A Unified Low Computational QRS Detection-Delineation Algorithm Designed for Implementation on PDA and Mobile Phones

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Due to existence of measurement noise, holter systems with different sampling frequencies, uncalibrated data, motion artifacts, appearance of arrhythmia and baseline wander, accuracy of the ECG signal event detection-delineation algorithm is reduced significantly. On the other hand if the computational burden of a QRS detection-delineation algorithm is high, the method will not be appropriate for some devices such as personal digital assistant (PDA) and mobile phones. This paper presents a noise robust algorithm to detect and delineate QRS complexes of holter ECG signal with affordable computational cost. To this end, after application of appropriate preprocessing stages, by using the average of slopes of lines drawn from a reference point in the mid location of a sliding window to other points in the window, the time-differentiation of signal was fulfilled. Numerous tests pointed out that the maximum values of the absolute signal derivative indicate presence of QRS complexes. Therefore, the location of maximum-slope samples can be called as R location. Afterwards, an interval was selected surrounding the R locations with enough duration for including certainly probable S and Q events. Next, a window was slid in this interval and the standard deviation (std) of signal in this window was calculated. A sequential ascending-descending behavior of the std trend in this window is an indicative of existence of Q and S locations. The presented algorithm was applied to 500,000 holter ECG beats (acquired and recorded by the medset Cardiolight holter system-sampling frequency 1000 Hz), and the following merits and capabilities were concluded: having the advantage of running on mobile phones (processing speed about 2000 samples/second for 123 MHz processor of an ordinary mobile phone), Se=99.26%, P+=99.87%, robustness against ambulation noise, capability of working with different sampling frequencies and high efficiency for working with uncalibrated data.