

Low Cost Portable Ventilator for Rural Area

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ABSTRACT

The paper focuses on the study and design of proposed low cost portable ventilator specially meant for rural area. This portable mechanical ventilator is Arduino-based with a connected motor driver and having a Max 301000 sensor which is an oximeter and heart rate monitor sensor. Arduino gives the output given by the motor driver to the DC motors, MAX 301000 sensor, and the display. It is driven by an electric motor powered by a Power supply and features an adjustable tidal volume of up to 750 ml. Tidal volume and number of breaths per minute are set via user-friendly input knobs of the motor driver. Through this design of portable ventilator, the idea of compressing Ambu bag is proven to be convenient to give a low-cost portable ventilator at a fraction of the cost of existing technology. The ventilator delivers breaths by compressing a conventional bag-valve-mask (BVM) with two 12V DC motors, eliminating the need for a human operator for the BVM (Also called a self-inflating bag).

Keywords: Portable, Covid-19, low-cost, Bag-valve mask, Ventilation, Low Power.

1. INTRODUCTION

Respiratory diseases like covid-19 and injury-induced respiratory failure make a big impact on public health problems in both developed and less developed countries. Covid-19, Asthma, chronic obstructive pulmonary disease, and other chronic respiratory diseases are widely spread diseases across the world. These types of diseases are mainly caused by air pollution, smoking, and burning of biomass for fuel, all of which are on increasing in developing countries also the covid-19 which is spread by air medium or community transmission is very dangerous for human beings. Patients which are undergoing lung disease may have a respiratory failure under various circumstances and challenges can be more in case do not get support by mechanical ventilation. These machines mechanically assist the patient inspires, oxygen level, and exhale, allows the exchange of oxygen and carbon dioxide to be done within the lungs. The process of inhalation of oxygen and exhalation of carbon dioxide is referred to as artificial respiration. While the ventilators which are used in modern hospitals are highly reliable, functionally, and technologically sophisticated, their acquisition costs are correspondingly very high. High costs of technologically sophisticated mechanical ventilation

prohibitively expensive for use in resource-poor and less developed countries. Additionally, these ventilators are often delicate and vulnerable during continuous use, requiring costly service contracts from the manufacturer. In developing countries, this problem is overcome by such as sharing of ventilators among hospitals and purchasing less reliable refurbished bed units. Since the medical resources in these countries are concentrated in the major urban center areas, in some cases rural and remote areas have no access at all to the mechanical ventilators. The need for an inexpensive transport ventilator is therefore high-priority. The need for mechanical ventilation is one of the common causes of admission to the intensive care unit.

Ventilation is an Exchange of air between lungs (Exchange of air in the other word is the process of moving air in and out of the lungs). Its most important effect is the removal of carbon dioxide from the body. This is basic ventilation, but we recognize the global interest when a hospital has used up all ventilators and the only option is manual bagging a patient. We hope that such a system may serve as bridge devices and help with the urgency of the ventilators of available respirators and clinicians trained in respiratory therapy. This may allow less severe patients to be cared for by less specialized clinicians, while resources are focused on those who need it most. However, at no time patient should be unattended without someone skilled available to directly monitor their vital signs and suggest further. We are going through a very bad phase as the surge of covid19 is increasing day by day and all beds are fully occupied and there is also lack of oxygen as there is a number of patients are very big. In the developed world, where well-stocked medical centers are widely available, but this problem is of a different nature. While there are enough ventilators for regular use, there is a lack of preparation for cases of mass casualty such as influenza pandemics, natural disasters, and massive toxic chemical releases, and currently ongoing covid19. One example of this shortage that occurred is the ongoing covid19 pandemic when there were insufficient numbers of ventilators, and personnel needed to be forced to resort to manual BVM ventilation. However, considering the low number of stocked ventilators and their current high cost, there is a need for an inexpensive portable ventilator for which production can be scaled up on demand and help to fight a pandemic [4].

2. RELATED WORK

Versatile ventilators are utilized to convey room air or oxygen-improved gas into the breathing circuit, where it very well may be humidified by a warmed humidifier or warmth and dampness exchanger before conveyance to the patient from the oxygen pipe. This provides long-term support for patients who do not require complex critical care ventilators. It can also be used as first aid in emergency conditions. Lot of research is done on portable ventilators. Some of the researches on portable ventilators are given below

The “Prana Vayu” low cost Ventilator developed at IIT Roorkee is a closed-loop ventilator. It is minimal effort, protected, dependable and simple to use as it is furnished with constant spirometry and cautions and can be immediately made. Also, it doesn't need compacted air for working and can be particularly valuable in situations when medical clinic wards or open zones are changed over into ICUs. It can consequently restrict high-pressing factors with an alert framework. If there should arise an occurrence of a disappointment, the circuit opens to the climate, which forestalls gagging. Some extra highlights are far off checking by wellbeing experts, contact screen control of every working boundary, moisture, and temperature control for inhaled air.

Portable Low-Cost Ventilator “DEVEN” designed by Harminder Singh Johar and Kuldeep Yadav is a dependable, convenient, and easy to use ventilator planned and created by those researchers of Dr. APJ Abdul Kalam Rocket Complex, RCI, DRDO, Hyderabad. It highlights practically identical to very good quality ventilators and would serve the prerequisites of an enormous number of ventilators under the present Coronavirus pandemic circumstance. Additionally, it is being a compact ventilator can be utilized in field applications utilizing a convenient air blower and repository. Subsequently, it may be utilized in a rescue vehicle, any portable vehicle, or for application in any remote/rural area [7].

“MADVent” is another low-cost ventilator designed by Acute Ventilation Rapid Response Taskforce (AVERT) for patients with Covid-19. The Covid-19 pandemic has created basic deficiencies of ventilators around the world. There is a neglected requirement for quickly deployable, emergency-use ventilators with adequate usefulness to oversee Covid-19 patients with extreme intense respiratory pain disorder.

The paper on Design and Prototyping of a Low-cost Portable Mechanical Ventilator by Massachusetts Institute of Technology, Department of Mechanical Engineering Boston University, School of Medicine portrays the plan and prototyping of an easy versatile mechanical ventilator for use in mass setback cases and asset helpless conditions. The ventilator conveys breaths by compacting a regular bag valve mask (BVM) with a turning cam arm, disposing of the requirement for a human administrator for the BVM [4].

Design of Efficient Low-cost Ventilator for Emergency COVID19 Patients By Rouf-ul-Aalam et.al. proposed the plan of a ventilator which can be handily produced and incorporated into the emergency clinic climate to help Coronavirus patients. The unit is intended to help standard ventilator methods of activity, above all SIMV-PC (Synchronized Irregular Compulsory Ventilation) mode [12].

3. DESIGN/BLOCK DIAGRAM

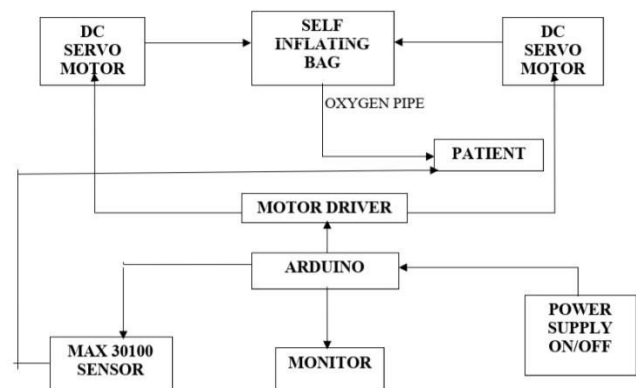


Fig.1 Block diagram of portable ventilator

4. ADVANTAGES OF PROPOSED SYSTEM

The available ventilator prices are extremely high also the portable ventilator that is available in the market is very good value for money, but our portable ventilator will cost lower than that. For example, ‘prana Vayu which is a closed-loop ventilator is designed by the IIT Roorkee costs around ₹25000/- which is equipped with state-of-the-art features which makes it more advance but our portable ventilator will be available around ₹10000/-. The other low cost and portable ventilators which is available in the markets are low cost and advanced too but our product is very handy to use, reliable and can easily be handled by anyone without having proper knowledge of it and a common can use it as first aid at their home or working place. It will help the patients to get adequate oxygen and will clear the carbon dioxide. The compression technique which we use will cost exceptionally low for services as compared to other portable ventilators which are available in the market. Our portable ventilator will provide a continuous supply of fresh outside air to the patients. This portable ventilator can be driven either by a power supply or the battery supply as other ventilators will only work on a power supply or only battery supply. The portable ventilators give room air or oxygen-enriched gas into the breathing circuit to give adequate oxygen.

5. DRAWBACKS OF OUR SYSTEM

As there are very overly complex, functionally, technically fully equipped sophisticated ventilators available in the market. We cannot match the highly efficient service given by those ventilators. Those ventilators use costly and technically strong equipment's to give prior result but in our, we are trying to make this ventilator cheaper as much as we can for that we didn't use high technologies or costly equipment's so maybe the reliability of this portable ventilator is less as compared to other portable ventilators or the fully equipped high-cost ventilators. Also, this portable ventilator we can't use on severe patients as there is no facility to give acute compressed oxygen which is the requirement of the severe patients.

6. PROBLEM ADDRESSED

In a surge of a covid-19 pandemic, there are lots of casualties occur due to the lack of ventilator beds and lack of oxygen supply. In an emergency if a patient at home there is no way to provide ventilation to that patient until we shift them to the hospital but that span of time is very crucial for that patient if proper ventilation is not given to the patient there is chances of increase in problem to their health or maybe sometimes casualties also happen. In a rural area or say remote area there are no modern hospitals and there is not a convenient source to help them. This is not only for covid-19 patients, but other patients also face this type of problem. The ventilators are awfully expensive too and need proper expert servicing to work smoothly which increases its expenses.

7. AIM & OBJECTIVE

To overcome this problem, we must design a Portable ventilator that will help to get adequate oxygen to the patient. Our purpose to build this ventilator is to make it available for everyone that too at cheaper prices. Which will act as first aid for the patients and reduce the number of problems and casualties. Ability to give proper ventilation in acute respiratory distress syndrome to the patients. To provide the lowest possible cost for adequate oxygenation and ventilation. It will have open-source compatibility which will allow anyone to recreate this system. This portable ventilator is convenient to use in a remote area where ventilators are not available and helps them to give at least proper ventilation until they reach the hospital.

8. CONCLUSION

In conclusion, when we examine the available data and observe the environment it appears that one-third of patients admitted to

the ICU will receive mechanical ventilatory support more than 12 hours [13]. The reason for initiating mechanical ventilation will be an acute respiratory failure in 2 out of every 3 cases. So in such situations, it can be seen that the ventilator plays a vital role but in rural areas, remote areas, and also patients at their home are unable to get proper ventilation until they go to the hospital, for that we design a low-cost portable ventilator.

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