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BIOMECHANICS & BIOENGINEERING

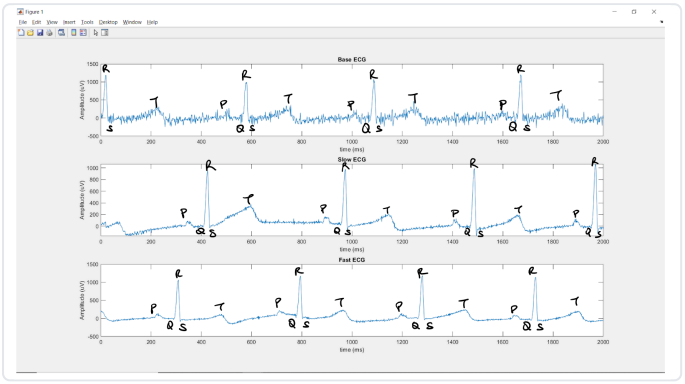
Physiological Control and ECG Analysis

University of Toronto, BME331 (Physiological Control Systems) · Group project

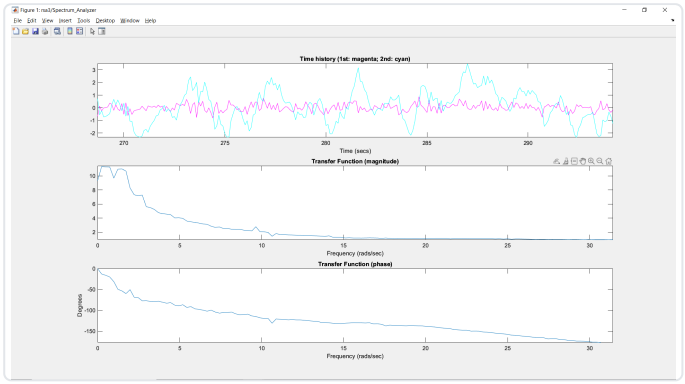
Modeling and signal analysis

A Simulink model of how breathing drives heart rate, validated against real ECG recordings.

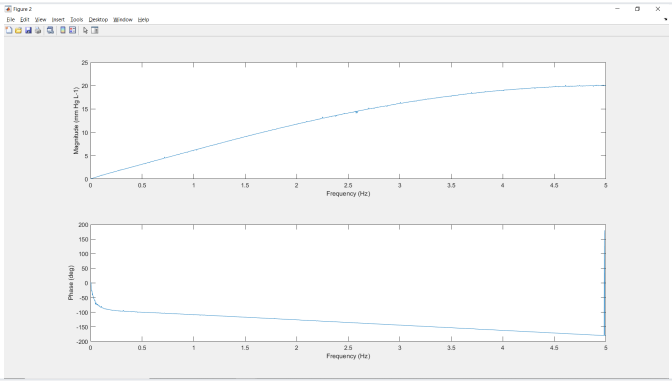
This lab modeled respiratory sinus arrhythmia, the effect of breathing on heart rate and arterial blood pressure, in Simulink, then cross-checked it against recorded ECG signals. The signal analysis computed resting heart rate and variability, reconstructed a lead using Einthoven's law, and estimated the heart's mean electrical axis.



ECGs at rest and under slow and fast breathing, annotated for the P-Q-R-S-T complex.



Frequency response of the respiratory-sinus-arrhythmia model.



Arterial blood-pressure frequency response.

Model

A Simulink model driven by a chirp breathing input produces heart-rate and blood-pressure responses, analyzed in the frequency domain and run separately for parasympathetic and sympathetic modulation.

ECG analysis

Recorded ECGs at rest and under slow and fast breathing were annotated for the P-Q-R-S-T complex, with heart-rate variability quantified, lead II reconstructed from leads I and III within about 22 microvolts, and the mean electrical axis estimated from Einthoven's triangle.

SELECTED REFERENCES

- "Modelling Heart Rate Variability Due to Respiration and Baroreflex," Springer.
- "Central regulation of heart rate and the appearance of respiratory sinus arrhythmia," ScienceDirect, 2014.

Engineering portfolio brief. Course and team project; contribution as noted above.