IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 2, February 2021

DOI: 10.17148/IARJSET.2021.8232

Low cost ventilator design using Arduino

Hridhya AP[1]

Lecturer, Department of Biomedical Engineering, EKNM Government polytechnic College, Thrikaripur, India[1]

Abstract: This document gives formatting instructions for authors preparing papers for publication in the Proceedings of an International Journal. The authors must follow the instructions given in the document for the papers to be published. You can use this document as both an instruction set and as a template into which you can type your own text.

Keywords: AMBU bag, Arduino, NodeMCU, IR sensor

I. INTRODUCTION

The ventilator is a lifesaving equipment that hospital should have. In practice, a ventilator is a bedside machine that takes over the breathing process of a patient suffering from respiratory failure. For the patient who is suffering from an injury or illness which makes it hard to breathe. A ventilator will assist to breathe during these conditions. It is also useful in surgery. So simply ventilator is a machine that helps a patient to breath when they are having a surgery or cannot breathe their own due to a critical illness, that is why the device is more important in hospitals. In ventilator, the patient is connected to the ventilator with a hollow tube which is placed in patient's mouth and then down into their main airway or trachea. In this paper a portable ventilator is designed using AMBU (Artificial Manual Breathing Unit) Bag. Using sensors, the breathing count, pressure, and volume of air passed to the patient from the ventilator can be measured and the readings can be displayed using both Android app and LCD display. When the pressure exceeds the threshold level, the assistant near the patients alerted by the buzzer and the doctor by telegram message notification. The controlling of pressure is possible with the help of android app. The main advantages of this ventilator is that it is less expensive, portable and also automatically work.

II. BLOCK DIAGRAM

The Fig.1 shows the schematic block diagram of the system operation. This operation started from the microcontroller which is the main component in this system with a set of coding uploaded into this component. From the microcontroller, the Servo motor from Arduino compresses and releases the AMBU bag.

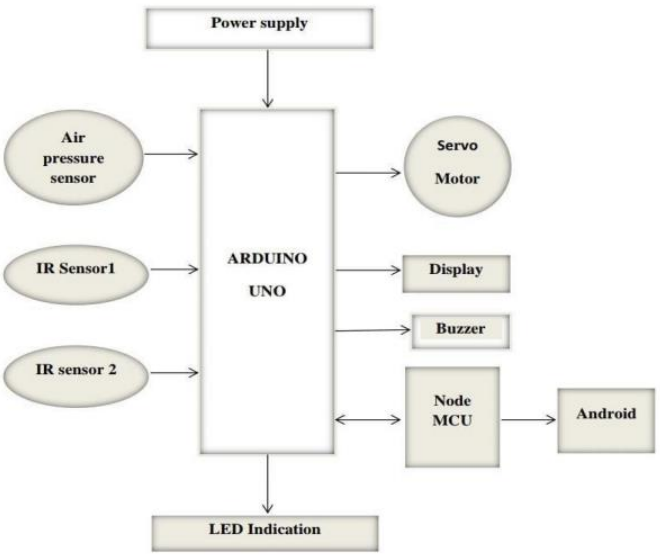

Fig. 1 Block diagram

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 2, February 2021

DOI: 10.17148/IARJSET.2021.8232

This mechanism gives breaths to the patient. The air pressure sensor tracks the breathing of the patient and detects if breathing deteriorates. Ot also detects when filters for air and oxygen input are obstructed and if a change is required. Also, it detects and regulates the airflow and oxygen supplied to ventilators. The Blood Pressure Sensor, a non-invasive sensor designed to measure human blood pressure is used. It measures systolic, diastolic and mean arterial pressure. The central part of the block diagram is Arduino UNO. A 28 pin ATMEGA 328 IC is integrated in the Arduino UNO. When a 5V power supply is provided to Arduino, it will start to operate. While the start button is in ON position, the machine will start to work. In the default condition the AMBU bag is in dilated state, this will be detected by the IR sensors and the 12V gear motor starts to rotate and thus the plank attached with the motor will be compressed over the AMBU bag. That time the air inside the AMBU bag will be transferred to the artificial lungs. The gear motor needs 12V for proper rotation, but the arduino can output only 5V at its I/O pin. So not enough voltage supply is attained by the motor. That will cause the proper rpm of the motor. Also, the motor will produce a back emf which damages the Arduino UNO. This problem will be solved by using a motor driver IC L293D in between the Arduino and motor. The pumping count can be measured and stored in the server. Firstly, the pumping count or the data is sent to the node MCU, which is a WIFI integrated module. Then the data from node MCU transferred to the server database via the internet. Thus, the data gets stored in the database. By using the Ip address or server domain we can display the data in an Android app. Three LED indications are used here. One for proper power supply detection, that is power LED. A program LED is used to indicate whether the program is performing well and a data LED to indicate whether data is transferring.

A. Arduino Uno

Arduino Uno Arduino/Genuino Uno, a microcontroller board based on the ATmega328P. It is provided with 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, ICSP header and a reset button. It can be powered either by a USB cable connected to a computer or power it with a AC-to-DC adapter or battery.

B. Ambu Bag

Ambu bag is a valve mask is a manual resuscitator or "self-inflating bag". This hand-held device is used to provide positive pressure ventilation to patients who can't breathe on their own or can't breathe adequately. Ambu bag is the inevitable part of resuscitation kits used by trained professionals in and out-of-hospital settings. It is also used in hospitals with standard equipment found on a crash cart, emergency rooms or in critical care settings.

C NodeMCU

It is an Lua based firmware, which is open source and ment for ESP8266 WiFi SOC.An on-module flash-based SPIFFS file system is used here. The firmware was developed as a companion project to ESP8266-based NodeMCU.

C. IR Sensor

An Infrared (IR) sensor is an electronic device which can measures and detects infrared radiation from its surrounding environment. Infrared sensors are of two types, active and passive. Active infrared sensors are able to both emit and detect infrared radiation. The main two two parts of IR sensor is a light emitting diode (LED) and a receiver.

D. Servo Motor

A servo motor can be considered as a rotary actuator or linear actuator. It provides precise control of angular or linear position, velocity and acceleration. It has a motor coupled to a sensor which provides position feedback. A relatively sophisticated controller is required for its operation.

E. Power supply

A power supply is an electronic circuit that converts the voltage of an alternating current (AC) into a direct current (DC) voltage. It basically consists of the following elements: transformer, rectifier, filter and regulator.

III. CIRCUIT DIAGRAM

The circuit is simulated using Diptrace software prior to circuit development. This simulation is performed to confirm that all components in the circuit are properly connected and there are no short circuits or faults in the designed circuit. The Arduino UNO, infrared sensor module (SN-IR-MOD), and Servo motor are the major components of this circuit. The Servo motor, while the infrared sensors (indicated as IR1 and IR2) are used for the detection of the inflation and deflation of the AMBU bag by detecting the rod. Inflation of the AMBU bag occurs when rotated clockwise, and deflation when rotated counterclockwise. The circuit diagram consists of a power supply system. It consists of a stepdown transformer, a bridge circuit and a voltage regulator. The stepdown transformer converts 230V ac to 12V and then the

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 2, February 2021

DOI: 10.17148/IARJSET.2021.8232

voltage regulator converts it into 5V also. Then the circuit diagram consists of three sensors: an air pressure sensor and two IR sensors. Air pressure sensor for measuring the pressure of air and IR sensors for measuring the count of pumping air. The buzzer system consists of a buzzer, transistor and a resistor. It is to provide buzzer indication in case of detection of high pressure. Then there are three LED indications. They are represented as D5, D6and D7 which indicates the power, data and program respectively. A 16*2 LCD is used here as the display section. Then there is a section of servo motor which is used for inflation and deflation of the AMBU bag with the help of a stick attached to it. A node MCU is used for providing wifi connectivity and data transfer to the Android app which is developed for the visualization of patient status and also for pressure control mechanism.

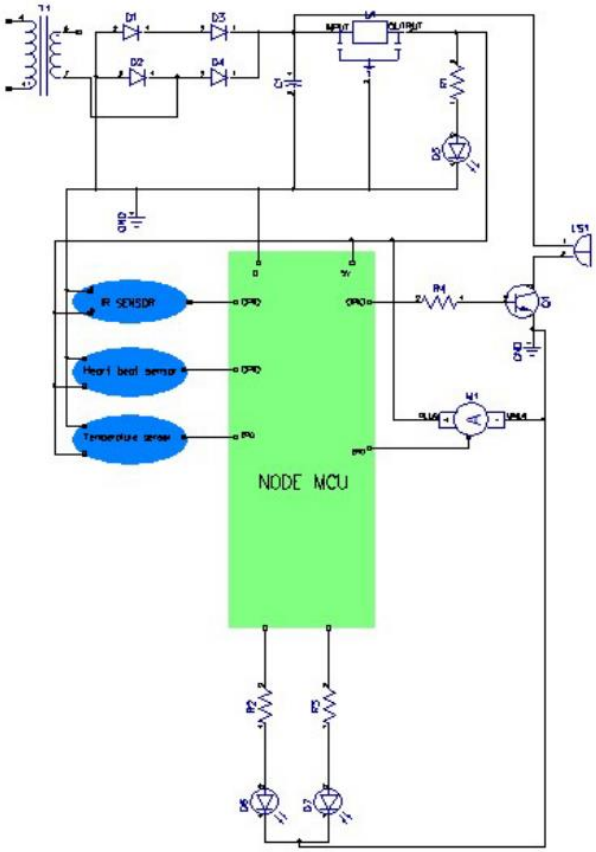

Fig. 2 Circuit diagram

IV. FLOW CHART

In this project, the mandatory control mode is used by default. The flow chart of the breath delivery system is shown in figure. The breath delivered to the patient is based on the equal time delay by using an internal timer at the controller. The time delay set depends on the breath rate prescribed by the doctor. The delivered breath is set to 60cmH2O because of the pressure limiting valve at the AMBU bag. This value was also found to be the maximum breath pressure needed for an adult patient. The figure shows the flow chart of a low-cost portable ventilator, Here the flowchart begins with a start block. Firstly, it requires initialization of all the global variables and communication.

The initialization of Global variable is used for the machine coding and Initialization of communication is for the server path clearance. If the button is pressed it checks the values of IR sensors. If it is equal to 1 the gear motor rotates forwardly. Otherwise, it rotates reversely. The two outputs from the Servo motor displays on the screen. If the button is not pressed it updates data to the database, feedback is provided to the path again and checks whether any changes have occurred then it stops working. If button is not pressed read pressure sensor and regulate motor speed corresponding to reading. And this value will be stored in the database then programming is stopped but recheck will be done if the button is pressed.

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology
Vol. 8, Issue 2, February 2021

DOI: 10.17148/IARJSET.2021.8232

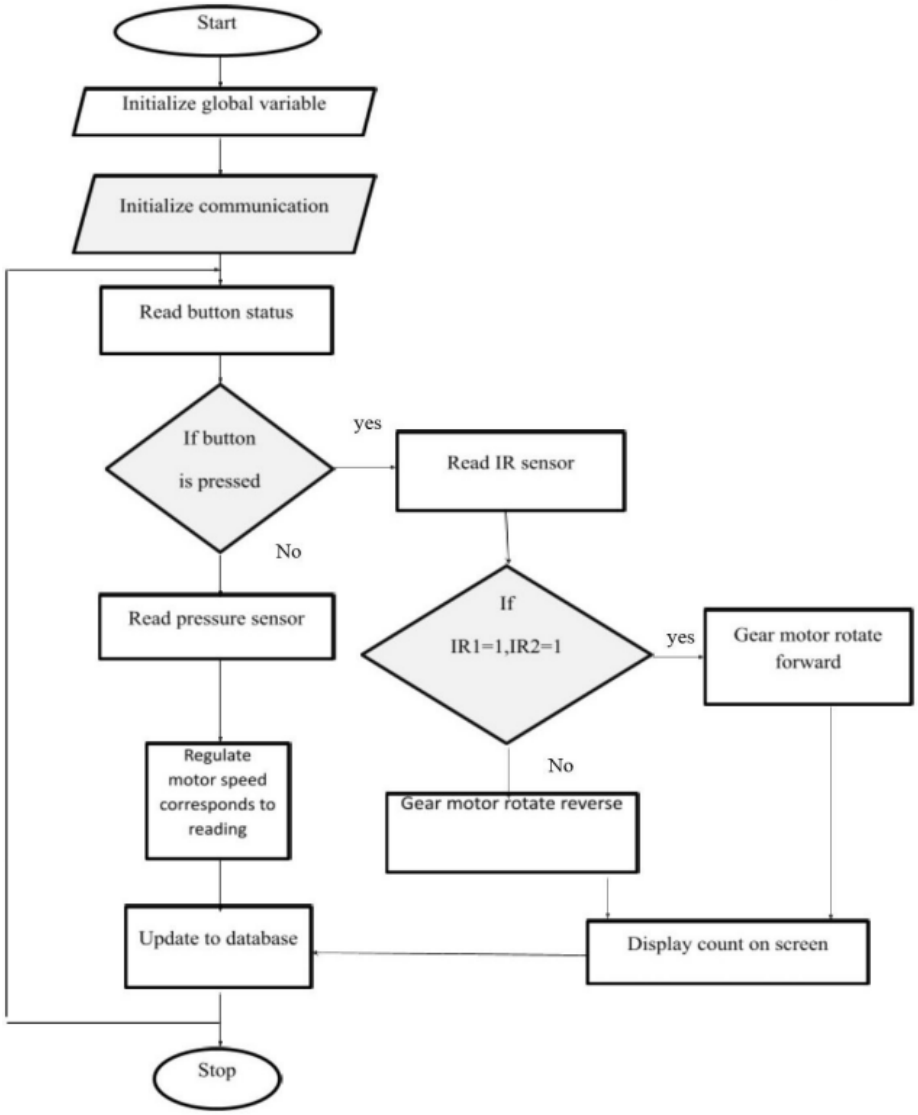

Fig. 3 Flow chart

V. RESULTS

A low-cost portable ventilator using pressure regulation is designed and developed successfully. The information of count, pressure and volume of air given to the patient in a ventilator is captured using specific sensors and then the results are stored in a 16*2 lcd display and also stored in a database and sent to an Android application for further purposes.

At emergency conditions the doctor can adjust the amount of air using a control mechanism that is built in Android application. Also if the Doctor is no there a will be sent to telegram of the Doctor or the hospital health assistant,and people around are alerted by the buzzer if pressure increase.

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology
Vol. 8, Issue 2, February 2021

DOI: 10.17148/IARJSET.2021.8232

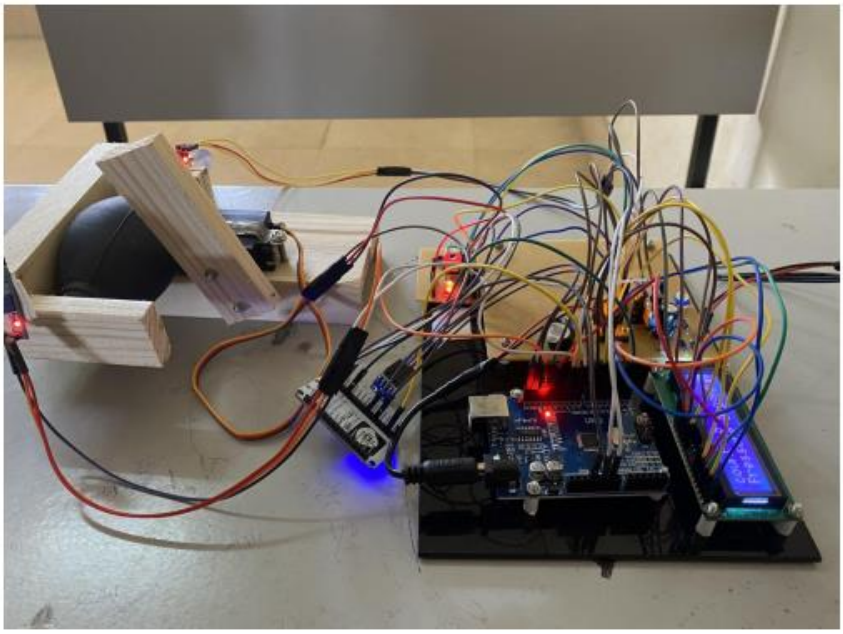

Fig. 4 Ventilator prototype

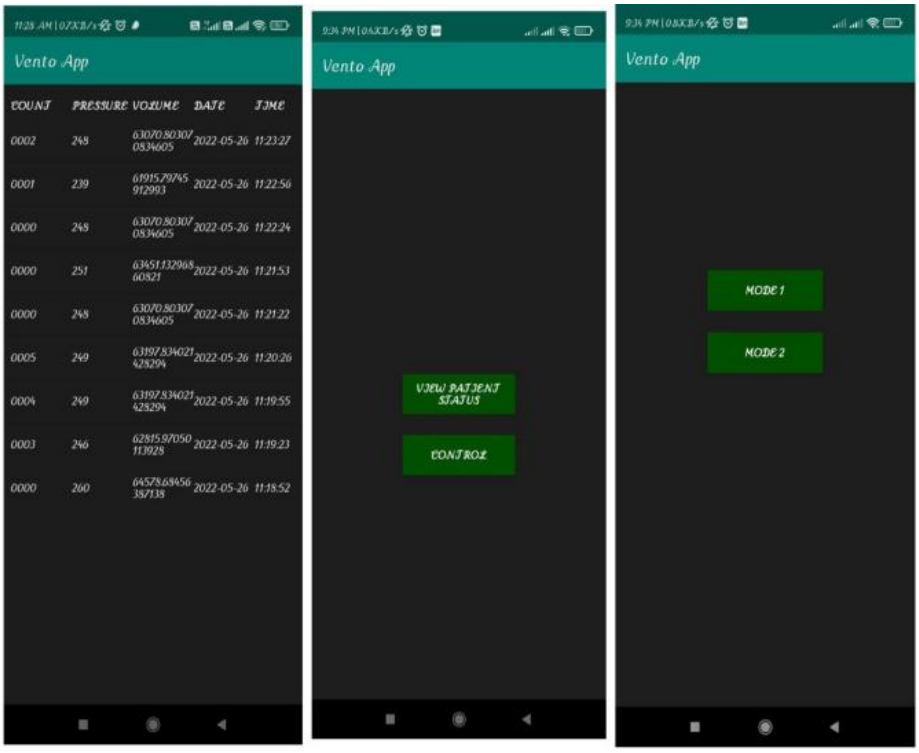

Fig. 5 Vento app interface

VI. CONCLUSIONS

In this study, a prototype featuring an energy-efficient, portable, and low-cost breath delivery system was developed. This prototype works connecting after connecting it to Arduino to the power supply. This study used IR sensing technology for detection of inflation/deflation of AMBU bags. Based on the obtained signals, the mechanical mechanism would automatically trigger the AMBU bag to inflate hence producing the air needed by the lung. This provides a constant

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology
Vol. 8, Issue 2, February 2021

DOI: 10.17148/IARJSET.2021.8232

air flow to the artificial lung. This work found a comparatively higher consistency in the breath delivered of 18.6 ± 1.45 bpm and lower performance discrepancy of 10 % using the developed system as compared to that of manual method. The low price is the result of the low-end off-the-shelf items and also the sensors used can also be found. In the future, a function, as well as a PEEP valve, a humidity exchanger, and a blow-off valve, can be added to further enhance the performance of the developed system. Finally, the wooden cutting board should be replaced with an acrylic board for the casing. This is because the wooden board is much heavier compared to the acrylic board. An acrylic board offers much lighter features and is compact that is more suitable for the portability of this project.

REFERENCES

[1]. M. Shahid, "Prototyping of Artificial Respiration Machine Using AMBU Bag," International Conference on Electronics, Information, and Communication (ICEIC), pp. 1- 6, 2019M. Zhao et al., "Assessment of Medication Self-Administration Using Artificial Intelligence", *Nature Medicine*, vol. 27, no. 4, pp. 727-35, 2018

[2]. S. Y. Lu, H. Lin, H. T. Kuo, C. L. Wu, W. J. Wu, "Design and study of a portable high frequency ventilator for clinical applications," 41st Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), pp. 2353-2356, 20Y. Yuan and F.-Y. Wang, "Blockchain: The State of the Art and Future Trends", *Acta Automat. Sin.*, vol. 42, no. 4, pp. 481-94, 2016.

[3]. S. Ahmad, A. Ahmad, M. Naeem, W. Ejaz and H. Kim, "A compendium of performance metrics pricing schemes optimization objectives and solution methodologies of demand side management for the smart grid", *Energies*, vol. 11, no. 10, pp. 28-31, 2018.

[4]. Prasath, T Arun and Deepak, D and Vigneshgandhi, R and Raj, RS Sivatharshini and Vishnuvarthanan, G and Vigneshwari "Smart Ambu Bag Using Electronic Devices" ,623--625,2019,IEEE.

[5]. Mukaram Shahid1"Prototyping of Artificial Respiration Machine Using AMBU Bag Compression" Faculty of Electrical Engineering, Ghulam Ishaq Khan Institute of Engineering Sciences and Technology, Topi, Swabi, 23640, Khyber Pakhtunkhwa, PakistanS. Lee et al., "Fabrication and characterization of a magnetic drilling actuator for navigation in a three-dimensional phantom vascular network", *Sci. Rep.*, vol. 8, no. 1, pp. 1-9, 2018.

[6]. Ryan Rhay Vicerra, Edwin Calilung, Jason Española, Elmer Dadios, Alvin Culaba, Edwin Sybingco, Argel Bandala, Alma Bella Madrazo, Laurence Gan Lim, Robert Kerwin Billones, Siegfred Lopez, Dino Dominic Ligutan, Julius Palingcod, and Carl John Patrick Castillo, "Implementation of a Programmable Logic Controller (PLC)-Based Control System for a Bag-Valve-MaskBased Emergency Ventilator ",2020,

[7]. Ryan Rhay Vicerra, Edwin Calilung, Jason Española, Elmer Dadios, Alvin Culaba, Edwin Sybingco, Argel Bandala, Alma Bella Madrazo, Laurence Gan Lim, Robert Kerwin Billones, Siegfred Lopez, Dino Dominic Ligutan, Julius Palingcod, and Carl John Patrick Castillo, "Implementation of a Programmable Logic Controller (PLC)-Based Control System for a Bag-Valve-MaskBased Emergency Ventilator ",2020, IEEE

[8]. Abdul Mohsen Al Husseini , Heon Ju Lee , Justin Negrete , Stephen Powelson , Amelia Servi , Alexander Slocum , Jussi Saukko in 2010; in "Design and Prototyping of a Low cost Portable Mechanical Ventilat