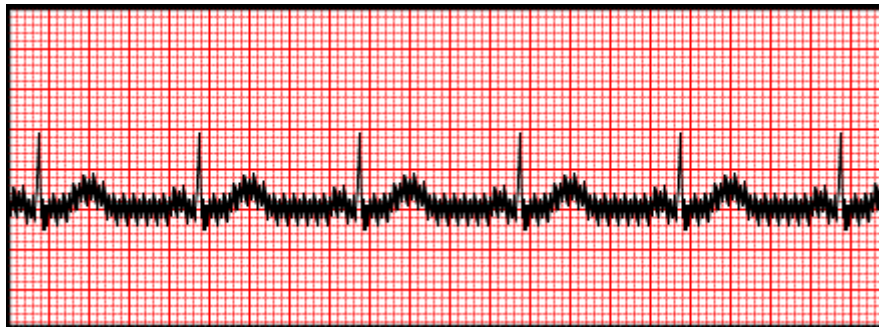


Data Acquisition and Digital Filtering of Biomedical Signals

In the previous Lab Experiment, simulation for an ECG signal with AC interference was considered with result as shown below. Such interference can be removed using proper signal filtering that removes the frequency range of the interference while allowing original signal frequencies to pass without much change. In the previous Lab Experiment, this was considered using analog filters. In this experiment, we consider the application of digital filters for this purpose.



Design, conduct and analyze results of experiments to do the following:

- (A) Acquire the digital version of sample analog biomedical signal (e.g., ECG) using digital storage oscilloscope and determine the sampling rate and quantization level used.
- (B) Acquire the digital version of sample analog biomedical signals (e.g., ECG) using Biopac system and determine the sampling rate and quantization level used.
- (C) Change the sampling rate and quantization level of both of the above signals on the computer using Matlab and determine appropriate rate/level for both to preserve the signal and Compare the above two methods of data acquisition.
- (D) Repeat Lab Experiment #4 using digital filters to clean up the noisy ECG signal shown above using properly designed digital filters.

General Requirements

- 1. Experimental Design procedure including all requirements of Assessment Rubrics must be ready and approved by Lab Engineer before conducting any experiment.
- 2. All students must Conduct the experiment and document it according to the requirements of Assessment Rubrics and approved by Lab Engineer after conducting any experiment.
- 3. You are free to select any components you prefer for your experiments.
- 4. You should be prepared to demonstrate your experimental setup and answer questions in all aspects related to your experiment.
- 5. You should work in groups of 2 students each. One report addressing all parts of Assessment Rubrics should be submitted on behalf of the whole group.

6. You may use any resources you find useful to your experiment as long as you acknowledge such use in your report in accordance to ethical guidelines.

Assessment Rubrics

KPI's	Exemplary 3	Satisfactory 2	Developing 1	Unsatisfactory 0
Designs a reliable and relevant experiment	Objectives are identified and measurable. Covers relevant Background/Theory with exhaustive references. Work Plans are meticulously developed step by step. Identifies Variables and selects appropriate Tools . Lists and explains all pertinent Safety/Environmental/Ethical issues .	Objectives are identified and measurable. Covers relevant Background/Theory with sufficient references. Work Plans are meticulously developed step by step. Identifies Variables and selects appropriate Tools . Just lists all pertinent Safety/ Environmental/	Objectives are identified but contains technical and conceptual error. Work Plans are developed with no distinct steps. Not all Variables/Tools are appropriately selected. List some of the pertinent Safety/Environmental/	Objectives are not identified. Work Plans are not developed step by step. Selects inappropriate Tools . Fails to list any pertinent Safety/ Environmental/ Ethical issues .
Conducts the experiment	Experimental Set-up is always neat and accurate. Always records complete data, identifies possible sources of error. Measurements are always accurate with symbols, units and significant digits. Collects data always in a meaningful way. Always demonstrates reproducibility and good knowledge of lab procedures.	Experimental Set-up is mostly neat and accurate. Mostly records complete data, identifies possible sources of error. Measurements are mostly accurate with symbols, units and significant digits. Collects data mostly in a meaningful way. Mostly demonstrates reproducibility and good knowledge of lab procedures.	Experimental Set-up is workable with minor help. Records incomplete data e.g., sampling (number of data points) is just sufficient, understands possible sources of error with minor help. Measurements are less accurate with some errors in symbols, units and significant digits. Collects data that are sometimes difficult to handle and understand. Lacks reproducibility in results and demonstrates some	Experimental Set-up is mostly untidy and inaccurate. Rarely records and collects data in a meaningful way. Measurements are inaccurate and often without symbols, units and significant digits. Does not demonstrate reproducibility as well as required knowledge of lab procedures.
Analyzes and interprets data	Comprehensively understands the data in terms of variables (dependent/independent), assumptions, deviations and experimental uncertainties etc. Organizes the data in figures and tables using modern software tools extensively for analysis. Discusses/compares his/her results in the light of obtained results/theoretical models of similar studies from other sources extensively. Concludes rationally based on experimentation and clear reasoning.	Sufficiently understands the data in terms of variables (dependent/independent), assumptions, deviations and experimental uncertainties etc. Organizes the data in figures and tables using modern software tools sufficiently for analysis. Discusses/compares his/her results in the light of obtained results/theoretical models of similar studies from other sources sufficiently. Concludes rationally based on experimentation and fair reasoning.	Fairly understands the data in terms of variables (dependent/independent), assumptions, deviations and experimental uncertainties etc. Organizes the data in figures and tables using modern software tools fairly for analysis. Discusses/compares his/her results in the light of obtained results/theoretical models of similar studies from other sources fairly. Concludes based on his/her experimentation and acceptable reasoning.	Poorly understands the data in terms of variables (dependent/independent), assumptions, deviations and experimental uncertainties. Fails to Organize the data in figures and tables using modern software tools. Fails to Discuss/compare his/her results in the light of obtained results/theoretical models of similar studies from other sources. Fails to conclude rationally based on experimentation and acceptable reasoning.

References

- http://www.mauvila.com/ECG/ecg_artifact.htm
- <http://www.medteq.info/med/ECGFilters>