DALHOUSIE UNIVERSITY
FACULTY OF ENGINEERING

GROUP 15

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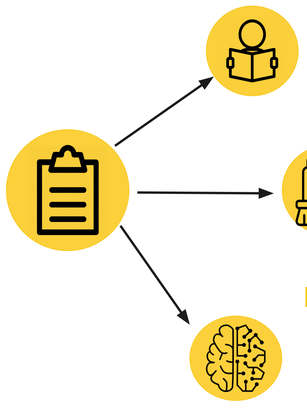
Signal Quality Improvement in Oscillometry/ML Methods for Disease Classification

Scope of Work

- Oscillometry (OS), also known as the forced oscillation technique, assesses respiratory system resistance (Rrs) and reactance (Xrs) during normal breathing.
- While easy to perform and sensitive to changes in lung function it can be more variable.
- Current recommendations limit variability as measured by coefficient of variation to < 10% or 15% in some populations such as preschoolers.
- Currently, physician performing tests are required to manually filter the results until an adequate CV is met. This process is time consuming and in cases does not fully minimize the variability of the results.
- Here, we explored different automated quality control approaches to reducing variability. Once an effective approach is met, we look to implement machine learning techniques to classify the patients test results to achive in a more acurate and faster diagnoses.

Project Planning



Phase 1

Collect and interpret wide range of oscillometry data

Phase 2

Implement and test algorithms to reduce variation in oscillometry testing

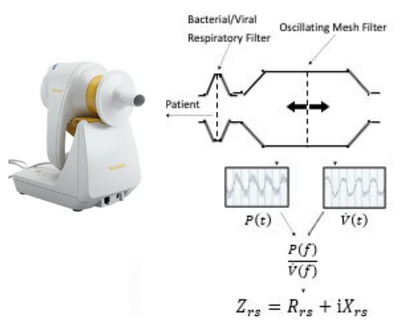
Phase 3

Explore machine learning techniques for reporting patient status

Details of Design

Stage 1: Data Collection

- Oscillometry is a technique used in measuring the impedance (Zrs) of the lungs. Impedance is determined by the quotient of pressure and flow (Z = P/V). The real part of the impedance is the resistance of the lungs (Rrs), while the imaginary part is the reactance of the lungs (Xrs).
- OS involves superimposing an oscillatory waveform over the patient's normal tidal breathing, no forced expiratory phase necessary.



Stage 2: Data Cleaning

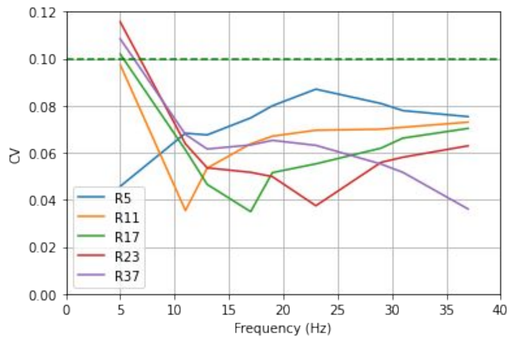
- Currently, the user must manually select the breathing signals that will be analyzed for the patient. We are developing code to automatically select the best signals, based on the coefficient of variation (CV) between the data. Cleaner datasets will allow us to develop a much more reliable machine learning algorithm in our project's next step.

Stage 3: Machine Learning Methods

- Once we've decided that the data cleaning code is working to its full potential, we will begin planning our machine learning approach in detail by mapping out possible useful classes as well as performing preliminary testing on smaller datasets.
- Our plan is to explore machine learning algorithms much more deeply in the Summer and Fall, we're hoping to have enough datasets available to us to build a reliable algorithm for reporting patient status.

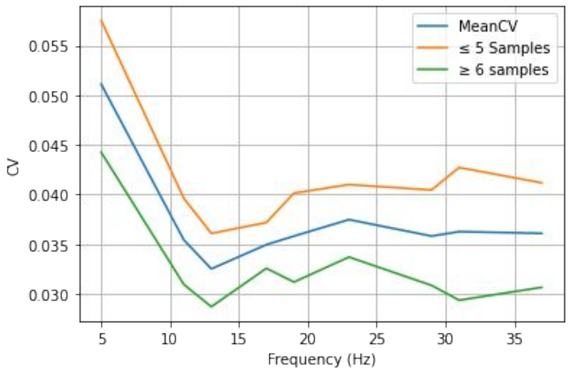
Testing and Analysis

CV of Multiple Resistances vs Frequency



CV of Multiple Resistances vs Frequency: Initial CV analysis indicates low variation at small frequencies for resistance at both 5Hz and 11Hz. Combining measurements at 5Hz & 11Hz may provide a low CV at frequencies most important to lung function analysis.

CV of Varying sample Size vs Frequency



CV of Varying sample Size vs Frequency: Although CV is mostly dependent on frequency, the amount of measurements available can heavily influence variation in data

Standardization

- Working to develop an industry standard that's comparable to the existing Spirometric measurements.
- Standardizing data analysis techniques requires reliable data sets.
- Minimizing CV for past data sets as well as future testing will help validate Oscillometric testing

Future Work

- Machine learning algorithms will be developed in the coming term as well as further improvements with respect to minimizing CV. Multiple datasets will be useful early on to indicate problems with our learning algorithms and classification techniques, then progressively larger datasets will be used to train and test the network to increase its accuracy.

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