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Region of Interest-Based Tamper Detection and Lossless Recovery Watermarking Scheme (ROI-DR) on Ultrasound Medical Images

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Abstract Tampering on medical image will lead to wrong diagnosis and treatment, which is life-threatening; therefore, digital watermarking on medical image was introduced to protect medical image from tampering. Medical images are divided into region of interest (ROI) and region of non-interest (RONI). ROI is an area that has a significant impact on diagnosis, whereas RONI has less or no significance in diagnosis. This paper has proposed ROI-based tamper detection and recovery watermarking scheme (ROI-DR) that embeds ROI bit information into RONI least significant bits, which will be extracted later for authentication and recovery process. The experiment result has shown that the ROI-DR has achieved a good result in imperceptibility with peak signal-to-noise ratio (PSNR) values approximately 48 dB, it is robust against various kinds of tampering, and the tampered ROI was able to recover to its original form. Lastly, a comparative table with the previous research (TALLOR and TALLOR-RS watermarking schemes) has been derived, where these three watermarking schemes were tested under the same testing conditions and environment. The experiment result has shown that ROI-DR has achieved speed-up factors of 22.55 and 26.65 in relative to TALLOR and TALLOR-RS watermarking schemes, respectively.

Keywords Watermarking · Region of interest (ROI) · Least significant bit (LSB) · Speed up · Tamper detection · Recovery

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Introduction

Digital watermarking in medical images serves as a layer of protection against tampering. In medical image watermarking, a region of interest (ROI) is defined but untouched and the generated watermark is embedded in the region of non-interest (RONI). It is because ROI is the significant area for clinical diagnosis and modification was restricted to prevent any misdiagnosis from occurring. Several studies had divided a medical image into protection zone (ROI) and insertion zone (RONI) in their proposed watermarking schemes [1–3]. All these watermarking schemes focused on the intrinsic algorithm; therefore, it was usually conducted on a single frame medical image, but most of the medical images are formed by multiframes, such as ultrasound and MRI medical images. Wenbo D. et al. had introduced an improved version of dual-layer watermarking scheme and exploited the 3-D property of volumetric (multiframes) Digital Imaging and Communications in Medicine (DICOM) images [4, 5]. They had utilized the advantage of 3-D property and manipulated them into their watermarking scheme algorithm. It is easy to migrate watermarking scheme from single frame to multiframe environment by using a control loop, such as loop to perform watermarking process on medical images sequentially, but it may be time-consuming; for example, the average processing time of Tamper Localization and Lossless Recovery (TALLOR) watermarking scheme was reported as 20.13 s per frame, and it would be 20.13 min for 60 frames of