Principal Component Analysis-Based Method for Reconstruction of Fragments of Corrupted or Lost Signal in Multilead Data Reflecting Electrical Heart Activity and Hemodynamics

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Multilead signals reflecting electrical activity of the heart and hemodynamics give comprehensive, but usually redundant representation of the processes. Therefore fragments of transient corruption or loss of data in one or more leads can be restored substituting them by the signals reconstructed using information carried by the other leads. Multivariate analysis methods, particularly Principal Component Analysis is successfully used for optimal representation of quasiperiodic biomedical signals as ECG or ICG. Concatenated arrays of particular fragments of all registered leads are used to represent processes during each heart beat. Every such array can be represented by finite sum of Principal Components (eigenvectors of covariation matrix formed from these concatenated arrays) multiplied by coefficients calculated for each particular cardiocycle. Principal Components calculated from enough long learning set can be used as universal basis functions too. Using such basis functions for fragments of corrupted or lost data in one lead it is possible to reconstruct the data if coefficients are calculated ignoring fragments of lost or corrupted data in concatenated cardiocycle array. Our elaborated method performs structural analysis of ECG to find fiducial time point of every cardiocycle (peak of R wave). Excerpts of samples around fiducial time point in all registered leads are concatenated to form one dimensional array representing cardiocycle. Universal basis functions (Principal Components) are calculated using the arrays formed from the part of recording free of corrupted or lost data. Coefficients of the basis functions for corrupted or lost data fragments are calculated ignoring data of corrupted or lost leads. Corrected data fragments are formed firstly substituting corrupted or lost fragments by interpolated baseline adding to it reconstructed data using basis functions in particular time points according previously detected fiducial points. Our investigations showed that not only the variation in shape of one of corrupted or lost leads of ECG, but also variation in shape of signals reflecting hemodynamics can be pretty good restored using other synchronically registered signals.