Application of wavelet analysis to the electrocardiogram

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The wavelet transform has emerged over recent years as a powerful time–frequency analysis and signal coding tool favoured for the interrogation of complex nonstationary signals. Its application to biosignal processing has been at the forefront of these developments where it has been found particularly useful in the study of these, often problematic, signals: none more so than the ECG. In this paper, the emerging role of the wavelet transform in the interrogation of the ECG is discussed in detail, where both the continuous and the discrete transform are considered in turn.

Muscular contraction is associated with electrical changes known as depolarization. The electrocardiogram (ECG) is a measure of this electrical activity associated with the heart. The ECG is measured at the body surface and results from electrical changes associated with activation first of the two small heart chambers, the atria, and then of the two larger heart chambers, the ventricles. The contraction of the atria manifests itself as the 'P' wave in the ECG and contraction of the ventricles produces the feature known as the 'QRS' complex. The subsequent return of the ventricular mass to a rest state–repolarization–produces the 'T' wave. Repolarization of the atria is, however, hidden within the dominant QRS complex. Analysis of the local morphology of the ECG signal and its time varying properties has produced a variety of clinical diagnostic tools. In this paper we review the application of the wavelet transform to the analysis of the ECG signal.

ECG signals are collected both over long periods of time and at high resolution. This creates substantial volumes of data for storage and transmission. Data compression seeks to reduce the number of bits of information required to store or transmit digitized ECG signals without significant loss of signal quality. Many schemes have been proposed for this task. These can be categorized as either direct methods or transform methods. Direct methods involve the compression performed directly on the ECG signal. Transform methods, as their name implies, operate by first transforming the ECG signal into another domain including Fourier, Walsh, Kahunen Loeve, discrete cosine transforms and more recently the wavelet transform. Some examples of original and compressed signals are shown.