Multi Health Checkup Device with Graphing for Pandemic Diseases

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ABSTRACT

We present a low-cost portable sensor based respiratory clinical gadget collaboration of sensor technology with devops flow, which utilizes different available sensors for respiratory signal acquisition and transmits the data onto a visualization dashboard on mobile or web devices. This device can be useful to keep regular checks on lungs health in the self-quarantine times during pandemic without the need of frequent visits to clinic.

1. INTRODUCTION

At the times of extreme situations of pandemic like COVID-19, the healthcare sectors face various hospital admissions problems due to higher rate of patient admission to hospital. Also, to undergo preliminary health detections become difficult due to lack of facility at these times. This also increases the chances of patients coming for basic health check getting infected with the virus spread. Also, the patients who would have got cured of the disease, have the chances of getting re-infected with the disease gets higher after period of 70 days. To this aim, a self-care device is proposed for easy access to the preliminary respiratory health monitoring checks and that also helps early detection, being at home. The patients those who get cured of the disease, also have access to regular checks at home using the device, without frequently visiting the doctors. The patient's lung health check can be shared in the form of periodic graphical data with the health professionals.

2. OBJECTIVE

- To get the respiratory information about human health in real time using protable sensor based device for remote diagnosis of respiratory diseases..
- To bring sensor-based low cost healthcare monitoring solutions, anywhere, anytime, that can be used at home in the situational times of self quarantine during pandemic breakdown.
- To have the preliminary pulmonary health check handy for early detection. This would enable healthcare activities.
- The device is proposed as a supplementry multi-health care device that can be used for general wellness.

3. IMPLEMENTATION

With the help of 3 sensors , one for measuring the difference in pressure while the users blows air into the spirometer , one IR sensor to read the temparature of ths user and particle sensor for Oxygen in blood measurement. These raw data is transferred to the Raspberry Pi for accurate data analysis and time series data plotting with InfluxDB and Grafana which is launched in AWS

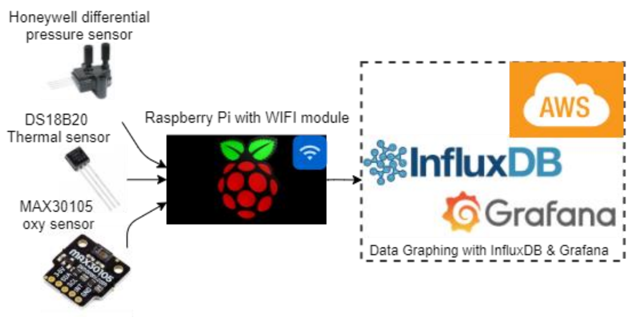

Figure 1. Architecture of Device

2.1 Mathematical calculations of Spiro meter

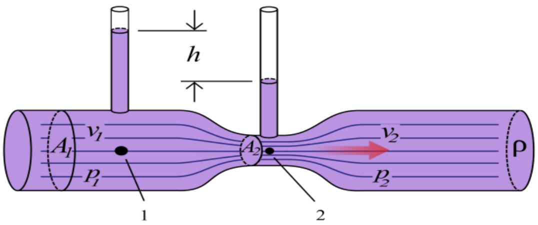

Figure 2. Model for Spirometer

When the user blows air into the pipe, the pressure difference of both the cross section will be measured by the MPX10DP or Honeywell differential pressure sensor.

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Using knowledge of fluid Mechanics, the pressure drop can be converted to mass flow rate using

Volumetric flow rate , $Q = V_1 A_1 = V_2 A_2$

By Bernoulli's principle , $P_1 - P_2 = \frac{\rho}{2} (V_2^2 - V_1^2)$

Therefore

$$Q = A_1 \sqrt{\frac{2}{\rho} \frac{(P_1 - P_2)}{\left(\frac{A_1}{A_2}\right)^2 - 1}} \quad \text{and} \quad Q = A_2 \sqrt{\frac{2}{\rho} \frac{(P_1 - P_2)}{1 - \left(\frac{A_2}{A_1}\right)^2}}$$

Where

Q = Volumetric flow rate (m^3/s)

V1 = Velocity of air through first circular duct

V2 = Velocity of air through second circular duct

A_1 = Area of first circular duct = $\pi {r_1}^2$ (m/s)

A_2 = Area of second circular duct = $\pi {r_2}^2$ (m/s)

r_1 = Radius of first circular duct (m)

r_2 = Radius of first circular duct (m)

P_1 = Pressure inside first circular duct (Pa)

P_2 = Pressure inside second circular duct (Pa)

ρ = density (kg/m^3)

Volumetric flow is ,Volume over time.

Therefore Volume = $Q \times time$

To test the Lung functionality, Volume over time graph is used for FEV(Forced expiratory volume), EV(total Expiratory Volume),FEV1(Forced expitatory volume in first second).

The time series data collected is dumped into InfluxDB which is launched in AWS EC2 and Graph is plotted with Grafana with influxDB datasource.

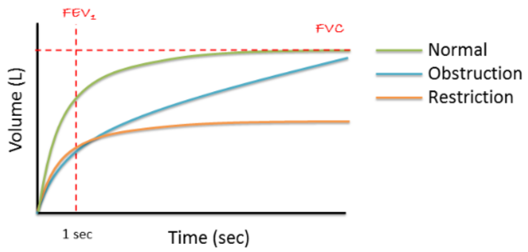

Figure 3. FEV Graph with time

The flow of control begins by user blowing into the tube which has built-in pressure sensors. The sensor's output data is transferred to raspberry pi device, as can be seen below.

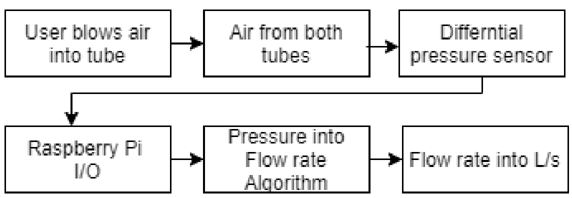

Figure 4. working of pressure sensor

2.2 Spo2 meter for Oxygen level of blood

The MAX30105 particle-sensing module is used to get the blood oxygen percentage. It has been equipped with three LEDs as well as a very sensitive photon detector. The LED's will pulse and then detect the reflection, based on the reflected signature it's possible to detect oxygenated blood percentage.

The data from sensor is passed to the Raspberry pi for the calculation and then moved to DB. Oxygen saturation (SpO2) is a measurement of how much oxygen your blood is carrying as a percentage of the maximum it could carry. For a healthy individual, the normal SpO2 should be between 96% to 99%.

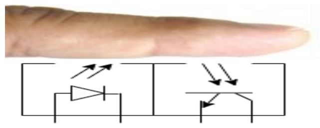

Figure 5. Working of particle sensor

2.3 Temperature sensor with IR

With IR DS18B20 sensor, Temperature of the user is measured. The user should keep his hand/forehead in front of the sensor without touching it. The sensor will read the data and using Pi data is moved to InfluxDB and plotted in Grafana.

4. CONCLUSION

Pandemics like COVID and SARS spread primarily influence Lungs and winds up in Pneumonia. Because of the high number of patients at a solitary timespan and the profoundly bordering ailments will make our wellbeing framework powerless. Keeping a more affordable clinical gadget at user end will help individuals to correct the variations from the norm at beginning period and misbehave in like manner. Ailment like pneumonia that is brought about by these maladies reduces the blood oxygen levels, can be estimated with the gadget over a scope of timespan and distinguish abnormalities and is contrasted with other individuals' information. The lungs exhalation parameter FEV1 is extremely significant information to quantify the lungs wellbeing after the ailment and at the hour of illness. The average cost of proposed model is 2500(raspberry pi) + 1200(Honeywell differential pressure sensor) + 400(IR temperature sensor) + 1200(spo2 sensor). As we realize that these pandemics show relapse and quiet spreading, so these sort of modest gadget for singular use will help to a degree with the battle with COVID.

5. REFERENCE

[1] GambinoBritt, COVID-19 in Chronic Lung Disease:What You Need to Know. https://www.pulmonologyadvisor.com/home/topics/lung-infection/ https://www.pulmonologyadvisor.com/home/topics/lung-infection/potential-effects-of-novel-coronavirus-disease-on-patients-with-chronic-lung-disease/(2020)

[2] Sensirion Company, Using Differential Pressure and Flow Sensors with Raspberry Pi https://developer.sensirion.com/tutorials/raspberry- pi-tutorial-using-flow-sensors/

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