Encoding the Electrocardiogram Details in the Host Record's Bandgap for Authorization-Dependent ECG Quality

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AIM AND NOVELTY

Storage of high frequency details of the ECG within the signal in a way that:

1. they are accessible only for authorized readers allowing them for a more precise analysis of the signal in a specified region of interest (e.g. VLP),
2. they are not visible and even detectable for regular users,
3. they allow regular users to interpret the signal as accurately as a raw ECG.

Previous methods proposed with similar aims are often referred to as "*steganography*" or "*watermarking*"

WHAT IS THE BANDGAP IN ECG ?

The **concept of a bandgap** results from the research on instantaneous bandwidth of cardiac components in the ECG related to the positions of P, QRS and T waves in the heart cycle. The usage of constant sampling frequency of a value appropriate for the QRS complex (lasting for ca. 15% of beat's length) leads to oversampling of cardiac components in large remaining parts of the ECG record.
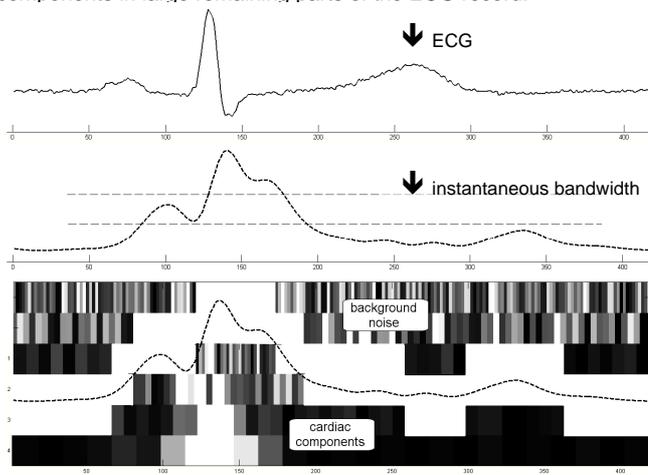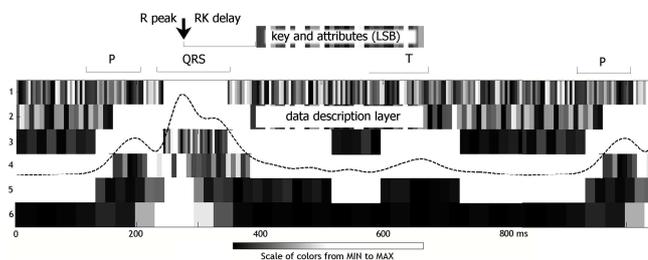

HOW TO USE THE BANDGAP AS DATA CONTAINER?

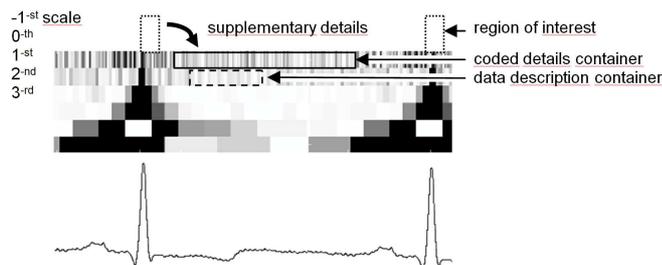The data itself are stored in the 1st scale of bandgap with specified bit depth
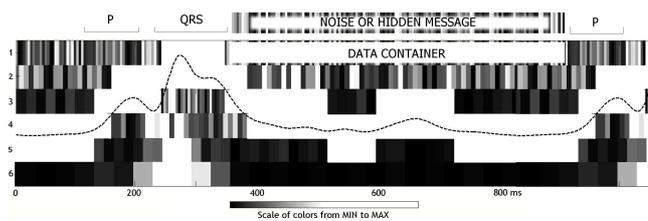
The data description is stored in the 2nd scale of bandgap with LSB method

## PROPOSED FORMAT FOR DETAILS DATA STORAGE

The supplementary details are acquired with signal oversampling and maintained in specified region of interest.

- the statistics of details data must mimic the statistics of 1st scale noise,
- the size of details data must not exceed the (variable) size of data container.

We applied the DCT to sort the detail t-f coefficients accordingly to decreased relevance, and then the thresholding technique to truncate the least relevant data.

BLOCK DIAGRAMS OF CODING AND DECODING PROCEDURES
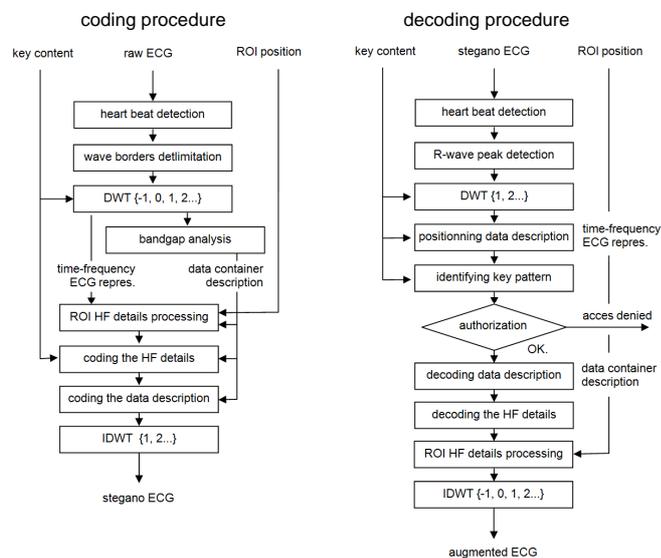
RESULTS AND COMMENTS

Average complementary details (D_{PRD}) and ECG signal (E_{PRD}) distortion values for coding depth ranging from 1 to 5 bits per sample.

coding depth [bits]	D_{PRD} ROI duration [ms]			E_{PRD} [%]
	10	25	50	
1 (0.5 µV)	0	0.41	1.16	0.03
2 (1.0 µV)	0	0.14	0.59	0.06
3 (2.0 µV)	0	0.05	0.28	0.13
4 (4.0 µV)	0	0	0.07	0.27
5 (8.0 µV)	0	0	0	0.51

- using **high bit depth**, we fail to mimic the statistic properties of the noise and causes distortions in the electrocardiogram (E_{PRD}).
- using **low bit depth** limits the size of hidden data container, thus the prioritized sequence of details has to be truncated accordingly causing detail signal distortions (D_{PRD}).