Evaluating Pauses in Holter ECG Signals

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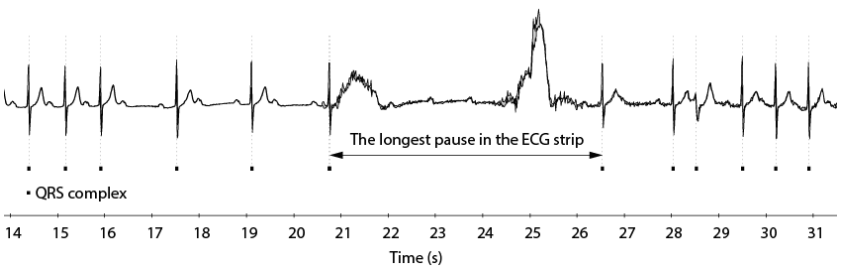
Background: Information related to pauses in heart activity is an important output of ECG holter monitoring reports. This information should be quickly assessed from interbeat (RR) intervals only (a naïve approach). However, evaluating pauses in holter ECGs recorded during usual daily activities can be more challenging. For example, when a standing patient becomes unconscious and falls due to a pause, the ECG will become noisy, but a real pause is also present. On the other hand, false pauses can be accidentally reported due to noise from movements or bad electrode contact, although there are not any.

Aim: In this paper, we propose a method to improve pause detection in heart activity from holter ECG recordings.

Method: We used 976 recordings (length 45 seconds, 1-lead ECG, sampled at 200 or 250 Hz) with a known longest RR interval (from 1.12 to 13.6 seconds, a mean duration 2.70 ± 1.11 seconds). QRS complexes were detected by a convolutional neural network with a recurrent layer. This study started with the automated removal of suspicious QRS complexes by a QRS amplitude. Then we iterated through RR intervals, seeking saturated areas, missed QRS, or a strong noise; potentially, examined RR intervals were further refined. The longest interval was reported for each recording.



Results: A mean difference between computed and expert values was 0.067 ± 0.234 and 0.047 ± 0.094 seconds for the naïve and the proposed approach, respectively. The ability to find severe pauses (equal to or longer than 4 seconds) showed an F1 score of 0.95 and 0.98 for naïve and the proposed method.

Conclusion: Our results showed that the proposed method improved pause detection in holter ECG recordings compared to the naïve approach.