

Computer Project # 1

Programming Approach

My initial response was to use the transfer functions provided in the references ¹ and implement the Pan-Tompkins algorithm using MATLAB's transfer equation functions. I defined a series of functions whose independent variable was z and then I simulated the results and passed each simulation from one step of the algorithm successively into the next step like so:

INPUT \rightarrow LPF \rightarrow HPF \rightarrow Derivative \rightarrow Squaring \rightarrow Moving Average \rightarrow **OUTPUT**

While this approach to the programming seemed to work in theory, the results were not acceptable. Below, figure 1 illustrates the results from the symbolic approach for record 112.

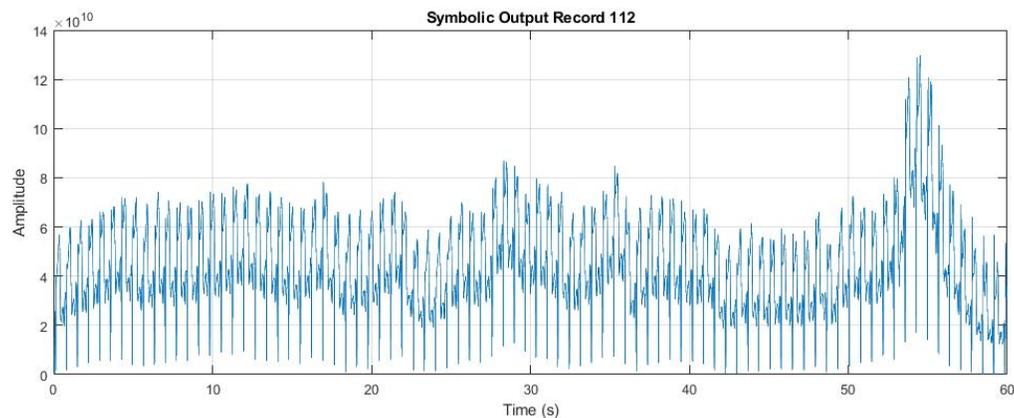


Figure 1: Symbolic approach output.

Ultimately the peaks were not clear enough, figure 1, and I decided to use the difference equations in another paper ² provided as part of the assignment. This approach would not simulate the filter symbolically but would use the difference equations iteratively for $1 \leq n \leq \text{Sample size}$. The results for all signal samples were improved with this approach and the ultimate results are shown to the right in figure 2.

As we can see, the peaks are more apparent to us and stand apart from the signal noise, indicating that the filtering process are working more effectively. Unfortunately the system is not removing the noise shown below the peaks. Please see the code provided for all functions and main files. Individual filter outputs show in the next section.

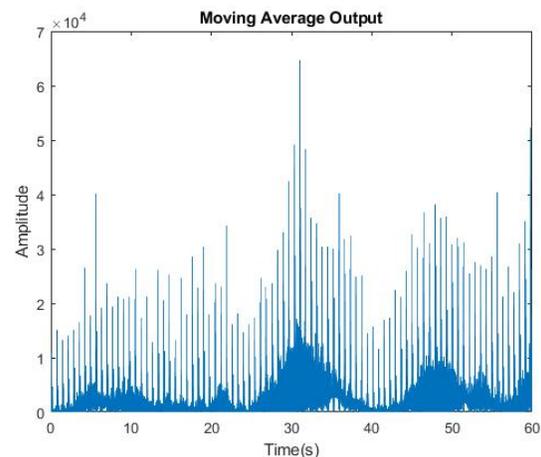


Figure 2: Iterative approach output.

¹<https://tinyurl.com/y8kvs8wc>

²<https://tinyurl.com/yddx59c7>

Individual Filter Outputs

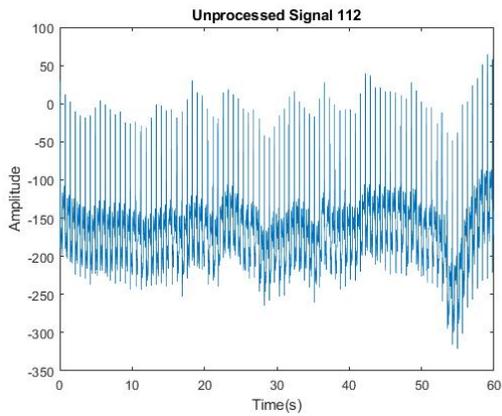


Figure 3: Original signal input.

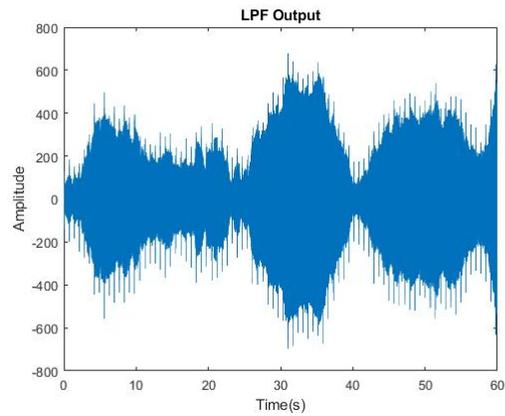


Figure 4: Low-pass filter output.

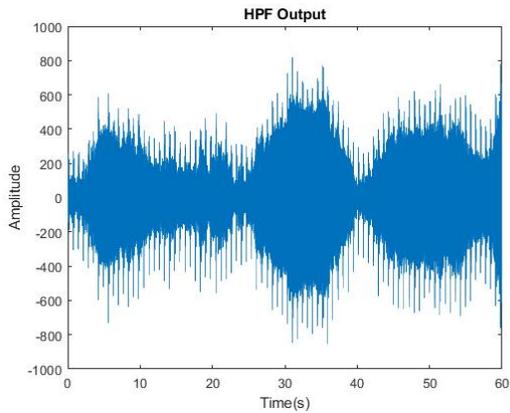


Figure 5: High-pass filter output.

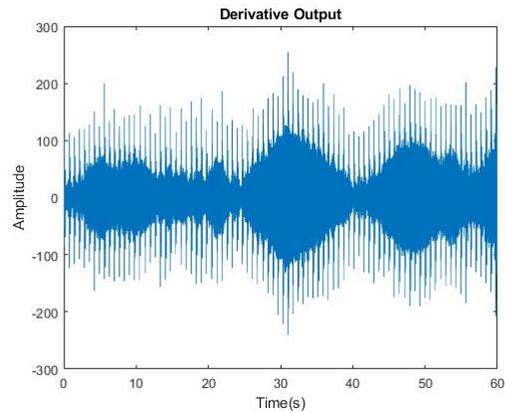


Figure 6: Derivative output.

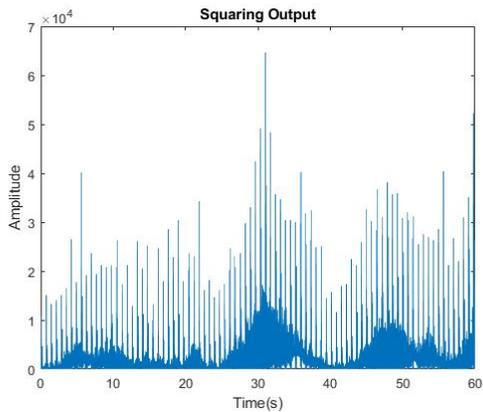


Figure 7: Squaring output.

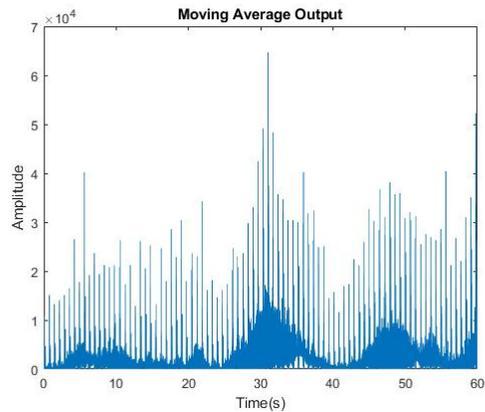


Figure 8: Moving average output.

Conclusion

To be honest, I was a little disappointed with my results, I was expecting to see simple straight lines for each heart beat like a Dirac-delta but instead it looks as if the moving average was not working. I was using the MATLAB included function *movmean* with a window size of 30 as the research papers had recommended for the digital signal sampling.

Perhaps more surprising was the fact that the original approach of using the symbolic logic was not effective in processing the signal. I had anticipated this approach to so pure and exact but in reality it was flawed.