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# Real time QRS complex detection using DFA and regular grammar

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## Abstract

**Background:** The acquisition of QRS and ST-segment QRS complex detection is a crucial procedure in electrocardiogram (ECG) processing and analysis. We propose a novel algorithm for QRS complex detection based on the dynamic time warping (DTW) algorithm with the addition of some constraints. This paper considers that signals can be used for detecting QRS complex and separating normal ECG signals. A QRS is considered to be a pair of adjacent peaks which meet the four criteria of standard deviation and duration.

**Results:** The proposed method was applied on several trials of ECG signals received from the standard MIT-BIH arrhythmia database. A total of 40 signals were used. For an input signal, several parameters were determined such as QRS duration, RR distance, and the peak amplitude. RR and rPPG parameters were added to quantify the regularity of RR distance and QRS duration. Additionally, the sensitivity, specificity, and the specificity rates were 99.74%, and the specificity rate was 99.94%. Moreover, the sensitivity and the specificity rates according to the topographic maps were very promising.

**Conclusions:** Regular grammar with the addition of some constraints and additional rules summarizes a novel algorithm for ECG signal processing. Compared to traditional methods, the use of grammar provides satisfactory and competitive results and makes it more comparable to or more better than those used in the literature.

**Keywords:** ECG signal, QRS complex, RR distance, DFA, Regular grammar

## Background

The acquisition of QRS and ST-segment complex detection is one of the most frequently addressed tasks in ECG signal processing and analysis. A wide range of methods allowing high detection rates have been proposed and used [1–4]. Nevertheless, the problem remains open since the variety of ECG signals and the noise that might corrupt them. These methods include the Sugiura Vector Matching (SVM) [5–10], the fuzzy neural networks [11–14] and the wavelets [1, 17–24]. Saha et al. [15, 16] utilized the first-order derivatives of the Gaussian function as a window for the discrimination of ECG beats. The authors used the dyadic wavelet transform to detect and measure the different parts of a signal, especially the duration of the beginning and the end of the QRS complex. Subsequently, it showed the robustness of the algorithm in the presence of a high-frequency noise added to the signal. In [11, a dyadic wavelet transform was used to extract

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