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DIY Ventilator using Arduino with Blood Oxygen Sensing for Covid Pandemic

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Abstract- This article depicts outlines of various examination conducted. Human lungs are used for breathing. They employ a push mechanism in each movement of breath mechanism and exhalation process occurs. Here we have the DIY ventilator configuration to assist people during the Covid pandemic. This is very lowcost and affordable. When patients suffer from lung or breathing disorder this can be used in a patient basic condition. Stepper Motor component is used to push the ambu sack. While breathing heartbeat levels identified are low this component can be executed. The LED screen is used to display the breathing heartbeat levels. Similarly, in a patient basic condition or breathing problem ringer is installed in the system to ring a ready when any irregularities are identified. Apart from this, the ventilator should provide the facility to monitor the patient's blood oxygenation level and exhaled lung tension to avoid over under air pressure simultaneously. The ventilator we here design and develop using Arduino incorporates all this mass of requirements to develop a reliable yet affordable DIY ventilator to assist during pandemic.

Keywords- Arduino, ventilator, bag valve mask , pneumatic, COVID-19.

I. INTRODUCTION

The human respiratory system relies on the diaphragm's contraction and relaxation to facilitate breathing, a vital process that supplies oxygen to the body's tissues and removes carbon dioxide. A ventilator is a medical device designed to support or replace a patient's breathing by delivering a precise volume of air into the lungs, thereby assisting patients who require respiratory assistance due to illness, injury, or other medical conditions. The key characteristics of a ventilator include a variable breathing rate, usually between 10-30 breaths per minute, control over the volume of air delivered to the lungs per breath, and an adjustable ratio of inhalation to exhalation. Furthermore, it tracks the patient's blood oxygen levels and airway pressure to avoid excessive or insufficient lung inflation. a DIY ventilator project has been created utilizing Arduino technology. This device employs a silicone ventilator bag that is compressed by a system of DC motors and a mechanical compression mechanism, which squeezes the bag to deliver air to the patient. The breath duration and BPM are controlled by an electric switch and variable potentiometer, while sensors monitor the patient's vital signs and display them on a compact screen. An alarm system is also incorporated to alert in case of emergencies. The creation of open-source, improvised ventilators can help fill the gap in medical equipment shortages. Although a DIY ventilator may not be as effective as a clinical-grade device, it can be a alternative in emergency situations if it meets essential functional requirements. By harnessing technology and innovation, we can develop solutions to support patients in need and reduce the strain on healthcare systems.

Tidal volume: it is the volume of air delivered to the lungs with each breath by the ventilator - typically 500ml at rest.

BPM (Breaths per minute): this is often the set rate for delivering breaths. Range is 10 – 30.

Inspiratory: Expiratory ratio (IE Ratio): refers to the ratio of inspiratory time: and expiratory time.

Flow rate: is that the most flow at which a set tidal volume of breath is deliver by the ventilator

Peep (Positive end-expiratory pressure): it's the pressure within the lungs above gas pressure that exists at the top of expiration.

System Overview

Our proposed system is designed to monitor patient breathing patterns, providing critical support for individuals in need. The setup consists of a ventilator, breath rate controller, and user interface controls, working together seamlessly to ensure effective ventilation.

The primary goal of this project is to develop an affordable ventilator solution that can be easily assembled using readily available components, making it accessible to a wider range of people. To achieve this, we successfully created a functional prototype of a low-cost ventilator, demonstrating the potential

for innovative medical solutions that are both effective and affordable.

System Design
A medical ventilator prototype was developed using rapid prototyping technologies, featuring integrated blood oxygen monitoring via Arduino. The design incorporates a respiratory component linked to a wall oxygen supply, regulated by a flow meter to ensure precise air delivery.

Software Application
Upon executing the Arduino code, the motor will perform specific rotational cycles, ensuring the mechanism operates smoothly and efficiently. The code controls the motor's direction, including counterclockwise and clockwise rotations, to achieve optimal performance.

II. LITERATURE SURVEY

The creation of affordable, open-source automated ventilators marks a significant breakthrough in medical technology. By harnessing the power of numerical data to monitor lung function, healthcare professionals can make informed decisions that directly impact patient care. At the heart of this innovation is a pressure sensor that categorizes lung health status, providing critical insights that guide treatment. The sensor's data is processed by an Arduino board, which transmits the information to a Raspberry Pi, controlling the actuator and breathing bag compression with precision. Aliaksei Petsiuk, Nagendra G. Tanikella, Samantha Dertinger, Adam Pringle, Shane Oberloier, Joshua M. Pearce, (Partially RepRapable automated open-source bag valve mask-based ventilator)[1] What sets this ventilator apart is its simplicity, portability, and adaptability. The device's 3D printable structure makes it remarkably easy to manufacture and repair, reducing costs and increasing accessibility. The Arduino controller's real-time capabilities enable seamless task management, ensuring that patients receive the care they need in a timely manner. This project builds upon previous research, demonstrating the vast potential of open-source ventilator designs. (Nurses role in prevention and management of mechanical ventilation related complications) (2006)[2]

Effective ventilation management requires a delicate balance of nursing expertise and technological know-how. Healthcare professionals must be well-versed in the potential complications associated with mechanical ventilation and take proactive steps to mitigate those risks. By leveraging evidence-based practices, such as elevating the head of the bed and sedation vacation, healthcare teams can significantly improve patient outcomes. issues undying the patient- centered approach. Mechanical ventilation precipitates [3]

A groundbreaking prototype of a low-cost, portable mechanical ventilator has been developed for use in emergency situations and resource-limited settings. This innovative device utilizes a pivoting cam arm to compress a standard Ambu bag, eliminating the need for manual compression and streamlining patient care. With adjustable tidal volumes and default settings for breathing rate and volume, this prototype is poised to revolutionize ventilation solutions. Future versions will include advanced features, such as controllable inspiration-to expiration ratios and safety valves, further enhancing patient care
By harnessing the power of automated Ambu bag compression, this technology has the potential to provide low-cost, portable ventilation solutions for those in need, bridging the gap in healthcare access and improving patient outcomes.. [4]

III. BLOCK DIAGRAM

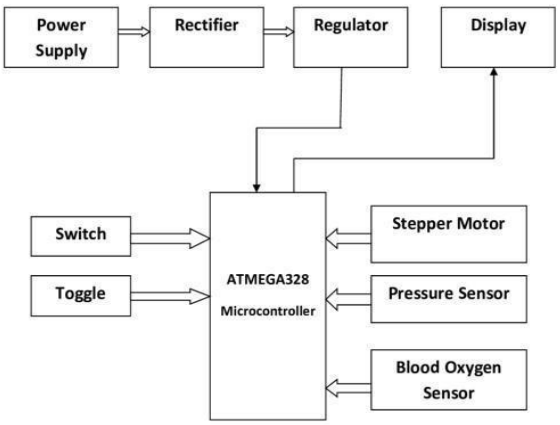

Figure.1: Block Diagram

IV.WORKING

The extension rectifier is used to change ac over completely to throbbing dc. The rectifier changes AC to DC power. Capacitors help make the power smooth. Transformers give 5V DC power to Arduino
.
The ventilator uses a special bag with DC motors and a push system. We can adjust breath length and rate using a control This allows us to customize the ventilation for each patient's needs.

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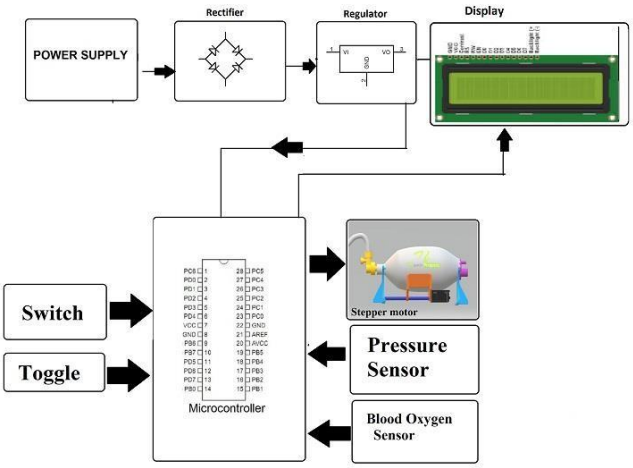


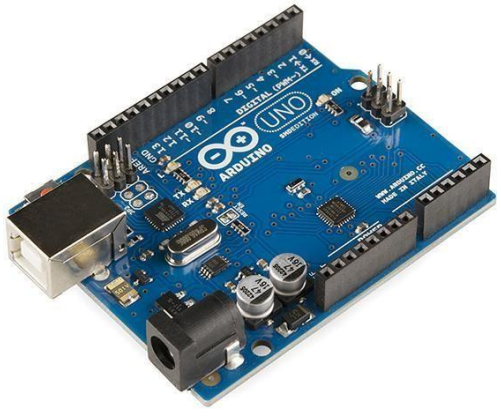
Figure : 2:Flow Chart

The system checks oxygen levels and shows them on a small screen. If something goes wrong, it sounds an alarm. This helps take care of patients with serious breathing problems. It can be used in hospitals and other healthcare settings. The system is easy to use and monitor, making it a valuable tool for healthcare professionals. The whole framework is driven by Arduino regulator to appreciate wanted results and to help patients in COVID pandemic and other crisis circumstances.

V. HARDWARE USED

Components used are as follows:

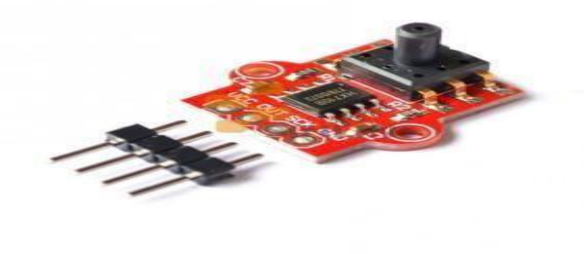
Arduino Uno



The Arduino Uno is a microcontroller board that features the ATmega328 chip. It has 14 digital input/output pins, with 6 of them supporting Pulse Width Modulation (PWM), allowing for precise control over outputs. Additionally, it includes 6 analog input pins for reading sensor data, a 16 MHz crystal oscillator for timing, a power input for connecting an external power source, and USB connectivity for programming and communication. The board also has an In-System Circuit Programming (ICSP) header for advanced programming and areset button for restarting the board. The Arduino Uno can be powered via USB, an AC-to-DC adapter, or a battery, and it operates at a voltage of 5V

Pressure Sensor

A pressure sensor is a device that measures the pressure of liquids or gases. It works by detecting the force applied and converting it into a readable signal. These sensors are used in many applications to control and monitor pressure levels They come in different types, categorized by the pressure range they measure, the temperature they operate in, and the type of pressure they detect. Although they may be called different names depending on their use, the technology behind them is often similar.



16x4 LCD Module

A 16x4 LCD module is a type of display screen that shows letters and numbers. It's often used in electronic devices and circuits. The "16x4" means it can display 16 characters on each of its 4 lines.The display shows characters in a 5x7 dot matrix format and can present various symbols. It has 16 pins and works with a voltage of 4.7V to 5.3V. This LCD module is useful for displaying information in a clear and readable format.

VI. RESULT

VII. CONCLUSIONS

A new approach has been developed to address the COVID 19 pandemic by creating affordable, open-source ventilators using accessible manufacturing techniques. This design aims to increase access to essential medical equipment. While it's still in the early stages and needs further refinement, this initiative has potential for significant impact. Additional work is required to meet clinical standards, but it could be valuable in both pandemic situations and resource-constrained environments.

VIII. FUTURE SCOPE

We can engage this venture in time of crisis as first help gadget. For example: If a person develops a respiratory condition. He actually needs to be taken to clinic properly while traveling in rescue van or in the accident site he desired of ventilator to breathe SO around then our venture is small, supportive and to operate which can help to save life. As the price of our project is modest it is easy buy by a poor community and affluent people. In future we can develop the venture by incorporating GSM module to keep in touch with experts while going in rescue vehicle we can incorporate BP sensor instead of pressure sensor for more precision, we can incorporate camera to live communication with experts guidance for help treatment during traveling

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