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DEVELOPMENT OF ELECTRONIC AUTOMATED BAG VALVE MASK (BVM) FOR RESPIRATORY PROBLEM WITH IOT

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Abstract

Bag Valve Mask (BVM) is a flexible reservoir bag used for artificial ventilation connected by tubing and a non-rebreathing valve to a face mask to provide positive pressure ventilation to a patient who is not breathing or breathing inadequately. However, the high demand and prices for ventilators makes it difficult to get breathing aid at hospital . An automated low-cost Bag Valve Mask was developed to help provide emergency breathing aid to patients with IoT technology on the Blynk application for the easy monitoring system. The project involving software Arduino that combines with motor for compressing air deliver to the patient. The Node MCU is for IoT technology where parameter readings are sent through the mobile phone to facilitate the nurse or health staff to monitor the patient's breathing.The result this device can be as a breathing aid to the patient in emergency which provide the breathing mode tidal volume from 350-700mL, breathing rate from 12-40 bpm and range I/E ratio. As the conclusion, this device can be portable and widely used at the centre and ambulance.

Keywords: Respiration, Portable, Bag Valve Mask (BVM), Automation, Emergency, Monitoring

1. Introduction

Breathing is a necessary part of existence, and it is controlled by an unusual arrangement of the entire body. When the respiratory system is harmed by contamination

due to infection or other respiratory illnesses, the natural symphony shifts into a condition of respiratory disappointment. When this happens, the mechanical ventilator (MV) becomes a common breathing aid that should also protect the lungs from further injury(Islam et al., 2020). It provides a positive aviation routeIt becomes challenges in getting a mechanical ventilator at the hospital due to the very limited use of ventilators as well as the very high price(Chauhan et al., 2020). Next, the previous BVM very not practical to the patient because of the patient have to compress manually to use and the BVM comes with no indicator indicator that causing patient to only take guesses in delivering air to patient (Petsiuk et al., 2020). This might be life threatening to the patient as it can cause further damage to the patient's lung(Vicente et al., 2016).The objective of this project is to develop an automated Bag Valve Mask as an emergency aid life support to the patient with other respiratory problem by linear actuator mechanism using servo motor.This device is designed for the usage on ambulance and hospital as an initial respiratory aid before further action. This device focuses on delivering oxygen to patients with had respiratory problem such as short breaths, asthma, and chest pain that may require breathing aid support to circulate oxygen in the body to prevent more serious. The goals of this project will be widely used in hospitals and the use of ambulances as a portable life support to treat the patient can restore breathing in a short time which will increase the oxygen in the blood.

2. Literature Review

2.1 Bag Valve Mask

The Bag Valve Mask often known as a "self-inflating bag," is a hand-held device that delivers positive pressure ventilation to the respiratory system of patients who are incapable or insufficiently breathing(Jacob, Divya, 2020). After first inventing a medically innovative suction pump, it was invented by German engineer Holger Hesse and his co-developer, Danish anaesthetists Henning Ruben in 1953. The device is commonly used in hospitals as part of the standard equipment found in every emergency room and critical care institution. The use of manual resuscitators to provide ventilation to a patient is commonly referred to as "bagging" the patient, and it is frequently required in medical crises when the patient's breathing is considered insufficient or has entirely stopped.

2.2 Types of Bag Valve Mask (BVM) Compression Mechanism

2.2.1 BVM – Based Ventilator Mechanical Design Components

The compression mechanism transfers rotary motion from the motor to linear oscillating motion required for cyclical compression of the BVM via the mechanism drive. Power is transferred from the motor to the mechanism via the compression drive. The compression pad or plate is connected to the compression mechanism and oversees forcing the BVM into place. For a 1-side compression mode of operation, the cradle holds the BVM in place and provides reactive force to the compression force. Finally, the frame connects the mechanical components.(Calilung et al., 2020).The method compressing BVM- Based Ventilator Mechanism is shown in Figure 1.

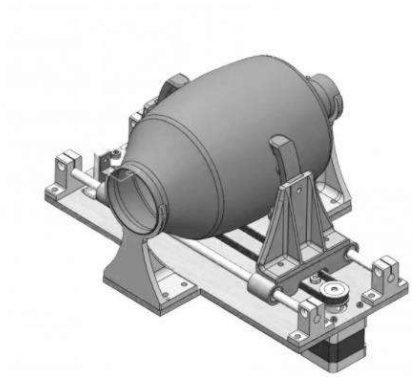

Figure 2: BVM – Based Ventilator Mechanism(REAL, 2020)

3. Methodology

This section is explained about the process and the method to implementing this study with successful that consist designing and implementation of hardware part of the automated bag valve mask, block diagram of the operating system, making flow chart of the operation device, and. The method is use to achieve the objective of the project that adding the automation concept on compressing the BVM.

3.1 Designing and implementation of hardware of the automated bag valve mask

Figure 2 illustrates the design of the automated bag valve mask.The component that used in developing this device is bag valve mask,servo motor,smartphone,and control box.

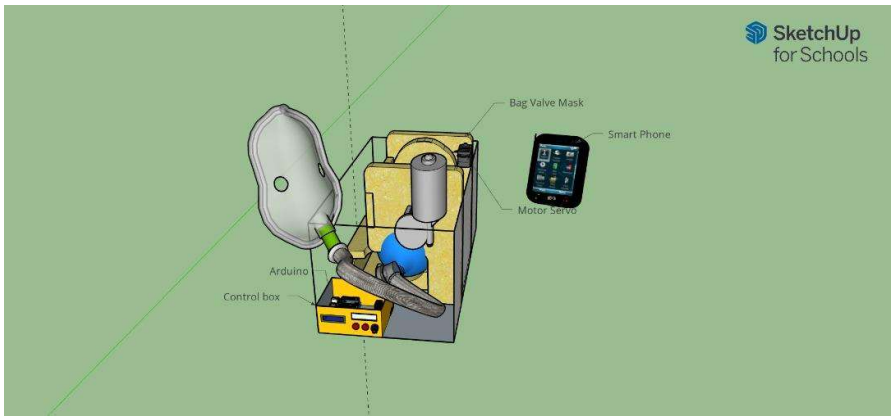

Figure 2: Design of Automated Bag Valve Mask

The automated bag valve mask cosist control box that included Arduino Uno as a microcontroller,three input knobs that controlled by encoder and potentiometer.The LCD display and pressure sensor are attached together on control box which is LCD display reading of tidal volume,breath per minute and I/E ratio while the pressure sensor detect the appropriate pressure and send to servo motor for compressing the bag valve mask. This device use IoT technology where nurses or health staff can monitor tidal volume, breath per minute and I/E ratio readings in the Blynk application via their mobile phones.The design weighing 5kg which dimensions 400mm × 250mm × 250 mm.

3.2 Block Diagram

In the figure 3,there are three parts : input, process, and output, which are all engaged in the system's operation.When the device had switched on,the setting range

input which is tidal volume and I/E ratio controlled by rotary potentiometer while adjustment set of breath per minute controlled by rotary encoder.The input send to Arduino Uno and the servo motor transfer the signal into mechanical to start compress

the BVM.The air pressure sensor is function to detect the appropriate pressure based on the input variable that had set that send to the motor to compress BVM . The air delivered through tube airway and patient mask and the reading three parameter which is VT, BPM and I/E ratio appears on the LCD display.The ESP32 is for IoT technology where parameter readings are sent through the mobile phone to please the nurse or health staff to monitor the patient's breathing.

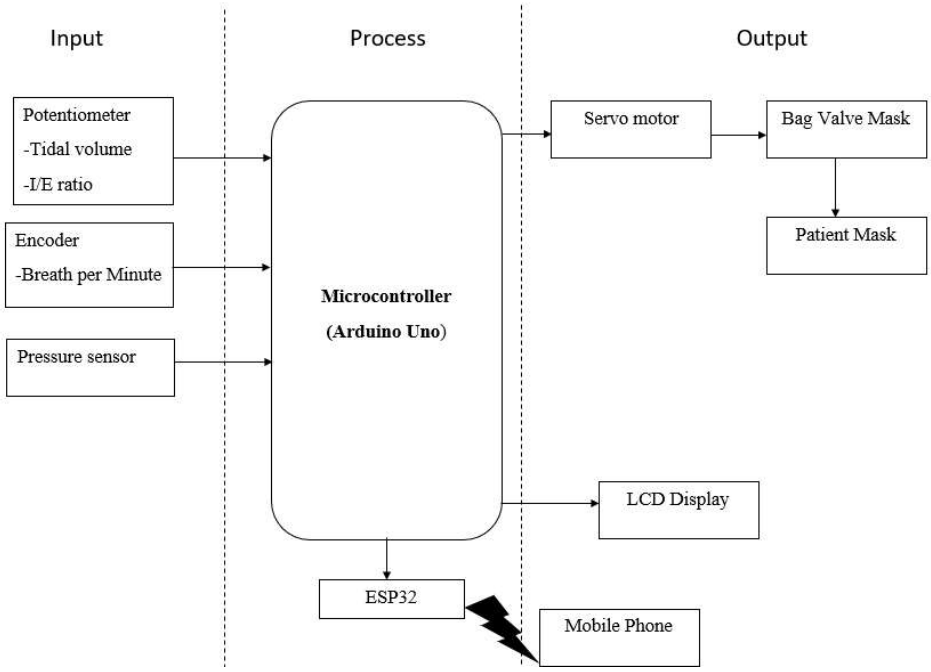

Figure 3: Block Diagram Operation

3.3 Schematic Diagram

The schematic diagram of this device are showed in Figure 4. In this figure,there are three parts which input,process and ouput component.The input component consist by adapter and keypad.Next,for process part consist by buck converter,Arduino Uno,and ESP 32 while for the output part consist by servo motor and LCD display.The main component for this device is servo motor to produce automation compressing Bag Valve Mask. Based on the schematic,input source 12V are supply to operate and connected to the buck converter to step down the output voltage from 12 V to 5V .

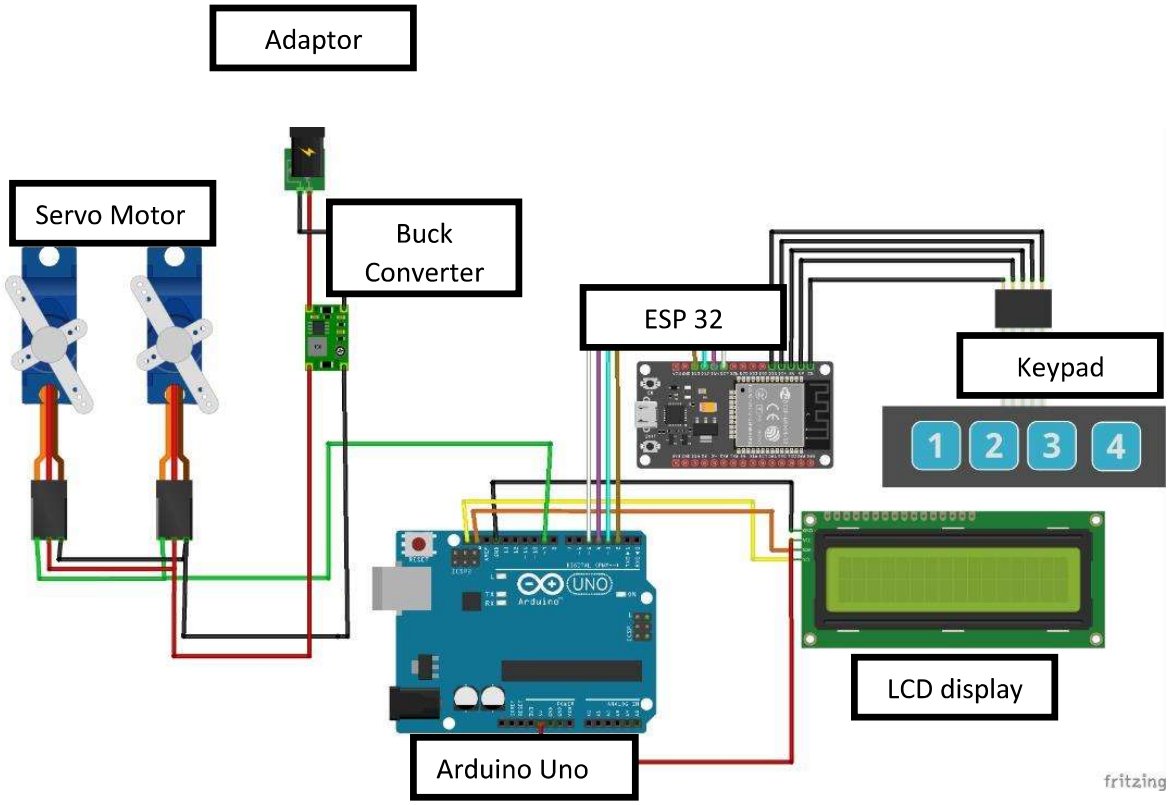

Figure 4: Schematic diagram of Bag Valve Mask

4. Result and Testing

Figure 5 and Figure 6 had showed the development of electronic and mechanical part the automated bag valve mask. The component of the hardware included bag valve mask,servo motor,patient mask,LCD display,keypad,Arduino Uno and ESP 32. The automated bag valve mask's dimensions are 400mm 250mm 250mm, and the mechanism for compressing the BVM is based on the BVM-based Ventilator Mechanical. A test was performed on this BVM to test the functionality of the motor for automation compressing the Bag Valve Mask. During the test, it was found that the device did not function and the BVM was not automatically compressed by the motor. The BVM used is quite thick causing a high force on the motor to press the valve mask bag so that the pins connected to the motor and getting loose and broken . Some modifications need to be done to improve the functinality of the device.

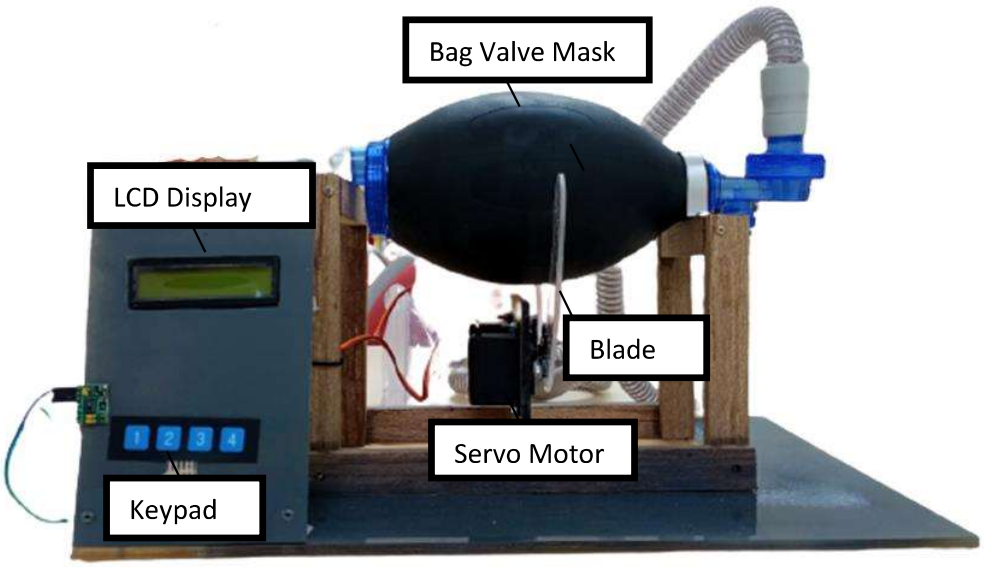

Figure 5: Front View of Bag Valve Mask

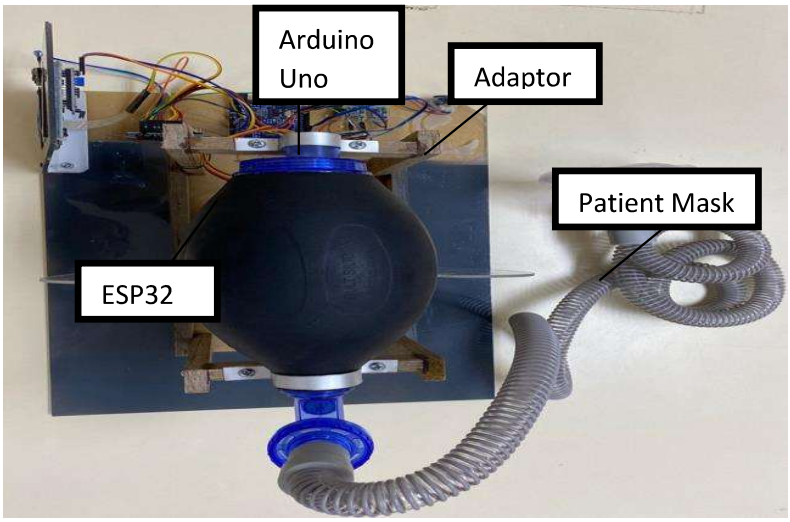

Figure 6: Top View of Bag Valve Mask

5. Conclusion

The hardware designed automated bag valve mask had developed with the dimension 400mm × 250mm × 250 mm according to the proposed specifications.This papers focuses on the development hardware component to produce the automation compressing Bag Valve Mask for delivering air to the patient due to the issues number of patients with respiratory problems is increasing it very challenges in obtaining breathing aids due to the very limited number.The method mechanism of compressing BVM is based on BVM based Ventilator Mechanical that used blade attached together with servo motor as a component to compress the bag valve mask.Based on the findings,there are some recommendations to upgrade the functionality of the device.Firstly, servo motor should be upgraded so that it can give input voltage above 5V so that less force is generated to compress the bag valve mask. Additionally, the way the bag valve mask is compressed needs to alter. Instead of compressing the Bag Valve Mask from the left and right sides, it should rather be done from the top side using the Scoth yoke mechanism.

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