Designing of Augmented Respiratory Assistance for Chronic Obstructive Pulmonary Disease

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***Abstract*— Respiratory disorders is an international health concern. Chronic obstructive pulmonary disease (COPD) is a chronic lung conditions that cause breathing difficulties and restricted airflow. Emphysema or chronic bronchitis is a progressive disease that damages the airways or other parts of the lungs, making breathing difficult. Due to its substantial morbidity and mortality, COPD places a heavy burden on people's lives as well as global healthcare systems. COPD patients may also have systemic symptoms like fatigue, weakness in their muscles, and weight loss in addition to respiratory symptoms, which can affect the quality of life. According to WHO estimates, COPD will account for 3.23 million deaths globally in 2019 and rise to the third-highest cause of death by 2030. In order to rectify the issue and save lives, a cheap portable ventilator was fabricated. The MAX30100 is integrated with heart rate monitoring system and pulse oximetry sensor that uses LEDs, a photodetector, optimized optics, and low-noise Analog signal processing unit is developed. It allows users to assign volume and pressure that connects to the Arduino Nano using Arduino ide. An essential gap in the emergency medical care system is filled by the portable ventilator system. It's a portable device that focuses on safety which makes it an invaluable tool for reducing healthcare difficulties in times of emergency and eventually saving lives.**

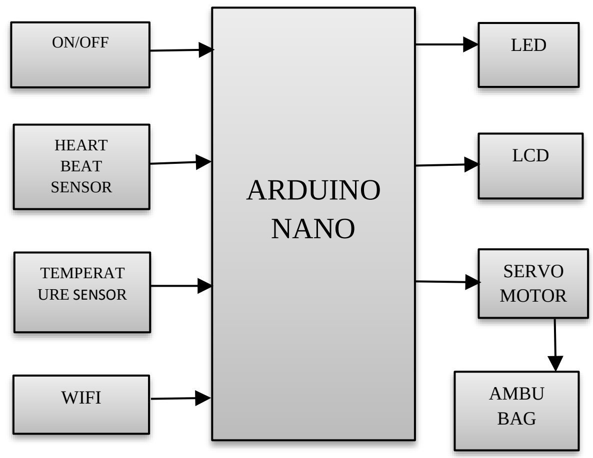
***Index Terms*— Chronic Obstructive Pulmonary Disease, Portable, Bag valve mask, Arduino Nano.**

I. INTRODUCTION

The medical community around the world had assumed, respiratory failures may occur during the epidemic's height. 75–80% of the hospital's capacity remains unfilled even after rapid steps to expand its capacity was implemented. During COVID-19, the availability of supplies raised awareness among people about the need for hospitals for rejuvenation. Chronic respiratory conditions and traumatic respiratory failure are major public health concerns in both developed and developing countries. Other long-term respiratory disorders, like chronic obstructive lung disease, are prevalent. Patients with underlying lung disease who encounter respiratory failure for any reason may require mechanical ventilation. The process of exchanging carbon dioxide and oxygen in the lungs with the use of mechanical devices that help patients breathe in and out is called artificial respiration. Modern American hospitals are equipped with highly advanced and sophisticated ventilators. Such advanced technologies would be too costly to afford in under-developing countries. These ventilators are driven down by regular usage, requiring rich maintenance contracts from the manufacturer. Numerous practical remedies have emerged in response to the possibility of widespread deaths from a respiratory pandemic sickness. Patients with acute respiratory distress syndrome (ARDS), which has a high likelihood of ICU admission, are frequently treated with mechanical ventilation for up to five days when they have acute respiratory failure (ARF) caused by pneumocystis carinii pneumonia (PCP). Pneumothorax and nosocomial infections carry a three-month death risk. Iron lungs were the first ventilators to be widely employed in the 1920s and 1930s polio epidemics. The majority of the patient's body has to be encased in a box in order to use these enormous noninvasive devices. It used negative pressure to force the patient's lungs and chest to expand and contract, allowing or excluding air. Regardless of the patient's desire, one of them simply pumps air into the lungs. These devices are based on traditional bag valve masks. Using a plastic bag that they can grip with their hands, a medical professional can physically pump air into the lungs. It's an inexpensive and easy way. Currently, more advanced ventilators are used to treat patients with Covid-19 and other disorders. These ventilators are able to detect when a patient is trying to breathe or exhale and then assist them in reaching their goal. The patient receives precisely the appropriate amount of air, which interacts with their body, based on sensor data. Patients therefore need a basic, affordable, and effective ventilator that makes it easier for them to breathe in and out. With extra help, such artificial breathing, the lungs are able to exchange oxygen and carbon dioxide. Mechanical ventilators and other complex devices are too expensive to adequately stockpile. Using advanced timing tools, the clinician can modify the Puritan Bennett 900 mechanical ventilator to suit the individual needs of each patient and guarantee adequate support throughout every breath.

II. MATERIALS AND METHODS

Creating an instrument to provide artificial ventilation using an Ambu bag, Arduino Nano, Potentiometer, and an LCD display involved various steps. Breathing difficulties and limited airflow are common symptoms of chronic obstructive pulmonary disease (COPD). Its primary symptoms are emphysema and chronic bronchitis. Breathing difficulties and a chronic cough are brought on by inflammation and increased mucus production in the airways. Emphysema is brought on by damage to the lung's air sacs, which decreases their flexibility and decreases airflow. Jumper wires were used to connect the temperature and heart rate sensors to the Arduino Nano. Heart rate monitoring and pulse oximetry are combined in the MAX30100. A photodetector, optimized optics, and low-noise analog signal processing are used to detect pulse oximetry and heart-rate signals. Volume and tension are determined by the user. The dossier, ground, and capacity pins were connected after connecting the LCD display to the Arduino Nano. The heart rate sensor was constructed using Arduino software. The LCD screen showed the age group, volume, pressure, and breath rate. The LCD display was designed to show age group, volume, pressure, and breath rate in a convenient connect. User interaction could be initiated and terminated via buttons or a touchscreen connection. Depending on the design, the Arduino Nano needs a continuous capacity supply, which could be a 12V assault, USB source, or another suitable power supply. The framework has an LED installed inside it to indicate the on and off modes. The framework assists patients in emergency situations and is powered by Arduino data.



2.1 BLOCK DIAGRAM

The figure portrays the block outline of the Ventilator which would have a 12 V power supply taking care of the Arduino. The Arduino UNO with LCD, Drove, Servo Motor, AMBU Bag are employed. The input device is Wi-Fi, Heart beat sensor and Temperature sensor. The LCD would show the upsides of the different modes accessible. Engine Driver would have a High Force engine which would change the various modes and the breath each moment values. There would be a temperature sensor added to the framework for the patient's important bodily function to be portrayed.

III. HARDWARE SPECIFICATION

- Ambu Bag

Bag valve masks (BVM), also known as Ambu bags or manual resuscitators, are portable devices used to provide positive pressure ventilation to patients who are not breathing enough. They are commonly used in emergency rooms, hospitals, and critical care environments as part of standard equipment on crash carts. BVM is also essential for certified professionals operating in non-hospital environments, such as ambulance crews. The American Heart Association's guidelines emphasize the importance of BVM use in healthcare.Manual resuscitators are used for temporary ventilation of ventilator-dependent patients who need to be moved within the hospital or have their mechanical ventilator inspected. They come in two main varieties: flow-inflation, which fills with air on its own and doesn't need extra oxygen, and flow-inflation, which is used in operating rooms for non-emergency purposes. Bagging a patient is a technique used to ventilate patients whose breathing is insufficient or has stopped completely. A manual resuscitator works by forcing air or oxygen into the lungs to cause them to expand under pressure. Expert rescuers often use it directly or in combination with a pocket mask in place of mouth-to-mouth ventilation.

- Arduino Nano

Arduino.cc is the creator of the Arduino Nano microcontroller board, which uses an Atmega328 microcontroller. This small, multipurpose board has numerous applications and is small in size. It shares many features with Arduino Duemilanove boards but has a unique package, allowing power supply to be connected to a tiny USB port instead of pins like VCC and GND directly. Other Arduino boards include Arduino Mega, Arduino Pro Mini, Arduino UNO, Arduino YUN, Arduino Lilypad, Arduino Leonardo, and Arduino Due.

- ESP8266

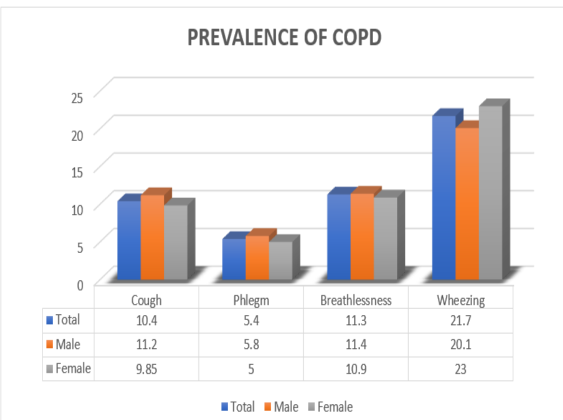
Espressif System's ESP8266 WiFi Microchip is an affordable, self-contained system with integrated TCP/IP networking software. It gained popularity in 2014 due to the ESP-01 module from Ai-Thinker, which enables microcontrollers to connect to wireless networks and create simple TCP/IP connections using Hayes-style commands. Initially, there was limited English-language documentation about the chip and its commands. The ESP8266 can host an application or assign all WiFi networking work to a different application processor.

- MG995 Servo motor

The MG995 Metal Gear Servo Motor is a high-speed servo motor used in various RC models like automobiles, aircraft, and helicopters. It features a digital servo motor with enhanced PWM signal reception and processing, delivering 12 kg/cm at 6 V and 10 kg/cm at 4.8 V. Its sophisticated internal circuitry provides good torque and holding power, reacting quickly to external forces. The motor is dust and water resistant and comes with a 3-wire JR servo plug compatible with Futaba connectors.

IV. RESULTS AND DISCUSSION

With a focus on user affordability, a ventilation instrument has been proposed. For improved maintainability, the instrument adopts a modular design with a dependable control algorithm. Standard parts are selected that are easily obtained from medical and electronics supply stores. The device can be further adjusted to include more accurate control features to handle various difficult pathological situations. This device is so inexpensive that it can be installed in small clinics or even homes for a fair price. It can also be used as initial medical support in emergency situations where sick patients need immediate respiratory assistance. The operator fully adjusts the mechanized ventilator's controllable breathing mode, which is its primary mode of operation. There are many situations where a patient receiving ventilation may experience pain because in those situations, the patient is given strong sedation to help them feel better. Frequently, this can be made worse by illnesses like barotrauma, in which the patient's diaphragm and intercostal muscles resist breathing. A positive end-expiratory pressure at every breath cycle and a strictly regulated peak pressure help to partially avoid barotrauma and atelectasis. Therefore, in a conventional intensive care unit, patient-triggered ventilation assistance is generally preferred. When access to conventional medical equipment is limited, building a low-cost ventilator with integrated temperature, BPM, and oximeter capabilities using Arduino offers a cost-effective substitute. It is important to remember that this ventilator should only be used as a stopgap measure and should not take the place of medical equipment that has been properly designed, tested, and manufactured. Before using such a ventilator in a medical setting, it is imperative to adhere to local regulations and guidelines and consult healthcare professionals. By adding sensory units along the airflow circuit that can monitor the patient's actual breathing cycle and adjust the AMBU bag actuation accordingly, the algorithm can be modified to include patient-triggered ventilation. This includes pressure-triggered ventilation, which is activated by a drop in air pressure in the patient's trachea, which indicates the expansion of the thoracic cavity, and flow-triggered ventilation, which is activated when a flow sensor detects airflow to the patient's lungs when they are trying to breathe. In these situations, the patient initiates the breathing sequences, so sedation is not really necessary. However, the ventilation machines are extremely costly due to their intricate workings. This instrument's hygienic component can be easily assembled and disassembled for post-use sterilization of the component parts. It's also quite practical to replace parts as needed. A small amount of power is used, that is swappable, strictly controlled, reliable, long-lasting, and battery-powered in areas with frequent power outages. The traditional manually operated AMBU bag is often taxing on the attendant, and is a practical replacement. Several patients who are ventilated can be watched by a single person here. Hospital ventilators are extremely scarce during pandemics that cause COPD. The suggested mechanized ventilator's expenses when compared to those currently in use are significantly lower.



4.1 Prevalence of COPD

V.CONCLUSION

The researchers create an easily assembled, reasonably priced, and highly effective mechanized ventilator unit that can be used to save a life when a patient is in critical condition. A direct closed-loop monitoring approach consistently improves the functionality of a manually operated and stand-alone AMBU bag. Even though this straightforward, less expensive device can't fully replace the expensive, highly advanced ventilators that are currently on the market, it can be installed in small clinics where access to ventilators is limited or in ambulances to treat patients experiencing acute respiratory distress while they are in transit. This inexpensive ventilator will undoubtedly aid in combating not only the COVID-19 pandemic but also COPD resulting from other causes, fulfilling the WHO's motto of "Health for All."

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