

A Low Cost Portable Ventilator using PIC 16F877A Microcontroller

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Abstract: Ventilators are critical life-support devices used in hospitals to assist patients with respiratory difficulties. However, their high cost and limited availability, especially in low-resource settings, make access challenging. This project aims to develop a low-cost, portable ventilator using a microcontroller-based system, providing an affordable and accessible alternative for emergency and home care applications. The ventilator design incorporates an Arduino (or other microcontroller) to control airflow, pressure, and respiration cycles. It utilizes sensors to monitor oxygen levels, airflow rate, and patient conditions, ensuring proper ventilation. A servo or stepper motor-driven mechanism controls the air delivery to the patient, simulating manual Ambu bag compression in a controlled and automated manner. The system supports multiple ventilation modes, including volume-controlled and pressure-controlled settings, which can be adjusted according to the patient's needs. A simple LCD or touch screen interface allows users to set parameters such as breath rate, tidal volume, and inspiratory/expiratory ratio. Additionally, a battery-powered option enhances portability for field and emergency use. By leveraging cost-effective electronic components and 3D-printed parts, this project offers a reliable, scalable, and affordable ventilator solution for low-income communities and remote areas. Future improvements could include IoT-based remote monitoring and AI-driven adaptive control for enhanced patient care. This low-cost ventilator design could significantly contribute to addressing ventilator shortages during pandemics, natural disasters, and emergencies, ensuring more accessible respiratory support worldwide..

Keywords: Arduino; Ventilator; Prototype

I. INTRODUCTION

While human lungs depend on the withdrawal of the stomach to make a negative weight that draws in discuss amid inward breath, ventilators utilize a diverse instrument. Ventilators utilize a pumping movement to blow up the lungs, giving the fundamental wind stream to bolster breath. A ventilator ought to be able of conveying a extend of 10-30 breaths per diminutive, with the adaptability to suit expanding increases in sets. Furthermore, it ought to be able to control the volume of discuss conveyed to the lungs with each breath and permit for the alteration of the inhalation-to-exhalation proportion. Observing the patient's blood oxygen levels and expiratory lung weight is pivotal to maintain a strategic distance from over or beneath pressurization. To address these necessities and make a dependable however reasonable versatile ventilator for utilize amid pandemics, we have planned a ventilator utilizing PIC. Our framework consolidates a silicone ventilator pack driven by DC engines with a dual-sided pushing instrument. An electric switch and a variable potentiometer direct the breath term and patient's breaths per miniature. Our framework incorporates a blood oxygen sensor and a touchy weight sensor to screen imperative signs, which are shown on a little screen. Besides, a crisis chime alarm is integrated to flag any anomalies. The complete framework is controlled by an PIC microcontroller to attain craved results and help patients amid the COVID-19 widespread and other crisis situations. As the infection spread quickly, it highlighted the basic significance of satisfactory healthcare framework, particularly the accessibility of life-saving restorative hardware such as ventilators. Ventilators are basic gadgets that help people with respiratory troubles by giving the fundamental bolster to their lungs. Be that as it may, the deficiency of ventilators



amid the widespread highlighted the require for inventive arrangements, counting the advancement of versatile ventilators. The objective of this college extend is to investigate and analyse the concept of versatile ventilators, cantering on their plan, usefulness, and potential applications. Besides, the venture will discuss the challenges and contemplations included within the plan and fabricating of versatile ventilators, counting control source necessities, commotion diminishment, and user-friendly interfacing. Another pivotal viewpoint to be investigated is the potential effect of versatile ventilators in various healthcare scenarios. By looking at case considers and real-life illustrations, we are going assess the benefits and limitations of versatile ventilators, surveying their viability in crisis circumstances, catastrophe reaction, and resource-limited situations. Additionally, we'll examine the financial suggestions and cost-effectiveness of convenient ventilators, considering their potential to move forward understanding results whereas diminishing healthcare expenses. The centrality of this extends lies in its commitment to the continuous endeavors to improve respiratory care and address the worldwide require for available therapeutic hardware. By comprehensively examining the concept of convenient ventilators, we point to broaden our understanding of their potential applications and advance advancement in healthcare technology.

II. LITERATURE REVIEW

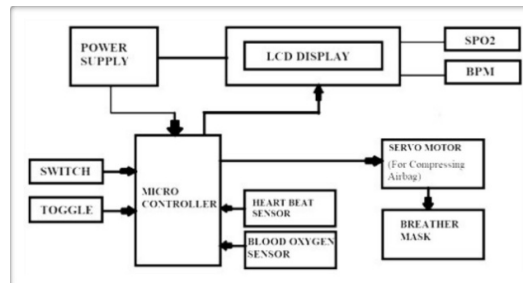
This content appears the advancement of low-cost, open-source automatic ventilators. This content too appears the numerical strategy for observing patients' aspiratory conditions. With the help of a weight sensor, we are going classify whether the patients have solid or undesirable lungs. An PIC board collects the information from the weight sensor. In line with the producer, the weight sensor can degree differential weight of up to 70 cm H₂O. The adapt was joined to the servo meter bar. The pole was made of a Plexiglass bar. The span of this adapt is 2.5cm. Aliaksei Petsiuk, Nagendra G. Tanikella, Samantha Dertinger, Adam Pringle, Shane Oberloier, Joshua M. Pearce, (In part Reparable computerized open-source sack valve mask- based ventilator). This content appears the occasion of a clear and simple to-build convenient mechanized cover esteem sack. This handles an PIC controller with the real-time bundle introduced on a generally 3d printable parameter component-based structure. For PIC broadly develops the conceivable results of the controller. A real-time software gives principal capacities to computer program errands, like arranging, dispatching, inter-task communication, and synchronization Couchman, Betel. (Medical caretakers part in avoidance and administration of mechanical ventilation related complications) (2006). In their article titled, restorative care of the mechanically ventilated quiet: What does the prove say? Summarized as therapeutic help and administration of mechanically ventilated patients are challenging and require nursing mastery for knowing the innovative issues undying the persistent centered approach. Mechanical ventilation accelerates a few real and potential complications for basically sick clients. The business of ventilator care is viable in mechanically ventilated patients creating positive results which carries with it four intercessions, those are; rise of the best of the bed, sedation get-away, peptic ulceration prophylaxis, and profound vein thrombosis prophylaxis. The restorative help hone needs strong noteworthy prove for demonstrating one care approach is more beneficial than the inverse. Inside the care of mechanically ventilated patients, the only restorative help hone is the utilize of evidence-based hone in conjunction with comprehensive and precise patients. This paper depicts the see and prototyping of a moo fetched convenient mechanical ventilator to be utilized in mass casualty cases and resource- poor situations. The ventilator conveys breaths by compressing a conventional Ambu sack with a rotating cam arm, disposing of the need for an individual's administrator for the Ambu sack. An beginning model is driven by an electrical engine fuelled by a 12 VDC battery and highlights an movable tidal volume up to a greatest of 750 ml. Tidal volume and number of breaths per miniature is set as per the default conditions.

Balamurugan C.R., Kasturi A., Malathi E. Dharanidhar S., Hariharan D., Kishore B.V., Venkatesh T., (Plan of Ventilator Utilizing PIC for Covid Widespread) (01 April 2021).[1] This ventilator is made with thrust component in each breath. This ventilator is very cheap and reasonable. The whole framework is controlled with PIC. If the oxygen level is the buzzer rings. Flip may be a exchanging and variable pot to check the breath length and BPM level of patients. Leonardo Achoo, Alessandro N. Vargas, Gisela Pujol-Vázquez, (Low-Cost, Open- Source Mechanical Ventilators with Aspiratory Checking for COVID-19 Patients) (12 September 2020). This article appears the development of low-cost, open-source mechanical ventilators.



III. METHODOLOGY OF THE PROJECT

Mechanical ventilation, helped ventilation or discontinuous obligatory ventilation (IMV), is the restorative term for employing a machine called a ventilator to completely or in part give counterfeit ventilation. Mechanical ventilation makes a difference move discuss into and out of the lungs, with the most objective of making a difference the conveyance of oxygen and expulsion of carbon dioxide. The technique of extend gives us the desired knowledge around ventilator operation by clearing us approximately on its major component which are there on which the ventilator is based upon and there required working. The association of each person component with other component has been controlled in strategy of extend. Ventilator is based on non-invasive operation so it major thought may be caught on of by the technique figure spoken to of below.



Block Diagram

The schematic block diagram of the system's operation is shown in Figure. This process began with a set of coding on the microcontroller, the system's primary component. into this component, which was posted. Microcontroller output, Located in the L298 motor driver, the H- bridge was used to command an Arduino-controlled DC motor to compress and Let go of the AMBU bag.

The patient receives breaths because of this process. The air pressure sensor monitors the patient's breathing and notices any changes in respiration. checks the status of the air and oxygen filters. There are input obstructions that need to be changed. It also detects and controls the oxygen and air supply to ventilators.

Arduino UNO occupies the center of the block diagram. The Arduino UNO includes a 28 pin ATMEGA 328 IC. Arduino begins to operate when a 5 volt power supply is connected to it for the operation. When the start button is pressed and turned ON, the device work is started by will. The AMBU bag is in its default state when the IR sensors and the dilated state will be able to detect this. The plank coupled with a 12 volt gear motor begins to revolve as Over the AMBU bag, the engine will be compressed. The air in the AMBU bag will then be delivered to the prosthetic lungs at that moment. For proper rotation, the gear motor requires 12 volts, However, the Arduino's I/O pin can only produce 5 volts. so insufficient the motor obtains the voltage supply. That'll result in the motor's correct rpm. The engine will also create a back. It causes damage to the Arduino UNO. These issues will affect a motor driver IC L293D in between an Arduino and a solution motor, too. It is possible to measure and store the pumping count in the server. The node MCU, a wifi integrated module, receives the pumping count or data first. then the data MCU was internet-transferred from the node to the server database. As a result, the data was saved in the database. Utilizing the IP In Android, the data can be displayed by IP address or server domain.

The components are;

Arduino Uno

A microcontroller board called Arduino/Genuino Uno is based on the ATmega328P (datasheet).It features 14 pins for digital input and output, 6 analogue inputs, USB connection - 16 MHz quartz crystal , a ICSP header, power jack, and reset button.It's just either use a USB cable to connect it to a computer or a power source battery or an AC- to-DC adaptor.



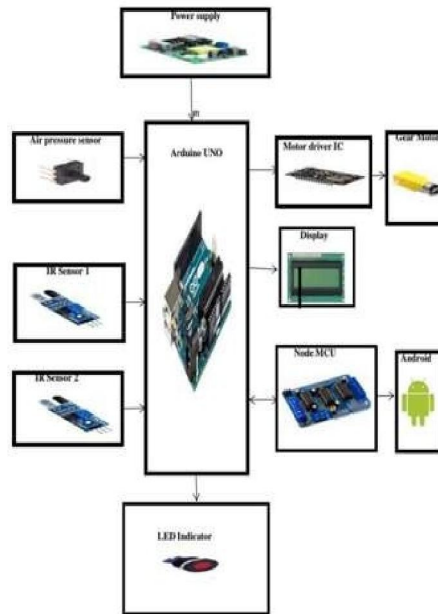


Fig 2. Block diagram

Ambu bag

A bag valve mask, also referred to as a manual resuscitator or "self-inflating bag" or by the brand name Ambu bag. It is a portable device that is frequently used to patients who are not receiving positive pressure ventilation should get it. either breathing or not breathing enough.

Node MCU

It employs a non-module flash-based SPIFFS file system and is an open-source Lua firmware for the ESP8266 WiFi SOC from Es press if. The firmware was first created as is an extension of the well-known ESP8266-based Development modules for Node MCU.

IR sensor

A sensor that measures and recognizes infrared radiation in its environment is known as an infrared (IR) gadget Infrared sensors come in two varieties: active and passive. Active infrared sensors produce and pick up infrared radiation.

Two components make up active IR sensors: a light emitting LED and a receive.

16x4 LCD Module

LCD Module utilizes a Fluid Precious stone Show (LCD) innovation. It is an alphanumeric show broadly utilized in different areas and applications. This module is profoundly fundamental and commonly coordinates into gadgets and circuits. Each character shown on the LCD is spoken to by a 5x7 pixel network organize. The advanced show has the capability to exhibit 224 distinctive characters and images in two modes: 4-bit and 8-bit. Shows can take numerous distinctive shapes, extending from little screens on handheld gadgets to expansive screens utilized in TVs or advanced signage. They utilize innovations that change over electronic signals into obvious pictures or content, permitting clients to associated with and decipher the displayed information.

Servo Motor

A servo engine (delineated in figure 3.7), may be a exceedingly exact engine competent of turning with uncommon precision. Regularly, it comprises a control circuit that gives criticism on the current position of the engine shaft, empowering exact revolution. When we got to turn a protest to particular points or separations, a servo engine is utilized. It comprises of a basic engine joined inside a servo component. On the off chance that the engine is fuelled by a DC control supply, it is alluded to as a DC servo engine, whereas an AC-powered engine is called an AC servo engine. In this instructional exercise, we are going centre exclusively on the working of DC servo motors.



Pulse oximeter sensor

The Pulse oximeter, a therapeutic device that utilizes a light source and two sensors to survey the oxygen immersion level within the blood. By measuring the color of oxygenated and deoxygenated blood, the sensors identify varieties in transmitted light through the tissue. Oxygenated blood shows up as a brighter shade of ruddy compared to deoxygenated blood. By analysing the inconsistency between these estimations, the beat oximeter precisely decides the rate of oxygen saturation.

IV. ADVANTAGES

Affordable Solution

Uses low-cost electronic components such as microcontrollers (Arduino, ESP32), servo motors, and sensors, making it budget-friendly compared to commercial ventilators.

Portability & Lightweight Design

Designed to be compact and battery-powered, allowing usage in ambulances, remote areas, and home care settings without reliance on hospital infrastructure.

Adjustable Breathing Parameters

Allows real-time control of breath rate, tidal volume, and inhale/exhale timing using buttons, potentiometers, or touchscreen interfaces.

Emergency & Pandemic Readiness

Can be rapidly deployed in emergencies, such as COVID-19 outbreaks, natural disasters, and war zones, where ventilator shortages are common.

V. APPLICATIONS

Emergency & Disaster Relief

- Used in ambulances, field hospitals, and disaster-struck areas where access to conventional ventilators is limited.
- Helps provide immediate respiratory support during earthquakes, floods, pandemics, and war zones.

Low-Resource Hospitals & Rural Healthcare

- Ideal for clinics and small hospitals in developing countries that cannot afford expensive ventilators.
- Supports patients with respiratory conditions like pneumonia, asthma, and COPD.

Home Healthcare & Assisted Living

- Beneficial for patients needing long-term respiratory support at home.
- Helps in cases of post-surgery recovery, sleep apnea, or ALS (Amyotrophic Lateral Sclerosis).

Military & Defence Medical Units

- Portable and battery-powered ventilators can be used in combat zones, military hospitals, and medical evacuation (medevac) units.

Industrial & Workplace Safety

- Can be used in factories and mines where workers might be exposed to toxic gases, smoke inhalation, or hazardous environments.

VI. CONCLUSION

In conclusion, low-cost versatile ventilators display a promising arrangement to address healthcare challenges and move forward get to respiratory back, especially in resource-limited ranges and different healthcare settings. These gadgets offer a few focal points that make them appropriate for arrangement in different scenarios, counting reasonableness, movability, adaptability, ease of utilize, and battery-powered operation.

The reasonableness of low-cost convenient ventilators makes them open to healthcare offices and patients, guaranteeing broader accessibility of respiratory bolster. Their compact and lightweight plan empowers simple transport and sending in different settings, such as domestic healthcare, ambulances, country clinics, and inaccessible regions. The flexibility



and user-friendly nature of these gadgets permit healthcare experts with diverse levels of preparing to successfully work them and tailor ventilation to person persistent needs.

Moreover, the battery-powered operation of versatile ventilators guarantees nonstop respiratory bolster amid control blackouts or in settings with restricted get to to power, including to their flexibility. These gadgets too give upgraded portability and freedom for patients, permitting them to lock in in day-by-day exercises and take part in social intelligent whereas accepting fundamental ventilation.

VII. FUTURE SCOPE

The future scope of low-cost convenient ventilators is promising and holds colossal potential for progressing healthcare, especially in resource-limited ranges and challenging situations. These gadgets have the capacity to convert healthcare conveyance by tending to basic needs and extending get to respiratory back. Amid times of emergency, our venture can serve as a vital first-aid gadget. For illustration, in circumstances where an person encounters a respiratory issue, quick transportation to a clinic may be vital. Whether in an emergency vehicle or at the location of an mishap, our compact and proficient ventilator can give life-saving respiratory bolster. Besides, due to its reasonable taken a toll, it is available to people from all socio-economic foundations. Moreover, we point to supplant the weight sensor with a more exact BP sensor and coordinated a camera for real-time communication with healthcare experts, subsequently moving forward farther therapeutic help whereas on the move. Low-cost versatile ventilators hold critical potential for future applications, especially in response to recent occasions just like the COVID-19 widespread that emphasized the significance of reasonable and promptly accessible therapeutic gear.

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