Abdominal signal processing: noise sensitivity evaluation of two algorithms for fetal QRS detection

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AIM: improvement of the fetal monitoring;
PROBLEM: signal of interest (fetal electrocardiogram, fECG) with low power and disturbed by high power interference sources;
SOLUTION: preprocessing the abdominal recorded signals (ADS) by cancelling the maternal electrocardiogram, mECG, before computing the fetal heart rate (fHR).

INTRODUCTION

fHR is an important instrument in fetal monitoring because it supports the medical decisions when evaluating the health state of the fetus. Moreover, fHR variability (fHRV) represents an useful index for evaluating the function of the autonomic nervous system (ANS) [1], and for identifying the hypoxic exposure of the fetus.

METHODS

A. Algorithm based on first and second derivative [2]

\[ y_0(n) = \text{ABS}(x(n+1) - x(n-1)) \]  
\[ y_1(n) = \frac{[y_0(n-1) + 2y_0(n) + y_0(n+1)]}{4} \]  
\[ y_2(n) = \text{ABS}(x(n+2) - 2x(n) + x(n-2)) \]  
\[ y_3(n) = y_1(n) + y_2(n) \]  
\[ T_{th1} = 0.8 \times \text{max}[y_3]; \quad T_{th2} = 0.1 \times \text{max}[y_3] \]  

B. Algorithm based on digital filtering [3]

\[ y_0(n) = \frac{x(n-1) + 2x(n) + x(n+1)}{4} \]  
\[ y_1(n) = \frac{1}{2m+1} \sum_{k=i-m}^{i+m} y_0(k) \]  

RESULTS

Table 1. Evaluation of the proposed algorithms based on false positive rate, Fp/ false negative rate, Fn/ true positive rate, Tp.

<table>
<thead>
<tr>
<th>SNR (dB)</th>
<th>-20</th>
<th>-15</th>
<th>-5</th>
</tr>
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<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
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<td>B</td>
<td></td>
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CONCLUSIONS

Both algorithms show a very poor ability to discriminate between QRS and noise when the noise level is high. The second algorithm, B has a better overall performance than the A algorithm.

REFERENCES


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