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LOW COST PORTABLE VENTILATOR

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ABSTRACT:

The goal of this project is to create an Internet of Things (IOT)-based smart ventilator system with a microcontroller board and sensors. The lightweight and portable design of the smart ventilator makes it easy to operate and doesn't require any additional expertise. We may adjust the pressure to suit our needs by using a high torque engine. The temperature and pulse oximetry readings are collected by the sensors and updated on the cloud server.

An attractive test lung was used as a patient surrogate in the construction and evaluation of a prototype ventilator. We studied compliance and resistance change detection, as well as ventilation pressure waveform circuit leak detection, using a digital pressure sensor and a changeable test lung. The prototype device demonstrated appropriate pressure waveform characteristics when the test lung was subjected to intermittent positive pressure breathing.

Kewords: Ventilator, Low cost, Iot, Ambu bag.

INTRODUCTION

Coronavirus disease 2019 (COVID-19) is a highly infectious illness caused by a novel coronavirus, leading to severe respiratory complications. As of April 23, 2021, it has infected over 103 million people and caused more than 3.071 million deaths globally [1]. This disease primarily affects the respiratory tract and can escalate to serious conditions like acute respiratory distress syndrome (ARDS) or hypoxemia due to widespread lung inflammation [2–4]. From early times, mechanical ventilators have been critical in treating severe respiratory failures in diseases such as polio [5] and influenza [6], by aiding patients' breathing while the underlying illness is addressed [7, 8]. Consequently, the COVID-19 pandemic has driven a significant increase in the demand for mechanical ventilators, with 3–26% of infected patients (varying by age group and symptom severity) requiring invasive and prolonged ventilation [9–11]. However, pandemic-related disruptions in supply chains, transport restrictions, and other factors have strained the ventilator supply, impacting efforts to reduce mortality rates [12].

Less expensive alternatives to mechanical ventilation, particularly automated manual ventilation (AMBU) bags, have received considerable attention among clinicians, researchers, and policy makers. These devices are preferred due to their rapid production, cost-effectiveness and wide accessibility. Automated AMBU bags or resuscitators assist the patient's breathing by compressing and releasing the AMBU bags at intervals, thus providing oxygen that meets the needs of individual patients in terms of respiratory rate, pressure and tidal volume [7]. Additionally, these systems offer advantages over manual counterparts by freeing up nursing staff for other critical tasks. Their simple structure, affordable price, portability, power options (battery or mains) and easy-to-use control systems make them suitable for patient transport without special training (depending on the situation).Because of these advantages, many low-cost automated resuscitation devices have been proposed worldwide to combat the ongoing pandemic. However, an objective evaluation of these plans is essential.Key factors to choose the best model are actuator (optimum torque, minimum wear, noise reduction, etc.), installed sensors and lifetime interference, medical efficiency (positive end expiratory pressure (PEEP), tidal volume, peak pressure, breaths per minute (BPM), inspiratory/expiratory ratio (I/E), fraction of inspired oxygen (FiO2), financial viability, user interface (display, control systems, interface ports, etc.), system reliability, and clinical trial results We present the World Organization on Health to assist users and researchers in the design of these portable mechanical ventilators (OMS) and the Medical and Healthcare Products Regulatory Agency (MHRA) guidelines for a systematic review of the benefits and limitations of various proposed resuscitation systems. of.

LITERATURE SURVEY:

- An overview of the history of contemporary mechanical ventilator systems is given in this work. An inexpensive portable ventilator design that is straightforward, easy to use, and simple to construct is suggested in this project based on the examined literature. It is assumed that the ventilator prototype here operates better than what is currently on the market. This ventilator has a sensitive pressure monitoring system and a blood oxygen sensor, both of which are quite inexpensive. Here, we design and create a ventilator using Arduino that satisfies all the criteria for a dependable, reasonably priced device that also meets all the specifications and characteristics of a genuine mechanical ventilator, including its mobility.

- This paper provides information about the ventilator system. The whole conversion from ac to pulsating DC is accomplished
- This article details the conception and development of a low-cost, portable mechanical ventilator that can be used in settings with limited resources and in mass casualty situations. By using a rotating cam arm to compress a traditional bag-valve mask (BVM), the ventilator may administer breaths without the need for a human operator. An initial acrylic prototype had dimensions of 11.25 x 6.7 x 8 inches (285 x 170 x 200 mm) and weighed 9 pounds (4.1 kg). It has a tidal volume that can be adjusted up to 750 ml and is powered by an electric motor that runs on a 14.8 VDC battery. User-friendly input knobs are used to set the tidal volume and breaths per minute. The prototype also has an alarm and an assist-control mode.
- This study details the design and early development of a low-cost, portable mechanical ventilator that might be employed in settings with limited resources and in mass casualty situations. Breathing is accomplished by compressing a standard Ambu bag using a rotating cam arm, which removes the need for an operator to hold the Ambu bag. The first version has an electrical motor that runs on a 12 VDC battery and can be adjusted to have a maximum tidal volume of 750 cc. The number of breaths per minute and tidal volume are set to the default values. The gadget will have an LCD screen, a pressure escape cock, an adjustable inspiration to expiration time ratio, and an alarm to indicate the over pressurization of the system in later versions.
- The development of inexpensive, open-source automated ventilators is demonstrated in this work. The numerical technique for tracking patients' lung status is also demonstrated in this literature. We shall categorize the patients' lungs as healthy or sick with the help of a pressure sensor. The pressure sensor's data is gathered by an Arduino board and sent to a Raspberry Pi. The Raspberry Pi issues the appropriate breathing bag compress and acuter commands. The pressure sensor can detect differential pressure of up to 70 cm H2O, according to the manufacturer. The servo meter rod had the gear fastened to it. Plexiglass bars were used to make the rod. This gear has a radius of 2.5 cm.

HARDWARE AND SOFTWARE :

Hardware components

- ARDUINO Uno: To control the whole system of the system
- HIGH TORQUE MOTOR: Peak force engine is formed, similar to a doughnut, along these lines has an enormous distance across and short pivot.
- AMBU BAG SETUP: The device is used in stowing to provide a continuous amount of oxygen to an individual's lungs.
- LCD with I2C: This is used here to provide a proper display of ongoing tasks.
- Potentiometer: It is used in order to increase or decrease the rate of flow of the air and breath rate.

METHODOLOGY:

So our first task was to create a system that will be low cost and reliable and so we created a setup in which we hardware components and a microcontroller to control these systems.

Working principale is simple it is having 3 modes 1st one is infant mode which allows less air to the the infant which pumps air in scale of 20-30mL, next mode is child mode in which the system pumps air on medium scale ranging from 280-300mL and last and final mode is adult mode this pushes more air in order to keep the flow rate more between 460-550mL.

Alongwith this heart rate and spo2 sensor is used to continoulsy keep track of the patients health and take required actions if required.

Circuit Diagram:

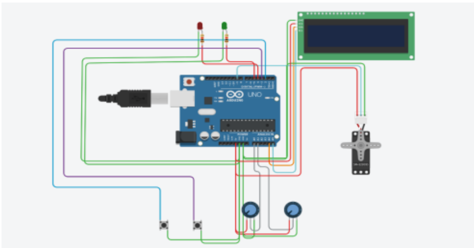

Fig 1.1 Shows the circuit arrangements

Cloud server: A local cloud server is implemented in order to keep track of the patients health and upload the required data onto cloud servers, local server is implemented in order to keep the system safe and not allow data breaches.

RESULTS AND DISSCUSSION:

So we got the desired results which we were expecting the ventilator was working completely as per the requirements and also the cloud server was functioning properly without any kind of error.

Fig 1.2 Physical model

Here below are some images of the project

CONCLUSION-

In conclusion, the development and implementation of a low-cost ventilator system represent a critical stride toward improving global healthcare accessibility, especially in resource-limited settings and times of crisis.

FUTURE SCOPE-

In future we can provide a dedicated app that will be continuously monitoring patient and if there is some risk with patients' health stats it will notify the doctor and nearby emergency services

Also, in Future we can add several other features like measurement of patient's temperature, Sleep cycle detection etc. with the help of this the patient will be provided more connivence and doctors can also analyze the data of patients reports and will take required action for further surgeries and other tasks.

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