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DIGITAL IMAGE WATERMARKING FOR MEDICAL IMAGES USING DEEP LEARNING

Hariharan S, Parthiban V, Ajay Pranav P.R, Shrikanth S, Mr. Pravin Savaridass M

[1]Student, Dept. of Electronics and Communication Engineering, Anna University, IN
[2]Student, Dept. of Electronics and Communication Engineering, Anna University, IN
[3] Student, Dept. of Electronics and Communication Engineering, Anna University, IN
[4]Student, Dept. of Electronics and Communication Engineering, Anna University, IN
[5]Assistant Professor, Dept. of Electronics and Instrumentation Engineering, Anna University, IN

Abstract -*Transferring and Protecting a patient data in crucial in telemedicine application. In order to protect the security and integrity of private medical information, this research investigates a reliable digital picture watermarking method designed specifically for medical photos. The Discrete Wavelet Transform (DWT) is used in the watermark embedding procedure to efficiently insert the watermark by breaking down the medical image into several frequency sub-bands. An U-Net architecture is initially used for image segmentation, which helps to isolate important regions of interest (ROIs) in the medical pictures, improving watermark embedding while lowering the possibility of data loss or distortion in crucial areas. The watermark is subjected to scrambling techniques to increase security and robustness, making it more difficult for unauthorized individuals to extract it. The Inverse Discrete Wavelet Transform (IDWT) is used to recover the watermarked image as part of the watermark extraction procedure. Peak Signal-to-Noise Ratio (PSNR) and Structural Similarity Index (SSIM), two well-known metrics that evaluate the quality of the watermarked and extracted pictures, are used to evaluate performance. The suggested approach is a potential solution for safe medical image sharing and authentication since experimental findings show how effective it is in terms of watermark imperceptibility, resilience to attacks, and maintenance of medical image quality.*

Key Words: *Watermarking, DWT, performance evaluation, U-NET architecture, data loss, telemedicine, authentication*

1.INTRODUCTION

Digital images are becoming more important in a variety of industries especially in medical industry because of its robustness. The patients sensitive and private information are important and should not be mismatched with another patient information. Unauthorized access to these private details may result in more significant problems, including invasions of privacy, infringement on intellectual property, and disruption of medical diagnosis [1]. For this reason, digital picture security is essential. Currently, watermarking methods are crucial for safeguarding patient's information. Within the cover image Patient information along with hospital logo are embedded by image watermarking, which also makes the marks strong and undetectable. The embedding of copyright marks in classical watermarking is accomplished by either directly altering the pixel value or by altering the transform coefficient of the cover picture. The transform domain strategy offers more flexibility and robustness than the spatial domain scheme [2] (Here DWT is used). However, the applicability of conventional watermarking systems is limited because they are less resistant to attacks. Thus, a thorough examination of the strong watermarking technique for digital photographs that works well is warranted. Separation of ROI and NROI in the cover image (Medical images like XRAY, MRI etc..) places a crucial role in image watermarking. ROI are the black areas where the information of patient, hospital logo etc are embedded as a watermark and NROI of the image is the part where watermark can't be embedded because there lies a main organ XRAY of the patient. U-NET Architecture is a Deep Learning based CNN framework which is used to separate ROI and NROI of a medical image using image segmentation. It has encoder and decoder which down-samples and up-samples the image for segmenting the image and separating ROI and NROI in the cover image.

Embedding of watermarking is done using DWT transformation technique after separation of ROI and NROI in cover image. Scrambling techniques are used in the watermarked image (watermark image + cover image) to encode the watermarked image so that only the receiver can decode and examine the image. Performance evaluation is done on the watermark image with different types of noise

values using algorithms PSNR, SSIM, Normalized correlation to assess the performance of the watermark image after its transmission. Normally performance evaluation above 40db is considered that watermarked image is robust against noises.

1.1 Background of the Work

Sending the medical images and details of patient over internet is not secure and there is a high possibility of data getting mismatched. Image processing and Deep Learning techniques offer an opportunity to address these limitations by embedding the patient detail in the respective medical image and allow for secure transmission and retrieval of data over internet

1.2 Motivation and Scope of the Proposed Work

The motivation for this study is rooted in developing telemedicine application by enabling an efficient and secure transmission of medical images over internet When the doctor wants to consult about his patients X-RAY, MRI or any other medical scans with his chief doctor who is far away, they need to rely on telemedicine application by sending the medical image and patient details separately. The data might get mismatched and security of the patient details is compromised. The proposed system addresses these needs efficiently by developing an image watermarking system that combines Image Processing and Deep Learning for comprehensive, secure watermark embedding and recovery. This project incorporates transformation techniques to embed and extract patient data in their respective medical image, deep learning for image segmentation of ROI and NROI in medical images, Scrambling techniques to encode the watermarked image which improves security and performance evaluation to determine how the recovered image differs from original image at the receiver end.

By designing a safety and flexible image watermarking system, it aims to promote efficiency, enhance safety, and promote long-term sustainability.

2. METHODOLOGY

The project aims to design and implement an Image Watermarking System that uses modern technologies and algorithms such as Matlab for the simulation, U-NET Architecture (Deep Learning algorithm) for image segmentation, DWT Transformation Technique for embedding Watermark image in the cover image and Scrambling Techniques for encryption of the image. The Image watermarking system will provide services to add the particular patient details and hospital logo in their XRAY or any type of medical images. After Transmitting, original image is extracted using Inverse DWT Transformation Technique. The project's primary focus is to create a secure and reliable watermarking system to embed and transfer medical images with patient information safely without any mismatch and leakage of private data.

2.1 System Architecture

The architecture of the proposed system includes Matlab where watermark embedding, encoding and extraction is simulated efficiently. The flow of the system architecture is shown in Fig-1.

2.2 Watermark embedding

To embed various information like patient name, patient blood group, organ, hospital logo on the medical image of the respective patient as an invisible watermark. This embedding process is done with the help of DWT transformation technique. An image is broken down by DWT into a collection of wavelet coefficients that correspond to distinct frequency bands at varying scales.: LL (low-low), LH (low-high), HL (high-low), and HH (high-high). The LH band will have the watermark.

2.3 Image segmentation

Image segmentation is used in separating ROI and NROI of the medical image and the Watermark image is embedded in the NROI part of the medical image. A deep learning architecture called U-Net was created especially for image segmentation applications, especially in medical image analysis. It is frequently used to separate objects or regions of interest (ROI) from non-regions of interest (NROI) in photographs. The distinctive architecture of U-Net, which comprises of a U-shaped structure with an expanding (up-sampling) channel and a contracting (down-sampling) path, enables it to effectively capture an image's global properties as well as its local context.

2.4 Scrambling of watermarked image

Unpredictability, pseudo-randomness, and sensitivity to initial conditions, chaotic scrambling techniques are being employed more and more for image encryption and watermarking. Because of these characteristics, they are especially well-suited for protecting private information, such medical photos. The method can use chaotic maps (such the Arnold Cat Map, Henon Map, or Logistic Map) to jumble the image's pixel values so that they can only be undone with the right key or settings. Without understanding the precise characteristics of the chaos map, it is difficult to forecast or reverse chaos because to its great sensitivity to initial conditions. Chaotic scrambling offers a method to protect the picture data and stop unwanted access to medical imaging (such as MRIs, X-rays, etc.). Logistic Map is used to perform chaotic scrambling on a medical image.

2.5. Performance Evaluation

To ascertain the extent to which the watermarking process has impacted the original image, it is essential to assess the quality of the watermarked image. For this, two often used metrics are SSIM (Structural Similarity Index) and PSNR (Peak Signal-to-Noise Ratio). These measurements quantify how the original and watermarked (or scrambled/recovered) photos differ from one another.

2.6. Recovering original image

In watermarking applications that use the Discrete Wavelet Transform (DWT), one of the most important steps is to recover the original picture from a watermarked image using the Inverse Discrete Wavelet Transform (IDWT). When watermarking, the watermark is incorporated into the original image's DWT coefficients, usually in the low-frequency sub-bands (LL). We must first extract the watermark from the DWT coefficients and then use IDWT to reconstruct the image in order to recover the original

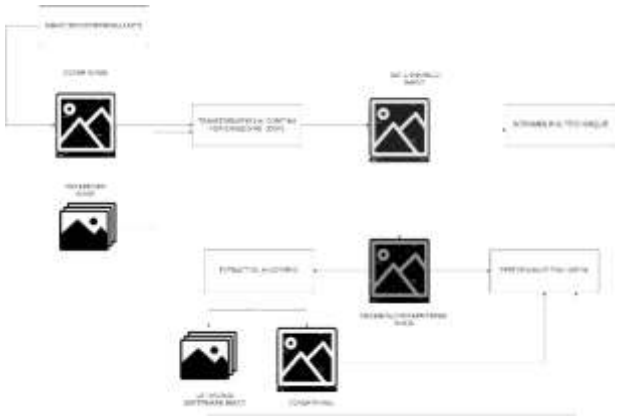

Fig -1- Flowchart

3. CONCLUSIONS

Implemented medical image watermarking system with the help of Transformation Techniques like DWT, Inverse DWT and Deep Learning techniques like U-NET architecture. This system successfully embeds patient data as the watermark image in the respective medical image ex: XRAY, MRI. Embedding of this data as watermark image in the medical image is done by using DWT Transformation technique. Image segmentation is used to separate ROI and NROI in the medical images and the embedding is done in NROI region with the help of U-NET architecture a Deep Learning architecture. Security measures, including encryption and secure transmission is achieved through Scrambling techniques which is used to encode the watermarked image. Original image is extracted at the receiver end using Inverse DWT Transformation technique. At each step of the image processing Performance Evaluation is Calculated using PSNR algorithm to measure the amount of noise in the image. Ratio above 40dB is considered as good. This system will perform well as a telemedicine application.

Suggestions for Future Work

Looking to the future, the development roadmap for the Medical Image Watermarking system is set to be continuously developing. We have planned to implement advanced Deep Learning Techniques to overcome the issues we face in this current system.

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