SUMMARY OF Ph.D. DISSERTATION

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Title

Abstract

The exchanges of the Medical Information (MI) through Internet and digital media have problems such as a leak of MI and patient privacy protection. In order to solve these problems, technical security countermeasures become necessary besides preparation of law systems. If safety of MI in open medical network environment is secured, in addition to telemedicine and telecare, then it becomes possible to construct the environment to support "Second opinion", which is to demand the opinion or judgment from plural doctors whether the diagnosis and the therapy are appropriate. Recently, development of digital watermarking techniques progress for the purpose of copyright protection of image and audio data. Because of the trade-off relation between watermark embedding intensity and quality of embedded data, maintenance of medical image quality becomes the most important problem, if we apply digital watermark to medical image aimed for the clinical use.

This thesis proposes a new hybrid digital watermark, on the basis of watermark embedding intensity depending on kinds of modalities and subjective image evaluation by doctors, which has high tolerance against image compression and cropping in open medical network environment, and also maintains medical image quality available to the clinical use such as disease observation.

Chapter 1 details MI's purposes, characteristics, classifications, and introduces an example of MI flows out from medical facilities, and raises problems about security of MI. Chapter 2 summarizes a trend of computerization / standardization of MI, cooperation among medical facilities and telemedicine by exchanging MI, and the current status of laws such as HIPAA (The Health Insurance Portability and Accountability Act) in U.S.A., the Law for the Protection of Computer-Processed Personal Data Held in Japan. Chapter 3 describes the current security problems and countermeasures from each viewpoint of medical staff and patient, and makes a comparison between digital watermark and data encryption / digital signature, and describes necessity of digital watermark. Chapter 4 shows the outlines of digital watermark, and summarizes its classification, technical problems, and application examples. Then, it describes two digital watermark principles of Bit-swapping method and DCT (Discrete Cosine Transform) method, and examines comparative experiments of both methods, and shows those characteristics of two methods. The deterioration of medical image by embedding digital watermark is evaluated with subjective evaluation by doctors, and objective evaluation by PSNR (Peak Signal to Noise Ratio) value. Chapter 5 suggests several assistant techniques for improvement of the detection rate, and compares among error corrections using the Hamming code and the BCH (Bose-Chandhuri-Hocquenghem) code, the majority correction method by multi-copied digital watermark, the scramble location method, and shows the effectiveness of these methods. In addition, it examines evaluation experiments of application of "range" in the DCT coefficient operation, and suggests the starting pattern to distinguish multi-copied digital watermark blocks, and shows its effectiveness. On the basis of results of Chapter 4 and 5, Chapter 6 proposes a new hybrid digital watermark for medical image, and discusses the optimum values of some parameters about embedding digital watermark, and shows its effectiveness by evaluation experiments.