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Medical Image Watermarking Technique in the Application of E-diagnosis using M-Ary Modulation

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Abstract

A robust and lossless ROI medical image watermarking technique using M-Ary modulation is proposed in this paper. The system's effectiveness is experimentally tested for two different medical image modalities of brain using various quality measures as payload, PSNR, MSE and SSIM. The proposed algorithm provides high robustness, higher PSNR and low relative entropy distance as a criterion for protection.

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Keywords: Data hiding; Digital Watermarking; Region of interest; Electronic patient record; and M-Ary modulation;

1. Introduction

Advancement in information and communication technologies helps health care system for easy access and distribution of electronic patient information (EPR). With these advancements there is a threat of illegal use of

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medical information. Thus, security of medical information is a primary requirement and to fulfil these requirements three major characteristics is derived: confidentiality, reliability and availability [1].
Confidentiality- only authorized users have access to the data
Reliability – This characteristic has two aspects

- Integrity: the information has not been altered by unauthorizeduser.
- Authenticity: is a proof that the information belongs to the rightpatient.

Availability- Is the ability of data systems to be applied by authorizedusers.

There are three primary applications for inserting the watermark in medical images:1) data hiding to facilitate the information management , 2) security control to affirm that the images are intact and 3) authenticity to demonstrate that the image is really what the user thinks it is [2,3]. To facilitate these requirements of medical image watermarking; imperceptibility property, robustness property and payload property must attain. However, these properties have a certain level of limitations and might conflict each other. Thus, a proper coupling is required to achieve an optimizedsolution.

Many medical image watermarking algorithms have been proposed by various researchers based on spatial domain technique and frequency domain technique. Zhou et.al.[4], proposed spatial domain watermarking scheme to verify authenticity and integrity of digital Mammography images. Another spatial domain watermarking technique is proposed by Zain et.al. [5] to verify the integrity and authenticity of DICOM ultrasound images. X. Guo et.al. [6], a proposed lossless watermarking technique based on difference expansion. Adjacent pixel values are calculated and are employed to embed several bits in RONI region. M. Kundu et.al. [7], a proposed reversible watermarking technique where EPR data is embed in RONI using advanced some encryption standard. H.M.Chao et.al.[8] proposed a frequency domain technique based on Discrete Cosine Transform (DCT) where an EPR-related data is embedded in quantized DCT coefficients of watermarked image. R. Acharya et.al. [9], proposed DCT based scheme where graphical ECG signals and encrypted text data of patient information are interleaved with medical images to reduce storage and transmission overheads. H.K. Lee et.al.[10], proposed wavelet based watermarking scheme to embed data other than ROI region. This scheme is used for integrity of DICOM images. K.A. Navas et.al.[11], proposed reversible EPR data hiding using integer wavelet transform. H.K. Maity et.al.[12], proposed reversible contrast mapping watermarking scheme for robustness improvement. To improve robustness; integer wavelet transform based on spread spectrum technique isapplied.

In all these previous works, either the watermarking algorithm works for a particular medical image modality or imperceptibility measure reduces as embedding capacity increases; also the watermarking systems are less secure. In order to enhance the security and confidentiality of medical images, a novel watermarking technique using M-Ary modulation is proposed in this paper. Medical image is separated into two parts region of interest (ROI) and region of non interest (RONI). ROI is extracted (brain tumour) using Fuzzy C-means segmentation method which yields better segmentation accuracy , and electronic patient record as watermark is embedded in RONI using M-Arymodulation in the mid-band DCTcoefficient.

The structure of the paper is organized as below: **Section 2** describes proposed watermark embedding scheme modules. Experimental results are discussed in **Section 3**. Finally, a conclusion has been made in **Section 4**.

2. ProposedScheme

A detailed description of the proposed system's module is described in this section. The proposed work is divided into two modules. Firstly, region of interest (ROI), a diagnosis part, which is to be extracted using Fuzzy C-means, and secondly electronic patient record (EPR) as a watermark is to be embedded in mid-band DCT coefficients using M-Ary modulation in RONI.