Mechanical Engineering Master's Defense

Pressure Based Spirometry: Mobile Spirometry Using a Pressure Transducer

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abstract

Spirometry is a type of pulmonary function test that measures the amount of air volume and the speed of air flow from a patient's breath in order to assess lung function. The goal of this project is to develop and validate a mobile spirometer technology based on a differential pressure sensor. The findings are used in a larger project that combines the features of a capnography device and a spirometer into a single mobile health unit known as the capno-spirometer. This defense will discuss the methods, experiments, and prototypes that were developed and tested in order to create a robust and accurate technology for all of the spirometry functions within the capno-spirometer. The differential pressure sensor is set up with one inlet measuring the pressure inside the spirometer tubing and the other inlet measuring the ambient pressure of the environment. The inlet measuring the inside of the tubing is very sensitive to its orientation and position with respect to the path of the air flow. It is found that taking a measurement from the center of the flow is 50% better than from the side wall. The sensor inlet is optimized at 37 mm from the mouthpiece inlet. The unit is calibrated by relating the maximum pressure sensor voltage signal to the peak expiratory flow rate (PEF) taken during a series of spirometry tests. In conclusion, this relationship is best represented as a quadratic function and a calibration equation is computed to provide a flow rate given a voltage change. The flow rates are used to calculate the four main spirometry parameters: PEF, FVC, FEV1, and FER. These methods are then referenced with the results from a commercial spirometer for validation. After validation, the pressure-based spirometry technology is proven to be both robust and accurate.

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