Chapter 11

Digital Image Watermarking: Impact on Medical Imaging Applications in Telemedicine

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ABSTRACT

With the advent of telemedicine, Digital Rights Management of medical images has become a critical issue pertaining to security and privacy preservation in the medical industry. The technology of telemedicine makes patient diagnosis possible for physicians located at a remote site. This technology involves electronic transmission of medical images over the internet, thus raising the need for ensuring security and privacy of such information. Digital watermarking is a widely used technique for the authentication and protection of multimedia data such as images and video against various security and privacy threats. But such digital rights management practices as watermarking often lead to considerable distortion or information loss of the medical images. The medical images being highly sensitive and legally valuable assets of the medical industry, such information loss are often not tolerable. Most importantly, such information loss may lead to incorrect patient diagnosis or reduced accuracy of disease detection. In this chapter we investigate the impact of digital watermarking, and its effect on the accuracy of disease diagnosis, specifically diagnosis of malarial infection caused by Plasmodium vivax parasite. We have used a computer–aided, automatic diagnostic model for our work in this chapter. Our experimental results show that although general (lossy) digital watermarking reduces the diagnostic accuracy, it can be improved with the use of reversible (lossless) watermarking. In fact, the adverse effect(s) of watermarking on the diagnostic accuracy can be completely mitigated through the use of reversible watermarking.

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INTRODUCTION

Telemedicine (Stanberry, 2001) is the technology dealing with electronic transmission of medical images, from one location to another remote location, for the purpose of interpretation of those images by physicians, clinical experts, as well as medical researchers, at the remote location. Pathological patient imaging, radiological patient imaging and nuclear patient imaging, are some of the significant medical imaging techniques contributing to telemedicine. Over the past few decades, telemedicine has evolved from the need to improve the existing quality of health care services to patients. With the help of telemedicine, physicians are able to extend medical diagnostic help to patients in a remote location. This technique removes the required constraint of pathologist, physicians, or even surgeons, to be present at the same location as the patient for correct medical diagnosis and treatment. Telemedicine allows the patient images to be analyzed and interpreted at a remote location, and the test reports to be electronically sent back to the patient’s location.

In telemedicine, the medical images of a patient are often transmitted across the world, often over public communication infrastructure such as the internet, and thus such communications are often insecure. Due to regular transmission of medical images in large numbers, issues of security and privacy preservation have arisen in the medical industry. Thus, a major concern of the present day medical industry is to maintain the security and privacy of medical information (Eid, 1995). Therefore, with the advent of telemedicine, Digital Rights Management (DRM) of medical images has become a necessity in the present day medical industry.

DRM has been in wide use over the past couple of decades, for content protection and authentication of security sensitive medical data. One significant instance of DRM, often used to protect such security sensitive medical images, is Digital Watermarking. However, sometimes the acts of DRM, specifically watermarking, causes some information loss of the medical images. In most cases, medical images and their integrity are assets of high legal value for the patients as well as hospitals. Therefore, such medical information losses are ideally highly undesirable, many times due to legal causes.

An example from the medical industry will clearly demonstrate how distortions are induced into medical images, due to watermarking. Most hospitals today, maintain patient records in form of digital data. Patient records include results of clinical tests, as well as patients’ personal information such as medical history. In hospitals patients’ personal information or medical history, also known as Electronic Patient Records (EPRs) (Berger & Cepelewicz, 1996) are used by professionals such as doctors, clinical researchers and insurance companies. Many times, the EPRs are kept embedded in form of watermark, into medical images, for example ultrasonography, Computed Tomography (CT), and Magnetic Resonance Images (MRI). This causes some distortion of the medical images. Moreover, patient records change over time, and this phenomenon requires the embedded EPRs to be updated from time to time. Repeated extraction and embedding of EPRs, in order to update them, causes the distortion of the medical images to accumulate. Such cumulative distortion effects adversely affect the quality of the medical images, so that it becomes difficult to make the correct diagnosis.

Our goal in this chapter is to investigate the effects of DRM on sensitive medical information, specifically, the effects of digital watermarking on medical image interpretation and disease diagnosis. In this chapter we carry out a computer–aided, automated diagnosis of malarial infection from a set of patient blood smear images, and investigate the effects of digital watermarking on those images, in terms of diagnostic accuracy. In summary, we investigate the impact of digital watermarking, on automated diagnosis of malarial infection.