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Lowcost Mechanical Ventilator with Patient Monitering

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Abstract:
This paper describes the design and prototyping of a low-cost open-source mechanical ventilator with patient monitoring. Ventilator is a machine that helps you take breaths if you can't do it on your own. A respirator is a mask that medical workers wear when they care for someone with a contagious illness. A ventilator is a bedside machine with tubes that connect to your airways. It delivers breaths by compressing a conventional ambu bag with a pivoting cam arm, eliminating the need for a human operator for the ambu bag. When your lungs inhale and exhale air normally, they take in oxygen your cells need to survive and expel carbon dioxide. It helps pump oxygen into your body. The air flows through a tube that goes in your mouth and down your windpipe. The ventilator also may breathe out for you, or you may do it on your own. It can be set to take a certain number of breaths for you per minute.
Keywords: Ambu Bag, respirator

I. INTRODUCTION

The first few months of 2020 have seen an increased demand for ventilators in the treatment of patients with COVID-19, a fact that led to a ventilator shortage worldwide . The Consequence of this shortage is calamitous, especially in deprived areas of not just our country but the world. Even well- equipped hospitals had developed protocols for sharing the same ventilator Between two or even more patients —a dubious practice because it opens up the possibility of not only sharing bacterial and viral load among patients, but also provoking untoward harm. As an attempt to face the worldwide problem of ventilator shortage, researchers have started an initiative of producing low-cost, open- source ventilator. This paper contributes to this initiative. Atelectrauma, in contrast, seems to be caused by insufficient ventilation; poor ventilation allows alveolar units to collapse and reopen, in a repetitive, sequential movement, which may lead to injury as well. To avoid atelectrauma, most researchers recommend clinicians doing mechanical ventilation with positive end-expiratory pressure (PEEP). PEEP has become a ubiquitous tool to prevent atelectrauma , gaining evidence after the seminal results.

However, using PEEP to reduce lung injury is debatable since recent findings suggest that PEEP causes other harm like lung inflammation and edema formation. These investigations together indicate that the full understanding of the mechanical ventilation process requires more research —yet mechanical ventilators undoubtedly help edema formation. These investigations together indicate that the full understanding of the mechanical ventilation process requires more research —yet mechanical ventilators undoubtedly help patients suffering from acute respiratory problems. Since mechanical ventilators potentially expose the patient's lungs to damage, all initiatives of constructing low-cost mechanical ventilators must provide the regulation of not only the lung's pressure but also the positive end-expiratory pressure (PEEP)— two points for concern. The first point involves regulating the machine to prevent excessive pressure, which is a side effect of the surplus of energy from the ventilator machinery. We developed a novel method that monitors the patient's health condition to mitigate the chance of occurring those undesired fever and increase or decrease the pulse rate.

A. TRADITIONAL VENTILATOR SYSTEM:

The main drawback with the regular ambu bag is their manual operation requiring continuous operator engagement to hold the mask on the patient and squeeze the bag. This operating procedure induces fatigue during long operations, and effectively limits the usefulness of these bags to temporary relief. Moreover, an untrained operator can easily damage a patient's lungs by over compression of the bag.

B. EXISTING SYSTEM:

Transport ventilators:-These ventilators are small and more rugged, and can be powered pneumatically or via AC or DC power sources.
Intensive-care ventilators:-These ventilators are larger and usually run on AC power (though virtually all contain a battery to facilitate intra-

facility transport and as a back- up in the event of a power failure). This style of ventilator often provides greater control of a wide variety of ventilation parameters (such as inspiratory rise time). Many ICU ventilators also incorporate graphics to provide visual feedback of each breath.

- Neonatal ventilators (Bubble CPAP [clarification needed]):-Designed with the preterm neonate in mind, these are a specialized subset of ICU ventilators that are designed to deliver the smaller, more precise volumes and pressures required to ventilate these patients.
- Positive airway pressure ventilators (PAP) :- These ventilators are specifically designed for noninvasive ventilation. This includes ventilators for use at home for treatment of chronic conditions such as sleep apnea or COPD.

C. OBJECTIVE:

As an attempt to face the worldwide problem of ventilator shortage, researchers have started an initiative of producing low-cost, open-source ventilators with patient monitoring. This project contributes to this initiative. To help a person breathe when they find it difficult or are unable to breathe on their own. A mechanical ventilator pushes airflow into the patient’s lungs to help them breathe. Mechanical ventilation assists lung function until ventilation is no longer needed. Mechanical ventilation helps in: relieving respiratory distress decreasing the work of breathing improving exchange of gases (oxygen/carbon dioxide) healing the lung reversing respiratory muscle fatigue allowing time for the patient to rest and recover. To monitor the patient condition such as temperatureand pulse rate.

D. DESIGN AND METHODOLOGY:

There will a frame where the motors are fixed for the movement of the two sheets for the open and close for the ventilator. In between the two sheets the oxygen can is kept, so when the two sheets while closing the oxygen can will get compressed and the oxygen is supplied to the patients when the sheets opening the air is again filled in the can. Like this we can use the ventilator. The motors are driven by the battery for the power supply. The Mechanical model is shown below and The Embedded model consist of ESP Microcontroller, Temperature sensor is connected to controller to measure the Patient body temperature and Pulse sensor to measure the pulse rate of the Patient for checking Patient condition and Monitoring will be done by Mobile Application.

E. COMPONENTS REQUIRED

HARDWARE REQUIREMENT:

- ESP32 Micro Controller
- 2 Channel Relay module
- Temperature Sensor
- Pulse Sensor
- Blood Oxygen Sensor
- DC Motor
- Ambu Bag

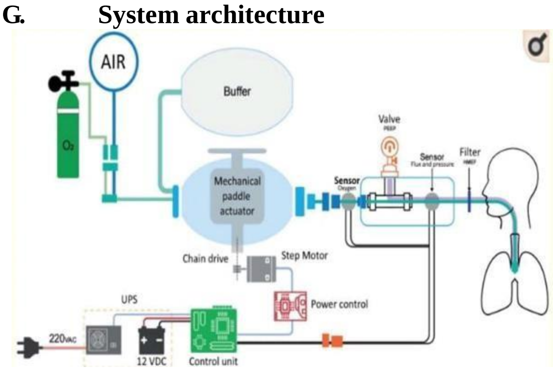
SOFTWARE REQUIREMENTS:

- Arduino IDE
- Blynk Application

F. PROPOSED SYSTEM

To overcome the challenges faced by the existing systems, two main strategies were identified for the ventilator’s air delivery system. One strategy uses a constant pressure source to intermittently deliver air while the other delivers breaths by compressing an air reservoir. The latter approach was adopted as it eliminates the need for the continuous operation of a positive pressure source. This reduces power requirements and the need
for expensive and difficult to repair pneumatic components.

G. System architecture



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H. DEMONSTRATION OF PROTOTYPE:

- The proposed model is built according to the block diagram of our project.
- Node MCU is the brain of the proposed system. It collects the patient's data from different sensors and sends to app for monitoring using cloud.
- Sensors such as LM35 for temperature, pulse sensor for heartbeat, Blood Oxygen Sensor for oxygen levels and tilt sensor for fall detection are connected to Node MCU microcontroller.
- Data Collected from these sensors are monitored in app by concerned doctors add medical authorities and can remotely control Mechanical Ventilator.
- Mechanical Ventilator in proposed system uses DC Motors and resuscitator bag.
- When Ventilator is turned on, DC motors starts pumping action with resuscitator bag and thus starts supplying ventilation to patient.
- Every action of Ventilator can be controlled remotely using App.

I. SOLUTIONS

- Even well-equipped hospitals have developed protocols for sharing the same ventilator between two patients -a dubious practice because it opens up the possibility of not only sharing bacterial and viral load among patients but also provoking untoward harm.
- Poor ventilation allows alveolar units to collapse and reopen, in a repetitive, sequential movement, which may lead to injury as well.
- Atelectrauma, is a common type of damage in contrast, seems to be caused by insufficient ventilation.

ADVANTAGES

Each type of mechanical ventilation systems, like other systems, has specific advantages and disadvantages. Rather than the pros and cons of each kind of mechanical ventilation system, some more general benefits are listed below:

- It can easily be integrated with the air conditioning system.
- Indoor humidity and inside temperature are easily under control.
- Filtration system can be added to the mechanical ventilation system.
- Regardless of ambient temperature and wind, the desired flow rate can be accessed consistently.
- You just need electricity for it to work.
- The airflow direction can be controlled.

DISADVANTAGES

Despite all the advantages mechanical ventilation system has, we cannot turn a blind eye to its drawbacks. Some of those weak points are mentioned below:

- If you ignore installing considerations, the inappropriate installation of a mechanical ventilation system may increase the maintenance costs dramatically.
- Backing up mechanical ventilation for a critical facility may be economically unreasonable.

APPLICATIONS

- Adult and pediatric intensive care: Intelligent high-end ventilation for all patient groups.
- Neonatal intensive care: The breath of life
- Critical care transport: Fully featured ICU ventilators for all kinds of transport
- MRI suite: Intelligent ventilation from ICU to MRI
- Long term acute care: Intelligent ventilation for long-term acute care.

II. CONCLUSION

This work is a clear procedure potential for emergency and Covid pandemic. It is an open source ventilator design fabricated using distributed manufacturing. This paper is a detailed explanation of producing low cost, open source mechanical ventilators for patients. This is at the early stages of design and needed further developments. Sure, this work will gain greater attention. There is a lot of future work to be upgraded to make it medical grade hardware. It is a big source for both the current pandemic situation and emergency purposes and even for everyday use in low resource settings.

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