ABSTRACT

This thesis deals with the development of several vector quantisation schemes for coding the electrocardiogram (ECG) at low bit rates while separately addressing the issues of computational complexity, storage complexity, and quality of reconstruction. Vector quantisation has been known to be an efficient compression scheme when a low bit rate is desirable, but conventional ways of applying vector quantisation to ECG data have not been very successful. The present work shows that without substantially increasing the coder complexity, it is indeed possible to achieve acceptable fidelity of reconstruction while attaining a high compression ratio.

In ECG, for the same subject, there exists a lot of similarity from beat to beat as well as sample to sample correlation. Unlike most of the techniques of ECG compression reported so far, which do not simultaneously exploit both the inter cycle and intra cycle redundancies present in the ECG signal, the techniques reported in this thesis exploit this particular nature of ECG. A novel QRS detection scheme is proposed for segmenting the ECG data. This technique uses the positive zero crossings of the average group delay of the windowed signal with the window position being varied over the length of the whole record. Multirate techniques or modeling is used on the segmented variable length ECG frames to generate vectors of constant length. These vectors are input to the vector quantiser.

In the first attempt to achieve constant length vectors, efficient multirate techniques are used to change the sampling rate of the variable length ECG frames. These vectors are input to the VQ coder. Two new fast VQ coders are proposed for ECG. The first coder is a constrained vector quantiser which uses a product structured codebook. The vector is broken down into sub vectors using discrete time wavelet transform. The wavelet coefficients at different scales are treated as separate entities and a product codebook is generated. This coder achieves significant reduction in computation compared to a codebook of ECG beats. The second fast coder belongs to the class of unconstrained VQ coders. It uses the mean and variance of the vectors simultaneously to eliminate the unlikely codewords before calculating the conventional mean square error. The efficiency of the search process is further enhanced.
by using the wavelet pyramid search algorithm This coder achieves complexity reduction without sacrificing the performance of the VQ.

In the other attempt to generate constant length vectors from the variable length ECG frames parametric modeling is used A new minimum phase pole zero model for ECG is proposed The global minimum in the ECG record is found and if it is less than zero the entire ECG data is modified by adding the absolute value of the minimum to all the samples The algorithm applies the discrete cosine transform on these modified ECG frames The transformed modified frames are subjected to Steiglitz McBride modeling Direct vector quantisation of the model coefficients is not suggested due to the large dynamic range of the coefficients and stability problems encountered by the model filter while quantising the model coefficients This problem is overcome by vector quantisation of the line spectral frequency (LSF) representation of the model coefficients The LSF vectors efficiently preserve all the clinical features in the ECG data By forming the LSF vectors satisfying the ordering property stability of the filter can always be ensured A new beat adaptive vector quantiser (BAVQ) scheme is proposed which is able to handle the abnormal ECG beats also very well The codebook of the BAVQ consists of a fixed number of immediately past quantised vectors This compression scheme has less storage complexity good quality of reconstruction and moderate computational complexity compared to conventional VQ.