Cost Effective Smart Ventilation System for COVID-19 Pandemic

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Abstract: **Medical term for artificial ventilator is electrical ventilator, in which an electrical motor replaces spontaneous breathing, which may necessitate the use of a ventilator. Manual compression of the Ambu bag can help with breathing. Engineering and architectures must be guided by current rules for the realization of every project. And we must check whether the parameters given is sufficient or not. From this cost-effective ventilator system comes into play. For treating covid-19 particularly in nations like India where we have large population there is a moment necessity of cost-effective ventilators which can operate with sufficient functionality to cure Covid patients. This paper describes the design of cost-effective ventilator system which detects oxygen level, body temperature and pulse rate.**

Keywords: **Artificial ventilator, Electrical ventilator, Electrical motor, Ambu bag.**

1. Introduction

The covid-19 epidemic wreaked havoc on the planet in 2020, spreading swiftly and killing tens of thousands of people in a matter of months. The number of deaths in the region climbed fast as the number of individuals in need of hospital care increased. Acute respiratory distress syndrome (ARDS) is a disorder that can be addressed with electrical ventilation in many of the covid-19 patients. Many healthcare experts believe that getting enough sunlight and fresh air to breathe is critical, but this is challenging for people who live in densely developed places or flats nowadays. This is the reason why ventilator exits. Some of the best ventilator service providers are HVAC [1] contractors in Edmonton. Ventilator system are one of the most important features in any type of construction, and also several studies have shown that ventilators play a significant function in both persons and structures. Modern heating and air conditioning (HVAC) services are replacing traditional ventilation systems. Ventilators are one of the most crucial devices for keeping Covid-19 patients alive in life-threatening situations. Ventilators can also be used to lower the risk of a variety of health problems, such as asthma, allergies, and headaches. Because the demand for ventilators is increasing every day, and there is a shortage of ventilators in our country, and because caring for patients is a huge task in these difficult times, the portable rechargeable Battery operated ambu bag compressing machine was created, which sends real-time messages about the patients to the doctor and other medical authorities.

And this cost-effective ventilator system has been improved by adding various new features like detecting oxygen level, body temperature and pulse rate where, it can be utilised in hospitals for emergency situations, such as isolation wards. In accident zones and in rural areas as well. Currently world is facing shortage of ventilators so this cost-effective ventilator plays a very important role.

2. Literature Survey

A. Survey Paper 1

T. Arun Prasath, D. Deebaa, R. Vigneshgandhi, R.S Sivatharshini Raj, and G. Vishnuvarthanan published a journal paper on Smart Ambu Bag Using Electronic Devices in which Smart Ambu Bag was built. This acts like a Ventilator in a Hospital but in a small size which takes less space and Human Resource as compared to original Ventilator System.it takes less time and supplies exact amount of oxygen at an emergency period. For a long time, ventilation system cannot give exact amount of oxygen for a patient. In this proposed system a smart ambu bag which gives oxygen automatically to a patient or a person who is suffering to breath. Human resources are not required for inlet of oxygen to body.

B. Survey Paper 2

Mohammed shuaib khan, Mohammed faraaz ur rahaman and Mohammed yousuf khan published a journal paper on as the global demand for ventilators is increasing and there is a shortage of ventilators in our country, on IoT Based Low Cost Ambu-Bag Compressing Machine for Low Cost Ventilator in which Portable rechargeable battery operated Ambu bag compressing machine that provides real time cloud messages to doctors and other medical authorities about the patients We have built a prototype and are now implementing new features to improve its performance. It can be utilized in hospitals. This undertaking is unique.

3. Proposed Methodology

The power supply is connected to the Arduino which converts 230v AC–12V DC. And power supply is the combination of Voltage Regulator, Transformer, Rectifier and filter.

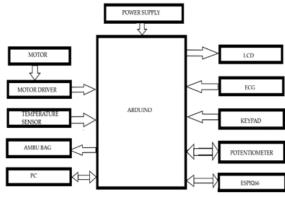*Corresponding author: jananiani056@gmail.com

Fig. 1. Block diagram of proposed model

Voltage Regulator is used to maintain a constant voltage, transformer is a device which transfers electric energy from one circuit to one or more other circuit, Rectifier converts AC to pulsating DC and Filter stores an energy and remove unwanted noise in the signal. Arduino is connected to 16*2 LCD display, where it represents 5*8-pixel box. The AD8232 Spark fun single lead heartrate monitor is a low-cost board that measures the electrical activity heart. This electrical activity can be shown as an ECG (Electrocardiogram) and read as an analogue readout. Keypad is also known as switch buttons, here pulldown push buttons are used. ESP8266 is a wi-fi chip with built in TCP or IP [2,4] networking software. Motor driver can drive 2DC (12volts) motors which is used for speed and direction control i.e., it can be used to rotate clockwise and anticlockwise direction. Arduino is an open-source microcontroller board which is based on ATmega328p. Arduino consists of 28pins where 20pins are used as general purpose (GPIO) pins and rest of the pins are used as input-output pins. Operating voltage of Arduino is 5volts and its input voltage is 7v-12v.

0 and 1 is used as UART (universal asynchronous receiver transmitter).

Pins which are used for the communication between the devices that are connected. And there are 6 PWM (pulse width modulation) pins which can vary the intensities, they can also act as digital input-output pins.

Temperature sensor MLX90614 is used for non-contact temperature measurement. Bag Valve Mask i.e., Ambu Bag is handheld device used to provide positive pressure ventilation to patients who are not breathing adequately.

Potentiometer is connected to Arduino to give its varied oxygen level input to display it on the lcd screen. Since oxygen level cannot be varied in human body, dummy patient with potentiometer is used to vary oxygen level in a dummy patient and display the measured oxygen level on LCD.

The regulator lowers the pressure of high-pressure gas from oxygen and medical air reservoirs to 6 bars before delivering it to the ventilator. The proportional valve regulates the amount of air delivered to the patient in terms of volume and pressure. When the expiration valve opens, the patient is able to exhale the breath he or she has taken in. The Arduino UNO is used to read sensor data and control the motor. The software needed to manage the ventilator and present the results on a system display is stored in the embedded computer system. Based on the patient's pulse and oxygen saturation, the embedded system also features fuzzy-logic based software that calculates the oxygen rate and frequency of the air to be delivered to him.

4. System Requirements

A. *Software Requirements*
- Operating System: Windows7/8/10
- Language   : Embedded C
- Tools   : Arduino IDE
- Libraries   : Blynk, ESP8266

B. *Hardware Requirements*
- Arduino
- ESP8266
- Motor
- Motor Driver
- Temperature Sensor
- Power Supply
- Ambu Bag
- LCD
- Keypad (push buttons)
- ECG
- Potentiometer

5. Design and Implementation

Motor connected to motor driver is used to pump oxygen automatically when oxygen level in patient's body decreases below 50, by rotating motor in clockwise and anti-clockwise direction. The input of the motor driver for its movement is monitored by Arduino through programming. Temperature sensor [6,8] is used to sense the body temperature. The measured body temperature value is fed as input to Arduino to display the output on the LCD. The Arduino containing program guides the Ambu bag to pump oxygen and stop it when the oxygen level in the human body becomes normal. The ECG which is connected measures the heart rate of the patient and displays the measured heart rate waveform on the PC screen. ESP8266 a wi-fi model is used to send the notification as "OXYGEN LEVEL IS LOW, OXYGEN IS PUMPING" to the respective patient's care taker through Blynk app. Since we can't vary the oxygen level in human body for the purpose of project, we have selected an alternative way by using potentiometer. By using potentiometer, we will vary the values of oxygen level and make our Ambu bag pump oxygen. Pushbuttons or Keypads are used to change the parameters that has get displayed on the LCD.

6. Results

The normal oxygen level in Human body is 50-60. When it goes below 50 persons cannot breathe adequately. At this time Ambu Bag pumps automatically to provide adequate Oxygen to the human body. To send a notification to a concerned person of patient about his health condition we have used Blynk app. this app sends a notification as "OXYGEN LEVEL IS LOW, OXYGEN IS PUMPING" when oxygen level is low, when it

comes to normal it sends notification as "OXYGEN LEVEL IS NORMAL" and stops pumping. Fig. 2 shows, "oxygen level is normal", Fig. 3 shows "Ambu bag is pumping when oxygen level is low", Fig. 4 shows "Notification sent to mobile phone through Blynk app", Fig. 5 shows "the measured value of oxygen that is   been displayed on LCD", Fig. 6 shows "Heart rate waveform of a patient".
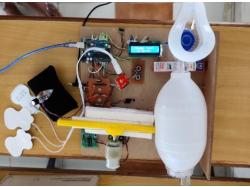

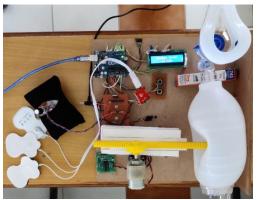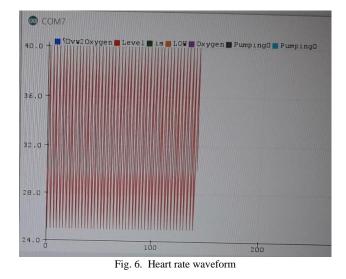Fig. 2.　Oxygen level is Normal

Fig. 3.　Oxygen level is low and oxygen is pumping

Fig. 4.　Notification sent to mobile phone through blynk app

Fig. 5.　Measured value of oxygen is displayed on LCD

Fig. 6.　Heart rate waveform

7. Advantages and Disadvantages

Advantages:
1. It's a cost-effective ventilator system.
2. It pumps oxygen automatically to the patient body.
3. It measures heart rate, oxygen level and body temperature in a single ventilator system.

Disadvantages:
1. It increases cost of electricity during installation.

8. Conclusion

In the proposed system, the measurements of temperature sensor, ECG is converted to electrical signals and displayed on lcd and oxygen is pumped automatically into a patient body using motor and motor driver which doesn't need any human resource.

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