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IoT Based Smart Ventilator & Patient Monitoring System

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Abstract - *The project is divided into two parts namely: 1. IoT based smart ventilator 2. Smart Health monitoring system. IoT based ventilator aims to provide a continuous breathing process to the patient whose lung capacity has decreased to a point where inhalation and Exhalation is not possible on their own. IoT based ventilator is a low cost, efficient and easy to make alternative for the currently present nasal ventilators. In normal situations, A ventilator is thought as a last alternative for saving a person's life but when the covid-19 Pandemic hit the globe, the demand for ventilators increased drastically, as the virus Decreased the lung capacity of an infected person. With the integration of IoT, the ventilator will be able to send real-time data of the vital levels of the patient to the doctor. The second part, the health care monitoring system will analyze BPM, SPO2 levels and body temperature of the patient. This will be integrated with IoT as well. All the real-time information of the patient will be received by the doctor on his mobile/PC. These two systems can be used together or separately as per The need of the patient. In the times of COVID-19 pandemic, both the ventilator and health monitoring system played a crucial role in saving patients' lives. The website will have Separate login tabs for the patient and the doctor. Both the parts namely hardware and software will be integrated into an IoT based ventilator and Health monitoring system.*

Key Words: **Internet of Things(IoT), Health, Ventilator, Monitoring, Covid-19, Arduino UNO, SpO2, Beats per Minute(BPM), ESP8266, Temperature, CSS, HTML, MongoDB, Express, Arduino IDE, Google Sheets**

1.INTRODUCTION

There has been an exponential growth in healthcare technology in the last century. Devices like health care monitoring systems and modern ventilators are being produced. A ventilator is an electromechanical device that can be used as an alternative breathing mechanism for a patient whose lungs have lost the capacity to inhale and exhale. There are two types of such ventilators, 1. Nasal based ventilator 2. Oral based ventilator. Nasal based ventilators are used for patients having minor breathing problems. Oral based ventilators are used at times when the condition of a patient is very severe. These already available ventilators require a lot of costs, space and an expert handler. Ventilators are used only in extreme conditions. COVID-19 pandemic taught everybody that ventilators are far more important than we thought. Most of the patients who lost their lives during the pandemic were due to the unavailability of a ventilator. Along with ventilators, patient healthcare monitoring systems also played a vital role. These systems can monitor vital data such as BPM, temperature and SpO2 levels of a patient. These can be separately used and are used in daily needs as well. In this project, we are combining these two systems but we have kept an option of using these together or separately as per need. In today's world, we need cost-friendly, portable and easy to make systems. IoT will help us to integrate these systems to a website that can be monitored by the doctors themselves and they will receive alerts if a patient's vitals fall below a certain level. With the use of IoT, the whole healthcare system based on these devices can become more efficient and reliable and fast.

2. PROPOSED MODEL

The proposed system aims to solve the problem of expensive and sophisticated ventilator systems and health monitoring systems by introducing an easy to use low-cost IoT based ventilator and patient monitoring system.

The proposed system also aims to provide an easy to use, scalable and easy to install alternative to the systems which are present in the market today. Ventilators in normal situation were thought of as last option to save a patient who has lost the ability to breath on it's own but the Covid-19 pandemic has shown that a ventilator could help save the life of infected patients in quite an early stage. The System Design of the proposed model has 3 different sections, namely:

1.Circuit design diagram & description.
2.Logic design diagram & description.
3.UI design & website description.

2.1 Circuit Design Diagram and Description

Figure 3 shows the block diagram of IoT based Smart Ventilator. It consists of a Arduino UNO board connected with a 5V supply. The main component of the ventilator is the MG 945 servo motor. The servo motor is connected to a mechanical arm that will inflate and deflate the Ambu bag. The Ambu bag is medical equipment which is used to pump air in and out to a patient who has lost the capacity to breath

on his own. MG 945 servo works on an external 9V power supply. A Potentiometer will act as a control knob. By changing the position of potentiometer, the breath cycle, speed of the arm and angle of the arm can be changed in accordance to the need of the patient.

Figure 2 shows the block diagram of IoT based Patient Monitoring System. It consists of an Arduino UNO board which is powered using 5V power supply. The Arduino UNO is connected to 3 sensors, namely LM32D temperature sensor and MAX30102 SpO2 and BPM sensor. Arduino board receives values from these sensors which are then displayed on 16*2 LCD screen. The Arduino board is connected with ESP8266 Wifi module which is used to send the data received from the sensors to the website server.

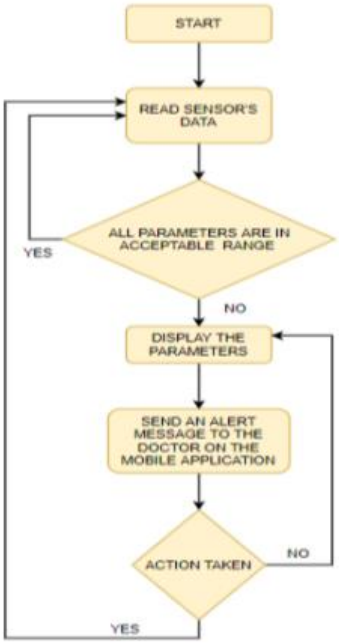

Fig -1: Flowchart of code

2.2 Logic Design Diagram and Description

Figure 1 gives a flowchart of the processes followed by the system combined. As the system is turned on, the data from arduino UNO is read. It is then checked if the parameters are in acceptable range or not. If the parameters are in acceptable range, the parameters are displayed on the LCD screen. If this condition fails, the process is reinitiated and the sensor data is received again. At the time when parameters are displayed, the data is also sent to the doctor's website. The doctor will receive the notification on his home page after he logs in to his account. What action is to be taken is then decided by the doctor.

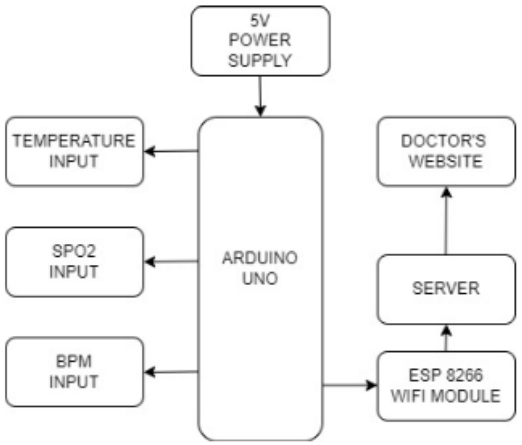

Fig -2: Block Diagram of Patient Monitoring System

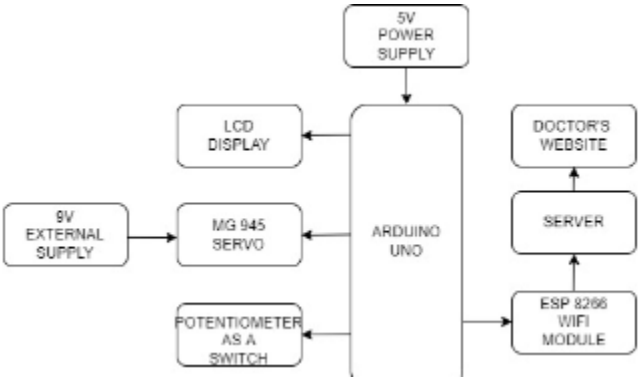

Fig -3: Block Diagram of IoT based Ventilator

2.3 UI Design and Website Description

The website will have a notification button through which the doctor will receive a notification on patient's condition. If the vitals are falling below a certain advised level, the Health Monitoring system will send a notification to the website which will be received at the backend of the website. The frontend of the website is made using HTML and CSS. The backend of the website is made using MongoDB and the frontend and backend are interconnected using Express.

3. RESULTS/FINDINGS/DISCUSSIONS

For Smart Ventilator:

The Ambu bag connected to the ventilator is the most important part of the ventilator. Air from the Ambu bag will be inhaled and exhaled by the patient. A mechanical arm controlled by MG 945 high-speed servo will inflate and deflate the Ambu bag with its force. This servo motor will be controlled by the Arduino Uno board. The pressure and volume will be controlled by the 10k potentiometer attached in the circuit. Setting the potentiometer at the required level will change the movement of the mechanical arm leading to the Ambu bag. The volume and pressure will be displayed on

the 20*4 LCD displays. Ambu bags will consist of a mask that will fit the patient's nasal part for inhalation and exhalation.
For Patient Monitoring System:
The Patient monitoring system will consist of a MAX 30100 Blood oxygen sensor, LM 35 temperature sensor and BPM sensor which will collect the vital data of the patient. This system is presently used in hospitals for monitoring patient health. Our model will be an easy to use, efficient and cost-friendly alternative to the ones in use. This can be used separately or with the ventilator depending upon the need and emergency.
Integration:
Finally, the important aspect of this project is the integration of data obtained from the hardware with the software part. Connectivity between the Node MCU ESP 8266 wifi module and cloud server using authentication tokens and libraries. As a result, the doctor will receive notifications about the health of the patient, be it a ventilator or health monitoring system on his/her PC/phone via the website. The website will have separate logins for patients and doctors and will be connected in the backend by a database.

4. APPLICATIONS

4.1 Ventilation to Patients

This system will provide ventilation to patients who have lost the ability to breath. Air along with oxygen will be pumped to the patient. The arm of the ventilator will be operated using MG945 servo motor which will create enough pressure to pump the air to a patient. The breath cycle, angle of the arm and speed of the arm can be set using the potentiometer which acts as a control knob. Controlling using a simple knob also makes operating the ventilator easy to the hospital staff who might have less experience.4.2 Smart Patient Monitoring.

4.2 Smart Patient Monitoring

Patient Monitoring is an important method to analyze the vitals of the patient so that treatment can take place with immediate effect. When this system is connected with IoT, the vital data of patients can be sent directly to the server and can be monitored by the doctor from his/her computer. The website will have a login system using which the doctor can monitor the patients' data. This will reduce the panic that takes place in the situation of a pandemic and will give clear idea to the doctor about conditions of each and every patient.

4.3 Flexibility

This project provides flexibility of usage. This means that the ventilator and patient monitoring system can be used together or separately as per the requirement of the patient or resource management of the hospital. This flexibility will allow hospitals and doctors to manage systems efficiently and would lower the expenditure.

CONCLUSION

The project, IoT Based Smart Ventilator and Patient Monitoring System has been completed and one prototype of the same is in the working condition. Using the patient monitoring system, the vitals of the patient can be received and the doctor can administer the same using the website. The dashboard of the website will display the vitals of the patient in the form of excel sheet on the website. The doctor can then take a decision if the patient needs a ventilator or not if the vitals fall below the advised level. The ventilator can then be used to provide oxygen to the patient using the pumping mechanism powered by MG945 servo and Arduino. The Ambu bag pumps oxygen when pressure is applied on it using the MG945 servo arm. The ventilator is functional and can provide enough pressure. Further developments can be made which will increase the efficiency of the complete project.

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