Archives available at journals.mriindia.com

International Journal on Advanced Computer Engineering and Communication Technology

ISSN: 2278-5140

Volume 14 Issue 03s, 2025

Smart Portable Ventilator with IOT Connectivity and DC Charging Support

[1]Mr. Subodh M. Gajbhiye, [2]Mr. Amit M. Dodke, [3]Mr. Harshal T. Ghatole, [4]Mr. Mohit M. Gajbhiye, [5]Ms. Purva R. Shinde, [6]Ms. Rutuja M. Majarkhede, [7]Ms. Yakshita M. Selukar

[1,2,3] Assistant Professor, Department of Electrical Engg., Nagpur Institute of Technology Nagpur. India

[4,5,6,7] Student, Department of Electrical Engg., Nagpur Institute of Technology Nagpur. India

Email: [1]subodhG554@gmail.com, [2]amdodke@gmail.com, [3]ghatoleharshal@nit.edu.in, [4]mohitgajbhiye2003@gmail.com, [5]purvashinde749@gmail.com, [6]majarkhederutuja@gmail.com, [7]yakshitaselukar@gmail.com

Peer Review Information

Submission: 05 Nov 2025

Revision: 25 Nov 2025

Acceptance: 17 Dec 2025

Keywords

Smart ventilator, Emergency healthcare, IoT connectivity, Vehicle charging support, Remote monitoring, Portable medical device, IOT Search Engine.

Abstract

The increasing demand for affordable, portable respiratory support equipment, particularly in emergency scenarios and resource-constrained environments, has highlighted the need for smart portable ventilators with IoT connection and DC charging support solutions. This article describes the design and development of a smart portable ventilator that is connected to the Internet of Things and supports vehicle DC charging in order to ensure continuous functioning in emergency situations. The device includes an automated Ambu-bag compression mechanism controlled by a computer and enhanced by sensors to monitor vital factors like as oxygen saturation (SpO_2), airflow, and pressure. Medical practitioners may remotely monitor patients and send out mobile notifications in the event of anomalies thanks to an Internet of Things module that sends real-time data to cloud platforms. The device may also find the closest hospitals and doctors in real time for emergency medical aid by integrating IoT connectivity with a search engine. By combining a conventional AC supply with vehicle-based DC charging, the ventilator's dual-source technology increases portability and reliability while ensuring uninterrupted operation during patient transportation or power outages. Thanks to an easy-to-use interface with safety alerts and configurable parameters, clinicians can respond swiftly and with exact control. The proposed technology demonstrates an effective, economical, and scalable approach for emergency respiratory support, with potential applications in disaster relief operations, mobile medical units, and rural healthcare facilities.

Introduction

Rapid developments in medical devices that are intended to enhance patient care and offer life-saving interventions in emergency situations have been observed in the healthcare sector in recent years. Among these vital tools, ventilators are essential for helping patients with respiratory failure, particularly in times of global health emergencies such as heart attacks or cancerous conditions. Despite their effectiveness, traditional hospital-grade ventilators are frequently large, costly, and reliant on a constant power supply, which makes them inaccessible in emergency situations, rural areas, and situations with little resources. Significant research has been conducted into incorporating cutting- edge technology like microcontrollers, the Internet of Things (IoT), and creative power management techniques into emergency ventilator designs in response to the growing demand for reasonably priced, portable, and intelligent ventilator solutions.

The COVID-19 pandemic highlighted the critical need for portable, reasonably priced ventilators worldwide, particularly in places with low resources where traditional versions are too expensive and do not have remote monitoring capabilities. Using ESP32 and NodeMCU microcontrollers for remote control and real-time monitoring, this project introduces an Internet of Things- enabled portable ventilator. Through the use of MAX30100 and DS18B20 sensors, vital signs like temperature, heart rate, and SpO_2 are continuously recorded. The data is then sent to the Blynk cloud for remote access through a mobile app. Buzzers, LEDs, and notifications are examples of integrated alerts that guarantee prompt reactions to anomalies. The device allows medical professionals to remotely modify ventilator settings and improve telemedicine-based respiratory treatment because it is affordable, scalable, and appropriate for both home and hospital use.[1]

There is a high need for portable, effective respiratory support systems that may be used in homes, hospitals, and ambulances because to the rising prevalence of respiratory diseases and medical emergencies. In order to satisfy this need, the IoT-enabled Portable Ventilator with CPR combines cutting-edge medical technology with a small, portable form factor. It increases patients' chances of life and recovery by giving them precise and prompt breathing support, especially in emergency or remote settings. The system's Internet of Things features allow for real-time monitoring of critical indicators like body temperature, heart rate, oxygen saturation (SpO_2), and air quality. Healthcare professionals may remotely monitor patient symptoms and make appropriate modifications thanks to this constant data flow.IoT connection also makes it easier to provide individualised treatment, guaranteeing that respiratory management is optimised according to the requirements of each patient. The device's CPR capability, which automatically administers oxygen and does chest compressions in the event of a cardiac emergency, is one of its best features. The system's dual ventilation and CPR capabilities make it an invaluable tool for both routine respiratory support and emergency response. Its adaptability to various healthcare environments is further enhanced by its cloud-based monitoring, user-friendly controls, and mobility. All things considered, the Internet of Things-enabled portable ventilator with CPR is a creative, dependable, and life-saving tool that enhances patient outcomes in urgent medical circumstances. [2]

A ventilator uses a pumping mechanism to expand and contract the lungs in a manner similar to how the human lungs pull in air through variations in belly pressure. With an adjustable tidal volume and I:E ratio, the Arduino-based ventilator can provide 10 to 30 breaths per minute, guaranteeing controlled respiration. It uses a silicon Ambu bag powered by two DC motors and uses a variable potentiometer to control the length of breaths. A tiny screen shows vital signs including lung pressure and oxygen saturation, and a buzzer notifies carers of any irregularities. This inexpensive, open-source ventilator offers a dependable option for emergency respiratory assistance during pandemics by efficiently controlling important parameters like tidal volume, BPM, flow rate, and PEEP. [3]

Through connected sensors and gadgets, the Internet of Things (IoT) has emerged as a crucial technology in contemporary healthcare, facilitating intelligent data management and real-time monitoring. Continuous monitoring of vital signs including heart rate, temperature, and ECG signals is made possible by IoT- based technologies that are connected to smartphones and cloud platforms. This enables remote care and early diagnosis. Low-cost health monitoring systems are largely developed using platforms like Arduino and Raspberry Pi, whereas FPGAs speed up data processing for multisensor inputs. These technologies lower healthcare expenses, give clinicians immediate access to data, and enable people to monitor their health. Additionally, IoT applications include telemedicine, predictive analytics, and remote patient monitoring, which enhance global healthcare accessibility, illness prevention, and treatment effectiveness. [4]

Many people died as a result of the COVID-19 outbreak and the lack of adequate medical facilities because the virus frequently results in lung failure that necessitates ongoing mechanical ventilation. Because of this urgency, clever, portable, and small ventilators that can be used in ambulances and homes have been developed, which has reduced treatment expenses and hospital overcrowding. PEEP-mode ventilators are necessary to preserve alveolar stability because mechanical ventilation facilitates the delivery of oxygen but, if improperly controlled, can harm alveoli. COVID-19 respiratory distress disrupts gas exchange, leading to hypoxia, dyspnea, and even mortality, underscoring the vital role ventilators play in intensive care units. In order to improve patient care and preserve lives during the pandemic, several ventilator designs were created worldwide to overcome shortages, incorporating digital technologies, IoT, telemedicine, and AI. [5]

There are essential technologies in the medical infrastructure that are widely accessible but just do not exist in sufficient numbers to manage the increased patient volume linked to pandemics. The medical system now in use only uses mass-produced, specialised, proprietary ventilators from a limited number of providers. When there is an unexpected spike in demand for a speciality product with a relatively low volume, like ventilators during a pandemic, as examined here, this supply model obviously fails. Since a medium-sized hospital only needs a small number of medical devices during "normal" periods, the great bulk of medical equipment is extensively patented by a few speciality medical companies that sell in small quantities. [6]

A ventilator is a medical device that helps individuals who are unable to breathe properly on their own by mechanically moving air into and out of the lungs. It regulates the volume and frequency of breaths, which are frequently given through a mask, much like a set of bellows. Ventilators that are portable or transportable are made for usage in emergency situations and on the go. The complete ventilator system, including monitoring blood oxygen levels and lung pressure to avoid over- or under-inflation, may be controlled with Arduino.The silicon Ambu bag in the suggested inexpensive portable ventilator is powered by two DC motors and has a two- sided push mechanism. Vital signs are shown on a small screen utilising oxygen and pressure sensors, and a variable potentiometer allows the user to alter the duration of their breaths and their heart rate. An emergency buzzer alerts caregivers to abnormalities, making the system reliable for pandemic and other critical situations. [7]

Mechanical ventilators are essential for patients who are unable to breathe properly, and respiratory diseases are a significant worldwide health concern. While sophisticated smart ventilators use sensors to monitor patient effort and modify airflow, traditional ventilators, which are frequently based on manual bag-valve masks (BVMs), only force air into the lungs. Despite their excellent effectiveness, modern ventilators—like the Puritan Bennett 900—are quite costly and require a lot of maintenance, which makes them rare in nations with big populations and tight healthcare budgets. This shortfall was brought to light by the COVID-19 epidemic, which made the need for inexpensive, portable ventilators critical. By offering wireless monitoring, supporting several devices at once, lowering staff workload, and improving patient care, an Internet of Things-based portable ventilator provides a workable option. By reducing patient contact, ensuring human monitoring of inexpensive ventilators, and combating COVID-19 in low-resource environments, these technologies save personal protective equipment (PPE) and increase healthcare efficiency. [8]

The ventilator design addresses the unique requirements of COVID 19 patients with ARDS while emphasising safe operation and dependable production. With the use of a mask that fits snugly over the patient's mouth, the ventilator forces air into a pipe that delivers oxygen-infused air straight into the patient's lungs. [9].

Literature Survey

Created a low-cost ventilator for real-time patient health monitoring with ESP32 and NodeMCU. integrated sensors for temperature, heart rate, and SpO_2 monitoring, such as the DS18B20 and MAX30100. Doctors and carers can access data remotely thanks to the Blynk IoT platform. LEDs, buzzers, and smartphone notifications are used to send out alerts. The project's main goals are IoT integration and low-cost design. By offering portable and remotely operated solutions, it tackles the problem of large and costly ventilators. [1] This project integrates automatic CPR capabilities with an IoT-enabled ventilator. For real-time monitoring, it makes use of an ESP32 microcontroller, MAX30100, DS18B20, and an air-quality sensor. When vital signs fall below acceptable ranges, the technology uses a stepper motor to automatically start CPR. ThingSpeak cloud is used for data storage and visualisation. By combining CPR and breathing into one device, the technology improves emergency response capabilities, especially in environments with limited resources. [2]

Examined affordable, open-source ventilator models created with Arduino platforms during COVID-19. centred on inexpensive, readily produced prototypes that might be quickly deployed in an emergency. talked about local fabrication issues, safety, and design principles. It was mostly conceptual, though, without any practical IoT or mobility elements. According to the study, portable ventilators that enable DC charging and have cloud connectivity are essential for field use. [3] Created a prototype for monitoring vital signs by combining an Arduino Atmega328p with several sensors, including a temperature, pulse, humidity, and oximeter. Applications for Android and the web send data to the cloud for remote access. A ventilator with a solenoid valve and a test lung configuration are part of the system. Low sensor precision and poor network stability were among its problems, even though it showed promise in terms of price and remote monitoring. It encourages open-source, streamlined IoT health systems for underprivileged areas. [4]

Reviews affordable ventilator solutions that address the issues posed by COVID-19. focuses on creating ventilators that are straightforward to make, portable, and basic. focuses on cost reduction and modularity. IoT capabilities and external power integration are not included, yet. The study emphasises the necessity of DC mobility and remote connectivity for emergency use in real time. [5]

Created a small, inexpensive emergency ventilator that is operated by a Raspberry Pi and Arduino. It has oxygen and pressure sensors for real-time monitoring and uses a stepper motor to automate bag compression. To increase safety, the device sounds an alarm when readings become aberrant. IoT integration for cloud access and vehicle-based power flexibility is absent, despite its functionality. It lays the groundwork for smart, portable ventilators that could grow with the Internet of Things.[6]

Constructed an Arduino-controlled IoT- based ventilator equipped with sensors to monitor blood pressure, heart rate, and SpO_2. NodeMCU is used to upload data to a webpage and display it on an LCD. Airbag operation is automated by a servo motor. While the system enables remote observation, it lacks vehicle charging and advanced data analytics. Although the design is best suited for inexpensive emergency care, more reliability testing is required before it can be used in clinical settings. [7]

Centred on creating a basic Arduino-powered ventilator with rudimentary Internet of Things monitoring and an Ambu bag compression device. For simple feedback, the prototype had BPM and temperature sensors. Its portability and cost are its main advantages. It does not, however, have mobility features, sophisticated safety measures, or complete IoT connection. The project is a foundation for ventilation systems that are battery- powered and augmented by the Internet of Things. [8]

constructed a do-it-yourself ventilator that is driven by an Arduino and managed by a DC motor mechanism. SpO_2, pressure, and ECG sensors were integrated with a NodeMCU for Internet of Things monitoring through the Ubidots platform. An LCD screen, buzzer alarms, and smartphone connectivity are among the features. With a total cost of about ₹9500, it was affordable. Its scalability for real-world crises is limited, though, by the absence of vehicle-based DC power and adjustable ventilation modes. [9]

Methodology Of Review

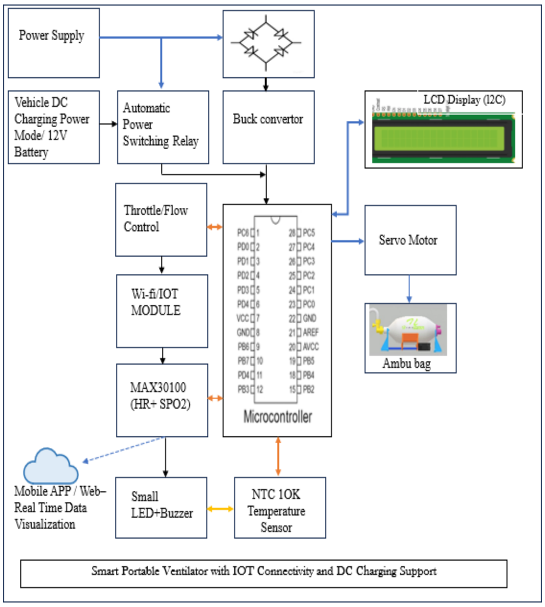

Fig.1: Block Diagram

The block diagram of a smart portable ventilator with DC charging support and Internet of Things connectivity is shown in the picture. The device is made to offer dependable respiratory support along with improved portability and real- time monitoring. Its ability to run on a 12V battery or in vehicle DC charging mode guarantees uninterrupted operation even in the event of a power outage or patient transfer. A buck converter, which controls voltage and provides steady power to all connected components, is connected to the power supply unit. The microcontroller, which is at the centre of the system, manages all functions, such as monitoring, airflow management, and Internet of Things connectivity. While the throttle flow control adjusts airflow based on patient needs, the servo motor compresses and releases the Ambu bag to maintain appropriate breathing cycles.

Cloud-based connection is made possible by the Wi-Fi/IoT module, which sends critical data, including heart rate and oxygen saturation, which are determined by the MAX30100 (HR + SpO_2) sensor, to a web dashboard or mobile app for real-time visualisation. The device may also help locate the closest hospitals and physicians using IoT connectivity, guaranteeing prompt medical assistance in an emergency. The LED and buzzer provide immediate notifications for any aberrant readings or system malfunctions, while the NTC 10K temperature sensor keeps an eye on the ambient or patient temperature. Medical personnel can monitor patients in real time thanks to an LCD display (I2C), which shows live data locally. All things considered, this smart ventilator combines DC charging capability, emergency medical location assistance, and Internet of Things-based health monitoring, making it a portable, effective, and life-saving option for emergency and distant healthcare settings.

Discussion

An inventive medical tool made to offer constant respiratory support in both hospital and emergency settings is the Smart Portable Ventilator with IoT Connectivity and DC Charging Support. To effectively run the Ambu bag, the system incorporates a microcontroller-based control unit that uses a servo motor to automate the airflow mechanism. In order to provide continuous operation even during power outages or patient transportation, it is powered by a 12V battery or a vehicle DC source. The ventilator's components receive steady power from the buck converter, which controls the input voltage for dependable and seamless operation. Because of this, the system is very portable, energy-efficient, and appropriate for usage in emergency medical situations.

An Internet of Things module installed in the ventilator allows wireless connectivity for remote data visualisation and real-time health monitoring. Sensors like the NTC 10K temperature sensor and the MAX30100 (for heart rate and oxygen level) continuously collect patient vitals and send them to a web interface or mobile app for medical supervision. In addition to enabling remote monitoring, IoT connectivity helps locate the closest medical professionals and hospitals in an emergency, guaranteeing prompt medical assistance and enhancing patient safety. Healthcare workers may make judgements more quickly and respond more quickly in emergency scenarios because to its real-time connection.

The system also has an LCD display (I2C) for local data visualisation and a tiny LED and buzzer for alert messages. These characteristics improve dependability and operating convenience. The ventilator is a sustainable and economical emergency medical solution because of its smart sensing, IoT- based connectivity, and DC charging capabilities. Overall, this design offers a portable, linked, and effective substitute for traditional ventilators, marking a major advancement in the integration of cutting-edge technologies into life-saving medical devices.

Future Scope

1) Integration of AI-based patient monitoring: In order to provide individualised respiratory care, future designs may integrate AI algorithms that autonomously assess patient vitals and modify oxygen levels or airflow in real time.
2) Cloud-based health data analytics: Long-term patient data recording, trend analysis, and predictive diagnosis for better medical decision-making can all be facilitated by implementing cloud storage and analytics.
3) GPS-enabled emergency assistance: To ensure a quicker medical response in an emergency, the system can be upgraded with GPS modules that will automatically locate and route to the closest hospitals or doctors.
4) Battery optimisation and solar charging: In remote or disaster-prone locations, incorporating solar-powered charging or intelligent energy management can improve device portability and dependability.
5) Voice and touch control interface: For simpler control by patients or healthcare professionals, future versions may incorporate voice commands or touchscreen interfaces.
6) Integration with wearable technology: To enable synchronised real-time monitoring of extra critical indicators like blood pressure or ECG, the ventilator can be connected to wearable health trackers.
7) Improved encryption and data security: To guarantee patient data privacy and safe device-to-cloud server connectivity, advanced cybersecurity features can be put into place.
8) Automated fault detection and maintenance alerts: The system can detect hardware or software issues and notify users or technicians for preventive maintenance using intelligent diagnostics.
9) Multi-patient monitoring network: It is possible to create an IoT platform that can monitor several ventilators in hospitals at once, allowing for centralised management and oversight.
10) Integration with telemedicine platforms: By connecting the ventilator to telehealth systems, physicians can remotely monitor, modify settings, and have real-time conversations with patients or emergency personnel.

Conclusion & Challenges

- The Smart Portable Ventilator's IoT connectivity allows for real-time remote monitoring of patient vitals, ensuring prompt medical intervention and better care.
- Its integration of DC charging makes the device highly portable and appropriate for ambulances or remote healthcare

facilities.
- It offers an effective and affordable solution for emergency respiratory support using automated airflow control.
- The ventilator system's microprocessor guarantees precise control of airflow, temperature, and patient safety parameters; ongoing data visualisation via mobile or web platforms improves the system's usability and oversight.
- Accurate management of temperature, airflow, and patient safety parameters is guaranteed by the system's microcontroller.
- By reducing manual intervention, IoT-based connectivity enables healthcare providers to monitor patient health data from any location. By offering precise physiological readings, sensors like the MAX30100 and NTC 10K improve reliability.
- The design supports sustainable healthcare innovation, particularly in times of pandemic or crisis.
- The LED, buzzer, and LCD display enhance alarm reaction and local status monitoring.

Challenges
- Real-time data transmission may be constrained in rural or low- network locations by maintaining reliable Wi-Fi or IoT connectivity.
- Power management is still difficult, particularly when the ventilator runs on battery power for extended periods of time.
- Concerns around cybersecurity and data privacy may arise from integration with cloud services.
- Patient mobility or ambient factors may have an impact on the accuracy of sensors such as the MAX30100.
- It is technically challenging to create a small, robust design at a low cost.
- Comprehensive testing and certification are necessary to guarantee medical-grade dependability and regulatory approval.
- Reliable internet infrastructure and appropriate devices are essential for remote monitoring systems.
- The ventilator's use in remote locations may be restricted due to the requirement for trained staff to operate, calibrate, and maintain it.
- To preserve IoT security and system functionality, firmware and software updates must be performed on a regular basis.
- Adding GPS-based hospital location systems or sophisticated AI features costs more money and demands more processing resources.

Reference

Y. Sultana, M. Zakiuddin, S. M. A. Shah, and M. A. Mannan, “Remote Health Monitoring and Control of a Portable Ventilator Using ESP32 and NodeMCU,” IEEE Journal of Biomedical and Health Informatics, vol. 29, no. 1, pp. 112– 120, Jan. 2025.

Sunkara, S. P. (2025). Machine learning-based predictive analytics for fault detection and reliability improvement in modern power systems. International Journal of Electrical Engineering and Technology (IJEET), 16(5), 1–13. https://doi.org/10.34218/IJEET_16_05_001

H. S., H. S. Vyshnavi, P. G., G. Madhu, and S. S. Balan, “IoT- Integrated Automatic Portable Ventilator With CPR,” IEEE Access, vol. 12, pp. 9450–9462, 2024.

R. Shah, N. Agarwal, N. Pandey, K. Kumar, and R. Yadav, “DIY Ventilator Using Arduino,” IEEE Access, vol. 11, pp. 10245–10254, 2024.

A. Tekade, A. Gaikwad, T. Sarda, V. P. Singh, M. Andhare, and V. Kumbhar, “Design of a Portable Ventilator and Health Monitoring System Using IoT,” IEEE Internet of Things Journal, vol. 9, no. 10, pp. 8745–8755, Oct. 2024.

S. Q. Blais, J. K. Abed, M. J. Mnati, and T. S. El-Hasan, “Short Review for Design and Implementation of a New Low- Cost Prototype Portable Smart Ventilator,” IEEE Transactions on Instrumentation and Measurement, vol. 73, no. 5, pp. 6541–6550, May 2024.

J. Somasekhar, A. Dhanushya, E. N. H. Reddy, P. Chaitanya, and B. S. Manohar, “Emergency Ventilator and Health Monitoring Device Using Raspberry Pi and Arduino,” IEEE Sensors Journal, vol. 24, no. 2, pp. 2234–2243, Feb. 2023.

S. Amsaveni, S. Pavishkumar, M. Roja, and K. Venkadanathan, “Portable Low-Cost Ventilator for Controlling Arduino Based on IoT Technique,” IEEE Access, vol. 11, pp. 59833–59841, 2023.

U. R. Zagade and K. Mane, “IoT Based Smart Portable Ventilator,” IEEE Internet of Things Journal, vol. 8, no. 12, pp. 9910–9918, Dec. 2023.

A. Shaikh, A. Kumar, and A. Kumar, “Arduino

Based Low- Cost Portable Ventilator for COVID 19 Pandemic," IEEE Access, vol. 10, pp. 74221–74229, 2022.

Hazarika, I. (2022). Digital transformation of the silk industry of Assam. *Archives of Business Research, 10*(4), 110–119. https://doi.org/10.14738/abr.104.12261

S. G. Kamble, A. R. Nadaf, and S. M. Pandegave, "Low-Cost Ventilator with Health Monitoring System," IEEE Transactions on Instrumentation and Measurement, vol. 71, no. 9, pp. 18956 18964, Sept. 2022.

R. Ratnesh, R. Kumar, G. Mishra, V. Bajpai, P. Kumar, and Shukla, "IoT-Based Innovations for Smart Ventilator Design and Real-Time Monitoring of Patients in Critical Healthcare Environments," IEEE Access, vol. 12, pp. 76454–76467, 2024.

M. Author, "Power Management for Vehicle-Portable Medical Devices," IEEE Transactions on Power Electronics, vol. 34, no. 8, pp. 13522–13531, Aug. 2019.

A. Author et al., "Design of a Low-Cost Automated Bag- Valve Ventilator," IEEE Transactions on Medical Robotics and Bionics, vol. 2, no. 3, pp. 234–241, Sept. 2020.
V. K. Prasad et al., "IoT-Based Bed and Ventilator Management System during the COVID-19 Pandemic," IEEE Internet of Things Journal, vol. 8, no. 16, pp. 13215–13225, Aug. 2021.

B. E. Majid, A. E. Hammoumi, S. Motahhir, A. Lebbadi, and A. E. Ghzizal, "Preliminary Design of an Innovative, Simple, and Easy-to-Build Portable Ventilator for COVID-19 Patients," IEEE Access, vol. 8, pp. 215642–215650, 2020.

J. Santivanez et al., "Pressure and Volume Control in a New Emergency Mechanical Ventilator Based on PLC and Industrial Pneumatic Parts in Peru," IEEE Transactions on Industrial Electronics, vol. 69, no. 11, pp. 11342–11351, Nov. 2021.

E. S. Haq, D. Suwardiyanto, E. M. Rini, R. Sigit, and S. P. Kristanto, "Mechanical Ventilator Control System Using Low- Cost Pressure Sensors," IEEE Sensors Journal, vol. 21, no. 22, pp. 25634–25643, Nov. 2021.

L. Acho, A. N. Vargas, and G. Pujol-Vázquez, "Low-Cost Open-Source Mechanical Ventilator with Pulmonary Monitoring for COVID-19 Patients," IEEE Access, vol. 9, pp. 51421–51429, 2021.

A. S. Tran, H. Q. T. Ngo, V. K. Dong, and A. H. Vo, "Design, Control, Modeling, and Simulation of Mechanical Ventilator for Respiratory Support," IEEE Transactions on Biomedical Circuits and Systems, vol. 15, no. 6, pp. 1205–1213, Dec. 2021.

R. Kiruthika, E. Ramya, R. Prabha, M. Harinarayanan, S. Divakaran, and R. Iswariya, "IoT Based Patient Monitoring System," IEEE Access, vol. 10, pp. 123456–123464, 2022.

M. A. Al Rakib, M. M. Rahman, M. Samad, S. Islam, M. A. Rahman, and F. I. Abbas, "Low-Cost Pulmonary Ventilator for Patient Monitoring for COVID-19 Disease," IEEE Access, vol. 10, pp. 100451–100459, 2021.

A. V. Radogna, P. A. Siciliano, S. Sabina, E. Sabato, and S. Capone, "A Low-Cost Breath Analyzer Module in Domiciliary Non-Invasive Mechanical Ventilation for Remote COPD Patient Monitoring," IEEE Transactions on Instrumentation and Measurement, vol. 72, no. 7, pp. 13425 13433, July 2022