Respirator for Patient with Variable BPM & Oximeter

Chinmay Kulkarni[1], Chirag Pakhare[2], Manali Patil[3], Kiran Napte[4]
[1,2,3]*Department of E&TC, PCCOER, Ravet, Pune, India*
E-mail: [1]kulkarnichinmay86@gmail.com, [2]chiragpakhare7744@gmail.com, [3]manalipatil1971@gmail.com, [4]kiran.napte@pccoer.in

Abstract -***The article describes the development of a cost effective, automated portable respirator that delivers breaths using a conventional ambu bag that eliminates the need of a human operator. It's a portable mechanical ventilator that delivers breathing using a standard ambu bag. The paper shows that this design can be utilized for mass casualty cases such as covid-19 in recent scenario and other poor resource environments. This system firstly measures the oxygen levels of the patient and accordingly the user can set a particular value through breath per length and breath per minute nodes, these values are pre-set for a certain amount of oxygen levels and should be accordingly set while using hence to take the maximum benefit of the model. In addition, the system includes a pressure sensor to measure the overall pressure within the system so as to provide more vital information regarding a patient's health. After all, values are set as per standard requirements for machine according to which the motor within the system gets activated through microcontroller making ambu bag press, and providing the necessary air to the patient.***

Keywords:cost effective, automated, ambu bag, mechanical, ventilator, covid-19, BPL, BPM, sensor.

I. Introduction

This invention leads to the field of biomedical engineering. This invention relates to the design of a low-cost ventilator system that could be used for the initial phase of treatment of a patient in case of emergency. Particularly, this invention has an oxygen measuring device namely an oximeter and an Ambu bag.

Aside from the usual features of a respiratory system, this device, can also be used for monitoring a patient's vitals. It also has some added features to change the power of the device by varying breath per minute and breath per length (in short per minute push to the Ambu bag and amount of air to be pushed) making is more helpful.

III. PROPOSED METHODOLOGY

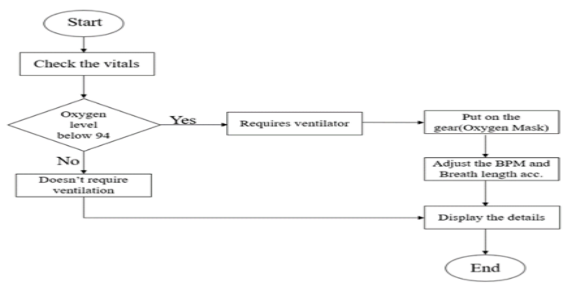

Fig 2. Flowchart Diagram

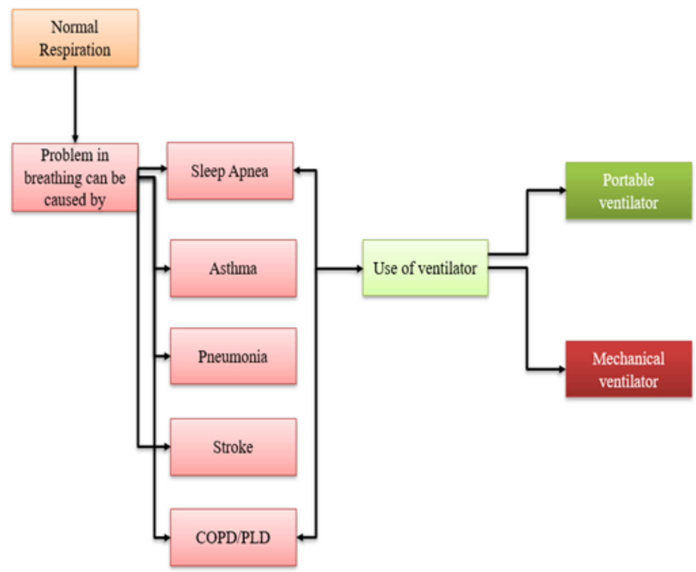

Fig 1. Use of ventilator chart

II. BACKGROUND

As it's known the ventilator has played a huge role during the recent covid-19 situation making it a need in recent times. The ventilator was reliable and simple to use, and performance was within acceptable limits in the anaesthetized patients. However, we recommend that a means of verifying the adequacy of ventilation should always be used when transporting critically ill or anaesthetized patients with any portable ventilator, particularly when lung compliance or airway resistance may be abnormal [1]. But, due to the complexity of the previous products and their high cost, they cannot be mass-produced in mass production. This could be a huge issue for a patient during the initial phase of treatment without any maintenance personnel. Maintenance personnel are persons who are responsible to the operating company for the maintenance of the product. Maintenance personnel are persons authorized to install, reprocess or maintain the medical device [2]. Based on the findings of a study, it was seen that to overcome such a problem the medical community urgent need is to have a portable, low-cost, fast production, and easy to use a portable respirator.

Above flowchart as shown in Fig. 2 depicts the structural flow of the project/system. The first step involves providing the power to the controller, then moving on the sensors get activated which as oximeter and pressure sensor in the system. The sensors check the vitals which means to check oxygen level as well as the pressure generated within the system.

In this we secondly have to decide if patient needs ventilator or not according to values shown by sensor, in which if the oxygen level is less than 94% than ventilator is needed.

After, gathering the output of sensors it first gets displayed on the lcd screen then the user has to accordingly decide at what values the breath per length and breadth per minute has to be regulated according to standard values.

IV. PRIORART

Earlier the devices made in this field were only able to provide a constant phase of air with a particular amount set per push without any variations or power change, also few others having variable parameters were eventually available at a higher price. Whereas the present portable respirator provides variable parameters such as breath per minute and breath per length which makes the provision of air, uniform and available as per requirements.

V. DIAGRAM

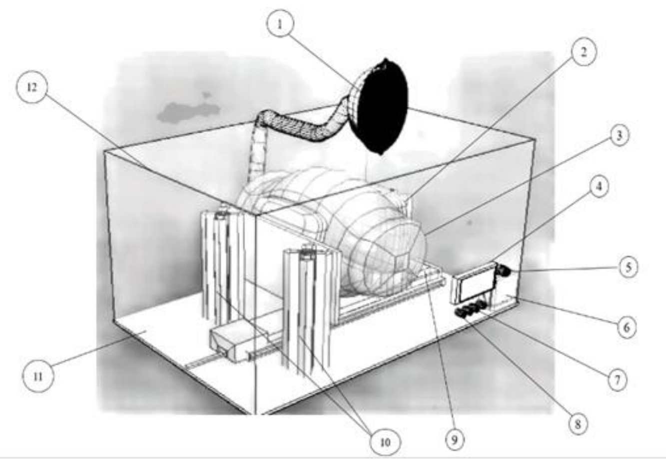

Fig 3. 3-D model of portable respirator

A. COMPONENTS:

OXYGEN MASK-

The use of a breather mask is to focus the air pushed from the BVM bag to the nose of a patient with any loss of air at that point.

PUSH MECHANISM-

This mechanism is implemented to make the pushes on the Ambu bag so that air gets pushed to the oxygen mask as per values set using BPL & BPM nobs.

BVM (BAG VALVE MASK)-

A bag valve mask is a device that's used to provide positive ventilation to individuals who are not breathing or have respiratory issues.

LCD SCREEN-

The display used in the project is an LCD display. LCD stands for liquid crystal display. LCD display size 16x2 is been used to indicate the live status of a patients vital after-processing values through an oximeter.

LED-

The led has been implemented in the system to indicate that the system is in working mode after the power supply has started.

LEAD ACID BATTERY-

The lead-acid battery is used to power the whole system as well as due to the rechargeable feature available in it, it can also be used in case of power failure.

NOBS (BPM & BPL)-

Nobs in the available system does the controlling of breath per minute (BPM) and breath per length (BPL) as per standard values given, hence making the BVM bag press accordingly.

MICROCONTROLLER (ATmega8a BOARD)-

The Arduino Uno is an open-source board that uses the ATmega8a microcontroller. It features a built-in digital and analog output pin that can be used with various expansion boards.

PRESSURE SENSOR-

A pressure sensor is a device that measures the pressure exerted on a liquid or gas to prevent it from expanding. The force is usually expressed in terms of force per unit area.

OXIMETER-

A pulse oximeter is a vital checking device which helps to indicate the oxygen level of patients. It does so by sending an infrared light through the capillaries in your finger and after which the amount of light which gets reflected off helps to indicates the level.

SUPPORT BAR-

This support bar makes the whole system stay intact during the pushes made in the push mechanism hence acting as a support part in the system.

BASE BOARD-

The system is structured or fully implemented on this board so as to get a firm base and make the whole system stable while working

OUTER CASING-

The casing is done to protect the inner structure of the system so that it doesn't get tangled and remains dust-free will be in use at the time of treatment.

B. BLOCK DIAGRAM:

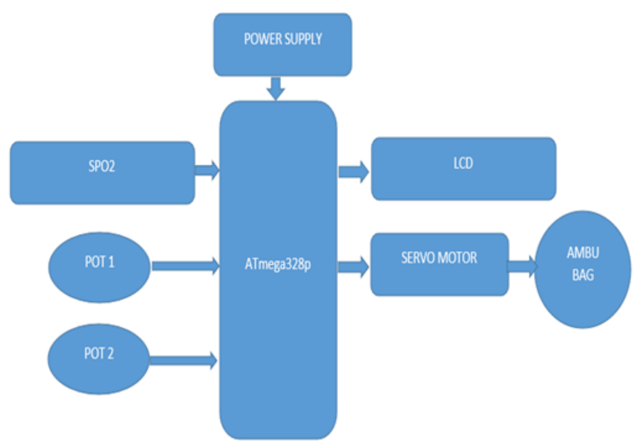

Fig. 4 Detailed Block Diagram

C. ALGORITHM:

Step 1. Initialize Phase

Initialize Microcontroller (Atmega328p)

LCD Initialization.

Initialize Oximeter

Step 2. Check oxygen level (O_2) using an oximeter

Step 3.

if O_2< Standard oxygen levels

go to Step 4.

else O_2> Standard oxygen levels

go to Step 8.

Step 4. The patient needs a ventilator due to less oxygen (O_2) levels.

Get the gear on.

Step 6. Adjust breath per minute (BPM).

Set the BPM in range 5 – 30.

Step 7. Adjust breath per length (BPL).

Set the BPL in range 0 – 100.

Step 8. Display the details.

Display the oxygen level.

D. WORKING:

This innovation will now be described in relation to the accompanying drawings, in which portable respirator for the patient using variable breath per minute/length with an oximeter device.

The ambu bag acts as the main component to pump the oxygen which is driven by DC motor which is pushed as per the bpl and bpm set through the potentiometer values given at the beginning of the project.

In this system we are going to include oximeter which detects the oxygen level and we have also included pressure sensor to monitor the necessary vitals of the patient. The monitored values are displayed on LCD screen. Mainly the vital checking components check whether the patient is having proper vitals beforehand getting the main treatment. In this system we are going to use microcontroller to get appropriate output results.

E. PROPOSED METHODOLOGY:

1. Human Lungs Working –

So, humans' breath in a reverse mechanism which means negative pressure drives inhalation. We breath by contracting our diaphragms which expands our chest cavities. Now, there are various elements/body parts that take part in this mechanism.

Firstly, the wind pipe from nose than comes the trachea which pushes the air in bronchi from which further air moves to bronchioles which are tiny long shaped air stream veins that are connected to alveoli. Alveoli inside the lungs inflates due to air pressure. Here alveoli are a small balloons filled with mesh of blood-filled capillaries. This capillary absorbs the oxygen from alveoli and leaves behind the carbon dioxide and other gases.

1. Project Working –

In this project we have used an ambu bag which is been pushed by the servo motor and which can vary or can be adjusted at a particular power according to the values set by the potentiometer. But firstly, the whole system checks the vitals of patient through the oximeter and pressure sensor and then according to standard values we can give inputs to vary the bpl and bpm after which the servo motor accordingly it presses the ambu bag. The output or the air push through the ambu bag is passed to patient by a ventilation pipe.

F. COMPONENT IMAGES:

Fig 5. MG995 SERVO MOTOR

Fig 6. AMBU BAG WITH RESERVIOR BAG

VI. CONCLUSION

This device has been made to help the patients with breathing problems and assist them in the crucial phase of treatment. This reliable and cost-effective device can be produced in large scale to assist in emergency times. Main focus of this project is to make it cost effective as well as also making it comfortable and easy to use with proper instructions. Atmega328p has been used which is easy to burn and push the code to it.

VII. REFERENCES

1. McCluskey A, Gwinnett CL. Evaluation of the PneupacVentipac portable ventilator: comparison of performance in a mechanical lung and anaesthetized patients. Br J Anaesth 1995; 75: 645 –50.
2. Dra¨ger Medical. Oxylog 3000 Emergency and Transport Ventilator—Instructions for Use. 2nd Edn. Hemel Hempstead: Dra¨ger Medical UK, 2002
3. Austin PN, Campbell RS, Johannigman JA, Branson RD. Work of breathing characteristics of seven portable ventilators. Resuscitation 2001; 49:159–67.
4. Emergency Care Research Institute. Portable/Transport Ventilators. Health Devices 2004; 33: 381–401.
5. Lowes T, Sharley P. Oxygen Conservation during long-distance transport of ventilated patients. Air Med J 2005; 24: 164–71.
6. Martin T. Aeromedical Transportation—A Clinical Guide. Aldershot, Hampshire: Ashgate Publishing Limited, 2006.
7. Taylor, L. The pandemic's new centre. New Sci. **2020**, 246, 12–13.
8. Fitzgerald, D.A.; Maclean, J.; Rubin, B.K. COVID-19 pandemic: Impact on children, families and the future.
9. Paediatr. Respir. Rev. **2020**, 35, 1–2.
10. Baqui, P.; Bica, I.; Marra, V.; Ercole, A.; van der Schaar, M. Ethnic and regional variations in hospital mortality
11. From COVID-19 in Brazil: A cross-sectional observational study. Lancet Glob. Health **2020**, 8, e1018–e1026.