Reviewer's report

Title: Characteristic Wave Detection in ECG Signal Using Morphological Transform

Version: 3 Date: 28 July 2005

Reviewer: Irena Jekova

Reviewer's report:

General

This is a revised version of the original manuscript. The authors have corrected the manuscript in response to the previous reviews. I believe this revised manuscript can be published as a paper if the authors take into account the minor essential revisions and editorial changes, which are listed below.

Major Compulsory Revisions (that the author must respond to before a decision on publication can be reached)

Minor Essential Revisions (such as missing labels on figures, or the wrong use of a term, which the author can be trusted to correct)

1. The authors should specify in the text of the manuscript that they have used only the 1st ECG leads of the selected databases for development and testing. This information is missing in the text, although it is included in the answers to the referees’ reports.

2. The authors should note that the claim ‘its left derivative is positive and its right derivative is negative’ is valid only for positive peak. Therefore, everywhere in the text they should specify that the discussed peak is positive (for example: page 4, 1st line from top ‘At a peak in ECG signal, its left derivative is positive and its right derivative is negative, therefore, peaks in the ECG signal correspond to the local minima …’ must become ‘At a positive peak in ECG signal, its left derivative is positive and its right derivative is negative, therefore, positive peaks in the ECG signal correspond to the local minima …’).

3. In section ‘Experimental results and discussions’ the authors declared, that they have used ‘MIT-BIH arrhythmia database’ and ‘QT database’. However, at the end of the same section they wrote: ‘Best detection performance is observed for MIT normal sinus rhythms database. The other records with poor detection performance are mostly from the European ST-T database and the Supraventricular database, in which, low signal-to-noise ratio or non-homogeneous repolarization exists.’ If they had used the European ST-T database and the MIT-BIH Supraventricular database, they must note that at the beginning of the section. Otherwise, they must correct the above listed sentence to correspond to the declared databases. Moreover, there is no ‘MIT normal sinus rhythms database’. I suppose that the authors had in mind the normal sinus rhythms from the MIT-BIH arrhythmia database, but this must be explained.

4. Editorial corrections:
- Everywhere ‘sample frequency’ to be substituted with ‘sampling frequency’
- 1st page, Abstract, Methods – ‘… where these points related to …’ to become ‘… where these points are related to …’
- 2nd page, Introduction, 12 row from the top – ‘… false positive and false negatives.’ to become ‘… false positive and false negative detections.’
- 3rd page, 1st row from the top – ‘different values’ to become ‘different signs’.
- 4th page, 10th row from the bottom – ‘The local minima with amplitude …’ to become ‘The local
minima with absolute amplitude …‘

- 4th page, 1st row from the bottom – ‘Same time interval as Q wave …‘ to become ‘Same time interval as for Q wave …‘
- 5th page, 4th row from the top – ‘For the preprocessing in step 1, it is performed as follows:’ to become ‘The preprocessing in step 1 is performed as follows:‘
- 5th page, 15th row from the bottom – ‘The width of QRS generally from 0.06s to 0.12s.’ to become ‘The width of QRS is generally from 0.06s to 0.12s.’
- 5th page, last paragraph – (i) ‘ThR was used for the detection of the local maxima and minima which corresponding to R peak; Thf was used for the detection of the local maxima and minima which corresponding to other characteristic waves.’ must become ‘ThR was used for the detection of the local minima, which corresponds to R peak; Thf was used for the detection of the local minima, which corresponds to other characteristic waves.’ and (ii) the sentence ‘The determination of ThR and Thf assumed a tri-modal histogram from which the two valleys gave rise to the values of ThR and Thf.’ must be clarified.
- 6th page, 8th row from the bottom – ‘at different scales’ should be deleted, since on page 5, the 13th row from the bottom the authors declared that ‘No calculation was performed at other scales since MMD operation does not cause drift of singular points across different scales.’
- 6th page, 7th row from the bottom – the comma after ‘where’ should be deleted; 6th row from the bottom – ‘ventricular contraction (PVC)’ must become ‘ventricular contraction (PVC)’; 4th row from the bottom – ‘beat selected from MIT-BIH’ is duplicated and this must be corrected; 3rd row from the bottom – ‘MMD transformed signal points marked’ to become ‘MMD transformed signal with marked points’
- 7th page, 2nd row from the top – ‘in spite’ is duplicated and this should be corrected; 3rd row from the top – ‘no preceding premature’ is also duplicated and this also should be corrected. Since there are a lot of corrections in the first paragraph, I propose the whole paragraph ‘As shown in Figure 1, the characteristic waves in normal beat are observed to be well detected. For LBBB, in spite of in spite of the appearance of a sub-R peak, the boundaries of all waves are still well detected. In APC or PVC, no preceding premature no preceding premature P wave appears. In addition, the position of the left ‘^’ is overlapped with the ‘*’. That is, the onset of the preceding T wave is merged with the QRS complex. The position of the right ‘^’ is also overlapped with the ‘*’. So that the Q wave is judged to be missing. In PVC, by the MMD detector, negative peak was detected. to be inverted.’ must be rewritten and clarified. After that the paragraph continues with: ‘Figure 2 gives more results of characteristic wave detection in ECG signal series. It is obvious that all three characteristic waves (the QRS complex, the P wave, the T wave) in ECG time series with normal beats, APCs, and LBBB beats, are detected reliably. Even the onsets and onsets of inverted T waves in PVCs can be detected reliably.’
- 7th page, 3rd row from the bottom – ‘in ECG analysis’ to become ‘during ECG analysis’
- 8th page, second paragraph ‘The statistical results of m, _, and Se, for ECG fiducial characteristic wave detection by the proposed MMD technique are obtained by the threshold-based detector (TD) in [22] and the wavelet-based detector (WD) in [23], as shown in Table 1.’ to be changed to ‘The statistical results for m, _, and Se, for ECG fiducial points and characteristic waves detection by the proposed MMD technique are compared with the threshold-based detector (TD) [22] and the wavelet-based detector (WD) [23], as shown in Table 1.’
- 8th page, 11th row from the bottom – ‘That is to say’ to be deleted. I recommend ‘P wave onset’
and ‘P wave offset’ to be used instead of ‘P onset’ and ‘P offset’
- 9th page, 2nd line from the top – ‘(from the Q wave to the offset of the T wave)’, please specify
onset or offset of Q wave.

It is obvious that the editorial changes are too much and I am not in a position to point out all of
them, so I strongly recommend the authors to look through the entire manuscript and to check for
other mistakes.

Discretionary Revisions (which the author can choose to ignore)

What next?: Accept after minor essential revisions

Level of interest: An article whose findings are important to those with closely related research
interests

Quality of written English: Needs some language corrections before being published

Statistical review: No

Declaration of competing interests:

I declare that I have no competing interests.