ABSTRACT

The whole world is under the influence of the novel Coronavirus disease-2019 (COVID-19), which hit hard most of the developed and developing countries, leading to the death of millions of people around the world. This disease majorly affects the respiratory tract, which can progress to more severe or potentially deadly conditions such as acute respiratory distress syndrome (ARDS) or hypoxemia, owing to widespread inflammation of the lungs. Conventionally used ventilator devices are quite expensive and require trained staff for its smooth operation. Generally, in developing countries these types of ventilators are limited in numbers and available only at multispecialty hospitals. So as to tackle and fulfill the urgent need of ventilators, we come up with a device which is a low-cost, easy to assemble, portable automated AMBU resuscitator system that can be easily scaled, to fight the ongoing pandemic. We have developed a low-cost and portable critical care ventilator named "LIFE SAVING KIT EQUIPPED WITH AMBU BAG". The ventilator is based on the automated compression of an AMBU bag. The system has a sophisticated control system that includes Pressure Sensor, Temperature Sensor, as well as Pulse Oximeter Heart Rate Sensor Module and valves.

INTRODUCTION

As of June 15, 2020, the total number of cases of coronavirus disease 2019 (COVID-19) surpassed 7,900,000 with more than 430,000 fatalities worldwide. Acute respiratory distress syndrome (ARDS) has so far been the most common complication in COVID-19 patients requiring intensive care unit (ICU) admission. While mild cases of ARDS may respond to non-invasive ventilation (NIV) such as high-flow nasal cannula, moderate to severe cases of ARDS often require intubation and ventilator support. To tide over this crisis, presently, a large number of patients are being ventilated with the help of a mechanical device manually an artificial manual breathing unit (AMBU), which is a simple hand-held self-inflatable device that needs to be compressed manually by patients' attendant/caretaker on a regular basis to deliver air or oxygen to patients' lungs.

A simpler form of ventilation support in case of emergencies is through manual resuscitation using artificial manual breathing unit (AMBU) bag or bag-valve-mask (BVM). It comprises a self-inflating silicone or rubber bag that is manually compressed and released to deliver a fixed tidal volume of air to the patient's lungs either through a mask or through intubation (the process of inserting a tube, called an endotracheal tube). Manual operation is not often a convenient and preferred option for the healthcare staff or the person attending the patient during an emergency. Keeping all these factors in mind, a very simple, rudimentary, easy to operate, and reliable ventilation unit incorporating an AMBU bag was incepted. It can be easily assembled and disassembled by any healthcare personnel without any extensive prior knowledge and training about the conventional ventilator parts and their assembly. The user interface is also very easy and convenient to operate and monitor and can be made better with further development. Most of the standard parts are available at medical equipment stores. The mechanized linkages can be conveniently manufactured using CNC milling machines or by rapid prototyping techniques such as 3D printing and fitted with commercially available ball.

OBJECTIVE & SCOPE

Artificial ventilation is life-saving for a vast majority of patients in respiratory failure. Unfortunately, the high cost of ventilators forbid their common use, especially in emergency departments of many hospitals in low-income countries with high patient load. To tide over this crisis, manual resuscitators or AMBU bags are used, which have to be rhythmically compressed at a set rate manually. This is no easy task and has inherent shortcomings and dangers. They are tiresome to operate and have no control over the amount of air pumped in to inflate the lungs during each breath as it depends entirely on how much the patient's attendant squeezes the AMBU bag.

Main Objective can be stated as:-

- Create a manual ventilator based on "AMBU BAG" which is used as manual ventilator to provide oxygen to patient and it is based on the automated compression of an AMBU bag.
- The system has a sophisticated control system that includes Pressure Sensor, Temperature Sensor, as well as Pulse Oximeter Heart Rate Sensor Module and valves.
- Use Arduino IDE for coding in Arduino device and various dependencies.
- Proper research for Arduino device and its circuit.
- Proper circuit design for the project.
- Proper testing and debugging of the device configuration.

Scope:-

Manual operation is not often a convenient and preferred option for the healthcare staff or the person attending the patient during an emergency. Keeping all these factors in mind, a very simple, rudimentary, easy to operate, and reliable ventilation unit incorporating an AMBU bag was incepted. It can be easily assembled and disassembled by any healthcare personnel without any extensive prior knowledge and training about the conventional ventilator parts and their assembly. The user interface is also very easy and convenient to operate and monitor and can be made better with further development.

NEED OF THE PROJECT

- Cheaper alternatives for mechanical ventilation, especially automated artificial manual-breathing units (AMBU) bags, have received wide attention from clinicians, researchers and policymakers, owing to fast production, economical deployment and easy accessibility to a larger portion of the population all across the world.
- Automated AMBU bags or resuscitator devices aim to assist patient breathing via compressing and releasing the AMBU bags at a specific frequency while delivering oxygen to meet the breathing rate, pressure, tidal volume and other needs of individual patients.
- Apart from this, these systems provide an edge over their manual counterparts, allowing staff to perform other critical tasks relevant to patient healthcare, rather than manually bagging patients.
- Additionally, owing to the simple design, low-cost, portability, battery or mains-in powered, simple control systems with few knobs to control variables, these kinds of systems can be easily used during transportation of patients without even requiring specialized training to operate these devices.

TOOLS & TECHNOLOGIES

- **Hardware Requirements**

S. NO	Parts	Function
1.	Motor	12–24 V DC motor interacting with other parts of the actuator to deliver the movement.
2.	Mode Switch	To control the motion of the device, stopping the movement when triggered.
3.	Temperature Sensors	To measures the temperature of its environment and converts the input data into electronic data to record, monitor, or signal temperature changes.
4.	Pulse Oximeter	To estimate the oxygen saturation of the blood and the pulse rate.
5.	Heart Rate Sensor	To measures pulse waves, which are changes in the volume of a blood vessel that occur when the heart pumps blood.
6.	Rack and Pinion	To compress the AMBU Bag as per the requirement.
7.	Microcontroller	Empowers system designed to optimize the device for power consumption versus processing speed. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in a single instruction executed in one clock cycle. The resulting architecture is more code efficient.
8.	LCD display module	Use to display data collected by sensors.

9.	Real Time clock	Used to keep track of time, date, day of the week and other chronometric parameters.
10.	Bluetooth	The Bluetooth module at the other end receives the data and sends it to Arduino through the TX pin of the Bluetooth module (RX pin of Arduino).
11.	AMBU Bag	The AMBU resuscitation bag is an instrument consisting of a self-expanding plastic bag connected at its ends to two one-way valves.

Other hardware requirement:

- Resisters
- Transistors
- Jumper wires and probes

Software Requirements

Arduino IDE: Arduino IDE platform is used for coding purpose; the microcontroller is feed by the predefined code which then command the Nodemcu to start operating by switching on and off the Ventilator and start fetching user's data.

SENSORS

Temperature Sensor

A temperature sensor is an electronic device that measures the temperature of its environment and converts the input data into electronic data to record, monitor, or signal temperature changes. There are many different types of temperature sensors. Some temperature sensors require direct contact with the physical object that is being monitored (contact temperature sensors), while others indirectly measure the temperature of an object (non-contact temperature sensors).

Pulse Oximeter Sensor

Pulse Oximeters are low cost non-Invasive medical sensors used to continuously measure the Oxygen saturation (SPO2) of hemoglobin in blood. It displays the percentage of blood that is loaded with oxygen.

The principle of pulse oximetry is based on the differential absorption characteristics of oxygenated and the de-oxygenated hemoglobin. Oxygenated hemoglobin absorbs more infrared light and allows more red light to pass through. Whereas deoxygenated hemoglobin absorbs more red light and allowing more infrared light to pass through.

OLED Display

An organic light-emitting diode (OLED or organic LED), also known as organic electroluminescent (organic EL) diode, is a light-emitting Diode (LED) in which the emissive electroluminescent layer is a film of organic compound that emits light in response to an electric current. This organic layer is situated between two electrodes typically, at least one of these electrodes is transparent. OLEDs are used to create digital displays in devices such as television screens, computer monitors, and portable systems such as smartphones and handheld game consoles. A major area of research is the development of white OLED devices for use in solid-state lighting applications.

SYSTEM ARCHTITECTURE

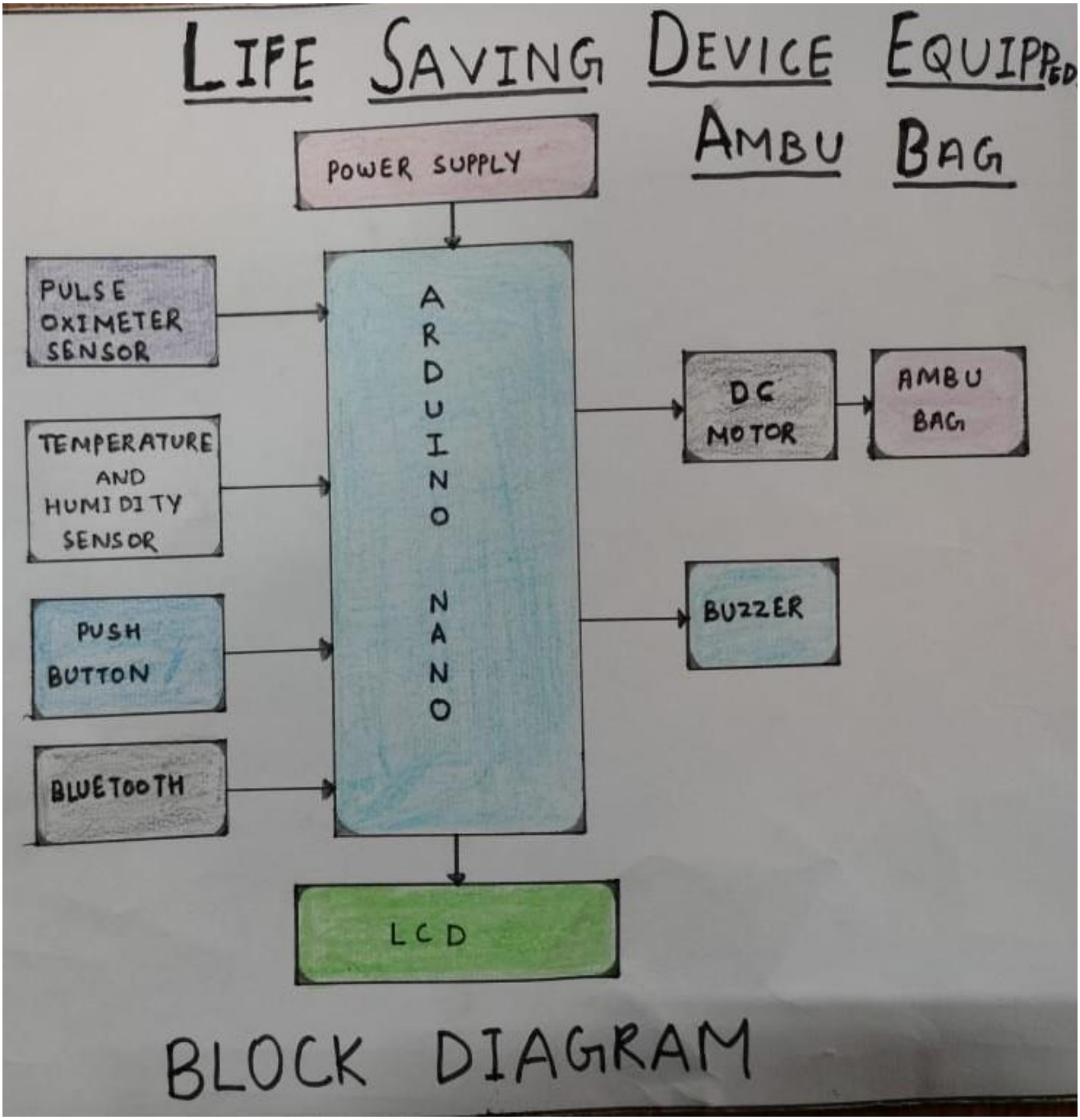

Figure 1: Block Diagram OF AMBU Bag Ventilator

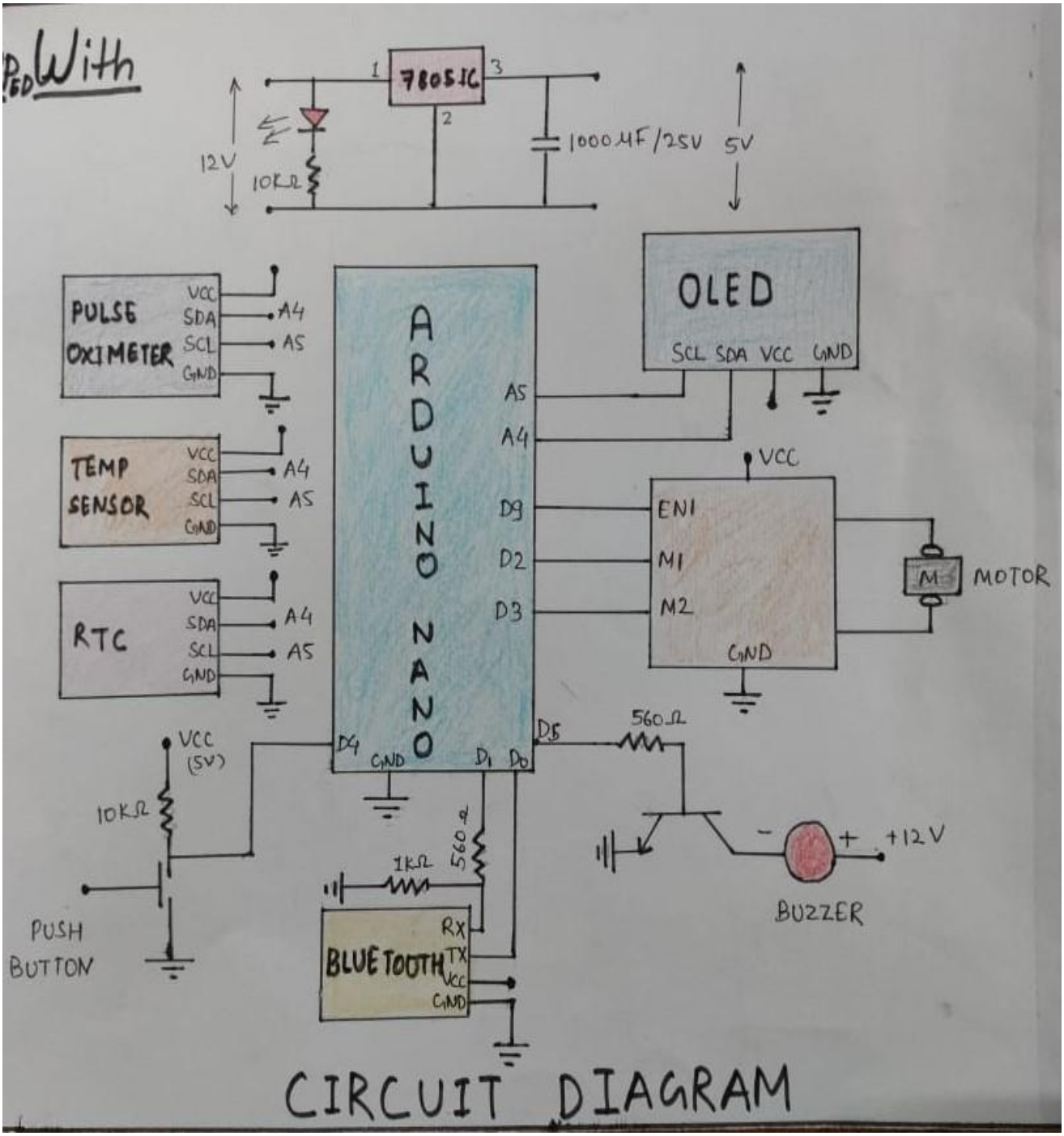

Figure 2: Circuit Diagram OF AMBU Bag Ventilator

METHODOLOGY

We use rack and pinion to compress the AMBU bag and motor is installed which rotate in both directions clockwise and anti-clockwise. When the AMBU bag is pressed by rack and pinion then oxygen is produced, and we connect the pipe through AMBU bag to the nasal of the patient.

We use so many sensors to make it more advance we use Temperature Sensor, Pulse Oximeter Sensor and Real Time Clock Sensor which give accurate data and we use these data to guide the patient.

COST ANALYSIS

S. No.	Hardware Components	Specification	Quantity	Cost
1	Pulse Oximeter	Measure the Oxygen saturation (SPO2)	1	300
2	Temperature Sensor	Measure the Temperature of the body	1	200
3	Real Time Clock	Show real Time	1	300
4	Microcontroller	Arduino Uno	1	600
5	LCD display	2*16 display	1	50
6	Bluetooth	Connect with IOT Devices	1	330
7	Push Button	To control speed of motor	1	50
8	DC Motor	To press AMBU Bag	1	100
9	AMBU BAG	To give oxygen to patient	1	2000
10	Other	Wooden Structure, Resister, Transistor, Etc.,	-	3200

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