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Non-Invasive Method for Covid-19 Detection with Volatile Organic Compounds Sensors Using Arduino Uno Processor

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Abstract-Ventilator-associated pneumonia (VAP) is a nosocomial infection occurring in the intensive care unit (ICU). The diagnostic standard is based on clinical criteria and bronchoalveolar lavage (BAL). Exhaled breath analysis is a promising non-invasive method for rapid diagnosis of diseases and contains volatile organic compounds (VOCs) that can differentiate diseased from healthy individuals. In this project we proposed a method to classify Covid 19 breathe odour by using e-Nose combined. A highly accurate, non-invasive, disposable breath test that aims detect the SARS-CoV-2 virus before the onset of symptoms in less than three minutes. Using exhaled Volatile Organic Compounds (VOCs) found in human breath as biomarkers of the virus, the screening test named ASU Detect CV19 is designed to detect the virus in people with and without symptoms. Viral infections increase oxidative stress. The highly reactive free radicals produced by oxidative stress are powerful biomarkers of the diseases found in exhaled breath. The presence of unique VOC signatures in COVID-19 and similar viruses like rhinovirus, influenza, MERS and SARS are well established. Designed to detect a COVID-19 infected person in less than three minutes, the disposable breath test, which mitigates the risk of contamination, uses highly sensitive nano sensors to collect breath samples to determine if a person is infected. E-Nose is a non-invasive, rapid technology solution that can meet the current COVID-19 crisis.

Key words – Covid-19, E-nose, Volatile Organic Compounds, Non-invasive, Exhaled Breath, Biomarkers.

I. INTRODUCTION

The COVID-19 pandemic has already caused significant loss of life, social disruption and economic standstill. The crisis is still continuing at an alarming speed throughout much of the world. As of now, the future of this pandemic remains to be largely uncertain. Diagnosis and screening of the COVID-19 is central to stemming the pandemic. Presently, reverse transcription-polymerase chain reaction (RT-PCR) is mainly used together with throat and/or nasal swabs for diagnosis and hospital discharges of COVID-19. However, the technique requires lengthy procedures and many bio-agents; and it often unfortunately leads to false negatives. A computed tomography scan (CT) is sometimes used to supplement RT-PCR. For asymptomatic patients yet posing a hidden infection risk, the accuracy of current methods needs to be investigated and validated urgently. In clinical settings, it is challenging to render a decision for discharging a COVID-19 patient solely based on the results from throat or nasal swabs. It is equally important, yet no methods available, to monitor the public environments for its SARS-CoV-2 safety. The world is now historically at the cross road of opening up economies while tolerating the risk of another wave of the COVID-19 spread. This work is conduced to search for a specific biomarker for COVID-19 that can be used non-invasively to rapidly screen COVID-19 patients even before they develop symptoms.

E-Nose is a non-invasive, rapid technology solution that can meet the current COVID-19 crisis. The electronic nose is a device that detects the smell more effectively than the human sense of smell. An electronic nose consists of a mechanism for chemical detection. The electronic nose is an intelligent sensing device that uses an array of gas sensors which are overlapping selectively along with a pattern recognizing component. So, this project is developing to search for a specific biomarker for COVID-19 that can be used non-invasively to rapidly screen peoples even before they develop symptoms.

II.HARDWARE DESCRIPTION

1.Arduino UNO

Arduino is a prototype platform (open-source) based on an easy-to-use hardware and software. It consists of a circuit board, which can be programed (referred to as a microcontroller) and a ready-made software called Arduino IDE (Integrated Development Environment), which is used to write and upload the computer code to the physical board.

2.MQ-135 - Gas Sensor for Air Quality

The MQ-135 Gas sensors are used in air quality control equipments and are suitable for detecting or measuring of NH3, NOx, Alcohol, Benzene, Smoke, CO2. The MQ-135 sensor module comes with a Digital Pin which makes this sensor to operate even without a microcontroller and that comes in handy when you are only trying to detect one particular gas.

3. MQ-2 Gas Sensor

In MQ sensor series, MQ2 is the most commonly used gas sensor. It is a Metal Oxide Semiconductor (MOS) type gas sensor. The concentration of Gas can be detected using a simple voltage divider network. It can detect LPG, Smoke, Alcohol, Propane, Hydrogen, Methane and Carbon Monoxide concentration anywhere from 200 to 10000ppm.

4.Proximity Sensor

A proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact.

5. Buzzer

A buzzer is a small yet efficient component to add sound features to our project/system. It is very small and compact 2-pin structure hence can be easily used on breadboard, Perf Board and even on PCBs which makes this a widely used component in most electronic applications.

6.BME280 Sensor

The BME280 sensor module reads barometric pressure, temperature, and humidity. This precision sensor can measure relative humidity from 0 to 100% with ±3% accuracy, barometric pressure from 300Pa to 1100 hPa with ±1 hPa absolute accuracy, and temperature from -40°C to 85°C with ±1.0°C accuracy.

III.PROPOSED METHODOLOGY

The electronic nose has a housing retaining an array of metal-oxide semiconductor (MOS) gas sensors retained in the chamber of the housing. These sensors are capable of being saturated by a target gas then produce a voltage drop across the sensors resulting in an output response in volts (V) .

The MOS-based sensors are capable of detecting gas concentrations in parts-per-million (ppm) of CO, acetone, and alcohol. Referring to circuitry of the Arduino Uno microcontroller electrically connects to the MOS-based MQ-2 and MQ-135 gas sensors. Then Arduino Uno microcontroller is electrically connected to a BME280 sensor configured to measure pressure and temperature within the exhaled breath of the person.

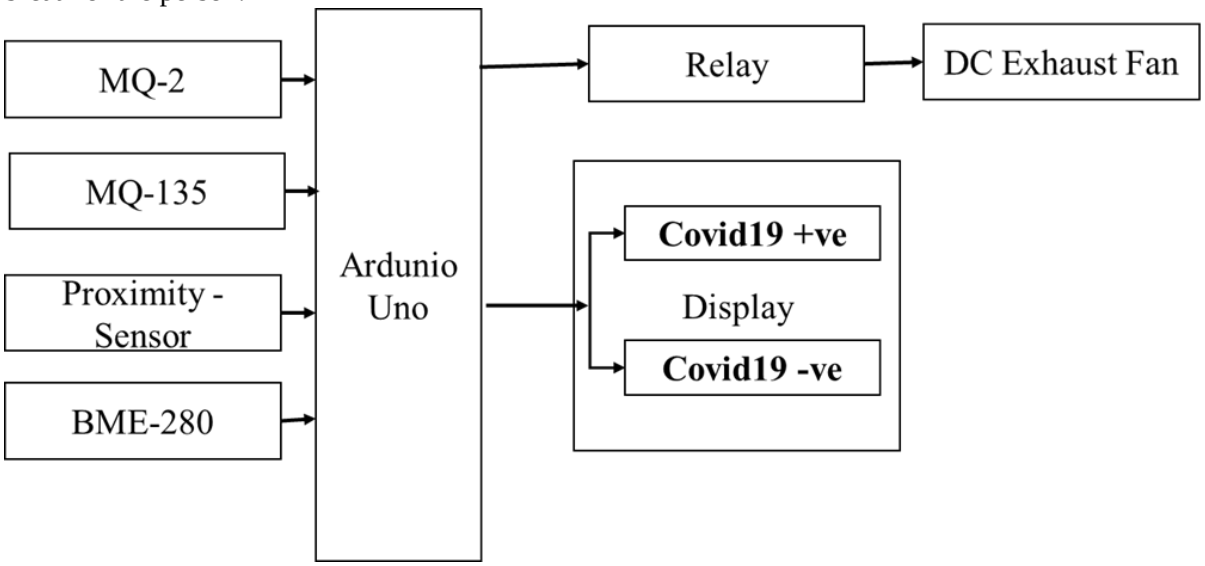

Figure 1. Block diagram

For a gas analysis system to indicate to a user when concentrations within an exhaled breath fall within a suitable range considered to be a breath pattern signature of COVID-19, whereby, elevated concentrations of CO and acetone combined with the lowered concentration of alcohol are detected in COVID-19 breath samples and are not characteristic of non-COVID-19 breath samples. In order to accomplish incorporating a light emitting unit indicator to the current electronic nose system to accurately activate in response to both the CO and alcohol concentrations detected within a sample, a MQ-2 sensor having a high sensitivity to CO and alcohol and MQ-135 gas sensor having a high sensitivity to acetone would need to be provided. Carbon Monoxide (CO) emitted from a non-COVID-19 breath sample has a concentration range of approximately 2 ppm

100 ppm, corresponding to a “healthy” signature. When a MQ-2 sensor, having a high sensitivity to CO, detects a concentration value of CO emitted from the simulated breath sample solution having a value over 100 ppm, that indicates a potential inflammatory response symptom of COVID-19. Alcohol emitted from the a non-COVID-19 breath sample has a concentration range between 0.4 ppm – 2.0 ppm, corresponding to a “healthy” signature.MQ-2 sensor, having a high sensitivity to alcohol, detects a concentration value of alcohol emitted from the simulated breath sample solution having a value less than 0.4 ppm that indicates a potential inflammatory response symptom of COVID-19. Acetone emitted from a non-COVID-19 breath sample has a concentration range between 0.24 ppm – 1.69 ppm, corresponding to a “healthy” signature. When the MQ-135 sensor detects a concentration value of acetone emitted from the simulated breath sample solution having a value over 2.0 ppm, that indicates a potential inflammatory response symptom of COVID-19.

VOC TYPE	SENSOR TYPE	VOC MEASURED VALUES EMITTED FROM NON COVID-19 BREATH	VOC MEASURED VALUES EMITTED FROM COVID-19 BREATH
Acetone	MQ-135	0.24 to 1.69 ppm	Greater than 2.0 ppm
Alcohol	MQ-2	0.4 to 2.0 ppm	Less than 0.4
CO	MQ-2	2 to 100 ppm	Greater than 100 ppm

Table 1. VOC ppm range for Covid-19 &Non Covid-19 Breath

When the person exhaled breath is sniffed in front of the proximity sensors until the buzzer alarms. Then LCD display, displays the ppm of Acetone, CO and Alcohol present in exhaled breath & then displays the person is affected with Covid-19 or not. Then the persons unwanted exhaled breath will be removed by using exhaust fan.

IV.CONCLUSIONS & FUTURE WORK

Currently there does not exist an ideal test that could be a real time, non-invasive, highly accurate mass screening tool to be used to reduce transmission. The biomarkers in the breath are as unique as our fingerprints in the identification of diseases. The Canary breath test has the potential to responsibly open the economy and protect the population. This is next-generation technology and has the ability to completely revolutionize testing for COVID-19 and play a critical role in stopping the spread of the virus.

In future, E-Nose can be used as a platform for other medical conditions as well as meeting its original goal of monitoring astronaut health and crew cabin air quality.

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