International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Automation of Mechanical-Based Blood Oxygen Level Ventilator Using Arduino

[1]Gnanasekaran. S, [2]Ashwinraj. M, [3]Naveenkumar. S, [4]Parveen Kumar. R , [5]Prasannaa.V

[1,2,3,4,5]Department of Mechanical Engineering, Sri Shakti Institute of engineering and Technology, Chinniyampalayam, Coimbatore

ABSTRACT

This paper describes the development of a compact automated bag valve mask (BVM) compression system which could be used as a temporary emergency ventilator amid acute shortages and supply chain disruptions. The resuscitation system is built on an Arduino controller and a real-time operating system on a mainly parametric component-based structure. The materials are affordable, allowing manufacturers all around the world to create it. The device has a regulated breathing mode with tidal volumes ranging from 100 to 800 mL, breathing rates range from 5 to 40 breaths per minute, and an inspiratory-to-expiratory ratio range from 5 to 40:1. Because the object-oriented algorithmic approach, the system is designed for measurement circuit reliability and scalability through using serial peripheral interface. It has the capacity to link additional hardware. positive end-expiratory pressure, Peak inspiratory pressure , respiratory rate , tidal volume, proximal pressure, and lung pressure were tested on an artificial lung and indicated repeatability and accuracy in BVM-based manual ventilation that exceeded human capabilities. Further work is necessary to further develop and test the system when it can be used in clinical situations outside of emergencies such as COVID-19 pandemic. However, the design is that desired features are comparatively easy to add using protocol and parametric.

Keywords: Mechanical ventilator, covid-19, pressure sensor, health monitoring.

1. INTRODUCTION

Ventilators for patients who require assistance with breathing due to COVID-19's respiratory effects are one important device for which there is a demand. A ventilator is essentially a machine that pumps breathable air into and out of a patient's lungs to help them breathe. It also has a reliable blood oxygen sensor built in. Both inpatient and outpatient settings may benefit from pulse oximetry.

A small clamp-like device is placed on a finger, earlobe, or toe during pulse oximetry examination. A small amount of light passes through the blood in the finger, estimating the amount of oxygen present. It does so by calculating variations in light absorption in oxygenated and deoxygenated blood. Even though, during Covid pandemics, this stable and reliable and affordable mechanical ventilator. After developing this model, it is distributed and made available on the internet so that others can use it to create their own ventilator, even on a small scale. A mechanical ventilator is a life-support system that helps in critical ill or anaesthetized patients maintain adequate lung function; however, it can harm the lungs. The benefits and drawbacks of mechanical ventilation are determined not only by how ventilator parameters are adjusted, but also by how ventilator-derived parameters are interpreted and used to guide ventilatory strategies.The interaction of physical forces acting on lung structures during mechanical ventilation is at the heart of this process. The information generated from the mechanical ventilator (outputs or ventilator-derived parameters) can also be examined.

VT should be adjusted depending on P [Pplat-PEEP or VT/Crs (respiratory system compliance)]. Because Crs is proportional to lung volume, P represents the level of VT in relation to aerated lung volume. P, on the other hand, does not reflect VT in the presence of reduced chest wall mechanics. In this line, a patient with a stiff chest wall has less lung overinflation than one with a normal chest wall, given the same P. As a result, the difference in transpulmonary pressure between end-expiration and end-inspiration is known as transpulmonary driving pressure (PL).Ventilator In this line, a patient with a stiff chest wall has less lung overinflation than one with a normal chest wall, given the same P. As a result, the transpulmonary driving pressure (PL) (the difference in transpulmonary pressure between end-expiration and end-inspiration) should be assessed, and VT could be restricted to keep PL within safe limits.Mechanical ventilator is more expensive in medical field ,so we are automating the mechanical ventilator by blood oxygen level sensor using arduino at affordable cost,it is very helpful for poor peoples.

1.2. Objectives

Using Arduino, automate a mechanical blood oxygen level ventilator.

1.3. Scope

To make it easier to use traditional ventilators.
To provide an affordable option for patients who require ventilators.

2. LITERATURE REVIEW

A literature review is an evaluative report of information found in the literature related to the project's chosen area of study. This literature should be described, summarised, analysed, and clarified in the review. It should provide a theoretical foundation for future research. A review of literature is more than just a search for information, and it extends beyond a descriptive annotated bibliography. All works included in the review must be read, evaluated, and analysed.

It is physician, pressure-limited, and (normally) flow-cycled. Triggering difficulty during PSV is generally caused by intrinsic positive end-expiratory pressure.On the ventilator, the pressure support and pressure rise time (pressurisation rate) settings determine the airway pressure generated at the start of inhalation. On many current-generation ventilators, the rise-time setting is clinician-adjustable. The pressure support setting, the pressure generated by the respiratory muscles, and respiratory system mechanics all influence the amount of flow delivered during PSV.

The nursing care of the mechanically ventilated patient, according to Couchman et al., (2007): What evidence do you have? Nursing care and management of mechanically ventilated patients can be summed as For critically ill patients, mechanical ventilation causes a number of real and potential complications. ventilator care is effective in producing positive outcomes and consists of four interventions: bed elevation, premedication vacation, peptic ulcer prophylaxis, and deep vein thrombosis prophylaxis. Strong evidence for proving one care approach is better than the other is missing in the nursing care procedure. The best nursing care practise for mechanically ventilated patients is the use of evidence-based practise in conjunction with comprehensive and systematic patient care.Branson, et al., (2008) found that mechanical ventilation in a mass casualty respiratory failure situation will necessitate a significant increase in mechanical ventilation capacity to avoid unnecessary mortality. Only our lack of experience on which to base decisions outweighs our concerns about the difficulties of treating large numbers of patients with respiratory failure.

Ventilator waveforms, according to Lian (2009), provide real-time information about patient-ventilator interaction and ventilator function. You can track how a patient's condition changes from breath to breath, detect problems with mechanical ventilation, assess the patient's response to interventions, and adjust therapy as needed with this information. Unfortunately, most clinicians working at the bedside are unfamiliar with ventilator waveforms.

3. MATERIALS AND METHODS

The raw materials, tools, and important chemicals used in your experiments are referred to as the materials. Here you will detail all of the steps or procedures you took to accomplish the research goals, including experimental design and data analysis.

3.1. Conceptual Design

The conceptual design of automation of mechanical based blood oxygen level ventilator using arduino is shown in the fig 1

Fig 1 3D Conceptual design

3.2. Block Diagram

The block diagram of automation of mechanical based blood oxygen level ventilator using arduino is shown in fig 2

Block diagram

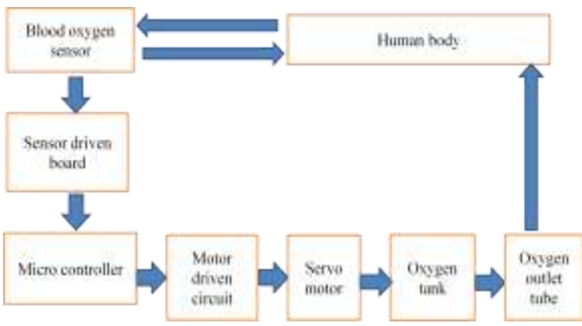

Fig 2 Block Diagram

System Analysis

The proposed system involves monitoring the patient's breathing. A ventilator, bpm, switches, and toggles make up the observation setup. The goal of this project was to create a low-cost ventilator using only one or two easily obtained parts in a timely manner.

B. System Design

The block diagram of an Arduino-based ventilator with blood oxygen sensing is shown in the diagram above. A medical ventilator was created using rapid prototyping techniques. A flow metre is used as an air reservoir to connect the unnatural physical respire element to the wall oxygen source.

C. Software Application

The motor executes cycles of dextrorotatory or anticlockwise rotations when the arduino code is run, ensuring that the mechanism is working properly.

3.3. Components description

(i). Arduino
(ii). Blood oxygen level sensor
(iii). Microcontroller
(iv). Printed circuit board
(v). LED
(vi). Pressure sensor

4. Arduino

Fig1 Arduino

Fig1 Arduino is an open source programmable embedded system that can be used in a variety of simple and complex marker space projects. This board includes a microcontroller that can be programmed to detect and control objects within the human body. The Arduino can interact with a wide range of outputs, such as LEDs, motors, and displays, by responding to sensors and inputs, as shown in Fig 3.3. Arduino has become a popular choice for makers and maker spaces looking to create interactive hardware projects due to its flexibility and low cost

4.1. Blood oxygen level sensor

the MAX30100 is a combined pulse oximeter and heart-rate monitor sensor system. It's an optical sensor that measures the absorbance of pulsating blood through a photo detector after emitting two wavelengths of light from two LEDs . This specialized LED colour combination is perfect for reading data also with tip of one's finger. The digital output data is stored in a 16-deep FIFO within the device, and it is fully customizable via software registers. It interacts with a host microcontroller via an I2C digital interface.

Fig 2 Blood oxygen level sensor

4.2. Micro controller

The regulator lowers the high-pressure gas from the oxygen reservoirs to 6 bars before delivering it to the ventilator. The proportional valve controls the volume and pressure of oxygen given to the patient. The expiration valve opens, allowing the patient to exhale the breath he or she has taken in. Flow sensors, oxygen sensors, and pressure sensors are used to measure the volume, oxygen rate, and pressure of the air that the patient gets. The PIC18F4550 microcontroller reads sensor data and controls the valves.

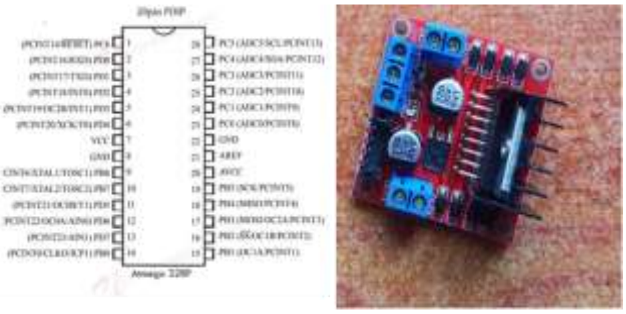

Fig 3 Micro Controller

Printed circuit board

Using conductive rails, pads, and other features etched from one or more sheet layers of copper bonded onto and/or between sheet layers of a non-conductive substrate, a printed circuit board (PCB) mechanically supports and electrically links electronic or electrical components. To both electrically connect and mechanically secure components to the PCB, they are usually soldered on. Printed circuit boards are utilised in all electronic products except the simplest. Some electrical items, such as passive switch boxes, also employ them.

4.3. LED

LEDs are semiconductor devices are made out of silicon. When current passes through the LED, it emits photons as a byproduct. Normal light bulbs .Light is produced by heating a metal filament until it becomes white hot. LEDs have a number of advantages over traditional light sources, including lower energy usage, a longer lifespan, increased durability, smaller size, and faster switching.

4.4. Pressure sensor

AMS 5812 IS A SERIES of high precision pressure sensor combining a ratiometric analog voltage output with a digital I2c output there are calibrated and compensated in a temperature range of -25 to 85 C. the pcb mountable sensors are available ina ceramic dip package in variants with tube fittings or for o-ring sealing.

5. SUMMARY AND CONCLUSION

5.1. Summary

A ventilator mechanism must be able to deliver in the range of 10 30 breaths per minute, with the ability to adjust rising increments in sets of 2. Along with this the ventilator must have the ability to adjust the air volume pushed into lungs in each breath. The last but now the least is the setting to adjust the time duration for inhalation to exhalation ratio.

Apart from this the ventilator must be able to monitor the patients blood oxygen level and exhaled lung pressure to avoid over/under air pressure simultaneously.

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.

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 and the BPM value for the patient.

Our system makes use of blood oxygen sensor along with sensitive pressure sensor to monitor the necessary vitals of the patient and display on a mini screen. Also an emergency buzzer alert is fitted in the system to sound an alert as soon as any anomaly is detected.

5.2. Conclusion

This work demonstrates an approach with strong emergency and pandemic potential. It is a distributed manufacturing-based open source ventilator design. This study explains how to make open source mechanical ventilators for patients at a reasonable cost. This is still in the early phases of development and need further work. This work will undoubtedly receive further notice. There is still a lot of work to be done to convert it to medical-grade hardware. It's a valuable resource for both the current pandemic and emergency situations, as well as routine use in low-resource contexts.

Researchers have been working to help humanity deal with the myriad challenges produced by the COVID-19 epidemic since it began. One endeavour that has caught the writers' attention is the development of low-cost, open-source mechanical ventilators. Mechanical ventilators keep critically ill patients alive, and there is a worldwide scarcity of them in the treatment of COVID-19 patients. This document is a part of that endeavour. The building of a practical, low-cost, and open-source mechanical ventilator is described in this study. The authors' contribution to this topic is to alleviate the effects of the global ventilator scarcity, which is a stunning and terrible situation that has a particularly negative impact on impoverished communities. This research has demonstrated a numerical method for monitoring whether the The patient's pulmonary status is either good or ill. This practical yet straightforward numerical technique has the potential to be used in different mechanical ventilators. In conclusion, this study contributes to theory and practise on both fronts. Alarms, such as those that inform professionals when blood pressure hits certain threshold values, can be added in this project utilising either an alarm screen or speakers. The knowledge obtained by the team while working on this project.

References

1. Acho, L., Vargas, A.N. and Pujol-Vázquez, G., 2020. ―Low-Cost, Open- Source Mechanical Ventilator with Pulmonary Monitoring for COVID- 19 Patients‖. In Actuators (Vol. 9, No. 3, p. 84). Multidisciplinary Digital Publishing Institute.
2. Al Husseini, A.M., Lee, H.J., Negrete, J., Powelson, S., Servi, A.T., Slocum, A.H. and Saukkonen, J., 2010. ― Design and prototyping of a low-cost portable mechanical ventilator‖. Transactions of the ASME-W- Journal of Medical Devices, 4(2), p.027514.
3. Bakkes, T.H., Montree, R.J., Mischi, M., Mojoli, F. and Turco, S., 2020, July. ―A machine learning method for automatic detection and classification of patient-ventilator asynchrony‖. In 2020 42nd Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC) (pp. 150-153). IEEE.
4. Branson,R.D.,Johannigman, J.A, Daugherty, E. L. and Rubinson, L.,2008. ―Surge capacity mechanical ventilation‖. Respiratory Care, vol. 53, no. 1, pp. 78–90.
5. Coyer, F.M., Wheeler, M.K., Wetzig, S.M. and Couchman, B.A., 2007. ―Nursing care of the mechanically ventilated patient‖.Part two. Intensive and critical care nursing, 23(2), pp.71- 80.
6. Hammond, R. and Murison, P.J., 2016. ―Automatic ventilators‖. In BSAVA manual of canine and feline anaesthesia and analgesia (pp. 65- 76). BSAVA Library.
7. Hess,D.R., 2005. ―Ventilator waveforms and the physiology of pressure support ventilation,‖ Respiratory Care, vol. 50, no. 2, pp. 166–186.
8. Hewing, L., Menner, M., Tachatos, N., Daners, M.S., Pasquier, C.D., Lumpe, T.S., Shea, K., Carron, A. and Zeilinger, M.N., 2020. ―Volume Control of Low-Cost Ventilator with Automatic Set-Point Adaptation‖. arXiv preprint arXiv:2009.01530.
9. Lian, J. X.,2009. ―Understanding ventilator waveforms—and how to use them in patient care,‖ Nursing Crit. Care, vol. 4, no. 1, pp. 43–55.
10. Oyekola, P.O., Muduli, K., Ngene, T.C. and Syed, S.A., 2021. ―COVID- 19 Ventilator: A Variable Compression Model‖. International Journal of System Dynamics Applications (IJSDA), 11(5), pp.1-12.