CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

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Project Number

S1019

Project Title

Cost-Effective Device that Analyzes Gas and VOC Concentrations in Exhaled Breath for Prevention of Chronic Lung Diseases

Abstract

Objectives

The goal was to create a cost-effective device using Arduino Uno kit that utilizes mathematical modeling of different gases and volatile organic compounds to detect chronic obstructive pulmonary disease (COPD) and other fatal diseases. Gases being monitored are Carbon Monoxide (CO), Ammonia (NH3), Hydrogen (H2), VOCs like Propane (C3H8), Butane (C4H10), and Ethanol (C2H5OH). There has been lot of interest in the analysis of breath constituents to measure inflammation and oxidative stress in lungs. I was doing research on fatal pulmonary diseases and realized that there is no device that exists which can proactively monitor medical emergencies like COPD and fatal conditions related to lungs, liver, stomach, and kidney.

Methods

Arduino Uno microcontroller, multi-channel gas sensor, cables, plastic pipe, LED, and buzzer were used to build the device. I performed testing on kids, adults, and elderly people. Testing variables were age, gender, effect of food, healthy vs people with mild pulmonary disease that I was building design for, smoker vs non-smoker. Testing was done for three different motion conditions subject being stationary, walking at 3 mph, running at 5 mph. Time interval was 1 min, 2 min, and 3 min. All motion tests were done on treadmill under supervision. Device was cleaned after each test. I also researched to study readings from medical devices that doctors use to validate my test results.

Results

Device worked in most cases and showed concentration of different gases in exhaled breath of healthy human. It was observed that food did not cause much variation in the reading of CO. It was also observed that smokers have high CO in exhaled breath than non-smokers. H2 Testing was done on healthy humans of different age to study variation in gases of exhaled breath at regular interval after ingesting Lactose. In healthy subject only, slight increase of hydrogen was observed. VOCs were at very low concentration and so it was difficult to get accurate readings. It was observed that most accurate readings are when subject is stationary. Walking, running variables in testing did not make any noticeable difference.

Conclusions

I observed that various gases and VOCs can be measured accurately using this device in healthy human. I also created a threshold limit for each gas that I was monitoring and device alerted for anything over this limit. I wanted adults to be alerted once a threshold limit was reached and device did that. The device can be calibrated so that it can alert differently for different gas concentrations. I would like to make this device work using blue tooth technology and build a mobile application that can be integrated with this device.

Summary Statement

I created a portable cost-effective breath sensing device that measures gas concentrations of CO, NH3, H2 and VOCs (C3H8, C4H10, and C2H5OH) to prevent fatal medical conditions related to lungs, liver, stomach, and kidney.

Help Received

I created and programmed the device myself. I researched on internet by watching videos and joining programming forums. My science teacher reviewed my findings.