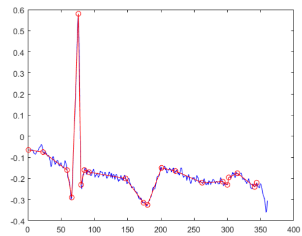
Adaptive ECG Sampling – A Minimum-Error Approach

Debelo Hinaw, Piotr Augustyniak

AGH University of Krakow
Krakow, Poland

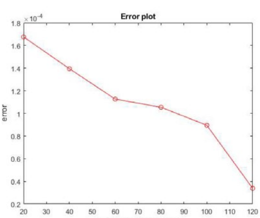
Adaptive sampling of the ECG, yet attractive as digital crowd reducing technique, involves a compromise of diagnostic quality and data size. Statistics-based approaches (i.e. compressed sampling [1]) are challenged by the noise and ECG model-based approaches poorly correspond to inter-individual variability. In this work we propose a data resampling method based on local minimization of reconstruction error able to flexibly assign a given data stream.



Non-uniformly distributed ECG samples

Our method works by establishing fixed number *N-1* of samples in target non-uniform representation. Extrema in the original signal are identified and sorted by descending amplitude. Then *N*/2 samples are assigned to extrema time points in the original ECG what results in *N*/2-1 non-uniform intervals between them. Next, the remaining *N*/2-1 samples are assigned one to each interval so as to minimize the distance collected in the interval between real data points and their linear interpolation The algorithm iterates through a loop 20 times, updating either even- or odd-indexed points based on minimum distances and handling edge cases effectively.

The proposed method was tested with MIT-BIH Arrhythmia Database (360 sps) and data streams were reduced from 120 to 20 sps. Our results show that with as few as 60 sps the error minimization procedure guarantees acceptable distortion level of 0.1%. The distortion level, however, besides unwanted alteration of medical finding also results from reduction of high frequency noise always present in real-life records.



Error depending on sample numbers

Our research also proves that non-uniform ECG sampling may efficiently adapt to the local features of the signal with no a priori model. The data stream can be then freely adjusted depending on medical content or occurrence of important cardiac events.

[1] Craven, D.; McGinley, B.; Kilmartin, L.; Glavin, M.; Jones, E. Adaptive Dictionary Reconstruction for Compressed Sensing of ECG Signals. IEEE J. Biomed. Health Inform. 2017, 21, 645–654.