CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
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Project Number
35729

Project Title
A Wireless Smartphone-Based System for Diagnosis of Pulmonary Illnesses

Abstract

Objectives/Goals
The prevalence of respiratory illnesses such as Asthma and COPD has been growing rapidly across the world, with more than 900 million currently afflicted. The spirometry equipment used in hospitals for pulmonary function testing costs thousands of dollars, which is beyond the means of health care facilities in many countries. In this project, my objective is to design a low-cost smartphone-based pulmonary function analyzer that can be used to measure lung function and diagnose various respiratory illnesses without the assistance of a trained healthcare professional.

Methods/Materials
My system consists of three parts: (i) the spirometer shell, (ii) the pressure sensor and electronics, and (iii) the software application. The mechanical part of my system consists of a 3D-printed spirometer shell. The instantaneous flow rate during breathing is measured by a pressure sensor as air passes through a fine stainless steel wire mesh in the shell. The pressure sensor output is monitored by a microcontroller, which transmits the information over a Bluetooth 4.0 link. The measurement data is received by an Android app running on a smartphone or tablet, which analyzes the data and displays it graphically. The app computes various quantitative metrics on the lung performance and compares them to their predicted values based on the user's age, gender, etc. Based on these comparisons, the app determines the probabilities of the results matching the characteristics of five different respiratory diseases: COPD, Asthma, Emphysema, Chronic Bronchitis and Restrictive Lung Disease.

Results
I have successfully developed a prototype of the pulmonary function analyzer with the Android app and completed extensive testing of the system using the ASL 5000 breathing simulator from IngMar Medical. I used the ASL 5000 to simulate the breathing patterns symptomatic of various diseases precisely and used my system to measure the flow rates and make inferences. The results show that my system was able to detect and classify the five different respiratory diseases accurately. The total cost of parts of my design is under $35.

Conclusions/Discussion
My low-cost pulmonary function analyzer has the potential to revolutionize healthcare, especially in poor countries. The modular and open-source design of my system makes it an attractive platform for the development of new software applications to diagnose and manage respiratory illnesses.

Summary Statement
I have designed a low-cost open-source smartphone-based pulmonary function analyzer that can be used to measure lung function and diagnose five common respiratory illnesses, including COPD and asthma.

Help Received
I used funding from the Cogito program at Johns Hopkins University to purchase parts for the project. Prof. Ali Yousuf answered my many questions on spirometry. Mr. Michael Blaisdell provided access to the ASL 5000 for testing my system.