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A REVIEW ON VENTILATOR USING ARDUINO WITH BLOOD OXYGEN SENSING FOR COVID PANDEMIC

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ABSTRACT:- The goal of this project was to create a low cost ventilator that could be constructed with radially-available hospital equipment for use in emergency or low –resource settings. In this project we are construction of a low-cost, open-source mechanical ventilator. The motivation for constructing this kind of ventilator comes from the worldwide shortage of mechanical ventilators for treating COVID-19 patients—the COVID-19 pandemic has been striking hard in some regions, especially the deprived ones. Constructing a low-cost, open-source mechanical ventilator aims to mitigate the effects of this lack on those locales. The hardware reported here utilizes business spare parts as it were. This task show mathematical technique for observing the patients' aspiratory condition. The technique considers pressure estimations from the inspiratory appendage and cautions clinicians progressively whether the patient is under a solid or undesirable circumstance. The most recent couple of months have seen an expanded interest for ventilators in the treatment of patients. This problem can be solve by create a low cost ventilator

Keywords: -*low- resource, low cost ventilator, COVID-19, Pandemic ,open -source T*

I. INTRODUCTION

The new corona virus behind the pandemic causes a respiratory infection called COVID-19. The virus, named SARS-CoV-2, gets into your airways and can make it hard for you to breathe. Estimates so far show that about 6% of people who have COVID-19 get critically sick. And about 1 in 4 of them may need a ventilator to help them breathe. But the picture is changing quickly as the infection continues to spread around the globe. You may be put on a mechanical ventilator if a condition makes it very difficult for you to breathe or get enough oxygen into your blood. This condition is called respiratory failure. Mechanical ventilators are machines that act as bellows to move air in and out of your lungs. Your respiratory therapist and doctor set the ventilator to control how often

it pushes air into your lungs and how much air you get. You may be fitted with a mask to get air from the ventilator into your lungs. Or then again you might require a breathing cylinder if your breathing issue is more genuine. Mechanical ventilators are basically utilized in emergency clinics and in transport frameworks, for example, ambulances and MEDEVAC air transport and so forth Now and again, they can be utilized at home, if the disease is long haul and the parental figures at home get preparing and have satisfactory nursing and different assets in the home. Being on a ventilator might make you more powerless to pneumonia, harm to your vocal strings, or different issues. A ventilator utilizes strain to blow air—or air with additional oxygen—into your lungs. This pressing factor is known as sure pressing factor. You generally inhale out the air all alone, however at times the ventilator does this for you too. A ventilator can be set to "breathe" a set number of times a minute. Sometimes it is set so that the machine only blows air into your lungs when you need it to help you breathe. Before your healthcare team puts you on a ventilator, they may give you:-

• Oxygen through a mask
• Medicines to make you sleepy and to stop you from feeling pain
• Fluids and other medicines through your vein (IV) to help keep oxygen-rich blood flowing to your organs.

A. Who needs Ventilator?

You may need a ventilator in an emergency if a condition makes it difficult to breathe on your own (called respiratory failure). You may also need a ventilator during surgery. When your lungs inhale and exhale air normally, they take in oxygen your cells need to survive and expel carbon dioxide. COVID-19 can inflame your airways and essentially drown your lungs in fluids.

A ventilator mechanically helps pump oxygen into your body. The air flows through a tube that goes in your mouth and down your windpipe. The ventilator also may breathe out for you, or you may do it on your own. The ventilator can be set to take a certain number of breaths for you per minute. Your doctor also may decide to program the ventilator to kick in when you need help. In this case, the machine will blow air into your lungs automatically if you haven't taken a breath in a set amount of time. The breathing tube may be uncomfortable. While it's hooked up, you can't eat or talk. Some people on ventilators may not be able to eat and drink normally. If so, you'll need to get your nutrients through an IV, which is inserted with a needle into one of your veins.

How a ventilator works a medical ventilator works to:

• Get oxygen into your lungs

• Remove carbon dioxide from your body

A breathing tube connects the ventilator machine to your body. One end of the tube is placed into your lungs' airways through your mouth or nose. This is called intubation. In some serious or long-term conditions, the breathing tube is connected directly to the windpipe through a hole. Surgery is needed to make a small hole in the neck. This is called a tracheostomy. The ventilator uses pressure to blow

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oxygenated air into your lungs. Ventilators usually need electricity to run. Some types can work on battery power.

Your airway includes you're: nose mouth throat voice box windpipe lung tubes.

Market is already witnessing number of ventilators which are efficient and portable in nature. But where those ventilators are very effective, they are also very costly. On the other hand the BVM ventilator are cheapest what's more, their cost is likewise most minimal. One of the best downside of BVM ventilator is that it requires ceaseless compressions which are being given by human hands because of which this sort of breathing is extremely tiring interaction for the individual performing compressions to the pack. In addition versatile electronic ventilators are likewise accessible in market, these ventilators have great execution yet they are expensive. Significant expense of the ventilator is a significant obstacle in the inaccessibility of ventilators on the lookout. Request of these ventilators is high. So there exist an enormous contrast between the accessibility and request of ventilators in immature nations. In this way, there is a space for a minimal expense yet similarly viable versatile ventilation machine [5]. Based on this minimal expense advantage, assumptions are come about into a majority of orders. An expected comparison of the different types of ventilators currently available in the market is given on a so our target was to design a low cost portable ventilator whose performance is also better than the conventional BVM. The ventilator we here design and develop using arduino encompasses all these requirements to develop a reliable yet affordable DIY ventilator to help in times of pandemic.

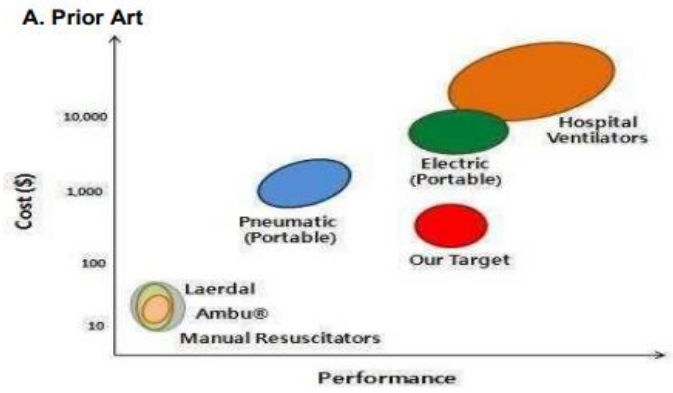

Fig 1.1 Ventilator graph

B. Functional Requirements of the Device

For the given circumstances, requirements that could be essential for the functioning of the movable ventilator are proposed as following points.
l) Medically based advantages and credentials: Requirements of the ventilator on medical basis are as follow:
Dead-space must be limited.
Proximity of infection should be controlled.
It should be capable of humidity exchange.

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It should have a user-specified number of breaths per minute.
It should contain assist control function. It should give the option of maximum pressure limitation option. It should have PEEP (positive end- expiratory pressure).

3) Aspects of mechanical effectiveness: Mechanical aspects of the ventilator are as follow it should be a portable device. It must contain operational capabilities of functioning as standalone device.It should have an effective predefined mechanical, electrical and software systems. Spare parts should be easily available and have the capability of easily repairable. It must require nominal power to function. It should have rechargeable battery which gives it most prominent aspect of portability.

4) Economic aspects: One economic aspect of this device is that it should be low cost. It must be highly economical (i.e. cost should be <16000).

5) Important aspects of User interface: Its user interface should be user friendly. Its parts must be of standard connection

Its parts must be of standard connection. It should have alarm for indicating low battery life.Based upon all these design requirements using the technique of rapid prototyping a rapid prototype was developed using papers and cardboards etc.

Fig 1.2 Hardware

Components Using for Making Low Cost Ventilator-

- Arduino Uno
- Blood Oxygen Sensor
- Pressure Sensor
- Servo Motor • Breather Mask
- Valves & Joints
- Air Breather Bag

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• Push Rods • Connector Rods
• Gear Mechanism
• Plastic Enclosure
• LCD Display IC
• Vtg Regulator IC
• Resistors
• Capacitors
• Transistors
• Cables and Connectors
• Diodes • PCB and Breadboards
• LED • Transformer/Adapter
• Push Buttons • Buzzer
• IC Sockets and IC

II. SYSTEM DEVELOPMENT

A. Technique of Air Delivery

Air delivery system of ventilator works mainly on two strategies. One strategy functions upon the constant pressure source for continuously delivery of air. Whereas the second strategy supplies uninterrupted air by compacting an air supply. For the model being under the light second technique of conveying of air was being embraced. Reason being this was no need of consistent activity of an emphatically charged pressing factor hotspot for the method involved with breathing in. It results into lower necessities of energy and force. This proposed model is indistinguishable as it is comprised of a cheap Bag Valve Mask (BVM). Though any remaining ventilators accessible in the market are planned with qualifications of standard mechanical parts. It is the most customary and least difficult type of compact ventilator innovation. This is the fundamental reason for this model to be that much basic and cost proficient that it is being utilized by the greater part of the emergency clinics and ambulances. BVM's are exceptionally modest when contrasted with different innovations which fills in as an or more point for this innovation and ensure the accessibility in those nations which need assets or are neediness streaking nations. Presence of an airtank and an arrangement of stopcock makes it a total bundle to address the issues of fundamental ventilation machine. BVM has already being consolidated in various clinical offices. In any case, they had a negative part of persistent administrator's commitment. It results normally into fatigue when it comes to operations for long durations. Thus it confines the performing abilities in negative sense to occasional and transitory relieving tasks only. In addition to that an untrained operator could be an evident threat to the patient's life. It can hurt its lungs by over or under compression of the bag. Considering this aspect of BVMs, this prototype is designed to actuate the BVM. It not only facilitate the function desired as well as it reduces the cost of required systematic ventilators being produced A. Two side arm push mechanism Basic method of stimulating a BVM is the use of pumping of air with the movement of hands on a bag made for the purpose cited above. This activity requires additional space in order to use linear actuation mechanism. For the purpose of squeezing maximum benefits from compression, cylindrical BVM were introduced. But those were produced by taking into consideration the corner stone of manual operating techniques.

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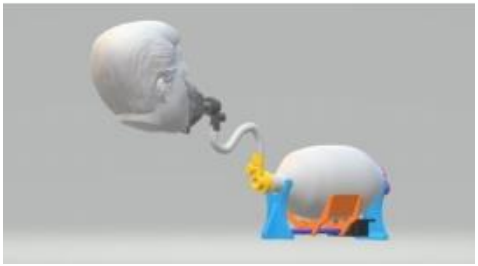
Therefore they are produced with such rough and hard materials which produce fraction to some extend as well as provide safety, and grip as well as help in order to avoid slippages . Two side arm push mechanism have gear like spur gear structure at the end. In this method two side arms were used in a to press the BVM. Bag was placed between the two side arms and those arms were connected to the DC gear motor via fish wire due to which two arms moved just like a scissor and in We here use a silicon ventilator bag coupled driven by DC motors with 2 side push mechanism to push the ventilator bag. We use toggle switch for switching and a variable pot to adjust the breath length a the BPM value for the patient. Our system makes use of blood oxygen sensor along with sensitive pressuresensor to monitor the necessary vitals of the patient and display on a mini screen. Also an emergency buzzer alert is fitted in thesystem to sound an alert as soon as any anomaly is detected. The entire system is driven by arduino controller to achieve desired results and to assist patients in COVID pandemic and other emergency situations



B. Microcontroller

We used Arduino Mega as a controller. The Arduino Mega is a microcontroller board based on the ATmega328. It has 54 digital input/output pins. Out of these 54 pins 14 pins can be used as PWM outputs. Besides these 16 analog inputs, 4 UARTs (hardware serial ports). A 16 MHz crystal oscillator is also embedded on the board. A USB connection is available for its connection to computer for communication. Power jack is there to provide power via DC source. An in-circuit serial programming header, and a reset button are also available .This piece of machine has all the elements mandatory to the functioning of a microcontroller. Itprovides the facility of connecting with a system through a cable or a power supplied facility backed by an ACto-DC adapter. It can be used for recharging of the machine as well as for the purpose of recharging of it. C Control design three modes of operation were used to run the ventilator. These three modes were infant, child and adult modes. Speed and pressure of each of them were different because respiratory requirements for different age groups are different. These requirements are described in the form of table below.

Mode of operation could be triggered by only pressing the desired mode button. If someone wants to use the infant mode he will have to additionally change the Ambu Bag also. Because these bags are different for adults and infants.

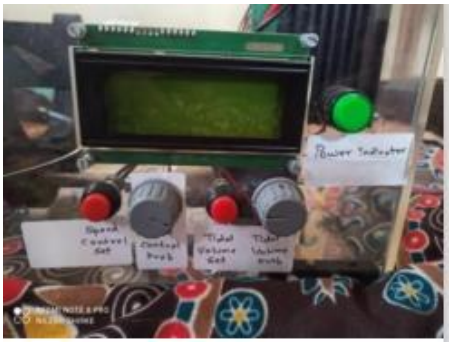
C Motor-

In the initial experiments we tried to use a stepper motor. But that motor was unable to provide the required torque to operate the two side arm push mechanism of the ventilator. So we switched to a DC

gear motor that was operating on 12 Volts DC voltage. This motor at full load was taking only 1.8 Amperes current.

D User Interface

Power on/off button along with three buttons for mode selection are provided. These buttons are labelled properly for their functions. A LCD in installed at the front panel of the ventilator. Mode of the ventilator is continuously displayed on the LCD.



F. Measures and inclusions of safety and protection In order to make sure that the patient is secure from any kind of injury caused by the machine, pressure being produced by the airway is monitored with an analog pressure sensor with is attached with the output of the bag. Beside this an alarm is connected for battery low indication. If the battery is low below the threshold value it triggers the alarm alerting the responsible personals to check and monitor the patients by their selves

G .Power Delivery–

For initial testing a constant 12 volts were applied from the power supply. On prototypes a 12 volts LiPo battery was used. A DC adapter was also provided so that the ventilator can be directly operated from the main power supply (220 volts).

Testing of battery as the prototype is believed to be operational with a battery, so testing of battery was an important element. It was done upon a test lung, it was provided with the continuous power until the battery voltage is dropped at dead level and operations of the device is no more possible. The device was set at maximum volume and BPM rate (35 breaths/minute). Two hours and fifteen minutes as the time period at which the battery was exhausted.

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Software Requirements-

Arduino UNO The most common version of Arduino is the Arduino Uno. This board is what most people are talking about when they refer to an Arduino. In the next step, there is a more complete rundown of its features. Before you can start doing anything with the Arduino, you need to download and install the Arduino IDE (integrated development environment). From this point on we will be referring to the Arduino IDE as the Arduino Programmer. The Arduino Programmer is based on the Processing IDE and uses a variation of the C and C++ programming languages.

Coding For Ventilator–

#define echoPin 7 // Echo Pin
#define trigPin 6// Trigger Pin
#define LEDPin 13// Onboard LED
#define buzzer 3
#define motor 9 long duration, distance;
// Duration used to calculate distance intultra_sense = 0; longcritcal_distance; longbuzzer_distance;
void setup() { Serial.begin (9600);

Serial.println("Serial_connected"); delay(100); pinMode(trigPin, OUTPUT);
pinMode(buzzer, OUTPUT); pinMode(LEDPin, OUTPUT);
pinMode(echoPin, INPUT); pinMode(motor, OUTPUT); digitalWrite(buzzer, LOW);

{ultrasonic(); check_obstacle();
// analogWrite(motor, 254);
// analogWrite(buzzer, 254); // delay(500);
// analogWrite(motor, 0); // analogWrite(buzzer, 0);
//delay(300); } void ultrasonic()
{ /* The following trigPin/echoPin cycle is used to determine the distance of the nearest object by bouncing soundwaves off of it. */ digitalWrite(trigPin, LOW); delayMicroseconds(2); digitalWrite(trigPin, HIGH); delayMicroseconds(10); digitalWrite(trigPin, LOW); duration = pulseIn(echoPin, HIGH);
//Calculate the distance (in cm) based on the speed of sound. distance = duration / 58.2;
//here we will get the distance measured by sensor if (distance > 400) { distance = 400; } Serial.print("distance="); Serial.println(distance);
//delay(100); }
voidcheck_obstacle() { if (distance <= 60)
{ critcal_distance = map(distance, 2, 60, 254, 0);
analogWrite(motor, critcal_distance); Serial.print("critcal_distance ="); Serial. Println(critcal_distance);
// if (distance < 30)
// { // buzzer_distance = (distance + 70); // }
// else // { // buzzer_distance = (distance + 150);
// } if (distance > 50 && distance <= 60)

```
{ buzzer distance = 370; } if (distance > 40 && distance <= 50) { buzzer_distance = 300; } if (distance
> 30 && distance <= 40) { buzzer_distance = 170; } if (distance > 20 && distance <= 30)

{ buzzer_distance = 110; } if (distance > 10 && distance <= 20)
 { buzzer_distance = 75; } if (distance > 2 && distance <= 10)
 { buzzer_distance = 35; }
digitalWrite(buzzer, HIGH); delay(buzzer_distance);
digitalWrite(buzzer, LOW); delay(buzzer_distance);
digitalWrite(LEDPin, HIGH); delay(buzzer_distance);
digitalWrite(LEDPin, LOW); delay(buzzer_distance);
} else
{ analogWrite(motor, 0);
AnalogWrite(buzzer, 0);
}
}
```

VI. CONCLUSIONS

Our ventilator has demonstrated efficacy in high-fidelity simulations to ventilate adults and pediatric patients alike with a range of pulmonary disease. Though it was conceived in the setting of the Covid19 pandemic, the applicability of this model may be far reaching, specifically for resource-limited communities. In end, the proposed novel gadget for mechanical ventilation, monetarily built of promptly accessible clinic supplies, has vigorous ventilator capacity and adaptability to address the range of pneumonic sickness in both the pediatric and grown-up populaces grown-up and pediatric reasonable for crisis and low-asset settings. This venture has nitty gritty the development of a practical, low cost, and open-source mechanical ventilator. The creators' commitment to this theme intends to alleviate the impacts of this overall ventilators deficiency a stunning, awful occasion that hits hard denied regions This task has shown a mathematical strategy that can screen, continuously, regardless of whether the patient has a solid or unfortunate aspiratory condition . This helpful yet clear mathematical strategy opens up the possibility of applications in other mechanical ventilators as well. In summary, this paper contributes to both fronts—theory and practice. Alarms can be included in this project, using either an alarm screen or speakers, like the ones that alert clinicians when the pressure reaches some threshold values.

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