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Review for Arduino based Portable Ventilator for COVID-19

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***Abstract*— In response to anticipated shortages of ventilators caused by the COVID-19 pandemic mechanical ventilation is a life-saver in the development of modern ICUs. This paper provides an idea of the origin of modern mechanical ventilators. Based on the reviewed literature, a simple, easy-to-use, and easy-to-build design of low- cost portable ventilator is proposed in this project. The proposed ventilator prototype here is assumed to have better working performance than already available around. This ventilator consists a of blood oxygen sensor and a sensitive pressure monitoring system all at a very low cost. The ventilator we here design and develop using Arduino encompass all the requirements to develop a reliable yet affordable whilst matching all the conditions and marks of an original mechanical ventilator along with its property of portability. This ventilator will help in a situation like COVID-19 when the whole world facing difficulties related to ventilators and thereby can also be used in other critical situations or mass casualties.**

***Keywords*— Ventilator, Arduino, Portable, Cost-effective, BPM.**

I. INTRODUCTION

Coronavirus is a dangerous disease caused by a virus that got spread two years back, made our lives up and down. Many people died because of the CORONA virus due to lack of medical facilities and eventually also due to lack of medical supplies like vaccinations, medical assistance, and ultimately ventilators. The diseases mentioned above require mechanical ventilation in case of failure of the lungs. The consequence of this shortage is calamitous, especially in deprived areas. Even well-equipped hospitals have developed protocols for sharing the same ventilator between two patients It infects our respiratory system and creates difficulty in breathing. In case a patient suffers from respiratory failure mechanical ventilators are needed. The ventilator is a medical device used for the breathing process. This prototype will help a patient to inhale and exhale so the exchange of carbon dioxide and oxygen could be possible and the patient has artificial respiration to survive Ventilators are needed to treat influenza and coronavirus and people in intensive care units. Before the Covid times, only people in intensive care units used ventilators but after a heavy spread of corona demand for ventilators increased drastically Ventilator helps in pumping air into the lungs. Whereas due to the heavy spread of corona there is a shortage of ventilators. There is a lack of ventilators for many medical units. As an attempt to face the worldwide problem of ventilator shortage, researchers have started an initiative of producing low-cost, open-source ventilators. This reliable and affordable ventilator during Covid pandemic times.

II. LITERATURE REVIEW

In [1], This paper provides concise information about the functionalities and the effectiveness of the ventilator which in addition to being economical is also easy to move. The ventilator is crafted and designed in a way that makes it efficient enough to operate during times of extreme medical crisis and as a result save as many human lives as possible. This ventilator was created using wooden pieces. It weighs exactly 6 kgs and its dimensions are 14 x 7 x 9 inches. This ventilator delivers oxygen to the patient with the help of an orthodox bag-valve-mask. The energy source of the ventilator is a 12 Volts DC battery. The Ventilator very effectively takes care of the two most significant aspects of mechanical ventilation i.e., BPM (Breaths per minute) and Pressure as it is equipped with a user-friendly input board. Not only this but it also consists of an alarm flow battery indication system in addition to assist control. The cost of the Ventilator is slated at $150 but it would be available at about 100 dollars once it starts getting mass-

produced. These characteristics of the ventilator make it a preferred choice during a catastrophe.

In [2], We are a witness to the times and the rapid advancement in the automation sector and almost all aspects of our lives are dependent upon it. Also, we are aware that the ongoing development in Automation will usher us into a future that we can predict might be literally ahead of its times. This global pandemic, the Covid-19 is catapulting us into that very future of smart automation. The covid-19 and its various variants have forced Scientists and Researchers all over the world to find a way to tackle it and it has thereby paved a way for great technological development. This has led to overwhelming demand in the automation sector in the Biomedical field. One of the results of this is the Industrial grade programmable logic controller which aims to control the mechanical ventilation process of a bag-valve mask-based emergency ventilator. The conclusions and the Mechanisms have been concisely documented.

In [3], In 2021, The second wave of the Covid-19 struck the entire globe which proved to be extremely contagious and dangerous because of which an unimaginable, overwhelming number of people had to be admitted to the hospital. This resulted in the shortage of ventilators, oxygen beds due to which a lot many people lost their lives. This situation forced medical and technological institutions and universities all over the world to work upon various designs for mechanical ventilators. These designs are concerned with the automation of the Bag-Valve-Mask. The Bag Valve mask (also known as an Ambu Bag) is a resuscitator device used during emergency situations mostly when the patient isn't able to breathe normally. This paper discusses how we could automate the manual operation of the big-valve-mask and how this BVM-based ventilator could be turned into a sophisticated and reliable device that can be used by a pulmonologist and other medical practitioners.

In [4], The paper deals with the construction of an economical ventilator that can effectively and efficiently deal with the shortage of ventilators which was experienced by an overwhelming number of people who were struck by Covid-19 and this resulted in the loss of many lives. In this paper, a numerical method to monitor the respiratory condition of the Patient is also cited. As per the method, a track is kept of Pressure measurements from the inspiratory limbs and the doctor or the clinician is alerted if something goes wrong. From the paper, we also come to know that the equipment was made using only commercial parts. The experiments conducted using this ventilator are testimony about the effectiveness and the other related benefits of the ventilator.

In [5], In response to anticipated shortages of ventilators caused by the COVID-19 pandemic, many organizations have de-signed low-cost emergency ventilators. This work reports a low-cost, easy-to-produce electronic sensor and alarm system for pressure-cycled ventilators that estimate clinically useful metrics such as pressure and respiratory rate and sound an alarm when the ventilator malfunctions. The algorithm, inspired by those used in hearing aids, requires little memory and performs only a few calculations on each sample so that it can run on nearly any microcontroller.

In [6], Treatment costs for ventilator-dependent patients are a substantial burden not only for their families but also for medical systems in general. To provide intermediate therapy for patients between hospitalization and complete discharge, a portable, light-weight high-frequency ventilator is an urgent need. This work presents the design of a portable high-frequency ventilator and a study of its practicality for further clinical medical applications. A miniaturized portable high-frequency ventilator with a digital controller and feedback system for stabilization and precision control is implemented.

In [7], Human lungs use lungs for respiration. They use a push mechanism in each breath. When people suffer from lung or breathing problems this can be used for emergency situations. A motor mechanism is used to push the airbag. When oxygen level counts are low this mechanism can be performed. The small screen is used to display the oxygen levels and pulse rate of patients.

In [8], Air Delivery System: Air delivery system identifies two main routes. It uses a source of pressure from time to time to bring air while another brings breath pressing the air reservoir. The last method is accepted as eliminating the need for a positive pressure source to operate continuously. This decreases energy requirements, as well as the need to fix parts of the air for difficult and costly things.

And they are easily found in countries which are in developing states. Accoutre within air cushioning total and comprehensive valve system, provides natural and basic requirements needed to get a respirator.

The biggest problem is their documentation operation that requires a continuous operator engaging in squeezing the bag as well as holding the mask to the patient. A. Compression Mechanism: The most pronounced ways to use BVM to do that mimic the moment of the hand that was in the bag built. This requires the use of line operating modes which although easy to use, need straight bears and more space. There were other ways of oppression available to take advantage of the cylindrical condition of BVM.

Table 1. Ventilator Techniques Comparison

Author and Year	Title	Technique Used
Muhammad Jawad Ghafoor et al. 2017 [1]	Prototyping of a Cost-Effective and Portable Ventilator	SIM808 GPS GSM Module
Ryan Rhay Vicerra et al. 2020 [2]	Implementation of a Programmable Logic Controller (PLC)-Based Control System for a Bag-Valve-MaskBased Emergency Ventilator	Programmable Logic Controller (PLC)
Edwin Calilung et al. 2021 [3]	Design and Development of an Automated Compression Mechanism for a Bag-Valve-Mask - Based Emergency Ventilator	BVM automation
Leonardo Acho et al. 2020 [4]	Low-Cost, Open-Source Mechanical Ventilator with Pulmonary Monitoring for COVID-19 Patients	Arduino , Raspberry pi
Ryan M. Corey et al. 2020 [5]	Low-Complexity System and Algorithm for an Emergency Ventilator Sensor and Alarm	8-bit microcontroller ATmega328
Shao-Yung Lu et al. 2019 [6]	Design and Study of a Portable High-frequency Ventilator for Clinical Applications	Arduino
Balamurugan C.R. et al. 2021 [7]	Design of Ventilator Using Arduino for Covid Pandemic	Arduino
Abhishek Pandey et al. 2017 [8]	An Introduction to Low-Cost Portable Ventilator Design	Arduino

III. DISCUSSION

According to the availability of sensors or development in biomedical trends more parameters can be sensed and monitored which will drastically improve the efficiency of the wireless or portable ventilators. it is assumed these projects will garner greater attention and resources to make significant progress to reach a functional and easily replicated open-source ventilator system. There is a large amount of technical future work needed to move open source ventilators up to the level considered adequate for scientific-grade equipment and further work still to reach medical-grade hardware. Future work is needed to achieve the potential of this approach not only on the technical side, but also by developing policies, updating regulations, and securing funding mechanisms for the development and testing of open source ventilators for both the current COVID19 pandemic, as well as for future pandemics and for everyday use in low-resource settings.

IV. CONCLUSION

The proposed ventilator can improve the use and functionality of next-generation portable ventilators. Even if it is portable and functional to the mark of a commercial ventilator system it still provides features that might not be available on a purely mechanical ventilator. This paper is a detailed explanation of producing low-cost, open-source mechanical ventilators for patients. The system can be built quickly with an ARDUINO UNO system and a few other electronic components. This can still be the early stages of such designs and might need further development eventually gaining more attention. It is a big source for both the current pandemic situation and emergency purposes. It is a big source for both the current pandemic situation and emergency purposes and even for everyday use in low-resource settings.

V. REFERENCES

1. Muhammad Jawad Ghafoor, Mustafa Naseem, Fahad I1yas, Muhammad Suleman Sarfaraz, Muhammad Irfan Ali, Ahsan Ejaz; Prototyping of a Cost-Effective and Portable Ventilator Software Technology Park, Ferozepur Road, Lahore
2. Ryan Rhay Vicerra, *Edwin Calilung, Jason Española, Elmer Dadios, Alvin Culaba, Edwin Sybingco, Argel Bandala, Alma Bella Madrazo, Laurence Gan Lim, Robert Kerwin Billones, Siegfred Lopez, Dino Dominic Ligutan, Julius Palingcod, and Carl John Patrick Castillo
3. *Edwin Calilung, Jason Española, Elmer Dadios, Alvin Culaba, Edwin Sybingco, Argel Bandala, Ryan Rhay Vicerra, Alma Bella Madrazo, Laurence Gan Lim, Robert Kerwin Billones, Siegfred Lopez, Dino Dominic Ligutan, Julius Palingcod, and Carl John Patrick Castillo Department of ECM, SNIST, Telangana, India.
4. Leonardo Acho 1, Alessandro N. Vargas 2, and Gisela Pujol-Vázquez 1,1 Department of Mathematics, Universitat Politècnica de Catalunya (UPC), 08222 Terrassa, Spain.
5. Ryan M. Corey, Member, IEEE, Evan M. Widloski, Student Member, IEEE, David Null, Student Member, IEEE, Brian Ricconi, Member, IEEE, Mark A. Johnson, Karen C. White, Jennifer R. Amos, Alexander Pagano, Michael L. Oelze, Senior Member, IEEE, Rachel D. Switzky, Matthew B. Wheeler, Eliot B. Bethke, Clifford F. Shipley, and Andrew C. Singer.
6. Shao-Yung Lu1, Hau Lin1, Hsu-Tah Kuo2, Chien-Liang Wu2, Wen-Jui Wu2, Chao-Hsien Chen2, and Yu-Te Liao1, Member, IEEE 1Electrical and Computer Engineering Department, National Chiao Tung University, Taiwan (R.O.C.) 2 MacKay Memorial Hospital, Taipei, Taiwan (R.O.C.)
7. Balamurugan C.R., Kasthuri A., Malathi E., Dharanidharan S., Hariharan D., Kishore B.V., Venkadesh T. 1Karthika J, 2Varshanapriyaa S, 2Sai Haran S, 2SuriyaPrakash C 1Assistant Professor, Department of EEE, Sri Krishna College of Engineering & Technology, Coimbatore, Tamilnadu 2UG Student, Department of EEE, Sri Krishna College of Engineering & Technology, Coimbatore,
8. Abhishek Pandey, Aradhya Juhi, Abhishek Pratap, Anupam Pratap Singh, Abhishek Pal, Mohammad Shahid, Department of Electrical Engineering, Galgotias College of Engineering and Technology, Greater Noida, India
9. Rubinson L, Vaughn F, Nelson S, et al.: Mechanical ventilators in US acute care hospitals. Disaster Med Public Health Prep. 2010
10. Huang HC, Araz OM, Morton DP, et al.: Stockpiling ventilators for influenza pandemics. Emerg Infect Dis. 2017
11. MacLaren G, Fisher D, Brodie D: Preparing for the Most Critically Ill Patients With COVID-19: The Potential Role of Extracorporeal Membrane Oxygenation. JAMA. 2020.
12. Smetanin P, Stiff D, Kumar A, et al.: Potential intensive care unit ventilator demand/capacity mismatch due to novel swine-origin H1N1 in Canada. Can J Infect Dis Med Microbiol. 2009
13. Stiff D, Kumar A, Kissoon N, et al.: Potential pediatric intensive care unit demand/capacity mismatch due to novel pH1N1 in Canada. Pediatr Crit Care Med. 2011
14. MacLaren G, Fisher D, Brodie D: Preparing for the Most Critically Ill Patients With COVID-19: The Potential Role of Extracorporeal Membrane Oxygenation. JAMA. 2020.
15. iderits R, Neyman G: Experimental 3D Printed 4-Port Ventilator Manifold for Potential Use in Disaster Surges. Open Journal of Emergency Medicine. 2014
16. Malatino EM: Strategic national stockpile: overview and ventilator assets. Respir Care. 2008
17. McNeil DG, Jr: Hospitals Short on Ventilators if BirdFlu,Hits. 20