Chapter 3.2
ECG Diagnosis Using Decision Support Systems

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ABSTRACT

ECG is one of the most common signals used in medical practice due to its noninvasive nature and the information it contains. Several systems and various automated approaches have been developed that use computer technology to provide ECG diagnosis. These systems detect abnormalities and other features in the ECG signal and produce a decision which helps the physician when performing diagnosis. ECG decision support systems can serve as a diagnostic tool for specific cardiac anomalies such as myocardial ischaemia and arrhythmia.

ELECTROCARDIOGRAM

The electrocardiogram (ECG) is a clinical test that records the electrical activity of the heart. ECG is used to measure the rate and regularity of heartbeats as well as the size and position of the chambers, the effects of drugs or devices used to regulate the heart, and the presence of any damage to the heart. An ECG is useful in determining whether a person suffers from a heart disease. If a person has chest pain or palpitations, an ECG will determine if the heart is beating normally. If a person is under medications that affect the heart or if the patient is on a pacemaker, an ECG can provide information on the immediate effects of changes in activity or medication levels. An ECG may be included as part of a routine examination in patients over 40 years old.

ECG ANALYSIS

Automated ECG analysis consists of a series of procedures that can be utilized in order to produce useful clinical information to help the physician to reach a diagnosis concerning the pathophysiological condition of the patient's heart faster and safer. ECG analysis consists of four stages: (a) signal acquisition, (b) processing, (c) feature extraction, and (d) diagnosis. Signal acquisition should fulfill certain specifications concerning the sampling frequency (100Hz to 1 KHz), the resolution (number of bits for each sample, 6 to 16), and the sensitivity, which expresses the signal's amplitude range (usually 5 mV or 6 mV). The digital ECG signal is then processed and filtered to suppress noise and enhance the relevant ECG characteristics.

In the feature-extraction stage, all the relevant ECG characteristics are recognized and some of their features are computed. The extracted features vary from simple ones like the duration and amplitude to the more complex like slopes, intervals, frequencies, or other discriminating indices. These are used in the diagnosis stage since the values of certain features are indicators of the existence of an underlying disease. Apparently, the measurement accuracy (Acc) is vital at this stage, and computerized methods are used to address it efficiently.

The last stage in the ECG analysis is the diagnosis, where explicit medical knowledge is utilized. Collaboration with medical experts is necessary, and the individual characteristics of each patient complicate the decision-making task. Various automated approaches have been proposed. These systems detect the abnormalities in the ECG and some of them can also produce interpretations for the decisions made. ECG analysis can help diagnose specific cardiac anomalies such as myocardial ischaemia and arrhythmia.

MYOCARDIAL ISCHAEMIA DIAGNOSIS

Myocardial ischaemia is the condition in which oxygen deprivation to the heart muscle is accompanied by the inadequate removal of metabolites due to reduced blood flow or perfusion. This reduced blood supply to the myocardium causes alterations in the ECG signal, such as deviations in the ST segment and changes in the T wave (Goldman, 1982). The detection and assessment of those alterations in long-duration ECGs is a simple and noninvasive method to diagnose ischaemia. In Figure 1, some of the typical ECG features employed for the diagnosis of myocardial ischaemia are shown.

Myocardial-ischaemia diagnosis using the ECG signal can be described as a sequence of two tasks: ischaemic beat detection and ischaemic episode definition. The first is related to the classification of beats as normal or ischaemic. Several techniques have been proposed for ischaemic beat classification, which evaluate the ST-segment changes and the T-wave alterations using different methodological approaches. More specifically,

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