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Design and Construction of VentilatorSynchronized with Pulseoximeter

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***Abstract*—COVID-19 has evolved into a global epidemic that is rapidly spreading over the globe. Because this pandemic primarily affects the human respiratory system, an intelligent ventilation device is required to preserve the lives of extremely ill people. Patients who have been affected COVID-19 has evolved into a global epidemic that is rapidly spreading. All throughout the world Because this pandemic primarily affects the human respiratory system, an intelligent ventilation device is required to preserve the lives of seriously affected individuals. In this regard, a mechanical ventilator is built that, without the participation of medical personnel, makes an appropriate decision to deliver artificial breathing for patients with lung disease or respiratory failure based on the measured value of SpO2 and pulse rate at any given time. A ventilator that has been designed will be able to perform artificial respiration in its entirety or in part. To communicate between the pulse oximeter and the ventilator, a serial communication approach is used. The pulse oximeter reads the patient's SpO2 and pulse rate and sends them to Node MCU, which then sends them to Arduino nano. The developed software analyses the patient's changing medical conditions and makes an intelligent decision to produce updated FiO2 and PEEP results for delivery to the patient.**

***Index Terms*— Mechanical ventilator . Pulse oximeter . SpO2 . Serial communication . FiO2 . PEEP . Microcontroller.**

I. INTRODUCTION

Hospitals and healthcare facilities are reporting shortages of critical equipment as a result of the global crisis caused by the corona virus epidemic. It is our obligation as creators to tackle the shortage by building temporary open-source replacement gadgets. Our country may be under siege, but our ingenuity is not! Ventilators for patients who require aid with breathing owing to COVID-19's respiratory effects are one key device for which demand has increased. A ventilator is essentially a mechanism that delivers breathable air into and out of the lungs to a patient who is physically unable to breathe or is breathing insufficiently. A DIY ventilator may not be as effective as a medical-grade ventilator, but it can be a good substitute in some cases. volume : of air given to the lungs by the ventilator with each breath - approximately 500ml at rest. BPM (Breaths per minute): This is the rate at which breaths are delivered. The ventilator's highest flow rate at which a given tidal volume breath is delivered is known as the flow rate. Blood Oxygen & Heart Rate Monitor: Using a mobile app, the blood

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Oxygen Concentration (SpO2) is monitored in percentage and the Heart Beat/Pulse Rate is measured in BPM These gadgets, which cost roughly $30,000 each, can keep patients breathing when they can no longer do so on their own. Designing and developing a low-cost portable ventilator could be one method to aid COVID-19 patients in India with pneumonia.
The proposed low-cost ventilator works by compressing a standard Bag Valve Mask (BVM) or Ambu bag with a pivoting motor drive mechanism, which eliminates the requirement for a human operation.

II. EXISTING SYSTEM

The pulse oximeter measures the patient's pulse rate and oxygen saturation level and the results of those are transmittedto the Raspberry Pi board. Ifthe SpO2 level is less than 90% and pulse rate is less than 60 beats per minute , Raspberry Pi computes the amount of FiO2 to be delivered to the patient externally. The patient also gets the voice message alert to wear a mask as his/her condition is critical.
The oxygen and the medical air coming from the reservoirs gets mixed in the mixer tube. Mixer tube is followed by flow sensor and the pressure sensor which measures the flow rate and pressure of the air which has to be delivered to the patient with the help of Arduino Uno. The measured values are then conveyed to Raspberry Pi for further computation. The volume and pressure of the air to be delivered to the patient is adjusted by the solenoid valve as per the results computed by Raspberry Pi,by using the values from the Oximeter and the sensors. The required amount of FiO2is then delivered to Ambu Mask through the solenoid. The Ambu Mask is connected to the patient. It operates with the help of motor which is driven by the motor driver. The expiration valveopens after each inspiration so that the patient can exhale the breath He or She inhales. A relay is used to stop the ventilation process when the SpO2 value and the pulse rate ofa patient reaches normal level. As soon as the patient reaches normal state he/she gets the voice alert to remove the mask.

III. RELATED WORK

"Adem Gölcük1 & Hakan Işık2 & İnan Güler3" In this , oxygen (FiO2) and the positive end-expiratory pressure (PEEP) to be delivered to the patient. A mechanical ventilator and a pulse oximeter were designed for this purpose. These two devices were operated in synchronization. The amount of oxygen in the air to be delivered to the patient from the ventilator is calculated automatically in this way. Thiscalculation is made by a fuzzy-logic-based controller developed for the ventilator. Oxygen concentration in the blood of the patient is measured by the pulse oximeter. The measured value is conveyed to the ventilator with serial communication and used as an input membership function of the fuzzy-logicbased controllers. The results of the conducted tests were recorded and presented in Tables 3–5. The results verified the efficacy of the proposed system.
R.Szlosareka R.Teicherta A.Wetzela A.Fichtnerb F.Reuterc M.Krögera, "Design and construction of a simplified, gas-driven, pressure-controlled emergency ventilator"Our researchresults describe a simplified gas-driven, fully mechanical, pressure-controlled emergency ventilator with semiautomatic adjustment of PIP-controlled tidal volume and frequency. The operating power comes from pressurized breathing gas. Lack of electronics and the developed piston-driven principle add endurance and thus safety in remote areas. Another characteristic is the easy manufacturing process. The device can be manufactured by hand-driven milling, turning and drilling machines. The detailed design should be adapted to the manufacturing machines, materials and purchasedcomponents which are locally available. Exemplarily, the dimensions of the housing or the threads should always be adapted in a way that the manufacturing can be done easy and repeatable. The functionality is independent of the used material.
In comparison to existing ventilators, the devised ventilator can be self-manufactured and is hence independent from the availability of purchased ventilators. The manufacturing and assembly can be done with some basic machines and a basic experience in engineering.
Overall, the paper describes the functionality and the basic influencing parameters of the ventilator. To adjust the device to the local needs and infrastructure, comprehensive supplementary material is provided.
Mashuk sheikh, Designing, Implementing, and Testing of a Microcontroller and IoT-based Pulse Oximeter Device In this work, a simple, microcontroller and IoT-based robust pulse oxygen saturation measuring device design process is described and then its experimental results are presented with a brief explanation of it. The implemented system is portable and is shown in the paper. It requires no expert medical personnel to measure the SpO2 state or heart/pulse rate of a person. The person himself/herself can also measure it easily. Due to the

easy connectivity with the internet through the IoT, the designed machine has the facility to send the measured data through the IoT to the mobile phones to get advice or treatment from any doctors who reside in remote areas withoutany physical or on-site visits. The measured data and its accuracy rate were satisfactory as compared to the standard commercial device bought from the drug store with average error rates of 1.1% and 0.6% for heart rate and SpO2 data. Besides, sending data to the mobile device was successful and displayed on the smartphone screen. Besides, the implementation cost was very low, of the order of US$30 (US Dollar thirty only).

IV. PROBLEM STATEMENT

A monitoring system is required to keep track of the patient's physiological parameters at all times. Although currenttechnologies allow for continuous monitoring, the sensors must be set in such a way that the patient is confined to his bed. This project focuses on developing a health monitoring system that employs a pressure sensor and a pulse oximeter to assist people with medical monitoring, medical data access, and contact with healthcare providers. The project includes sensors that track a person's pulse rate and oxygen level. Through a signal conditioning circuit in the patient unit, the sensed data is transferred to a Microcontroller. The sensorvalue is set to a desirable quantity, and if it is exceeded, the sensor information is sent to the controller..

V. METHODOLOGY

A ventilator mechanism should be able to give between 10 and 50 breaths per minute, with the option to regulate ascending increments in two-step increments. In addition, the ventilator must be able to control the amount of air pumped into the lungs with each breath. Last but not least, the time duration for inhaling to exhalation ratio can be adjusted. Aside from that, the ventilator must be able to simultaneouslymonitor the patient's blood oxygen level and exhaled lung pressure in order to avoid over- or under-air pressure. All of these needs are met by the ventilator we design and construct using Arduino to create a dependable yet economical DIY ventilator to aid in pandemic situations. To push the ventilator bag, we employ a silicon ventilator bag linked with Servo motors and a two-sided push mechanism. We employ atoggle switch for switching and a variablepot1 for adjusting the breath length, pot2 for adjusting the breath volume, and a variablepot2 for adjusting the patient's BPM value. Our device uses a blood oxygen sensor and a sensitive pressure sensor to monitor the patient's vitals and display them on a small screen. In addition, the system has an emergency alarm that sounds an alert as soon as any anomaly is recognized. To obtain desired results and to aid patients in COVID pandemicand other emergency scenarios, the complete system is controlled by a controller.

Open source non-invasive ventilator Its low-cost and easy to build, an emergency respirator to combat the health crisis Covid19 if there are no ventilators available and as long as the patient is not sedated or intubated. This project was the result of a challenge launched by my ex teacher and friend Serafim Piers who contacted me showing a Spanish project, saying that it would be good if I could develop a project to help fight this world crisis. After several researches and studies on the topic of non-invasive Ventilation I built this functional prototype based on 2 existing technologies, Alltests were successful and with a functional test with more than 20 days without any problem or interruption. Non- invasive ventilation is delivered using facemasks nasal masks, which push a set amount of pressurized air into the lungs. This supports the natural breathing process when disease has caused the lungs to fail, enabling the body to fightinfection and get better.

A. Arduino nano

Arduino Nano as a number of facilities for communicating with a computer, another Arduino or other micro-controllers. The ATmega328 provide UART TTL(5v)serial communication, which is available on digital pins 0(RX) and 1(TX). An FTDIFT232RL on the board channels the serial communication over USB and the FTDI drivers(included with the Arduino software) provide a virtual com port to software computer. The Arduino softwareincludes a serial monitor which allows simple textual data to be sent to and from the Arduino board . The RX and TX LEDs on the board with flash when data is being transmitted via the FTDI chip and usb connection to the computer (but not for serial communication on pins 0 and 1) A software serial library allows for serial communication any of serial communication of any of the nanos digital pins.

B. Node MCU

Node MCU is a IoT model based on ESP8266 wifi model. Node MCU uses lua scripting language is an open source internet of things. This model has CH340g USB to TTL IC.

C. Pulse Oximeter

General Description combines to LEDs, Photo director optimise opticals,and low noise analog signal processing to detect pulse oximeter and rate heart rate signals. The MAX30100 operates from 1.8v and 3.3v power supply and can be powered don through software with negligible stand by current.

D. Temperature sensor

The MAX30102 has an onchip temperature sensor(optional) celebrating the temperature depends on the SpO2 subsystem. The SpO2 algorithm is relativelyinsensitive inspiration of the data. The temperature sensor data can be used to compensate the SpO2 error with Ambient temperature changes.

E. Flow sensor

Water flow sensors are insulated at the water source or pipes to measure the rate of flow of water and calculate the amount of water flowed through the pipe. Rate of flow of water is measured as leters per hours or cubic meters.

F. Humidity sensor

This DHT11 temperature and humidity sensor features a temperate and humidity sensor complex with a calibrated digital signal output . BY using the exclusive digital signal Acquisition technique and temperature and humidity sensing technology, it ensures high reliability and excellent long term stability. These sensor includes a resist type humidity measurement component and an NTC temperature measurement component and connects to a high performance.

G. Potentiometer

Electronic symbol for pre-set potentiometer multi turn are also operated by rotating a shaft, but by several turns rather than less than a full turn. Some multi turn potentiometers have a linear resistivity element with asliding contact mood by a lead by scew.

H. Ambu Bag

A sack valve veil (BVM), otherwise called an Ambu pack or a manual resuscitator or "self-expanding pack," is a hand-held gadget used to convey positive strain ventilation to patients who are not breathing or are not breathing adequately. The gadget is an obligatory part of revival units for prepared staff in out-of-clinic settings, (for example, rescue vehicle teams), and it is likewise generally utilized in clinics as a feature of standard gear on crash trucks, in trauma centers, and other basic consideration settings. To underline the commonness and significance of BVM use in the United States, "All medical services staff ought to be educated with the utilization of the pack cover gadget," as per the American Heart Association's (AHA) Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiac Care. At the point when the mechanical ventilator should be assessed for likely breakdown or when ventilator-subordinate patients are migrated inside the medical clinic, manual resuscitators are likewise used for impermanent ventilation of patients who are subject to mechanical ventilators. There are two kinds of manual resuscitators: one that is self-loading up with air and the other that can be loaded up with extra oxygen (O2) however isn't expected for the gadget to work. The other significant kind of manual resuscitator (stream expansion) is habitually utilized in non-crisis working room applications to ventilate patients during sedative enlistmentand recuperation.

VI. IMPLEMENTATION

Open source non-invasive ventilator Its low-cost and easy to build, an emergency respirator to combat the health crisis Covid19 if there are no ventilators available and as long as the patient is not sedated or intubated. This project was the result of a challenge launched by my ex teacher and friend Serafim Piers who contacted me showing a Spanish project, saying that it would be good if I could develop a project to help fight this world crisis. After several researches and studies on the topic of non-invasive Ventilation I built this functional prototype based on 2 existing technologies, Alltests were successful and with a functional test with more than

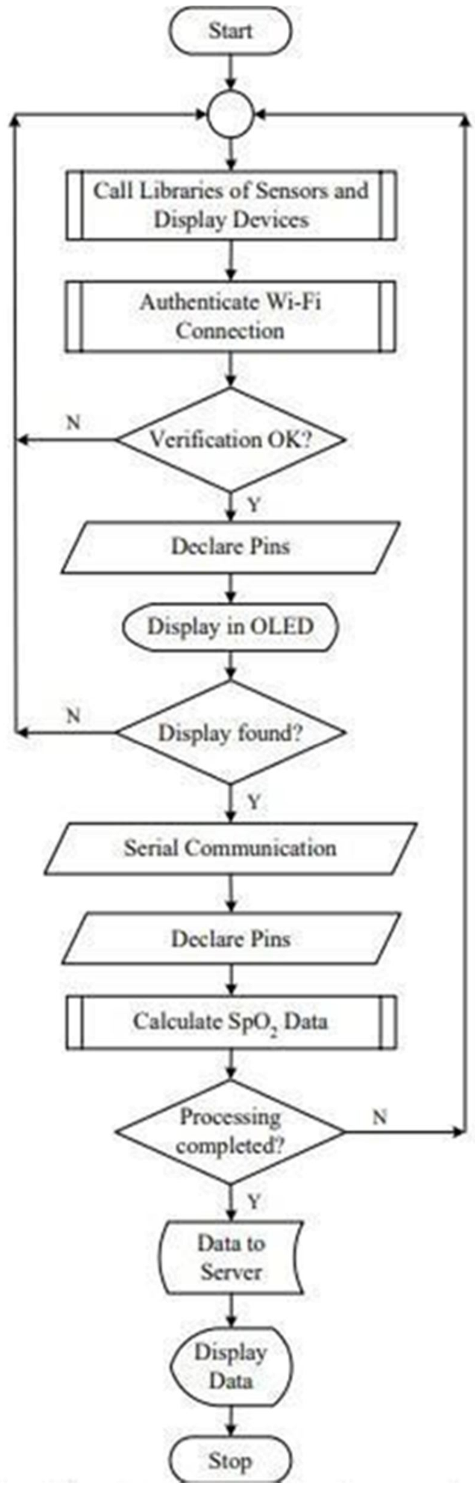

Figure 1: flow chart of the ventilator synchronised with pulse-oximeter

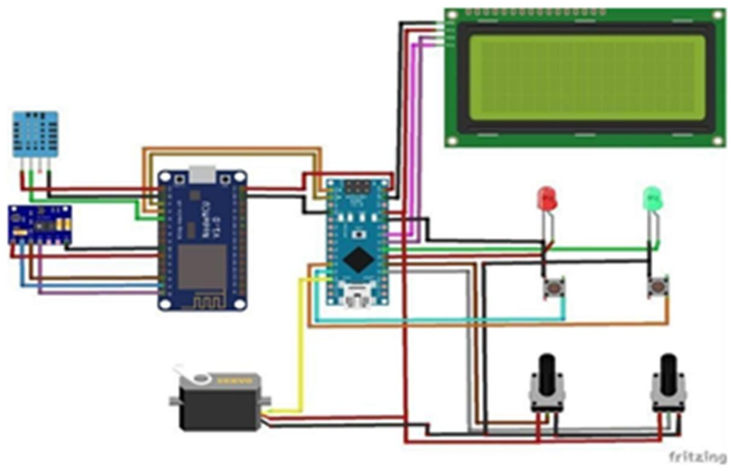

Figure 2 : circuit diagram of ventilator

20 days without any problem or interruption. Non- invasive ventilation is delivered using facemasks nasal masks, which push a set amount of pressurized air into the lungs. This supports the natural breathing process when disease has caused the lungs to fail, enabling the body to fightinfection and get better.

VII. RESULTS

- The pulse oximeter measures the patients pulse and oxygensaturation and convey it to Arduino. If the SpO2 is less than 90 % and pulse rate I less than 60 beats per minute thecritical stage is inducted.
- Arduino control measures the amount of SpO2 required by the patient. As per the value given by Arduino, the solenoid valve adjust to supply the mixtures of the oxygen and the medical air to the patient through ambu bag.
- The current state of the patient is monitored regularly to check the normality condition until patient reaches the normal condition.

Figure 3: Expected Result 1

- The results will be shown in the third phase, which includes infants, children, and adults.
- The outcome will be presented on an LCD display with Age group, volume, pressure, and breath rate of the relevant phase.

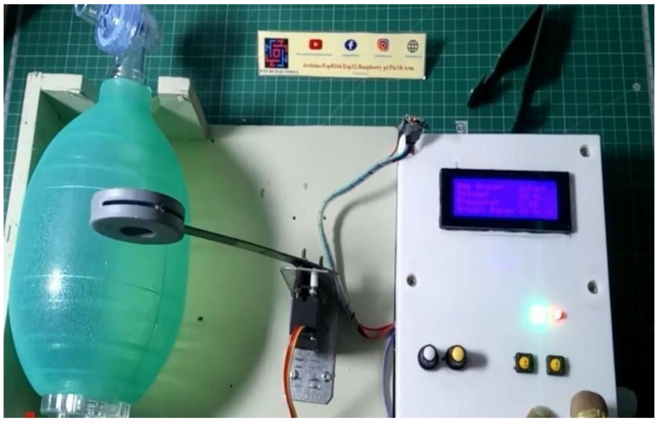

Figure 4: Expected Result2

VIII. CONCLUSIONS

We proposed a unique device to monitor the fraction of oxygen in the blood (FiO2) and the positive end-expiratory pressure (PEEP) to be administered to the patient in this investigation. For this, a mechanical ventilator and a pulse oximeter were created. Both of these devices were set to work at the same time. This method automatically calculates the amount of oxygen in the air that will be provided to the patient by the ventilator. The pulse oximeter measures the amount of oxygen in the patient's blood. The measured value is sent to LCD display.

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