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Patient Monitoring And Assistance Device

Portable Smart ECG, N.I.V. Ventilator

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Abstract

We have presented a Patient monitoring and assistance system that will allow continuous monitoring of patient vital signs, assist medical personnel in making decisions, and help improve patient care. In addition, we aimed to help the patient by providing a breathing assistance device, such as a portable Non-Invasive Ventilator (NIV) This system may include devices that measure, display, and record human vital signs such as body temperature, heart rate, and ECG, as well as devices that can be modified to monitor other health-related criteria. This paper proposes a system for monitoring a patient's condition by measuring heart rate and oxygen levels. In addition, the system will monitor the patient's ECG and can be accessed remotely via the cloud.

Keywords—*ECG, ventilator, medical electronics, patient monitoring*.

INTRODUCTION

The Smart Devices i.e., the Internet of Things is the next big step in the health care sector where the sensors collect the data from the patients and is transmitted over a cloud-based service. Through which a certified medicinal Practitioner can monitor the patient and provide the necessary treatment plan. We have proposed for the remote assistance along with the monitoring of the patient.

The Non-invasive method in providing ventilation for the patients is better than the traditional intra nasal methods. Non-invasive ventilation (NIV) is the delivery of oxygen (supported ventilation) through a face mask without the need for an endotracheal airway. NIV achieves physiological benefits comparable to conventional ventilators by reducing the work of breathing and improving gas exchange. Studies show that non-invasive ventilation after early extubating appears to help reduce the total number of days spent on invasive ventilation. This intervention is designed to improve breathing in chronic obstructive pulmonary disease, cardiogenic pulmonary edema, and other respiratory diseases without complications such as respiratory muscle weakness, upper airway trauma, ventilator-associated pneumonia, and sinusitis. It is recognized as an effective treatment for insufficiency.

Heart diseases have become a major problem in recent decades, and many people die from certain health problems. Therefore, heart disease should not be taken lightly. Therefore, there is a need for technology that can regularly monitor a patient's heart rate and heart motion.

Various heart diseases can be prevented by analysing or monitoring ECG signals in the early stages.

MOTIVATION

There is lack of research in developing an all-in-one patient monitoring device in addition to it the existing machine can’t assist the patient in any way like in assisting the breathing. The recent events have opened the eyes of the healthcare sector for the need of ventilators and the remote patient monitoring devices. Due to the nature of Covid there was a need of remote monitoring of patients and also assisting them. As the virus targets the patients’ lungs the patient needs to be assisted in breathing. The PMAD will make it possible for the remote monitoring and assistance of the patients.

LITERATURE SURVEY

A group of scientists published a paper on the use of electrocardiograms (ECGs) [1] to diagnose heart diseases. A health-care application based on Internet of Things (IoT) can continuously monitor individuals' ECG signals remotely over a longer time period. The main benefits of IoT in healthcare are patient monitoring, analysis, diagnosis, and control. Electrocardiograms are used to detect cardiac abnormalities by analysing small electrical impulses generated by the heart. According to AAMI guidelines, available ECG signal beats are divided into two categories: critical and non-critical.

A team of researchers has developed a mobile health monitoring device [2] that alerts the patient when he is in danger of developing a heart attack or another serious health condition. The CMS50D pulse oximeter is small, lightweight, accurate, inexpensive, and consumes very little power. When predefined warning levels are reached, the microcontroller software alerts the patient. The monitoring range is determined by the communication method used, with Bluetooth providing a short range (20 m) and wireless providing a range of up to 100 m.

A team of researchers has developed [3] an e-health system that monitors oxygen levels in an airplane's cabin. Pulse oximetry is a technique for measuring blood oxygen saturation (SpO2) and pulse rate. It provides data on lung capacity to ensure that the body receives an adequate amount of oxygen even when no effort is exerted. The person can be identified thanks to the use of a pulse oximeter integrated into the SDU. The pulse oximeter measures blood oxygen saturation based on the amount of red light or infrared absorbed by oxyhemoglobin or deoxyhemoglobin.

A low-cost sensor kit has been developed to help diagnose and treat novel coronavirus pneumonia and bronchitis. The rising number of coronavirus cases and deaths around the world has greatly increased the need for health surveillance, including: Researchers [4] developed a very low-cost wearable system based on the MAX30100 and tested it in 12 consenting subjects. The group found a minimum acceptable deviation of 0.8175% for pulse rate and 0.425% for SpO2. This study included 12 participants. You have indicated that there are many opportunities for further research and development. Potential applications include remote detection of Covid symptoms, mobile app-based telemedicine, and heart disease detection and analysis.

A researcher [5] used a smartphone to study the relationship between pain and weather and examined the results. Dixon and his colleagues (2019) reported that her 13,207 users downloaded the survey app during a 12-month recruitment period. A total of 10,584 had complete baseline data and at least he had one pain entry. Compared to an average day, the "worst" combination of weather variables increases the likelihood of pain occurrence by more than 20%. High relative humidity, high wind speed, and low atmospheric pressure are associated with increased pain intensity in people with chronic pain. The effect of weather on pain was not fully accounted for by its effects on mood and daily physical activity. The analysis included 2658 patients. However, the study was "advertised to participants with a clear research question," the authors write. They argue that rainy and cold weather was the prevailing belief. "Because pain reporting is subjective, participants' 'moderate' pain may correspond to 'severe' pain," the authors admit.

This paper [6] seeks to apply reverse engineering concepts to the design and construction of low-cost ambulatory CPR and ventilators. According to Abdullah Al-Aubidy (2021), in 2020 the world was exposed to the coronavirus known as his COVID-19 pandemic. The main goal of this research is to design and build a ventilator using reverse engineering concepts. The virus severely impacts lung function and can lead to patient death. Hospital ventilation and cardiac resuscitation equipment is complex, expensive, and has limitations.

A group of Scottish researchers [7] have proposed an ECG signal generator that could be used to detect and treat cardiovascular diseases. The world is dealing with a high rate of heart disease. The World Health Organization (WHO) estimates that more than 17 million people die each year as a result of cardiovascular disease. A typical method for detecting heart disease or cardiovascular disease in a person is to send a diagnosis to a pathology centre and obtain an ECG signal for testing. A portable ECG signal generator circuit, a data transfer device, and a smart device comprise the system design. It has the potential to reduce deaths from heart attacks and other cardiovascular diseases.

Proposed a scheme [8] that increases the bitrate of distributed video encoding by 2.9% while also increasing the speed by 15.3% over existing schemes. Myunghoon Jeon (2016) investigated content-aware video segmentation and scheduling in map reduce-based distributed video encoding. CAET increased bitrate by 2.9% when compared to the most popular segmentation schemes in the field of distributed encoding. It improved overall performance efficiency and increased encoding speed by 15.3%. More research is needed to improve the content differentiation process's efficiency. The encoding tasks that are part of the video coding process that require a high computational complexity are distributed using distributed encoding. The bitrate, Peak Signal to Noise Ratio (PSNR), and encoding speed of distributed encoding can all vary. CAET increased bitrate by 2.9% compared to the main existing segmentation schemes, but it also increased encoding speed by 15.3% and improved overall performance efficiency. The study included four subjects. The team claims that changes in the SOI differentiation performance based on window size resulted in different results depending on the video used. As a result, more research is required to effectively set window size.

Researchers [9] trained a neural network using artificial intelligence (AI) to identify human heartbeats from electrocardiograms (ECG). At an average heart rate of 80 beats per minute, this means that one PQRST period takes 0.75 seconds. The proposed algorithm employs ECG signals that have been normalized to be based on the same heart rate. The Fourier transform technique is used to extract ECG features. The heart rates of the ECG signals used in this paper have been normalized to a standard heart rate. Using a neural network, the significant Fourier components are used in the classification process.

METHODOLOGY

After carefully analysing the existing systems available on the market showed that some parameter constraints like the size i.e., bulkiness, price range, available functions, portability are of concern So the proposed system was aimed to overcome these problems.

The system is divided into Three modules for efficient working and work load distribution. The separation allows the one module to be turned off in case they are not being used. The buttons allow the modules to be operated at the user’s discretion.

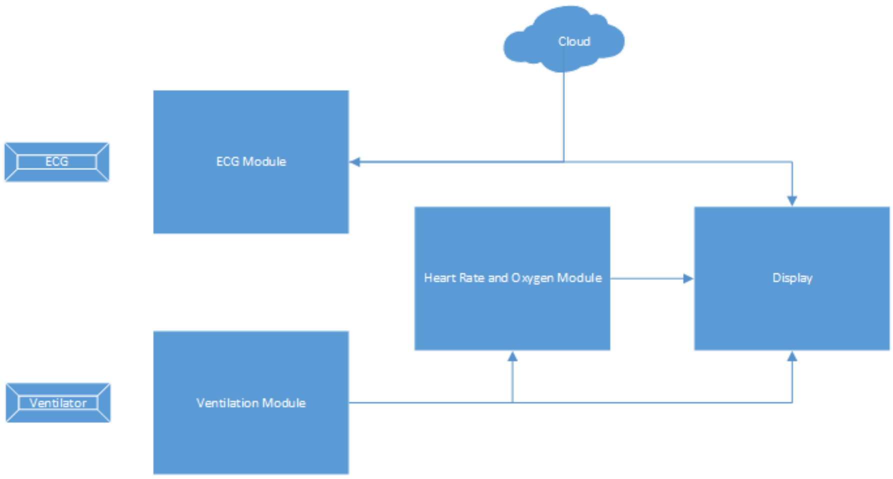

Figure 1 Proposed System Block Diagram

A. ECG Module

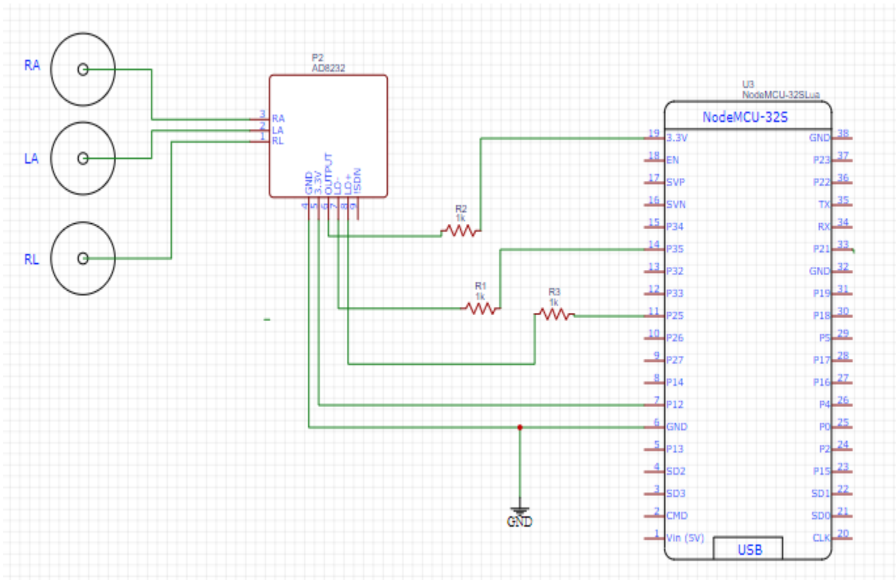

Figure 2 ECG Module

An electrocardiogram (ECG) was monitored using the AD8232 sensor. This sensor is an inexpensive circuit board that measures the heart's electrical activity. This electrical activity is recorded as an electrocardiogram and output as an analog reading. Electrocardiograms can

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be very noisy. The AD8232 single-channel heart rate monitor acts as an operational amplifier to easily obtain clear signals from the PR and QT intervals.

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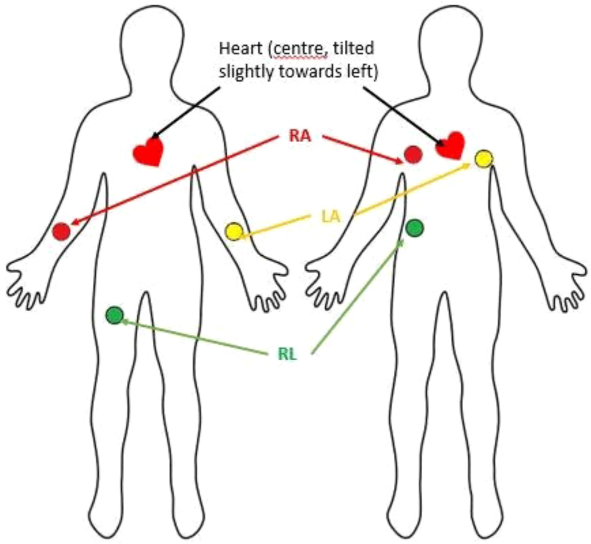

Figure 3 ECG Electrode Placement

This module will monitor the patients ECG and transmit the graph to the cloud through which any licensed medicinal practitioner anywhere in the world will be able to prescribe the necessary treatments and take the required steps. This module is designed keeping in mind the architecture of the current medical situation like the low doctor to patient ratio. Due to its remote monitoring the large sized hospitals can keep an eye on a number of patients simultaneously without compromising the patient’s needs.

B. *Heart Rate and oxygen Module*

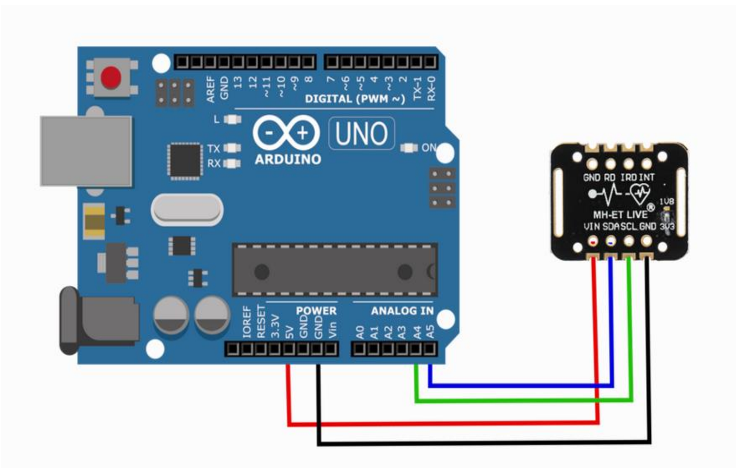

Figure 4 Pule & Oxygen Module

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This module houses the blood oxygen and heart rate sensors. Pulse oximetry measures the intensity of reflected red and infrared light to monitor blood oxygen saturation. By analysing the time series response of reflected red and infrared light, a pulse oximeter can also estimate heart rate. In addition to heart rate and blood oxygen levels, the MAX30102 sensor can measure other body temperatures. This is a sensor developed by Analog Devices that includes two LEDs (one for infrared and one for red), a photodetector, optics, and a low power sensor for detecting pulse oximetry (SpO2) and heart rate (HR) signals. It has a noise signal processing unit. The main idea is that he lights up one LED at a time and sees how much light is reflected back to the sensor. Based on reflexes, blood oxygen levels and heart rate can be determined. The module is equipped with a buzzer to notify of the drop in oxygen levels and the heart rate.

Ventilation Module

Most fluid power circuits are controlled by electrical and electronic equipment. Control schemes include relay logic, programmable controllers, and computers. Air logic is another approach to controlling pneumatic systems. All functions normally handled by relays, pressure or vacuum switches, time delays, limit switches, or counters can be performed by Air Logic Controls. The circuit is similar, but compressed air is used as the control medium instead of electricity. Air Logic controllers are ideal for humid or dusty environments. The Air logic system is non-explosive, shock hazard-free, and splash water will not affect control functionality. The control medium - clean compressed air - cannot be ignited in the event of an external explosion.

For full control of breathing, the board must be able to connect to high pressure, low pressure and atmospheric pressure independently. The diagram below describes a simple way to configure the pump and valves to accomplish this. Solid lines represent air tubes. There are three valves below, all closed. The inlets of the valve are connected from above to high pressure, low pressure and atmospheric pressure. All valve outputs are interconnected and connected to pressure sensors and masks.

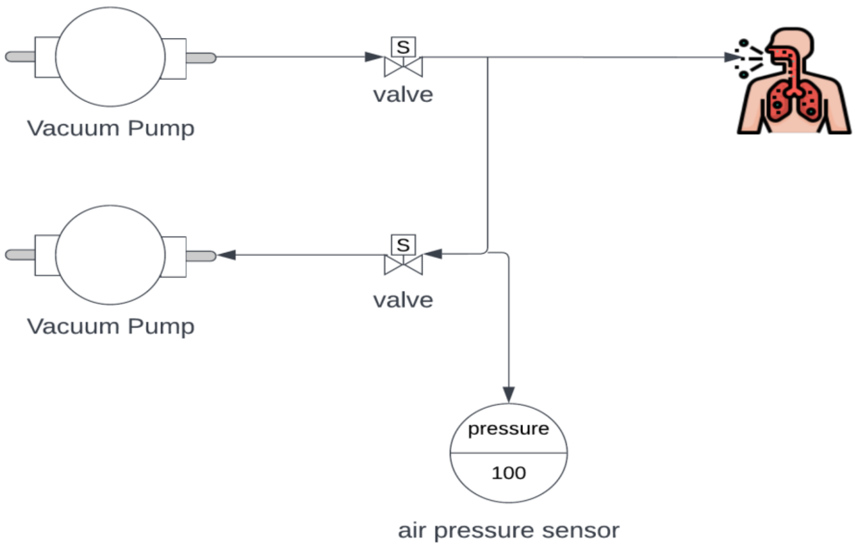

Figure 5 Ventilation Module

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PROGRAM FLOW

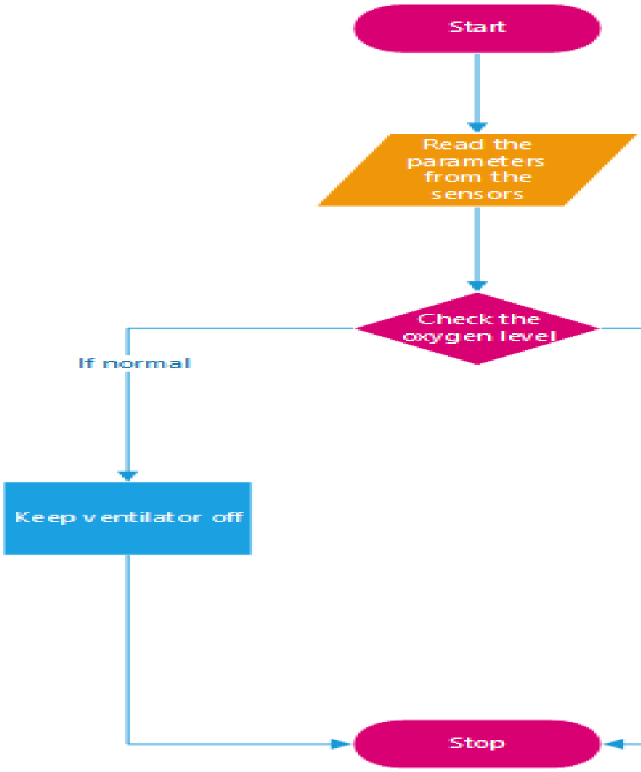

Figure 6 Program Flow 1

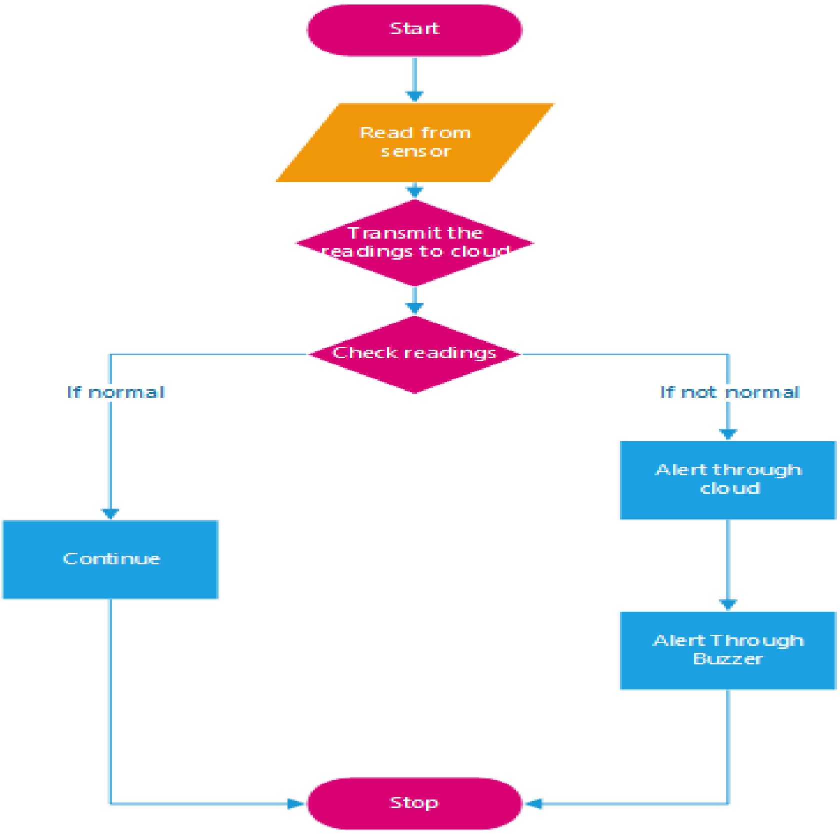

Figure 7 Program Flow 2

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II. RESULTS

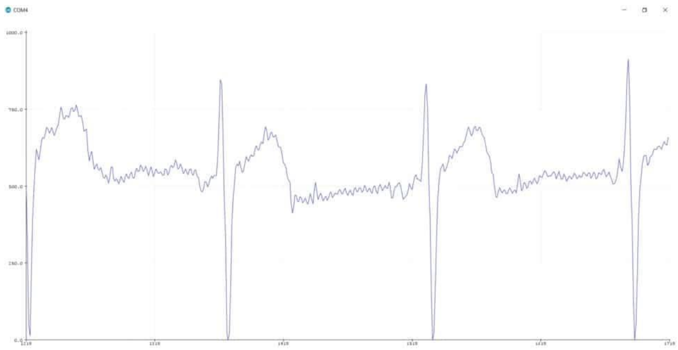

Figure 8 ECG Readings

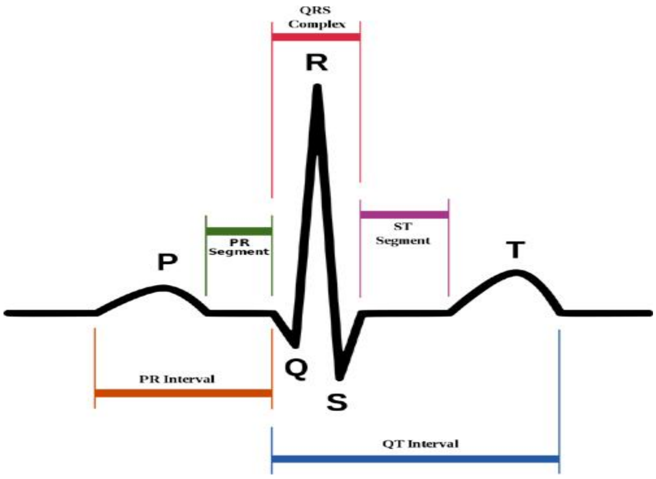

Figure 9 Ideal ECG Wave

Each interval has a range of optimal values, and deviations from this range may be associated with specific diseases. Here are the main components of the ECG signal.

1. P Wave - This is the left posterior wave of the QRS complex.
2. QRS Complex - Impulses produced by ventricular contraction.
3. T wave - This is the leading wave going directly to the QRS complex.
4. U wave - Not always observed due to low wave height.

Many heart diseases and irregularities can be diagnosed based on the shape of the above features, the intervals between them, and the intervals between them. Examples:

1. Irregular heartbeat or absence of P waves: Atrial fibrillation
2. Normal heart rate >100 = Tachyarrhythmia
3. Tachyarrhythmia and delta waves: Wolf-Parkinson-White or WPW syndrome
4. Serrated P wave: atrial flutter
5. ST segment depression: this may indicate ischemia

6. ST segment elevation: this may indicate myocardial infarction

Therefore, the ECG is It is very important for cardiologists and doctors on this subject.

Figure 10 ECG Electrode Placement on Hand

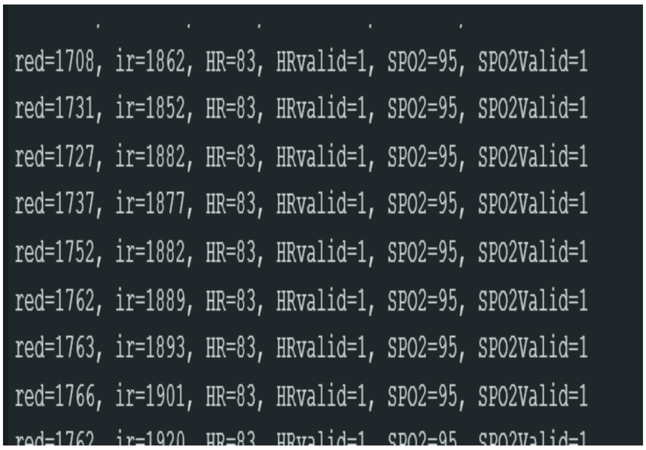

Figure 11 Heart Rate &SP02 Readings

The SPO2 i.e., the oxygen level in the patient will be continuously monitored and accordingly then the patient will be assisted in breathing through the Non-Invasive ventilator.

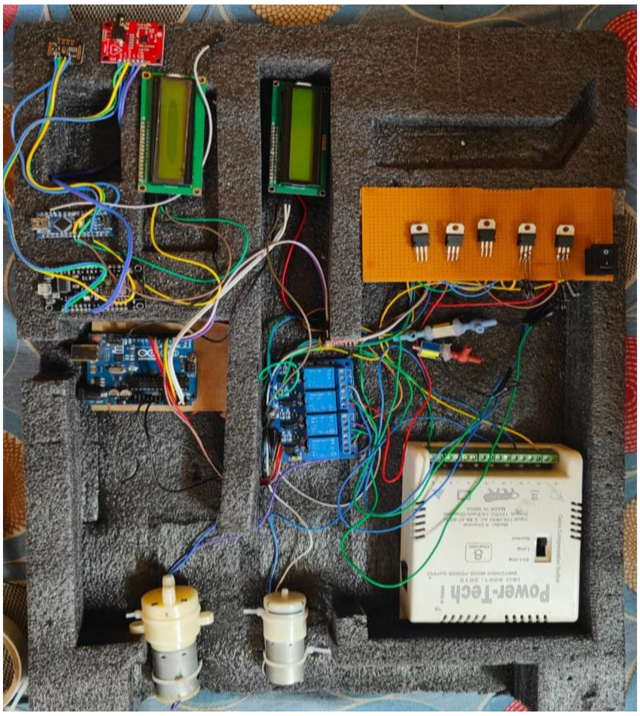

Figure 12 Proposed System

III. APPLICATIONS

A. *Post Treatment*

After heavy medication and therapy, patient is suffering from difficulty breathing. In such cases, P.M.A.D. can be used.

B. *Post Opertative Interventions*

After invasive interventions, breathing becomes difficult, especially in the abdomen. Proper breathing after surgery is very important. Used here to support P.M.A.D respiration. It provides adequate pressure, not too high to cause barotrauma.

C. *Respiratory Diseases*

Respiratory diseases affect the body's ability to breathe properly. Most commonly these are associated with bacterial or viral infections. Now on takes the COVID-19 pandemic as an example, mainly dealing with people not being able to breathe normally. The lungs become infected, resulting in a decrease in important body parameters such as blood oxygen saturation. In such cases, the patient needs external support. Patients must be able to breathe properly and feel comfortable during treatment.

D. *Veterinary medicine compatible*

The ECG can be modified to detect the pulse waves of animals.

E. *Patients Confined To Home*

Patients which are confined to home treatment can be monitored efficiently through this system the doctors can monitor the patients even from their clinics also can be assisted quickly with some modifications.

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FUTURE SCOPE

The proposed System can be improved through some modifications for more assistance. The Addition of a defibrator will give an advantage of correcting the sinus rhythm of heart in case of heart arrythmias remotely which can save the lives of patients. The Addition of BP monitor can improve the capacity of monitoring the patients' vitals. The ventilator can be modified to assist breathing for animals.

CONCLUSION

Keeping the purpose of designing a system to address a key in health care system, the proposed system gave us more benefits that a commercial bulky system can give. The issue of breathing ailments as well as the heart related issues still remain to save the patients' lives. The P.M.A.D. provides a cheap, fast yet an effective method of treatment in an efficient way. Furthermore, in future the model can be improved such as miniaturized, interconnectedness through extensive collaboration with industry experts and medical professionals.

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