. Giakoumaki, S. Pavlopoulos, and D. Koutsouris, "Multiple Image Watermarking Applied to Health Information Management." IEEE Trans. Info. Techno. Biomed., Vol. 10, No.4, Pages: 722-732,2006.

[9] C. Cruz C, R. Reyes, J. Mendoza, M. Nakano, and H. Perez, "A Novel Verification Scheme for Watermarking Based Image Content Authentication Systems." Telecommunications and Radio Engineering. Vol. 67, No. 19, ISSN: 0040-2508, Pages: 1777-1790, 2008.

[10] C. C. Chang , Z. H. Wang , and Z. X. Yin, "An Ingenious Data Hiding Scheme for Color Retinal Image", Proceedings of the Second Symposium International Computer Science and Computational Technology (ISCSCT '09)Huangshan, P. R. China, 26-28,Dec. 2009, pp. 001-006.

[11] D. Ananad, and U.C. Niranjan, "Watermarking medical images with patient information", In: proc. IEEE/EMBS Conference, Hong Kong, China, Oct 1998, pp. 703-706.

[12] Salwa A.K. Mostafa, Naser El- sheimy, A.S. Tolba, F.M. Abdelkader and Hisham M. Elhindy, " Wavelet Packets-Based Blind Watermarking for Medical Image Management", The Open Biomedical Engineering Journal, 2010,4, pp. 93-98.

[13] Tian, "Wavelet-based reversible watermarking for authentication", Proceedings of SPIE on Security and Watermarking of Multimedia Contents IV, vol. 4675, Jan.2002, pp. 679-690.

[14] Christian Rey, Jean-Luc Dugelay, "A Survey of Watermarking Algorithms for Image Authentication", EURASIP Journal on Applied Signal Processing. Volume 2002 (2002), Issue 6, Pages 613-621.

[15] Anumol T.J, P Karthigaikumar, ”DWT based Invisible Image Watermarking Algorithm for Color Images”, IJCA Special Issue on “Computational Science - New Dimensions & Perspectives” NCCSE, 2011.

[16] Mei Jiansheng, Li Sukang. Tan Xiaomei,”A Digital Watermarking Algorithm Based On DCT and DWT”, Proceedings of the 2009 International Symposium on Web Information Systems and Applications (WISA’09) Nanchang, P. R. China, May 22-24, 2009, pp. 104-107.

[17] M. CAROLINE VIOLA STELLA MARY1, ELIJAH BLESSING RAJSINGH2, (Member, IEEE), AND GANESH R. NAIK3, (Senior Member, IEEE) “Retinal Fundus Image Analysis for Diagnosis of Glaucoma: A Comprehensive Survey” *Digital Object Identifier 10.1109/ACCESS.2016.2596761*August 26, 2016.

[18] Marios Vlachos∗, Evangelos Dermatas “Multi-scale retinal vessel segmentation using line tracking” 0895-6111/$ – see front matter © 2009 Elsevier Ltd. All rights reserved. doi:10.1016/j.compmedimag.2009.09.006