CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
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Project Number
35292

Project Title
Sniffing Shepherd: A Noninvasive Low-Cost Electronic Nose Breath Analyzer to Detect the Deadliest Cancer

Abstract

Objectives/Goals
With lung cancer being the leading cancer killer in both men and women in the United States and worldwide, it has become crucial to develop a screening and diagnostic tool for early detection. Lung cancer causes more deaths in the U.S. than the next three most common cancers combined; colon, breast, and pancreatic, and has been the most common cancer in the world for several decades. The current screening methods for lung cancer not only is expensive, but also invasive. Studies have shown that patients with lung cancer produce a unique signature of volatile organic compounds in their breath when they exhale. One such signature is the presence of acetone and toluene in the ratio of 15:1. The objective of this innovation was to design and develop a noninvasive and cost effective system to detect lung cancer, using an electronic nose equipped with volatile organic compound (VOC) sensors to sense acetone and toluene present in the breath of the patient with lung cancer.

Methods/Materials
An electronic circuit was built using an Arduino kit with VOC sensors to detect acetone and toluene. The prototype was designed with 2 types of gas sensors with different sensitivity characteristics. The first sensor (sensor 1) has high sensitivity to acetone and the second sensor (sensor 2) was equally sensitive to acetone and toluene. Sensor 1 was calibrated using known concentrations of acetone. Sensor 2 was calibrated with known concentrations of acetone and toluene using ratios of 10:1, 15:1 and 20:1. The experiment was repeated with various concentrations of acetone ranging from 50 ppm to 500 ppm.

Results
The resistance values for sensor 1 and sensor 2 (0.2916 and 0.2512) corresponded to a ratio of acetone: toluene of 15:1, which is one of the unique signatures of VOCs present in the breath of patients with lung cancer. To investigate the accuracy of the prototype and validate the calibration curves, blind testing was conducted. The acetone concentrations obtained from the prototype showed a strong correlation of 0.93.

Conclusions/Discussion
This project successfully designed a noninvasive and cost efficient prototype of a breath analyzer, to screen and detect lung cancer. This novel approach can potentially save many lives by early detection. This work is also an important initial step in screening and diagnosing lung cancer, thereby revolutionizing medical diagnostics and pioneering future research.

Summary Statement
Design and development of a noninvasive and cost effective system to detect lung cancer, using an electronic nose breath analyzer equipped with volatile organic compound sensors.

Help Received
Lab equipment used at Monta Vista High School under the supervision of my teacher Mrs. Renee Fallon.