Chapter 4 Classification and Compression of ECG Signal for Holter Device

Chandan Kumar Jha Indian Institute of Technology Patna, India

Maheshkumar H. Kolekar Indian Institute of Technology Patna, India

ABSTRACT

ECG signal processing for holter monitoring of heart patients is still exploratory. Many signal processing techniques have been evolved for classification and compression of ECG signal. Despite an increase in research in this area, many challenges remain in designing an efficient classification and compression algorithm for ECG signal. These challenges include classification accuracy, good compression ratio with acceptable diagnostic quality etc. This chapter addresses a classification and a compression algorithm based on discrete wavelet transform. Classification algorithm uses discrete wavelet transform based feature to classify abnormal heart beat from ECG signal. Support vector machine is used as a classifier to detect abnormal heartbeat. The compression algorithm utilizes discrete wavelet transform and run-length encoding as a compression tool. Proposed classification and compression algorithms can be employed in monitoring of cardiac patients using holter device.

INTRODUCTION

Heart muscles generate tiny electrical impulses which can be recorded by electrodes by placing it on patient's body surface. This recording is called electrocardiogram (ECG) which is a non-invasive clinical tool in the field of cardiology. It is widely used by cardiologists for diagnosis of heart diseases. ECG waveform of a normal cardiac cycle is depicted in Figure 1 which consist P-wave, QRS-complex and T-wave (Chen *et. al*, 2014). Depolarization of atrium produces P-wave. Depolarization of right atrium reflects first half of the P-wave while latter half of the P-wave indicates depolarization of left atrium. Q-wave, R-wave and S- wave are collectively known as QRS-complex.

DOI: 10.4018/978-1-5225-2829-6.ch004

Classification and Compression of ECG Signal for Holter Device

Figure 1. ECG waveform of normal cardiac cycle



It is generated by left and right ventricular depolarization. Ventricular re-polarization generates Twave. Cardiologists diagnose heart diseases on the basis of different features of ECG waveform which includes amplitudes of PQRST waves and time intervals between different segments. ECG signal is recorded for several hours in holter monitoring of cardiac patients.

Holter Monitor

In pathological ECG test, ECG is recorded for very short duration. For a cardiac patient, it is possible that abnormal heart rhythm may come and go. In general, cardiologist cannot detect abnormal behavior of heart by observing short duration of pathological ECG record. Therefore long time monitoring of cardiac patient is necessary. Holter monitor provides this facility to cardiologist using which observation of heart function is possible on long-term basis. It also helps the cardiologist to determine medicine is working properly or not on cardiac patients. Holter monitor is a battery operated, small device which is used to record ECG signal for 12 hours to 48 hours continuously during normal daily routine of a cardiac patient. Holter monitoring is also called ambulatory ECG monitoring.

Classification of Heartbeats

Classification of heartbeats plays a major role to detect abnormal heartbeat during monitoring of heart patients. Many heartbeat classification techniques have been developed based on its features. These features include morphological features (De Chazal *et. al*, 2004), segmentation based features (De Chazal *et. al*, 2004) and frequency domain features (Romero *et. al*, 2001, De Chazal *et. al*, 2004). The technique of classification of heartbeats started two decades before using artificial neural network as a classifier (Hu *et. al*, 1992). At present classifier such as support vector machine (SVM) (Osowski *et. al*, 2004), hidden Markov model (HMM) (Coast *et. al*, 1990, Kolekar *et. al* 2004), artificial neural network (Hu *et. al*, 1992, Hu et. al, 1997, Barro *et. al*, 1998), self organizing maps (Lagerholm *et. al*, 2000) are widely used for classification of ECG heartbeats. A classification technique based on discrete wavelet transform

16 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: www.igi-global.com/chapter/classification-and-compression-of-ecg-signal-forholter-device/188150

Related Content

Mobile Robot Path Planning Using Continuous Laser Scanning

Mykhailo Ivanov, Lars Lindner, Oleg Sergiyenko, Julio Cesar Rodríguez-Quiñonez, Wendy Flores-Fuentesand Moises Rivas-Lopez (2019). *Optoelectronics in Machine Vision-Based Theories and Applications (pp. 338-372).*

www.irma-international.org/chapter/mobile-robot-path-planning-using-continuous-laser-scanning/209840

Object-Based Video Analysis and Interpretation

Ying Luo, Jeng-Neng Hwangand Tzong-Der Wu (2004). *Multimedia Systems and Content-Based Image Retrieval (pp. 182-200).*

www.irma-international.org/chapter/object-based-video-analysis-interpretation/27059

A Multi-Stage Framework for Classification of Unconstrained Image Data From Mobile Phones

Shashank Mujumdar, Dror Porat, Nithya Rajamaniand L.V. Subramaniam (2018). *Computer Vision: Concepts, Methodologies, Tools, and Applications (pp. 2387-2401).* www.irma-international.org/chapter/a-multi-stage-framework-for-classification-of-unconstrained-image-data-from-mobilephones/197058

Feature Extraction Methods for Intrusion Detection Systems

Hai Thanh Nguyen, Katrin Frankeand Slobodan Petrovic (2013). *Image Processing: Concepts, Methodologies, Tools, and Applications (pp. 1064-1092).* www.irma-international.org/chapter/feature-extraction-methods-intrusion-detection/77588

A Semi-Supervised Metric Learning for Content-Based Image Retrieval

I. Daoudiand K. Idrissi (2011). International Journal of Computer Vision and Image Processing (pp. 53-63). www.irma-international.org/article/semi-supervised-metric-learning-content/59878