Reversible Medical Image Watermarking For Tamper Detection And Recovery With Run Length Encoding Compression

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Abstract— Digital watermarking in medical images can ensure the authenticity and integrity of the image. This design paper reviews some existing watermarking schemes and proposes a reversible tamper detection and recovery watermarking scheme. Watermark data from ROI (Region Of Interest) are stored in RONI (Region Of Non Interest). The embedded watermark allows tampering detection and tampered image recovery. The watermark is also reversible and data compression technique was used to allow higher embedding capacity.

Keywords— data compression, medical image, reversible, tamper detection and recovery, watermark.

I. Introduction

IN modern health care facilities, systems such as HIS (Hospital Information System) and PACS (Picture Archiving and Communications System) form the information technology infrastructure for a hospital. Advancements in medical information system is changing the way patient records are stored, accessed and distributed. The integrity of the records such as medical images needs to be protected from unauthorized modification or destruction of information on the medical images. Current security measures used to protect the integrity of the patient records are such as VPN (Virtual Private Network), data encryption and data embedding [1].

Data encryption is being used on the Internet to protect sensitive data during transmission. It is also being used to protect medical images in the form of digital signature. The problem with digital signature is that it needs to be transmitted together with the image in a separate file or in the image header. There is also a risk of losing the signature during transmission. The signature will also be lost if the image file is converted to another format that does not allow headers. Data embedding is where related information such as digital signature can be inserted into the medical images as a watermark. Currently, there is no standard of implementation for digital watermarking. Watermark provides three objectives in medical images [2]:

- data hiding, for embedding information to make the image useful or easier to use;
- integrity control, to verify that the image has not been modified without authorization;
- authenticity, that is to verify that the image is really what the user supposes it is.

In practice diagnoses has been performed on medical images before being directed to the long-term storage, thus the significant part of the image is already been determined by doctors involved in the diagnosing process [3]. The significant part is called ROI (Region Of Interest). Since information in medical images is not to be modified in any way, the watermark is usually being embedded in the RONI (Region Of Non Interest) as this region does not contribute in the process of diagnosis. Another option is to allow the watermark to be reversible [2]. The usage of ROI in watermarking in medical images had been used by Lim [4] and Fotopoulus [5] where ROI and RONI were defined before the process of watermark embedding. Reversible watermarking is where embedded watermark is removed and the original pixel value is restored. Research by Coatrieux [6] produced a watermarking scheme where information describing the image is embedded into medical images and can be reversed later on.

The ability of to detect tampering of a watermarked image is crucial for authentication. Once tampering is detected, tampered section can be recovered. Research by Wu [7] and Jasni [9] divides medical image into blocks and each block is embedded with the authentication message and recovery information of other blocks. Tampered blocks can then be restored using this information.

Data compression can be used to increase the embedding capacity in an image. The usage of lossless data compression allows strings of bits to be compressed before embedding. The exact bits can be decompressed later on. RLE (Run-Length Encoding) is an example of a lossless data compression technique that can be applied in an image watermarking.

In this paper, a design of a reversible tamper detection and recovery for medical image is proposed. This design will be using ROI, RONI and blocks to divide the medical image. Authentication bit, parity bit and pixels average intensity will be used to detect tampering and recovery. RLE as a data compression technique will be introduced to allow higher embedding capacity.

In the next section, watermarking in medical images and

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