Digital Watermark Embedded Retinal Fundus Image for Secured Transmission

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Abstract : ***Telemedicine is nothing but going digital for medical diagnosis and findings of various diseases for a quick medications, the major obstacle in this field is nothing but security. To send patient's medical data or images securely over public network is quite a risky task. To overcome such limitations this research has provided a simple solution by covering or by encrypting the image and patient's medical information before transmission over network. We have various medical images such as MRI, CT Scans, Retinal Images, Sonography etc.. of which this research mainly focuses on Coloured Retinal Fundus Image which detects various ophthalmic diseases. Here we have proposed a hybrid solution for encrypting Fundus Image along with Digital watermarking for secured transmission.***

Index Terms – Retinal Fundus Image, Digital Watermarking,

I. INTRODUCTION

Health care institutions all around the world have started adopting digital imaging or we can say going towards digital world, this is nothing but transmitting and receiving data or medical images or information on vulnerable public network and is called as Telemedicine. For secured telemedicine it should fulfil three basic requirements i.e. Confidentiality, Integrity and Authentication. Here we suggest a hybrid approach of encryption and digital watermarking. Encryption is nothing but the process of encoding data and was only available for authorized entity, and 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 suggest a hybrid algorithm which combines encryption and digital watermarking in order to provide required authenticity and integrity [1]. The image is divided into two regions ROI (Region of Interest) and RONI (Region of Not Interest). ROI is responsible for generating a unique Hash value and RONI part of an image is responsible for embedding encrypted algorithm and watermark. A cryptographic watermark and patient's medical information is embedded in the covered image before being transmitted over public network [19]. The hybrid algorithm is implemented in frequency domain using Discrete Wavelet Transform. For detecting the affected area in retinal fundus image there is a requirement for clear vein or blood vessel detection and for this we have proposed line tracking algorithm. The implementation of embedding Watermark is done with the help of symmetric key cryptography technique by Caesar cipher algorithm.

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 [1].

Retinal Images are coloured image and for the purpose of secured transmission and for the implementation of proposed algorithm, this coloured (RGB) image has to be converted into Green channel image. Now this Green channel image is pre-processed and filtered for the clear and noise free input image using Weiner filter.

III. VEIN SEGMENTATION

The retina, which is a layer of a membrane at the back of the eye can be visualized as in image with the help of Fundus Camera, these images are often noisy and poorly contrasted and non-uniformly illuminated. They suffer from brightness variations along the same image. Many methods are proposed for the detection of retinal or eye diseases by vessel detection. Since it is not the single vein or blood vessel is used for detection of disease there are multiple veins involved in an image and to detect the affected area in an image is rectified by using multiple line tracking algorithm [18 – 19].

A new multi-scale line-tracking procedure is starting from a small group of pixels, derived from a brightness selection rule, and terminates when a cross-sectional profile condition becomes invalid. The multi-scale image map is derived after combining the individual image maps along scales, containing the pixels confidence to belong in a vessel. The initial vessel network is derived after map quantization of the multi-scale confidence matrix. Median filtering is applied in the initial vessel network, restoring disconnected vessel lines and eliminating noisy lines. Finally, post-processing removes erroneous areas
using directional attributes of vessels and morphological reconstruction. [18].

IV. DIGITAL WATERMARKING

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]. Now the same content authentication is used or deployed in proposed research. There are 3 different

level of watermark which is embedded in this research i.e. CRC -16, Hash value and finally Patient's information watermark at 3 different levels of DWT as shown in fig. [1]. There are several methodologies which are used for digital watermarking techniques, since our algorithm is based on wavelet transform we have used DWT based digital watermarking instead of others like DCT. DWT uses decomposition of an image in four respective sub bands i.e. LL, LH, HL and HH. Since we have to embed 3 watermarks as declared above we use three level decomposition of DWT and implement different watermark at different levels.

V. ENCRYPTION PROCESS

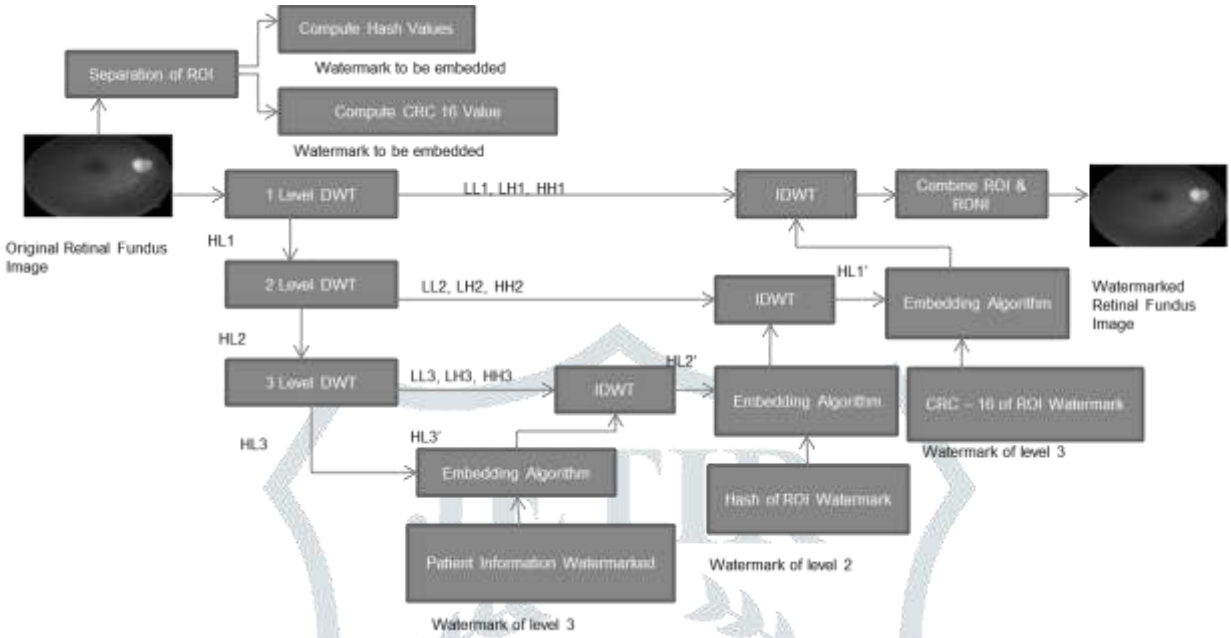


Fig. 1. Block Diagram of Embedding Process [1]

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 [20].

VI. EXTRACTION PROCESS

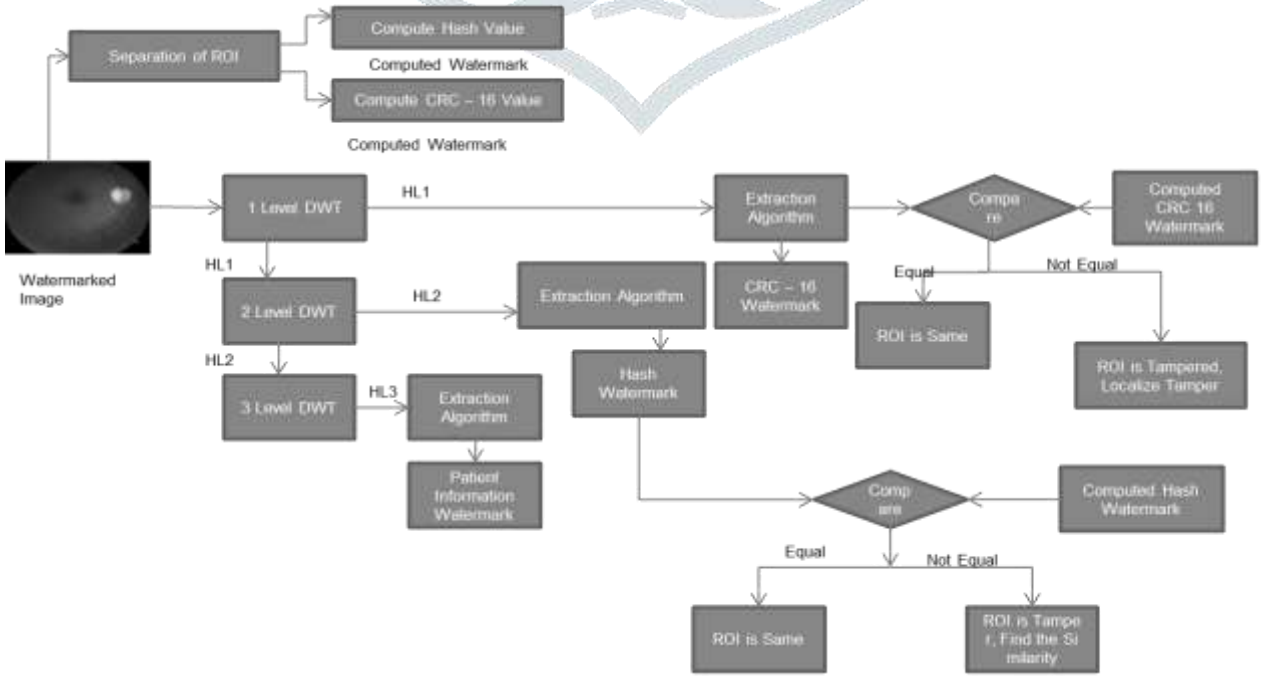


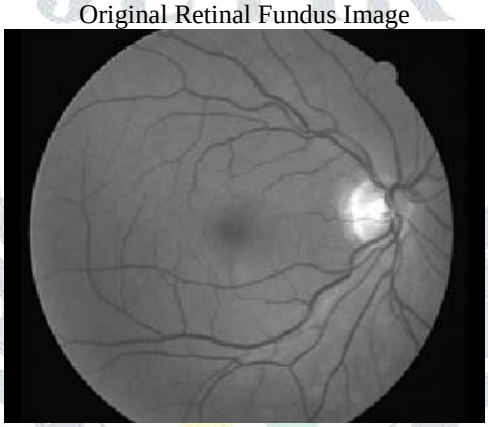
Fig. 2 Block Diagram of Extraction Process [1]

As we have seen in encryption algorithm, the watermarked image is saved and now sent for extraction of original image along with embedded patient's information. The image is again sent for the separation of ROI and RONI and compute CRC -16 and Hash value. Now from RONI 3 level decomposition level 1 will compare calculated CRC – 16 value with encrypted value and if it matched the image is authenticated at receiver's side with the selection of HL1 sub band of DWT level 1 decomposition. Now same HL sub band is decomposed for level 2 and sent for authentication of hash value by comparing with encrypted one by selecting HL sub band. And finally on third level decomposition the extraction algorithm is implemented for the purpose of fetching patient's information from watermarked image.

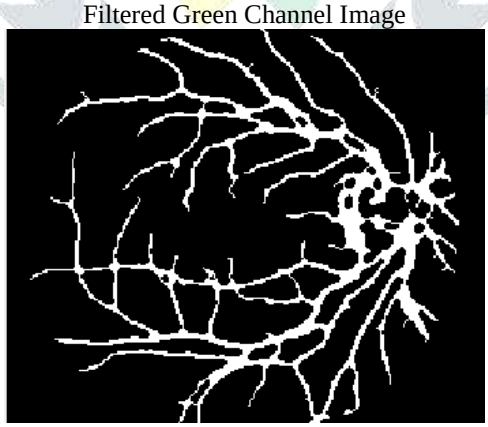
VII. EXPECTED RESULTS

The above algorithm or technique is providing secured transmission and extraction of Retinal Fundus Image with the help of embedding digital watermark at each level of DWT decomposition to provide authenticated and integrated solution. 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.

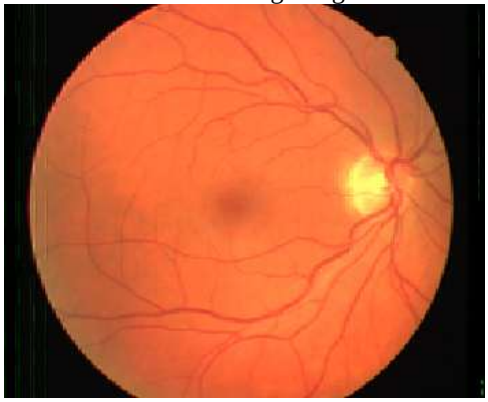
Original Retinal Fundus Image



Filtered Green Channel Image



Line Tracking Image



Extracted image with patient information embedded.

VIII. CONCLUSION & FUTURE SCOPE

The proposed hybrid algorithm was implemented and tested on Retinal Fundus Image and the image received after extraction algorithm was embedded with patient's information in RONI region where the scanned or ROI is not affected. The same algorithm or techniques can be used for different medical images for secured transmission. The up gradation or this algorithm can be implemented by using different error correcting codes like Hamming code, ECC etc. another variation in future scope or for different technique is, the same algorithm can be implemented in exact reverse process i.e. instead of Embedding watermark on RONI, ROI can be watermarked and also using vein segmentation the same algorithm can be used for anomaly detection in retinal blood vessels

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