# Managing Respiratory Disease with Wearable Devices

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***Abstract*— Pollutants such as dust particles and ozone are known to distress patients with respiratory disease. Currently the one pollutant map available give only a single value for the entire greater Phoenix area. The goal of this REU project is to develop wearable devices from small, inexpensive microprocessors and sensors that will measure these pollutants and compile the data into a real-time, publically available pollutant map. This will enable patients to better assess and manage their disease.**

**Keywords: Environmental, Sensors, Wearable Device**

## I. Description

Chronic respiratory disease such as asthma and chronic obstructive pulmonary disease (COPD) cause inflammation and narrow airways in the lungs. Patients conditions are known to be stressed by dust particles and ozone in the environment [1]. Exposure to these stressors lead to shortness of breath, chest pain, increased restriction of airways, etc [2]. Since there is no cure, most patients maintain the disease by managing their systems and their exposure to these stressors.

The Environmental Protection Agency has an air quality map that displays information on the pollutants in the air [3]. The current map for the over 517 square miles of the entire Greater Phoenix area provides only one value. This value is not real-time or localized.

Our goal is to develop wearable devices from small, inexpensive microprocessors and sensors that will measure stressors such as dust particles and ozone. The device will include environmental and physiological sensors. The environmental sensors include: a dust sensors, an ozone sensor, and a temperature sensor. The physiological sensors include: a galvanic skin response (GSR), a pulse oxygen (SpO2), and a force expiratory volume sensor (FEV).

The environmental sensor will track pollutants. Dust particles of two types will be tracked by the dust sensor. The small dust particles will be 2.5 micrometers and the large dust particles will be 10 micrometers. The concentration of dust particles will be determined through optical light sensing. An air flow will be created by using a resistor as a heater. An LED light is flashed on the dust particles and the refraction of light is captured by a lens. The amount of light sensed is related to the sizes of the particles [6]. The ozone sensor is an electrochemical sensor that will give out a current that is proportional to the volume of ozone. Similar to a galvanic cell, the sensor has two semi-conducing metals as the half cells connected by a wire. One electrode reacts with the gas creating a flow of electrons, or a current. The higher the volume of ozone the higher the current [5]. The temperature sensor is connected to the ozone sensor and determines the temperature of the system. It gives off a voltage that is directly proportional to the absolute temperature in degrees Celsius. Energy given to the sensor creates a current which is converted into the voltage that the sensor outputs.

The physiological sensors will measure characteristics associated with determining symptoms of respiratory disease. The galvanic skin response indicates if the patient is feeling distressed. The pulse oxygen sensor measures the amount of oxygen in the blood. The force expiratory volume sensor measures the amount of air exhaled from the lungs [10].

Data gathered from these wearable devices will be compiled and analyzed using signal processing by a microprocessor. The data will be displayed in a publically accessible pollutant map. Patients will be able to access this real-time localized data from an app, which will also privately store their medical information form the physiological sensors. Information from the app can be shared with physician at the patients discretion. This app will enable patients and physicians to better assess and manage their disease and its treatment

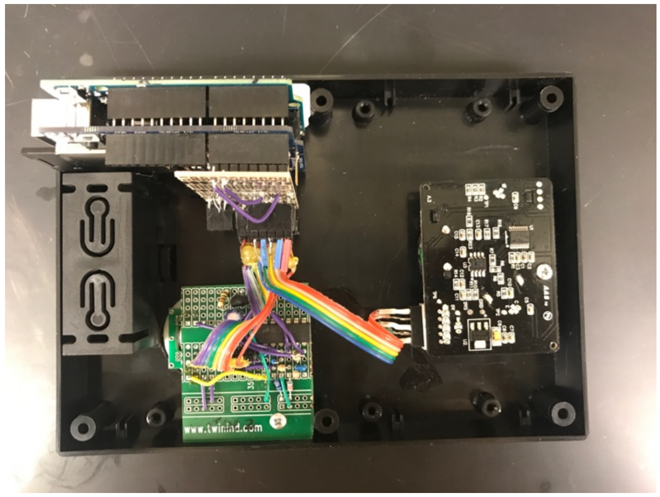


Figure 1: Initial Prototype of Sensors.

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## Outline

Experiments:

Calibration experiments- determine the sensitivity of the sensors and device over all

Power cycling experiment- graph Of ozone sensor and dust sensor

Distance data- picture of experiment/ graph from dust sesnsor over time

Ozone sensor experiment- graph of ozone data