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Portable Ventilator System with Blood Pressure Monitoring'

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Abstract: *The demand of ventilators has been increasing dramatically from the past few years due to the spike in the COVID-19 cases globally. Around the World, the absence of availability of ventilators has taken a lot of lives in just the past couple of years. The use of ventilators has been proven to be helpful from preventing the danger of lung harm through low- quantity airflow and helps us to get the adequate amount of influx of pure air. The ventilators available are expensive and scarce in supply. They are heavy and would normally weigh around 7 to 8 kgs, which makes it inconvenient to carry from place to place due to its enormous size. Our project aims at developing a smart ventilator system using a microcontroller board and sensors based on Internet of Things (IOT). The smart ventilator will be portable and very light in weight, which makes it handy to use and requires no additional expertise to handle it. Also this ventilator have low cost which makes it more affordable for most people. The usage of the high torque motor enables us to change the pressure as per the requirement. The sensors used collects the temperature and the Pulse oximetry levels and the same is updated on the LCD display.*

Through this prototype, the method of cam-actuated BVM compression is confirmed to be a feasible choice to acquire low-price, low-energy transportable ventilator compared to the high priced ventilators in the market currently. This project contributes to the medical services by providing a practical implementation of a Portable ventilator for the medical emergencies in the medical field..

Keywords: Portable Ventilator, low-price, low-energy transportable ventilator, Internet of Things (IOT), Affordable, handles pressure monitoring

I. INTRODUCTION

Respiratory diseases and disorders are a major public health problem in both developed and developing countries. There are two types of ventilation units. One of them simply mechanically pushes a volume of air into the lungs, regardless of whether the patient wants to push into his body. Most of these devices are based on the use of traditional bag valve mask. A BVM is a plastic bag that clinician manually operate with their hands, providing an inexpensive and easy way to force air into the lungs. The second type is more advanced and is currently used to treat patients with Covid-19 and others because these ventilators are smart enough to be able to tell if the patient is trying to breathe or expel air and then help the patient achieve the desired action. Such a ventilator has many sensors that interact with the human body, and the air is deliberately and precisely supplied to the patient based on sensor data. For example, the Puritan Bennett 900 mechanical ventilator, a top-of-the-range high-performance ventilator, offers advanced timing tools that the clinician can use to customize the ventilator for each patient's unique needs and provide adequate support throughout the breath. However, these devices have very complicated parts.

While the ventilators used in modern Indian hospitals are functionally and technologically advanced, their acquisition costs are the same (up to Rs. 5,00,00), expensive for use in resource-poor areas. In addition, these machines are often fragile and susceptible to continuous use, which requires expensive service contracts from the manufacture like sharing ventilators between hospitals and buying less reliable, refurbished units. As medical resources in this country are concentrated in the main urban centers, rural and peripheral areas are in some cases inaccessible. Hence, the need for an inexpensive portable ventilator is paramount. The cost of storing and using sate-of-the-art mechanical ventilators for

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mass accidents in industrialized areas is prohibitive. A Princeton University study estimates the existing hospital capacity of ICU's and ventilators. The estimate suggests that there are approximately 19lac hospital beds, 95,000 ICU beds, and 48,000 ventilators available in India, and most beds and ventilators in India are concentrated in seven states: Uttar Pradesh (14.8%), Karnataka (13.8%), Maharashtra (12.2%), Tamil Nadu (8.1%), Bengal (5.9%), Andhra Pradesh (5.2%) and Kerala (5.2%) ventilators, and their current high cost, require and inexpensive portable ventilator for which production can be expanded as needed.

That is why it is the need of time to design a low cost, smart, portable emergency use ventilator which can be easily used and maintained in the hospitals of low and middle income countries.

II. LITERATURE REVIEW

1. A Low Cost, Automated Portable Ventilator for Developing World (2021) – Muhammad Mujeeb-U-Rahman

The methodology focuses on analyzing the urgent need for affordable and accessible ventilator systems, particularly in developing countries where the healthcare infrastructure often lacks sufficient ventilator support. The study evaluates the design and implementation of a cost-effective, automated portable ventilator that can be easily deployed in low-resource settings. The research investigates how the device can be made efficient with minimal components while still offering essential features required for patient respiratory support. It explores mechanical design, electronic control, and safety aspects to ensure the device is both effective and reliable in emergency scenarios, especially during pandemics or natural disasters.

2. A Low-Cost Portable Ventilator Using IoT (2022) – P Lakshmi Prabha

This paper presents a methodology centered around developing a prototype ventilator using Internet of Things (IoT) technologies. The ventilator is designed with Arduino as the microcontroller, connected to a GSM module that enables remote communication. The methodology includes integrating sensors and electrical components to manage the functioning of the ventilator, allowing it to be operated and monitored remotely, which is vital in critical healthcare emergencies where immediate human intervention might not be possible. The paper emphasizes creating an efficient and accessible system for rural or resource-limited environments by leveraging IoT capabilities for improved real-time data transmission and control.

3. IoT Based Smart Ventilation System (2022) – Syed Ghouse

The methodology adopted in this study revolves around developing a smart ventilation system that prioritizes non-contact monitoring of patients' vital signs. The ventilator system integrates IoT sensors capable of measuring parameters such as oxygen saturation, blood pressure, heart rate, and body temperature. These measurements are transmitted wirelessly to a monitoring system, reducing the need for frequent physical interaction between healthcare workers and patients, thereby minimizing infection risk. The paper describes how data acquisition and transmission are handled through a microcontroller platform, ensuring that healthcare providers receive real-time updates, which improves patient care and response time in critical cases.

4. IoT Based Portable Ventilator (2024) – Mr. Lakshmeesha M., Mr. Mihir Venkat Sudarshan, Mr. Pranav A., Ms. Sneha B. S

This study explores the design and development of an IoT-based portable ventilator system powered by a 12V power supply. The methodology involves using an Arduino microcontroller as the central control unit to manage various interconnected modules, including an LCD display, keypad, motor driver, AMBU bag mechanism, contactless temperature sensor, and pulse oximeter. The LCD is programmed to display real-time values and operating modes, while the keypad allows users to select settings. The pulse oximeter monitors the patient's oxygen saturation, and the contactless sensor provides body temperature readings. This system aims to offer a comprehensive, compact, and user-friendly solution for ventilator support in both urban and remote healthcare settings.

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5. IoT Based Smart Ventilator (2022) –

Ms. Sindhu O, Ms. Deeksha Patel, Ms. Priyanka T, Ms. Shobha P

The methodology focuses on creating a reliable and simple ventilator prototype aimed at supporting patients who are capable of partial self-breathing. This project was initiated in response to the global shortage of mechanical ventilators during the COVID-19 pandemic. The design emphasizes minimal complexity, affordability, and ease of use. The system is built using basic electronic components connected through an Arduino platform, and it includes sensors for monitoring vital signs. The device is designed to be lightweight and non-invasive, ensuring comfort for the patient while providing sufficient respiratory support. The research also outlines testing procedures and adjustments made to maintain performance and safety across different patient needs.

III. METHODOLOGY

In this project, we focused on designing and developing a low-cost, portable ventilator system that can help patients with breathing support, especially in emergency or rural areas. What makes our system special is that we have also added a blood pressure monitoring feature, so doctors or caretakers can keep track of both breathing and BP in one compact device.

To build this system, we used an Arduino microcontroller as the brain of the project. It controls the working of the ventilator, processes the data from sensors, and displays important information. We connected a motor mechanism with an AMBU bag (used for giving air to patients manually) to automatically provide the required air pressure based on selected settings.

Table 1- Hardware Components

Component	Description
Arduino Uno R3	Arduino UNO is a microcontroller board with ATmega328P, 14 I/O pins, and 6 analog inputs. It runs at 16 MHz and can be powered by USB or battery.
DHT11 Sensor	DHT11 is a low-cost sensor that measures temperature and humidity with good accuracy and digital output.
MAX30100 Sensor	Monitors heart rate and blood oxygen saturation (SpO_2)
Servo Motor MU995	MG995 is a high-speed metal gear servo that rotates about 120° and is easy to control using standard servo codes.
Node MCU	NodeMCU is an open-source IoT platform based on the ESP8266 Wi-Fi chip. It includes a CPU, RAM, and Wi-Fi, making it ideal for smart and connected projects.
Power Supply	Powers the Raspberry Pi and peripheral sensors/modules

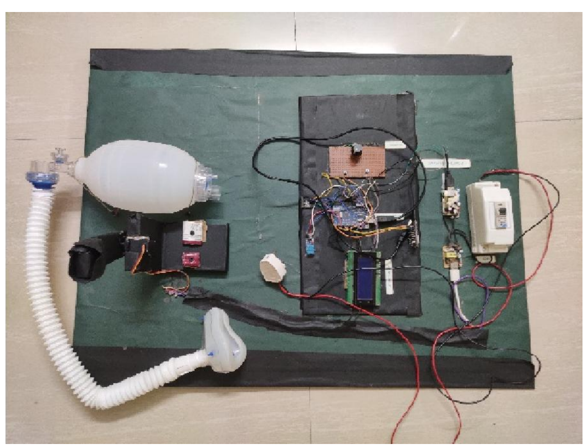

Fig. 1- fig shows the working model

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System Architecture and Design flow:

The portable ventilator system with blood pressure monitoring is built around an Arduino UNO microcontroller that controls the ventilator motor connected to an AMBU bag to provide breathing support. It integrates sensors for measuring blood pressure, oxygen saturation, pulse rate, and body temperature, with all data processed by the Arduino and displayed on an LCD screen. Users can select ventilator modes and settings through a keypad, while the system continuously monitors the patient's vital signs, adjusting ventilation accordingly and alerting if any readings exceed safe limits. This design ensures a compact, easy-to-use device suitable for emergency and remote healthcare situations.

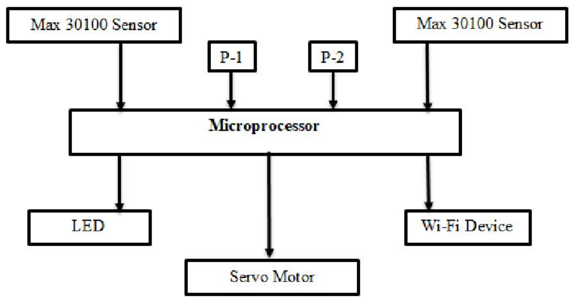

Fig. 2- fig shows the Block schematic

The block diagram of the transmitter for the proposed LiFi-based underwater communication system details the various components involved and how they interconnect to perform their respective functions efficiently. Central to the system is the Arduino microcontroller, which serves as the brain of the operation, managing inputs and outputs to ensure smooth functioning. The microcontroller receives digital inputs from buttons that allow the user to start or stop the system and select different age groups, providing a simple interface for operation. In addition to these, it handles multiple analog inputs coming from potentiometers that are used to control crucial ventilator parameters such as volume, pressure, and breath rate, allowing for real-time adjustments. Furthermore, the Arduino monitors the system's health and performance by reading signals from current and voltage sensors connected to its analog input pins, ensuring safe and reliable operation.

The control of mechanical movement within the system is managed by a servo motor, which receives PWM (Pulse Width Modulation) signals from the Arduino on a dedicated pin, typically Pin 9. This motor is responsible for driving the physical mechanism, such as operating the AMBU bag for ventilation. Proper power supply is critical for the servo motor's operation; it can be powered by the Arduino's 5V pin or through an external power source to provide the necessary current without overloading the Arduino board.The whole system is powered by a 5V power source, supplying energy to all connected devices and modules. The flow of operation is continuous and cyclic, meaning the system keeps monitoring, analysing, and responding in real time without any pause. This ensures that any irregularities in the patient's condition are caught immediately, allowing for quick responses that could be life-saving. This design offers a smart, low-maintenance solution for patient care—especially in homes or clinics where round-the-clock human monitoring might not always be possible.

Finally, a stable and sufficient power supply is essential for the entire system's reliable operation. While the Arduino can supply power to some components, the servo motor often requires a dedicated external power source due to its higher current demand. Ensuring proper power management prevents voltage drops or resets during operation, maintaining system stability.

Overall, this architecture combines mechanical control, user inputs, real-time monitoring, and feedback into a compact and efficient transmitter system designed to function reliably in underwater LiFi communication environments or ventilator applications.

V. CONCLUSION

In critical situations such as respiratory distress or medical emergencies, access to a reliable and affordable ventilator system can be life-saving. However, many regions still face shortages of such essential equipment, especially during pandemics or in rural healthcare settings. Our project, a portable ventilator system with integrated blood pressure monitoring, aims to address this issue by providing a compact, low-cost, and efficient solution. By combining core medical functionalities with microcontroller-based automation, the system ensures continuous monitoring of vital parameters such as blood pressure, oxygen level, and temperature, while delivering controlled ventilation support. This integration of essential features into a single portable unit enhances patient care, improves emergency response, and supports healthcare professionals in managing patients more effectively and safely.

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