

Smart Mask for Monitoring of Respiratory Condition for High Activity- Person During various scenarios

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Abstract - The paper present as smart mask that allow to monitor body temperature and the analyse the breathing pattern and frequency, the paper also represent the novel method to integrate all the sensor to get the effective result without losing the ergonomics of the mask. The system is tested in the three scenario when the person is relaxed, when the person is standing and doing mild work, when the person is doing High intensity activity like climbing steps or running for longer duration. From the experiment we envision that this zero-power and lightweight wireless wearable device may be beneficial for cough monitoring and the public health condition in terms of tracking potential contagious person and virus-transmissive events.

Keywords- *Smart, Health, Smart Mask , Breath analyser, breathing frequency*

1. Introduction:

With a cumulative death toll of up to 6 million, the Covid-19 pandemic is one of the deadliest pandemics to have been recorded in the twenty-first century. It is a potentially fatal infection, and many people have contracted it. Numerous pandemics have occurred over the years, but none have been as severe as the one that is currently sweeping the world.

Once infected, patients with coronavirus require at least 14 days to recover, but it is also quite harmful over the long term. The coronavirus cells grow as soon as they enter the body and subsequently target the alveoli in the lungs. While breathing in and out, oxygen and carbon dioxide are exchanged between the blood and alveoli in the lungs. When oxygen is inhaled from the air, it gets to the body's tissues via the alveoli, blood, and tissues throughout the body. SARS, or severe acute respiratory syndrome, will result from this.

Trouble breathing, dry cough, headache, fever, and other symptoms. These are the signs that a patient is experiencing right now. There are, however, a few long-term effects, including irregular breathing, persistent respiratory issues, cardiac issues, chronic renal disease, stroke, and Guillain-Barre syndrome. Scientists have determined that Covid-19 will result in long-term harm in 90% of individuals. It takes multiple tests to accurately pinpoint these symptoms in a patient. However, this technology has made the procedure simple. When a patient is jogging or walking, a microphone module placed on their nose

and mouth will pick up their sound waves and utilize the frequency to draw a graph on a computer

2. LITERATURE REVIEW

Today, we only think of masks as a COVID19 protection tool, but they have a wide range of other uses as well. Here, I've created a tool that tracks a



Figure 1: Person using a Smart Mask

person's breathing by using a mask. The gadget's advantages are

1. **Safety:** By using this tool, one may identify abnormal breathing patterns and avoid potentially dangerous situations. It aids one in staying safe and avoiding such accidents.

Existing Solutions:

Numerous electronic sensor types that may be put within clothing and connected to belts fastened to

the skin are used in wearable sensors for respiratory monitoring. There are several techniques to create wearable technology, and some of them are explained individually in the following sections according to the principal sensor type.

A. Pressure sensors

We can design wearable pressure sensor devices by using the diaphragm contraction's physiological processes. An electromechanical film (EMFit) was utilized by researchers to create a respiratory rate sensor that is shaped like a belt, as an illustration. They affixed the sensor to the belt in such a way that the force created by the expansion of the chest while breathing exerts a force on the sensor and results in a change in voltage corresponding to this movement. A capacitive pressure sensor with a thin porous polypropylene film construction and a sensitivity range of 30–170 pC/N is called fit.

Another technique to employ pressure sensors is to put them right up to the air pressure changes that occur during breathing. The facemask was first introduced and was designed for use in both clinical and home settings to assess respiratory impedance. Two pressure transducers, two low-power fans, a field programmable gate array, and a real-time processing engine make up the solution. The apparatus is based on the forced oscillation technique (FOT), an unreliable measurement of lung function. The plan is to quantify the opposing force generated by the respiratory system by using fans to input a periodic sinusoidal air pressure signal. Respiratory resistance and compliance are determined by these statistics.

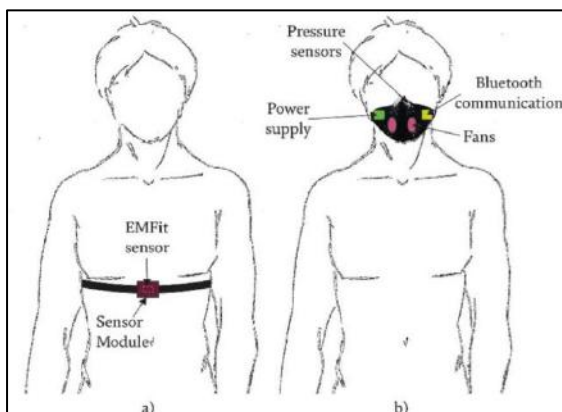


Figure 2: EMFit sensor based mask

The EM Fit sensor was effective in detecting respiration rates while being less obtrusive.

B. ECG

The FDA-cleared Eko DUO is a next-generation cardiac assessment tool from the cardiopulmonary digital health company Eko. It works as both an electrocardiogram (ECG) and a digital stethoscope to identify early heart disease symptoms and to help with timely treatment and individualized disease management. – With the help of the DUO pocket-sized cardiac examination device for professionals, patients may receive prompt care both inside and outside of the clinic and early indications of heart disease can be found. Frontline clinicians may now quickly and easily monitor or stream sound waveforms and ECG tracings from their mobile devices.

3. Our Solution

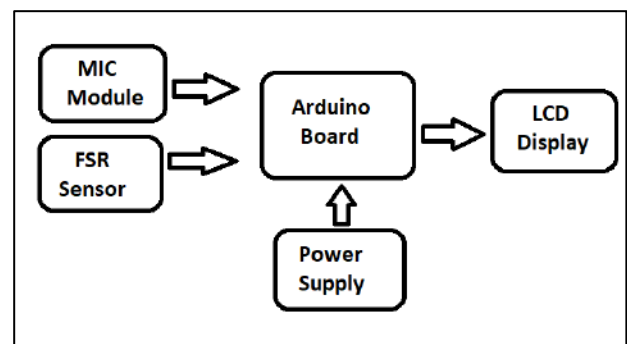


Figure 3: Flowchart of our solution

Our approach is based on using a MIC module to identify human breathing patterns and an LCD display to show the results. Consequently, one can learn about its respiration as a result. Additionally, an FSR sensor is attached to the chest to measure breathing. We will compare the two values and forecast how a person should breathe properly..

The Prototype

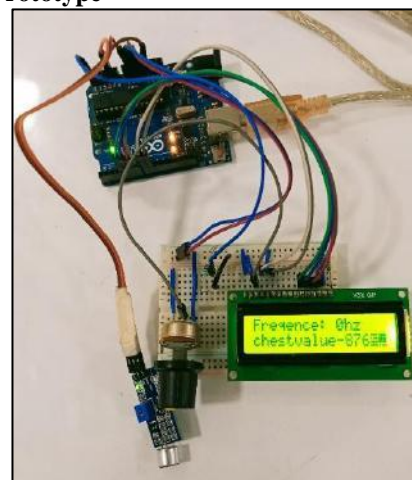


Figure 4: The prototype

Circuit Diagram:

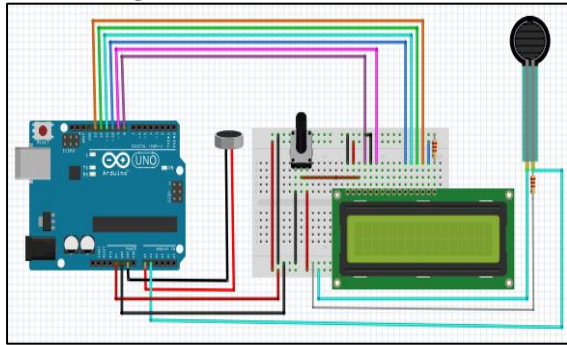


Figure 5: Circuit diagram for all the components

The above fig is a circuit diagram for all the components that were used in our band and their connections.

When	Fit (frequency)	Unfit (frequency)
Before exercise (normal)	0.166Hz	0.27Hz
While exercise	0.33Hz	0.47Hz
After exercise (rest)	0.2Hz	0.3Hz

We have used AtMega328 as the main microcontroller for the device. For the purpose of detecting a person's breath, a sound sensor and an FSR sensor are used as input. The gadget where we obtain the data has an LCD display connected as an output.

The circuit has the power supply module and the battery protection unit and has the following components-

1. 1000mAh li-ion battery
2. TP4056 Charging circuit
3. 3.7 to 5v Boost circuit

all three are connected to each other and provide consistent power to the device to work continuously.

Component

List:

The parts used in the circuit are as follows:

Arduino UNO: The Arduino Uno is an ATmega328-based microcontroller board. It has a 16 MHz resonator, a USB connection, a power jack, an in-circuit system programming (ICSP) header, and a reset button. It has 20 digital input/output pins

(of which 6 can be used as PWM outputs and 6 can be used as analog inputs), a 16 MHz resonator, a USB connection, a power jack, an ICSP header, and a reset button. It has everything you'll need to get started.

To use a microcontroller, just plug it into a computer through USB or power it with an AC-to-DC converter or battery.

Battery - The circuit is powered entirely by the battery.



Figure 6: The battery used

Switch: The switch allows the user to toggle the band on and off.

Sound Sensor Module: This sensor's operating system is based on how human ears function. The reason for this is that the human ear has a diaphragm, and the diaphragm's primary job is to convert vibrations into messages. This sensor employs a microphone, whose primary purpose is to convert vibrations into current or voltage depending on the situation.

In most cases, it consists of a diaphragm made of magnets wound around a metal wire. Magnets inside the sensor vibrate in response to sound impulses, which can also drive electricity to flow from the coils.

FSR Sensor: With numerous novel sensor types being launched in recent years, force-detecting resistors, also known as printed force sensors or force-sensitive resistors, are a significant and expanding group of embedded components. Force sensing resistors, however, are not in any way a recent invention. Force sensing resistors have really been a common integrated component for years.

Most engineers are aware that the formula for force is either applied pressure multiplied by the contact area ($F=P \cdot \text{Area}$) or an object's mass multiplied by its acceleration (or $F=M \cdot A$). In these equations, "F" is denoted by a variety of technical units, including Newtons (N), pounds-force (lbs), and others.

DC to DC Micro-Booster (FC - 400):

The Function of a micro-booster is to translate the incoming voltage from one level to another. In his case, we were using a DC-to-DC Micro-Booster as we needed to increase our voltage up to 6 volts. We resolved the USB port from the micro booster to allow connections from the 4 flat pins just underneath it.

TP4056: The TP4056 is a single-cell lithium-ion battery charger with a complete constant-current/constant-voltage linear charger. The TP4056 is appropriate for portable applications due to its SOP packaging and minimal external component count. A USB and wall adapter are both compatible with the TP4056.

Because of the intrinsic MOSFET construction, no blocking diode is necessary, but it must prevent negative current.

Circuit for Charge Current. Thermal feedback controls the charge current to keep the die from overheating when the power is high, or the ambient temperature is high. The charge voltage is set at 4.2V, and the charge current is controlled by a single resistor. When the charge current lowers to 1/10th of the programmed value after the ultimate float voltage is reached, the TP4056 automatically ends the charge cycle.

TP4056 current monitor, under voltage lockout, automated recharge, and two status pins to indicate charge termination and the presence of an input voltage are some of the other features.

4. Results and Discussions

The respiratory condition monitoring system used in this study makes preliminary estimates of respiratory conditions based on many categories based on a person's breathing frequency per minute. An adult's respiratory rate was 12-20 breaths per minute, which is classified as normal or eupnea. While the respiratory rate in the condition of tachypnea is greater than 20 breaths per minute, and the respiratory rate in the situation of bradypnea is fewer than 12 breaths per minute (4). Because of the use of the reference respiratory rate category in adults, where adulthood represents a shift from childhood,

the time of late adolescence to early elderly age, or adolescence to old age (17-55 years). In addition to breathing, air humidity management in masks was also carried out based on tropical Indonesia's air humidity conditions, with an emphasis on East Java as the location for mask implementation. According to BMKG statistics, the average air humidity in the

East Java region from 2015 to 2018 was 66 to 84%. In this study, this number is utilised as the fixed value for atmospheric humidity.

The data that is created in 117 rows and 6 columns, and breathing frequency is calculated for three situations

1. When the person is sitting
2. When the person is standing
3. When the person is playing

And corresponding to that the timestamp is also captured in milliseconds, as shown in the image below.

	Frequency_hz_sitting	Time_Stamp	Frequency_hz_standing	Time_Stamp.1	Frequency_hz_playing	Time_Stamp.2
0	111	1030	191	1030	70	1030
1	104	2066	260	2066	96	2065
2	145	3102	135	3102	0	3100
3	12	4141	252	4141	193	4135
4	173	5176	298	5178	124	5173
	--	--	--	--	--	--
112	52	117109	0	117113	124	117146
113	2	118145	121	118150	138	118184
114	6	119180	0	119187	58	119223
115	81	120214	26	120221	188	120258
116	9	121250	69	121257	96	121296

Figure 7: Dataset

The Calculated breathing frequency is plotted with the time and a line chart is plotted for all three situations as shown below

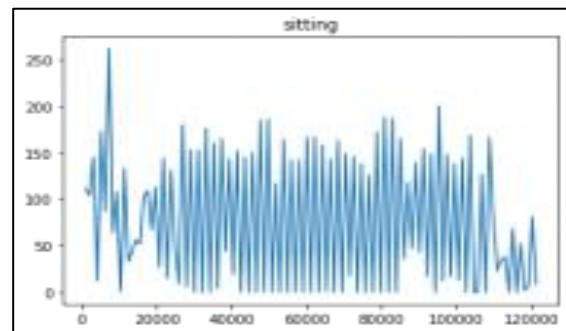


Figure 8: Sitting vs Time

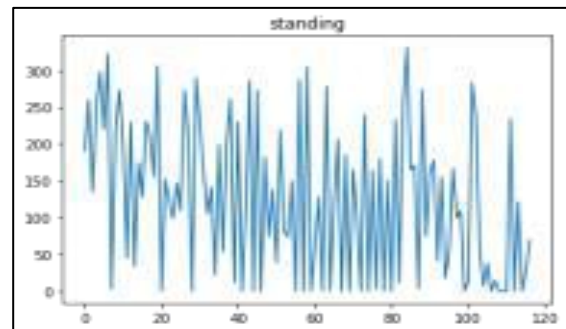


Figure 9: standing vs Time

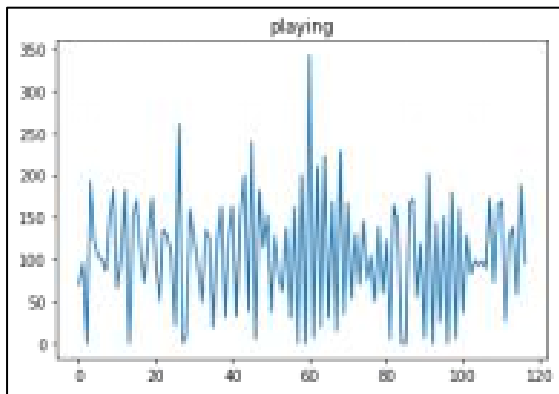


Figure 10: playing vs Time

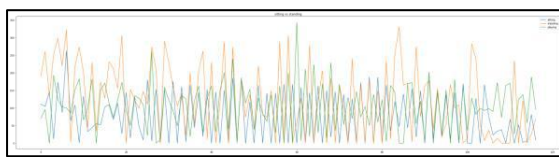


Figure 11 Comparative Graph

From the above charts we can analyze that the graph for the situation when a person is sitting is more stable as compared to the other two situations but to understand it in a more detailed we plotted Histogram as shown below

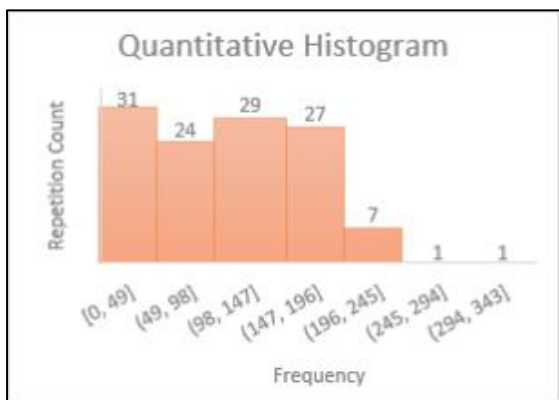


Figure 12: final data playing

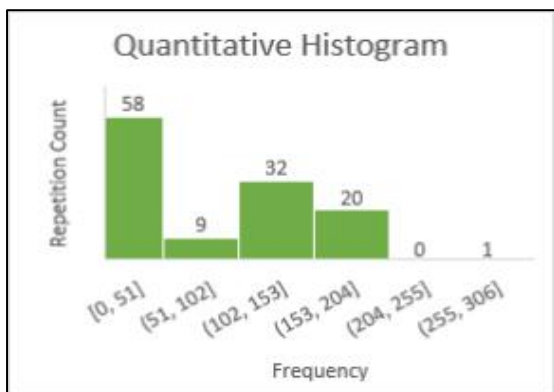


Figure 13: Sitting final data

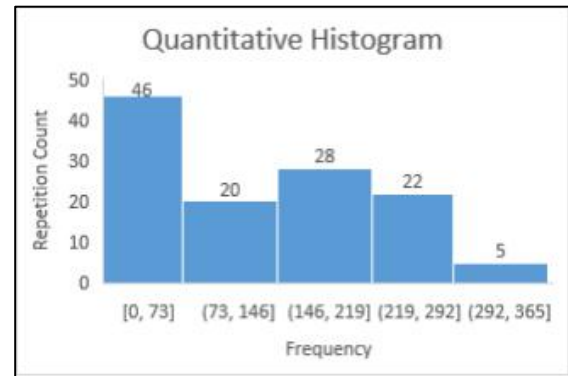


Figure 14: Standing Final data

5. Conclusion:

The technology, which assists in determining the breathing level and guards against various illnesses, is completely trustworthy. In addition, it guarantees complete safety and is completely functional at greater altitudes. It is also quite handy to use in the gym since it keeps track of three levels: before exercise, during exercise, and after exercise. This mask meets all our demands while bringing technology closer to components of our daily lives. A tool that delivers you the information you can trust while simultaneously keeping you safe. It is completely applicable to daily life. It is also quite accessible.

Future scope:

Our device may be modified to detect the blood pressure and heart rate of humans, allowing mountaineers to monitor their oxygen levels as they climb to greater altitudes.

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