

Chapter 2

Robust Steganography in Non-QRS Regions of 2D ECG for Securing Patients' Confidential Information in E-Healthcare Paradigm

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ABSTRACT

The upsurge in the communication infrastructure and development in internet of things (IoT) has promoted e-healthcare services to provide remote assistance to homebound patients. It, however, increases the demand to protect the confidential information from intentional and unintentional access by unauthorized persons. This chapter is focused on steganography-based data hiding technique for ECG signal in which the selected ECG samples of non-QRS region are explored to embed the secret information. An embedding site selection (ESS) algorithm is designed to find the optimum embedding locations. The performance of the method is evaluated on the basis of statistical parameters and clinically supportive measures. The efficiency is measured in terms of embedding capacity and BER while key space measures its robustness. The implementation has been tested on standard MIT-BIH arrhythmia database of 2 mins and 5 mins duration and found that the proposed technique embarks the proficiency to securely hide the secret information at minimal distortion.

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INTRODUCTION

The advancement in communication technology has brought revolution in almost every sphere of life. It is so permeated into human lives that every job is a click away and the whole world is confined to a small city. In addition to numerous applications, modern telecommunication infrastructure significantly helped the medical industry to generate e-healthcare paradigm that delivers quality health care to the patients without the physical presence of medical experts. Some of the advantages of e-healthcare services include

- Improved medical assistance: patients' can seek advice from the world's specialised doctors at any geographical area via remote healthcare assistance.
- Fast medical access: In case of emergency services, patient's medical reports (physiological signals, medical images and other metadata) can be immediately sent to the doctor and appropriate actions can be taken without any delay.
- Convenient and cost effective: monitoring patients through tele-services reduce the traffic in hospitals to great extent and also cuts the transportation cost.

Along with the medical information, it is required to transmit patients' personal information and other details such as his medical history and pathological reports for the purpose of identification and early diagnosis. But transmitting this confidential information over the unsecured public network is a matter of concern as any illegitimate personnel can access and tamper it that may cause erroneous diagnosis. Therefore safety and security of patients' vital information are the prime concerns in tele-health services. Various methods are reported in the literature to conceal the confidential information such as cryptography, steganography, watermarking *etc.* (Subhedar & Mankar, 2014) but steganography being the economical way of hiding information is preferred in which the sensitive information is interleaved into less sensitive features of the host media without disturbing its features (Johnson & Jajodia, 1998). In case of medical media (medical images or physiological signals) also, it is highly preferred because of following advantages:

1. Any doctor can diagnose the stego-signal but only the authorised administrative personnel can extract the hidden secret information.
2. It provides data security.
3. It provides efficient memory utilization.
4. Storing different information of the patient in same file avoids mismatching of information.
5. Steganography restrains false claim of health insurance, as the patients' personal details are already embedded into his physiological signal or medical image.

The selection of host media depends upon the nature of ailment for which the patient seeks the doctor's opinion. For *e.g.* in case of orthopaedic ailments, medical images such as X-ray, Positron Emission Tomography (PET), Computed Tomography (CT) scans, *etc.* are essential for diagnosis while in case of neurological disorders, Electroencephalograph (EEG) signals are required. It is preferred that the host media should have sufficient redundancy to accommodate adequate amount of secret information without destroying its diagnosability features. The commonly used host media in e-healthcare services include Magnetic Resonance Imaging (MRI) (Dmour HA & Ani AA, 2016) CT scans (Nambaksh, Ahmadian & Zaidi, 2011), PET (Nambaksh, Ahmadian & Zaidi, 2011) images, EEG (Rubio, Alesanco & García,

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