MECHATRONIC DESIGN AND ROBUST CONTROL OF AN ARTIFICIAL VENTILATOR IN RESPONSE TO THE COVID-19 PANDEMIC

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ABSTRACT

Human lungs use the reverse pressure generated by means of contraction motion of the diaphragm to suck in air for breathing. A contradictory motion is used by a ventilator to inflate the lungs by way of pumping type movement. A ventilator mechanism has to be able to supply inside the variety of 10 – 30 breaths consistent with minute, with the ability to adjust growing increments in units of 2. Along with this the ventilator need to have the capacity to regulate the air volume driven into lungs in each breath. The final however now the least is the placing to alter the time period for inhalation to exhalation ratio. Apart from this the ventilator need to be capable of display the patient's blood oxygen stage and exhaled lung stress to avoid over/beneath air pressure concurrently. The ventilator we here layout and increase using arduino encompasses most of these necessities to increase a dependable but low-priced ventilator to help in times of pandemic. We here use a silicon ventilator bag coupled pushed by servo motor with one side push mechanism to push the ventilator bag. Our machine uses blood oxygen sensor along side touchy heart Beat sensor to display the important vitals of the patient and show on a webpage the usage of IoT. To alter the time duration for inhalation the choice command given in the IoT application to set. The complete machine is driven by way of arduino controller to gain desired results and to assist patients in COVID pandemic and other emergency situations.

Keywords: Lungs, COVID pandemic and ventilator mechanism.

1. INTRODUCTION

Respiratory diseases and screw ups are a prime public fitness issue in each evolved and developing countries. This global trouble has been greatly accentuated by way of the COVID-19 pandemic, which has led to an urgent need for additional ventilators. Even advanced nations consisting of Spain, Italy, and the United States are laid low with a shortage of these steeply-priced respiratory gadgets which also require an exceedingly long time to manufacture them. There are varieties of ventilator gadgets. One kind honestly pushes a certain extent of air into the lungs automatically without accounting for whether the patient desires to draw air into their body or to push air out. Almost all of these devices are primarily based on the use of the conventional bag valve masks (BVM). A BVM is a plastic bag that a medical care practitioner can deflate manually with their hands, and consequently presents a less expensive and clean manner to pressure air into the lungs. Indeed, BVMs are implemented through first responders to patients who are not breathing, rather than performing mouth-to-mouth resuscitation. All ventilator gadgets based on a BVM are essentially robotic arms that

squeeze the bag time and again at a hard and fast frequency. These gadgets can be manufactured fast and in big numbers, however considering those ventilators are surely pumps that pressure air into the affected person's lungs, they are able to simplest be used for sufferers beneath preferred anesthesia or individuals who are near demise and have nonfunctional lungs. Applying this type of tool to an aware patient would result in a threat of demise thru barotrauma, which takes place while the human frame is exposed to an inappropriate air strain

The coronavirus ailment (COVID-19) is unexpectedly spreading all around the world, and has infected extra than 1,436,000 humans in extra than two hundred nations and territories as of April nine, 2020. Detecting COVID-19 at early degree is critical to deliver right healthcare to the sufferers and also to shield the uninfected populace. To this end, we develop a twin-sampling interest community to mechanically diagnose COVID-19 from the community obtained pneumonia (CAP) in chest computed tomography (CT). In specific, we endorse a novel on line interest module with a three-D convolutional network (CNN) to consciousness at the infection regions in lungs whilst making decisions of diagnoses. Note that there exists imbalanced distribution of the sizes of the contamination regions among COVID-19 and CAP, in part because of rapid development of COVID-19 after symptom onset. Therefore, we develop a twin-sampling strategy to mitigate the imbalanced getting to know. Our approach is evaluated (to our high-quality expertise) upon the biggest multi-middle CT facts for COVID-19 from 8 hospitals. In the training-validation level, we acquire 2186 CT scans from 1588 sufferers for a five-fold move-validation. In the trying out degree, we rent some other impartial massive-scale trying out dataset together with 2796 CT scans from 2057 sufferers. Results show that our algorithm can perceive the COVID-19 pictures with the place underneath the receiver working function curve (AUC) fee of zero.944, accuracy of 87.5%, sensitivity of 86.9%, specificity of ninety.1%, and F1-rating of 82.0%. With this performance, the proposed set of rules could doubtlessly aid radiologists with COVID-19 prognosis from CAP, especially in the early degree of the COVID-19 outbreak.

The sickness resulting from the novel coronavirus, or Coronavirus Disease 2019 (COVID-19) is quick spreading globally. It has infected extra than 1,436,000 people in more than two hundred international locations and territories as of April 9, 2020 [1]. On February 12, 2020, the World Health Organization (WHO) officially named the disorder due to the unconventional coronavirus as Coronavirus Disease 2019 (COVID-19) [2]. Now, the range of COVID-19 sufferers is dramatically increasing each day around the arena [3]. Compared with the earlier Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS), COVID-19 has spread to extra locations and triggered extra deaths, no matter its extraordinarily lower fatality price [4], [5]. Considering the pandemic of COVID-19, it's miles crucial to come across COVID-19 early, that can facilitate the slowdown of viral transmission and for this reason ailment containment. COVID-19 Pandemic in India is a part of Worldwide pandemic of Coronavirus sickness 2019. The most not unusual signs and symptoms of COVID-19 are fever, dry cough, and tiredness. Other signs and symptoms which can be common and might affect loss of flavor or scent, sore throat, coronary heart disease, Respiratory issues.

2. LITERATURE SURVEY

Narasimha Sai Yamanoor et al proposed "Low-Cost Contact Thermometry for Screening and Monitoring During the COVID-19 Pandemic"- IEEE 2020

They have evolved the key element of the UN Sustainable Development Goals (SDG) is purpose 3, Good Health, and Well-Being. Fundamental to the accomplishment of this aim is ladies's health. Pregnant girls and women raising babies might benefit from early screening. In socially disadvantaged areas, patients might not have ready and common get right of entry to to formal healthcare or screening answers. In such times, simple solutions that allow for self-monitoring can assist. Additionally, whilst supplied with gadgets that promote wonderful conduct change such as sensor-enabled wearable devices, different benefits might also accrue. Data collection from multiple topics for screening and contact-tracing may also have ability use in the ongoing COVID-19 pandemic and beyond. A low-price, contact thermometer answer based totally on a silicon bandgap temperature sensor that permits for non-public screening is defined the usage of a Proof-of-Concept answer.

Pnar Cihan et al proposed "Fuzzy Rule-Based System for Predicting Daily Case in COVID-19 Outbreak"-IEEE 2020

They have advanced the Covid-19 outbreak regarded in Wuhan in December 2019 and spread unexpectedly everywhere in the global. The Covid-19 disorder does not but have a clinically tested vaccine and drug for treatment. The maximum crucial physical factors in lowering the unfold of the epidemic are washing fingers, decreasing social distance and the usage of a masks. Today in addition to scientific studies, computer-aided research is also extensively accomplished for Covid-19 outbreak. Artificial intelligence techniques are successfully carried out in epidemic studies. In this examine, fuzzy rule basing system (FRBS) used to are expecting the wide variety of Covid-19 day by day instances. As a result of the take a look at, the quantity of every day instances changed into efficiently envisioned with FRBS (R2 = zero.96, MAE = 186 and RMSE = 254).

Mohammad Marufur Rahman et al proposed "An Automated System to Limit COVID-19 Using Facial Mask Detection in Smart City Network"-2020 IEEE

They have evolved a system that limit the growth of COVID-19 with the aid of finding out folks who aren't sporting any facial masks in a clever city community in which all of the public locations are monitored with Closed-Circuit Television (CCTV) cameras. While a person without a mask is detected, the corresponding authority is informed through the town community. A deep learning architecture is trained on a dataset that includes images of humans with and without masks gathered from diverse resources. The trained structure performed ninety-eight.7% accuracy on distinguishing people with and without a facial mask for formerly unseen take a look at statistics. It is hoped that our study would be a beneficial tool to lessen the unfold of this communicable disorder for many nations inside the global

Pnar Cihan et al proposed "Fuzzy Rule-Based System for Predicting Daily Case in COVID-19 Outbreak" - IEEE (2020)

In the existing machine addition to medical research, pc-aided studies are also extensively finished for Covid-19 outbreak. Artificial intelligence strategies are efficaciously carried out in epidemic studies. They studied, fuzzy rule basing device (FRBS) used to are expecting the wide variety of Covid-19 daily instances. As an end result of the take a look at, the quantity of every day instances was correctly estimated with FRBS (R2 = zero. Ninety-six, MAE = 186 and RMSE = 254).

Unique Identification for Monitoring of COVID-19 Using the Internet of Things (IoT)-Ankur Utsav, Amit Abhishek, Kamal Kant, Ritesh Kr. Badhai

In this exixting system can reveal the users from COVID-19 by using the Internet of Things(Iota). A device is designed in which thermal scanning of the human frame by a sensor and each day the record of the identical person is being stored inside the database. For identity of every consumer, there is a development of QR code that's a one-time generation system. If a person having an everyday GSM cellphone, then there might be a unique identification quantity is generated and shared with the operator who registers them to the system so that they also can take advantages. If any individual or consumer having a few symptoms and while scanning thru a thermal scanner if their frame temperature may be 100F or extra then a pop-up message will generate and thru the audio gadget will ask him or she is suffering from fever, shore throat, and trouble in respiration. If a person having a majority of these symptoms, then our gadget will ship a message to their cellular for consulting the health practitioner or for a test. Our proposed device is untouched and operates mechanically.

3. SYSTEM DESIGN

3.1 EXISTING SYSTEM

They have designed the robust mechatronic layout and manage of a low-cost non-invasive ventilator, for which rapid prototyping manufacture techniques such as 3-D printing and product design are used. In order to assure the reliability of the device operation, in this current paintings, a strong control scheme based on top notch-twisting sliding modes is proposed, which ensures the trajectory tracking manipulate corresponding to the respiratory profiles required by way of the patients. Experimental and simulation effects tested the effectiveness of the prototype design. Nevertheless, the prototype is waiting to be tested and permitted to be used in health help. In this feel, this work offers Experimental and simulation consequences validate the effectiveness of the proposed prototype design

Nevertheless, the prototype is waiting to be tested and accredited for use in fitness help.

3.2 PROPOSED SYSTEM

In this proposed machine, we're measuring the multipara meter which include coronary heart beat sensor, SPO2 sensor, body temperature sensor with Arduino Uno board. All the parameter facts are collected and given to the ATMEGA 328 after which up to date to the cloud server through IoT module. The doctor/user can video display units the fitness parameters. Max30100 sensor is used to get both Heart beat and SPO2 degree of the character since it works at the I2C protocol. Temperature sensor is used to display the human frame temperature and it's far displayed in the LCD and also up to date inside the iot. Comparing these kinds of values inside the Micro controller, whilst the SPO2 stage decreases from the regular degree or temperature sensor price increases to the unusual level then the ventilator is growing to become on to offer them oxygen supply. Once our device predicts the abnormality of human breathing charge, the minimized ventilator which is designed with the aid of dc motor produces air flow routinely without human intervention.
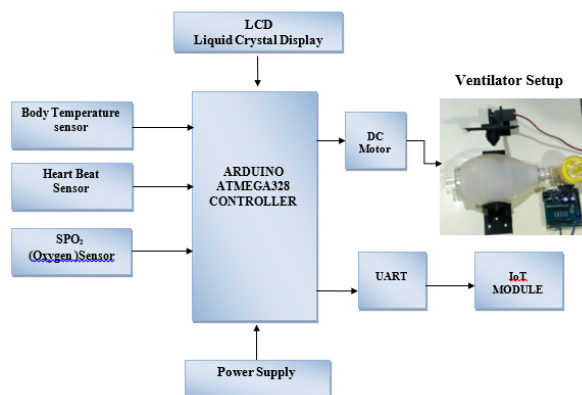
Fig: 1 Block Diagram

4. HARDWARE DESCRIPTION

    Power Supply
    Transformer
    Rectifier.
    Smoothing
    Regulator
    Heart Beat Sensor
    Temperature Sensor
    Ecg
    Relays

4.1 SOFTWARE REQUIREMENT

    Sketch
    Arduino
    MYSQL
Php
**Wamp Server**

5. RESULTS AND DISCUSSION

This work proposes the design of a low-fee synthetic ventilator wherein mechatronic layout techniques and production strategies based totally on rapid prototyping have been carried out. To assure the robustness and effectiveness of the proposed layout, a robust manage scheme primarily based on a sliding mode exquisite-twisting controller is used which allows the right trajectory tracking control and enables to comply with the desired respiratory profiles using DC motor
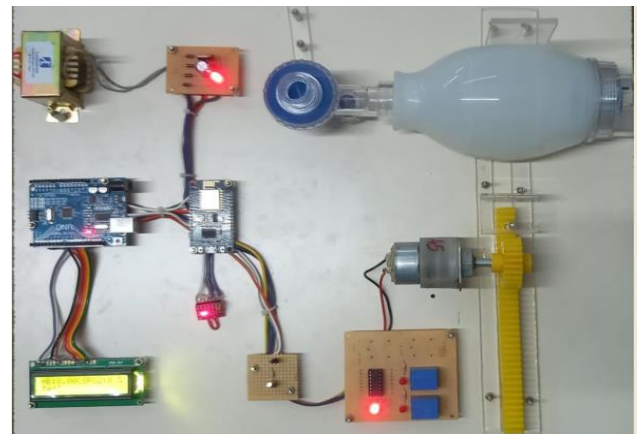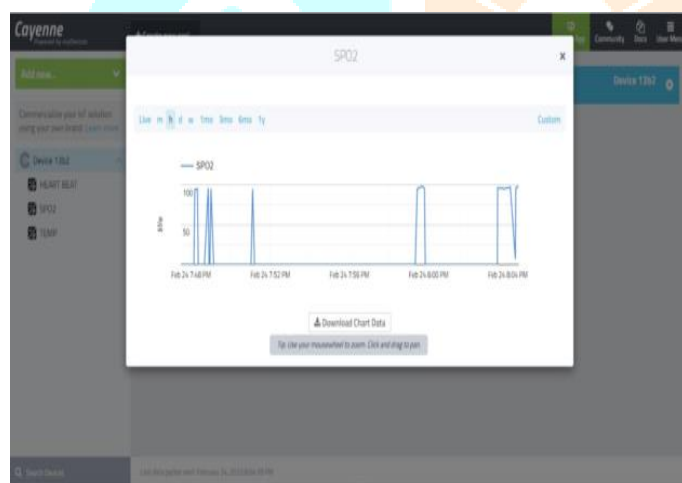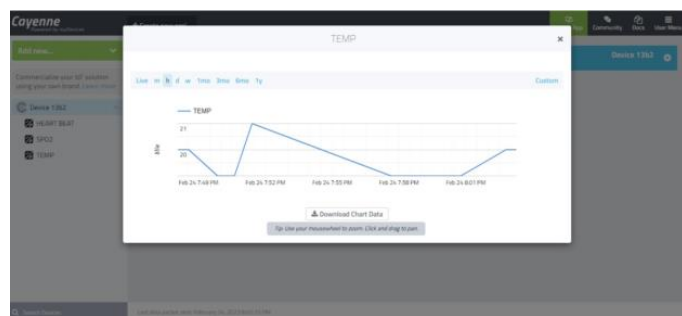

FIG: 2 EXPERIMENTAL SETUP THE SYSTEM

FIG: 3 HEART BEAT VALUE DISPLAYED ON LCD
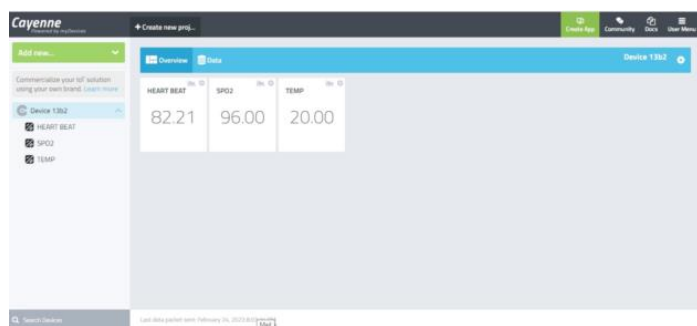
FIG: 4 MONITORING SENSOR VALUE ON CAYENNE APP

FIG: 5 SENSOR VALUE GRAPH

6. CONCLUSION

In conclusion, a ventilator is a scientific device that facilitates an affected person breathe by way of presenting mechanical air flow. It's normally used whilst a patient is unable to breathe on their very own or is having trouble breathing because of a scientific circumstance. There are numerous styles of ventilators to be had, which include invasive and non-invasive types. Invasive ventilators require intubation even as non-invasive ventilators use a mask or nasal prongs to supply air.

Ventilators are a critical device within the management of respiratory failure and can be existence-saving for sufferers with excessive respiration distress. However, they may be related to ability headaches together with lung harm, infections, and different unfavorable consequences. Therefore, their use requires careful monitoring and management by way of educated healthcare experts.

The COVID-19 pandemic has highlighted the essential importance of ventilators in treating extreme respiratory contamination. The excessive demand for ventilators for the duration of the pandemic has additionally highlighted the want for improved manufacturing and availability of these devices. Despite the challenges, ongoing improvements in technology and medical studies continue to improve the safety and effectiveness of ventilators, contributing to better patient consequences and quality of existence.

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