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Extended abstract

Machine learning approach for fetal QRS complexes detection

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Aims	The study presents a novel methodology for the detection of QRS events from four simultaneous noninvasive fetal ECG signals.
Methods	We have developed a three step procedure consisting of: A) transformation of ECG signals into a set of instances with 5 msec distance, so that each instance is defined by 93 features that describe characteristics of signals in the concrete time slot, B) evaluation of a multi-rule model on the set of instances so that a value in the range -200 to +200 is generated which is proportional to the probability that the instance is a fetal QRS event, C) transformation of a string of generated values into a string of QRS events taking into account that typical distance between fetal QRS is 250-600 msec. The central part of the approach is the preparation of the multi-rule model that consists of about 70,000 rules that vote either yes or no for fetal QRS [1]. Probability of fetal QRS is proportional to the difference between yes and no votes. The model is constructed by a machine learning approach from a set of 10,000 examples described by the same set of features. Positive examples are coming from time slots with known fetal QRS events, while negative examples are from time slots that are 50 msec far from the positive examples.
Results	For the Physionet Challenge in the year 2013 [2] the methodology enabled reasonable quality of QRS detection. For Task 4 the error in respect of the square of beats per minute has been 244.13 (best score 18.08) while for Task 5 mean squared error in milliseconds has been 11.72 (best score 4.34).
Conclusion	The achieved result demonstrates that the implemented approach is already able to recognize fetal QRS events with a reasonable quality, especially in respect of the precise position of the peaks. The further work is expected to result in an improvement of the quality of all three steps A-C. The main problem is very high time complexity of step b in which multi-rule model with many rules has to be evaluated on many instances.

Keywords: ECG signals • Fetal QRS • Random rules algorithm • Pattern recognition

Literature

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2. Physionet Challenge 2013: Noninvasive Fetal ECG (http://www.physionet.org/challenge/2013).