Comparative Study of Noise Suppression in ECG Signal by using different FIR Digital Filter

Anil Mourya, Arvind Ambey, R. P. Narwaria
Department of Electronics, Madhav Institute of Technology and Science Gwalior, India
anil.mourya123@gmail.com,
arvindambey555@gmail.com

Abstract: This paper deals with the application of the FIR digital filter on the ECG signal. In this paper different FIR filters are utilized. In this paper using ECG Arrhythmia data set from MIT-BIH database.

Keywords— Sample Text, Arrhythmia ECG data signal, FDA tool, different FIR filter.

1. INTRODUCTION
Electrocardiogram (ECG) is a diagnosis signal that reported the electrical activity of heart recorded by skin electrode. The morphology and heart rate reflects the cardiac health of human heart beat. It is a non-invasive technique that means this signal is measured on the surface of human body, which is used to analysis of the heart diseases. Any change of heart rate or rhythm, or change in the morphological pattern, is an indication of cardiac arrhythmia, which could be detected by analysis of the recorded ECG waveform. The amplitude and duration of the P-QRS-T wave contains useful information about the nature of disease afflicting the heart.

2. DIGITAL FIR FILTER
Power line interference is one of the most important reasons of disturbance of the ECG signal. Mostly it causes the 50 Hz interference and there higher order harmonics included to the ECG signal. This section deals with the design and implementation of the FIR digital filter on to the ECG data. The results are presented using the frequency spectrum of the ECG signal before and after filtration of the signal and compare there some parameters.

3. DESIGN OF THE FIR LOW PASS FILTER
In this design the minimum order of the filter is selected and other parameters are taken with the help of reference paper.
Sampling frequency = 360 Hz
Pass band frequency = 54 Hz
Stop band frequency = 60 Hz
Pass band attenuation = 1dB
Stop band attenuation = 80 dB
Density factor = 20.
The response is shown below in figures 1 to 6.[3][10].
4. RESULT OF IMPLEMENTATION OF THE TYPES OF FIR FILTER

In the types of filters, we are taking same value of the pass band frequency, stop band frequency, pass band attenuation, stop attenuation and minimum order.

Table 1
Before filtering the arrhythmia signal following quantities are below:-

<table>
<thead>
<tr>
<th></th>
<th>mean</th>
<th>Standard deviation</th>
<th>Variance</th>
<th>Signal to noise ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrhythmia signal(222txt)</td>
<td>0.1367</td>
<td>7.9796</td>
<td>63.6745</td>
<td>3.01713</td>
</tr>
</tbody>
</table>

Table 2
After adding noise in the arrhythmia signal and effect of noise on signal it which change the following quantities:-

<table>
<thead>
<tr>
<th></th>
<th>mean</th>
<th>Standard deviation</th>
<th>Variance</th>
<th>SNR</th>
</tr>
</thead>
<tbody>
<tr>
<td>After adding noise</td>
<td>0.3067</td>
<td>20.4082</td>
<td>416.4951</td>
<td>8.1549</td>
</tr>
</tbody>
</table>

Table 3
Denoising with the help of types filters:-

<table>
<thead>
<tr>
<th>Filter Type</th>
<th>0.0243</th>
<th>12.959</th>
<th>167.932</th>
<th>3.947</th>
</tr>
</thead>
<tbody>
<tr>
<td>Least squares Filter</td>
<td>0.0183</td>
<td>12.981</td>
<td>168.521</td>
<td>3.932</td>
</tr>
<tr>
<td>Maximally Flate Filter</td>
<td>0.1571</td>
<td>13.296</td>
<td>176.780</td>
<td>3.724</td>
</tr>
</tbody>
</table>

Table 4
When Signal passes through the Windows filters:-

<table>
<thead>
<tr>
<th>Filter Type</th>
<th>0.0597</th>
<th>12.151</th>
<th>147.644</th>
<th>4.507</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bartlett Window</td>
<td>0.0096</td>
<td>12.157</td>
<td>147.785</td>
<td>4.503</td>
</tr>
<tr>
<td>Blackman Window</td>
<td>0.0015</td>
<td>12.077</td>
<td>145.848</td>
<td>4.560</td>
</tr>
<tr>
<td>Hamming Window</td>
<td>0.0820</td>
<td>11.946</td>
<td>142.720</td>
<td>4.654</td>
</tr>
<tr>
<td>Hann Window</td>
<td>0.0189</td>
<td>13.783</td>
<td>189.969</td>
<td>3.412</td>
</tr>
<tr>
<td>Kaiser Window</td>
<td>0.0202</td>
<td>13.927</td>
<td>193.958</td>
<td>3.321</td>
</tr>
<tr>
<td>Rectangular Window</td>
<td>0.1928</td>
<td>12.125</td>
<td>147.016</td>
<td>4.526</td>
</tr>
<tr>
<td>Chevysheve Filter</td>
<td>0.3989</td>
<td>12.077</td>
<td>147.105</td>
<td>4.523</td>
</tr>
</tbody>
</table>

5. CONCLUSION

We have seen that table-1, table-2, table-3 and table-4 shows that noise has been reduced when ECG signal is filtered using FIR filter and results have been concluded by using different types of filters. Table 1 shows the different parameter before filtering like mean, standard deviation, variance & SNR. Table2 shows the same parameter when the noise is added in the signal, Table-3 & Table-4 shows the results after being filtered using different types of filters and we have seen that this signal is modified after filtering process. With the help of these tables we can categorize the signal in a ways like mean, variance, and standard deviation and signal to noise ratio.

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