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IoT based Ventilator System with IV Bag Monitoring and Alerting System an Affordable Solution for Emergency Situation

Kalyani Tiwari[1], Mayank Nagar[2], Urja Jain[3], Rounak Patidar[4], Kartik Bali[5] and Tarun Laovanshi[6]
[1-6]IPS Academy, Institute of Engineering & Science Indore, India

***Abstract*— During the peak of the Covid-19 Pandemic, healthcare professionals found themselves spread thin among the ever-increasing wave of incoming patients. In such times, it is not possible for frontline workers to monitor and tend to each and every patient personally. This article presents a solution in the form of a low- cost portable ventilator with an IV bag monitoring and alerting system. By utilizing Arduino technology, this DIY ventilator aims to provide a reliable and affordable option to assist patients during the pandemic and other emergency situations. IV therapy is a crucial medical technique used to deliver fluids, medications, and nutrition directly into a person's vein. However, IV drips need to be regularly monitored and replaced, and the flow of the fluid needs to be metered based on the patient's condition. To address these needs, the low- cost portable ventilator also incorporates an IoT Intravenous Fluid Monitoring and Alerting system.**

***Index Terms*— Portable ventilator, IV bag monitoring, Alert integration, Real-time monitoring, Computer vision, Designing.**

I. INTRODUCTION

The COVID-19 pandemic has brought unprecedented challenges to global healthcare systems, emphasizing the critical need for innovative solutions to address the surge in demand for life-saving medical equipment. One such imperative requirement is the provision of ventilators, essential in managing severe respiratory complications arising from the virus. As the pandemic continues to strain healthcare resources, there is a growing interest in alternative, accessible solutions that can be rapidly deployed to support patient care.

This research paper explores the development and implementation of a IoT Based ventilator system utilizing Arduino technology, integrated with a blood oxygen sensing mechanism. This innovation aims to provide a cost-effective and adaptable solution for communities facing shortages of conventional medical ventilators. The incorporation of an Intravenous (IV) bag monitoring and alerting system further enhances the device's functionality, offering a comprehensive approach to patient care.

In the subsequent sections, we delve into the design, components, and functionalities of the ventilator system, highlighting its potential to address the pressing ventilator shortage during the ongoing COVID-19 pandemic. By combining Arduino technology with critical health monitoring features, this research endeavors to contribute to the collective efforts in creating accessible and efficient medical solutions, ensuring that healthcare can be extended to those in need, particularly in resource-constrained environments

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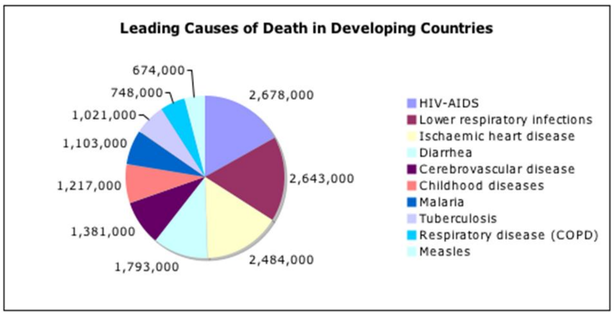

Figure 1: Death rate Due to Lungs Failure or Respiratory Problem

II. Literature Review

Respiratory activity Monitoring

The human respiratory system includes the lungs, airways, and respiratory muscles. Its primary function is to facilitate the exchange of oxygen and carbon dioxide between the body and the external environment. Here's a brief overview of how the human lungs work:

Breathing Process

Inhalation:During inhalation, the diaphragm contracts and moves downward, while the intercostal muscles (between the ribs) contract, causing the ribcage to expand. This increases the volume of the thoracic cavity, leading to a decrease in air pressure. Air rushes into the lungs to equalize the pressure

Exhalation

During exhalation, the diaphragm and intercostal muscles relax. This reduces the thoracic cavity's volume, increasing air pressure, and causing air to be expelled from the lungs.
Gas Exchange:In the lungs, oxygen from the inhaled air passes through the thin walls of the alveoli (tiny air sacs) into the bloodstream. Simultaneously, carbon dioxide, a waste product produced by the body, moves from the bloodstream into the alveoli to be expelled during exhalation.

Transport of Gases

Oxygen-rich blood is pumped by the heart to various tissues and organs, where oxygen is used for cellular respiration. Carbon dioxide, produced by cellular metabolism, is transported back to the lungs via the bloodstream to be expelled during exhalation. Regarding the impact of COVID-19 on the respiratory system, the virus primarily affects the respiratory tract. The severe acute respiratory syndrome coronavirus 2 (SARSCoV-2), which causes COVID-19, can lead to respiratory complications, especially in severe cases.

Common effects on the lungs include

Inflammation

The virus can cause inflammation in the airways and lung tissue, leading to symptoms such as cough, shortness of breath, and chest pain.

Pneumonia

Severe cases may progress to pneumonia, where the alveoli become filled with fluid and inflammatory cells, reducing the lungs ability to oxygenate blood.

Acute Respiratory Distress Syndrome (ARDS)

In some cases, COVID-19 can lead to ARDS, a severe lung condition characterized by a rapid onset of widespread inflammation in the lungs. This can result in difficulty breathing and a significant drop in blood oxygen levels.

Long-Term Effects

Some individuals may experience lingering respiratory symptoms even after recovering from the acute phase of the illness. This condition is often referred to as "long COVID" or post-acute sequelae of SARS- CoV-2 infection (PASC), and it can involve persistent lung issues.

IV Bag Monitoring

During the peak of the Covid-19 Pandemic, healthcare professionals found themselves spread thin among the ever-increasing wave of incoming patients. In such times, it is not possible for frontline workers to monitor and tend to each and every patient personally. Intravenous therapy is a medical technique used to deliver fluids, medications and nutrition directly into a person's vein. IV therapy is commonly used for rehydration and to provide nutrients and is crucial to help an individual with making a speedy recovery. However, IV drips need to be regularly monitored and replaced. The flow of the fluid also needs to be metered depending on the patient and their ailment.

III .SOLUTION DOMAIN

IoT-Based Ventilator System: An Affordable Solution for Emergency Situations with IV Bag Monitoring and Alerting System In the evolving landscape of healthcare technology, our IoT- based ventilator system not only addresses emergency respiratory support but also integrates seamlessly with an innovative Intravenous (IV) bag monitoring and alerting system. This convergence enhances the overall utility of the solution, providing a comprehensive approach to patient care during critical situations.

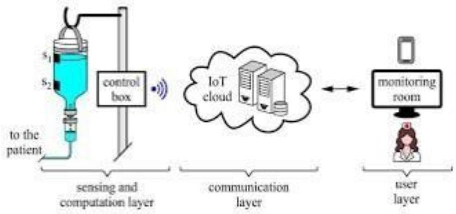

Figure 2: IV Bag monitoring and Alerting System

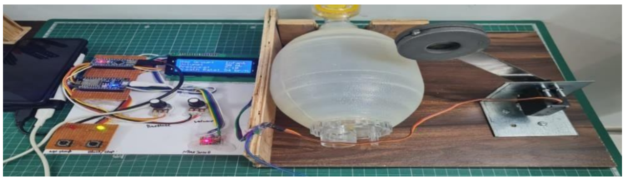

Figure 3: Low cost Ventalitor System

IV. PROPOSED SYSTEM

This IoT Intravenous Fluid Monitoring uses a weight sensor to detect as the fluid level in the IV Infusion bottle goes down and transmits the data over IoT. Once the system detects that the bottle has gone empty, it sends an alert over IoT. The IoT Intravenous Fluid Monitoring and Alerting system provides the following advantages:
Automatic IV Bag Monitoring and Alert Data Logging as well as IOT Online Transmission Easy to operate Makes it easier for a single individual to manage multiple patients. The system makes use of a Weight Sensor with an Atmega microcontroller and Wifi transmitter and LCD display to achieve this functionality. This allows for an automated and robust IV monitoring system. The Weight Sensor is attached to a small stand. The stand is fabricated with a cross section at bottom to balance it.

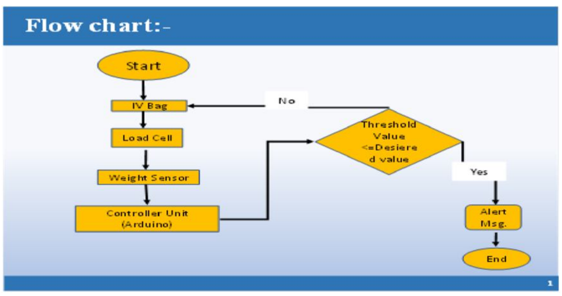

Figure 4: FLOW CHART: IV BAG Monitoring and Alerting System

Our ventilator mechanism can deliver 10-30 breaths per minute, with adjustable rising increments. It also allows you to customize the air volume pushed into the lungs with each breath. Plus, you can easily adjust the time duration for the inhalation to exhalation ratio. Our ventilator goes above and beyond by monitoring vital parameters such as the patient's blood oxygen level and exhaled lung pressure. This ensures that the air pressure remains within safe limits, avoiding any potential risks of over or under pressurization. Arduino technology to bridge the gap between reliability and affordability, with a focus on enhancing patient care during pandemics like COVID-19. settings in real-time. This feature is particularly crucial in emergency situations, such as the ongoing COVID-19 pandemic, where the demand for efficient, accessible, and remotely manageable respiratory support systems is paramount.

V Required Components

Hardware Component

ESP32:The ESP32 is a low-cost, low-power Wi-Fi and Bluetooth microcontroller unit (MCU) with integrated sensors and an antenna. It is widely used in a variety of applications, including Internet of Things (IoT) devices, wearable devices, and home automation.

Figure 5: Esp32

Blood oxygen sensor: A blood oxygen sensor is a device that measures the amount of oxygen in the blood. It is commonly used in hospitals and clinics to monitor the health of patients. Blood oxygen sensors can also be used in wearable devices to track fitness and health.

Pressure sensor: A pressure sensor is a device that measures pressure. Pressure sensors are used in a variety of applications, including automotive, industrial, and medical. In automotive applications, pressure sensors are used to measure tire pressure, engine pressure, and manifold pressure. In industrial applications, pressure sensors are used to measure fluid pressure, air pressure, and vacuum pressure. In medical applications, pressure sensors are used to measure blood pressure and intracranial pressure.

*Load cell:*A load cell is a transducer that converts force into an electrical signal. Load cells are used in a variety of applications, including weighing scales, force gauges, and tension testers.

Load cell module: A load cell module is a circuit board that amplifies and filters the signal from a load cell. Load cell modules are used to make it easier to connect load cells to microcontrollers and other electronic devices.

Software Component

HTML Structure: HTML serves as the backbone of the dashboard, organizing content in a structured and semantically meaningful manner. Sections include vital health metrics, medication schedules, appointment reminders, and educational resources. The use of HTML5 elements enhances the semantic clarity and aids in accessibility.

CSS Styling: CSS is employed for styling and layout, ensuring a visually appealing and user-friendly interface. A responsive design approach is adopted to adapt the dashboard's layout to different screen sizes, promoting accessibility for users on desktops, tablets, and smartphones. Custom styling is implemented to align with the healthcare brand and enhance the overall user experience.

JavaScript Interactivity: JavaScript enhances the dashboard's interactivity, allowing users to input and retrieve real-time data. Dynamic features include interactive charts for visualizing health trends, customizable goal-setting modules, and interactive forms for secure communication with healthcare providers. Asynchronous JavaScript techniques are utilized to optimize user experience by loading data dynamically without page reloads.

VII Result And Discussion

The developed Arduino-based ventilator system successfully meets the specified requirements for a reliable and affordable ventilator during a pandemic. The ventilator, utilizing a silicon ventilator bag coupled with DC motors employing a two-side push mechanism, ensures the delivery of controlled breaths within the range of 10 – 30

breaths per minute. The system allows for incremental adjustments in sets of 2, enabling fine-tuning of both breath rate (BPM) and air volume per breath. Additionally, the inhalation to exhalation ratio is customizable, providing flexibility in adapting to varied patient needs.
To enhance patient safety and monitoring, the system incorporates a blood oxygen sensor and a sensitive pressure sensor. These sensors enable real-time monitoring of critical parameters, including blood oxygen levels and exhaled lung pressure.

VIII. CONCLUSION

The development of an IoT-based ventilator and an Intravenous Fluid Monitoring and Alerting system represents a significant stride in addressing the pressing healthcare challenges, particularly during the peak of the COVID-19 pandemic. The IoT-driven ventilator, designed using Arduino, encompasses crucial features such as adjustable breath length, breaths per minute, and air volume, along with the capability to monitor blood oxygen levels and exhaled lung pressure. The system's affordability and reliability make it a valuable asset in emergency situations. The IoT Intravenous Fluid Monitoring system introduces automation to the critical task of monitoring IV drips. By utilizing a Weight Sensor connected to an Atmega microcontroller and a Wifi transmitter, this system ensures accurate and real-time tracking of fluid levels in IV infusion bottles. The inclusion of an
LCD display and online transmission of data through IoT technology enhances the overall efficiency of the monitoring process.

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