

AUTOMATED BLOOD OXYGEN MONITORING AND CONTROLLING DEVICE FOR BEDRIDDEN PATIENT

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Technology degree in
Biomedical Engineering

By

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**DEPARTMENT OF BIOMEDICAL
ENGINEERING SCHOOL OF BIO AND
CHEMICAL ENGINEERING**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

MARCH 2021



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DEPARTMENT OF BIOMEDICAL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **MONISHA.S (Reg. No.37240054), RADHA.K (Reg. No. 37240059)** who carried out the project entitled "**AUTOMATED BLOOD OXYGEN MONITORING AND CONTROLLING DEVICE FOR BEDRIDDEN PATIENTS**" under our supervision from **September 2020 to March 2021**.

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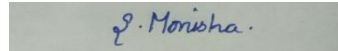
DECLARATION

We, **MONISHA.S** (Reg. No. 37240054), **RADHA.K** (Reg. No. 37240059) hereby declare that the Project Report entitled “**AUTOMATED BLOOD OXYGEN MONITORING AND CONTROLLING DEVICE FOR BEDRIDDEN PATIENT**” done by us under the guidance of **Dr. S. Krishnakumar, Department of Biomedical Engineering** is submitted in partial fulfillment of the requirements for the award of **Bachelor of Technology** degree in **Biomedical Engineering**.

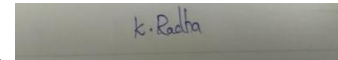
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ABSTRACT

The present research to control the oxygen flow meter valve by using servo motor based on the patient's blood oxygen saturation level. The most important factor for the efficient and secure care of the patient is blood oxygen monitoring. Mistakes in this area will result in the patient's life being severely compromised. Blood oxygen saturation level of humans must be 95%-99% (normal) .Here SpO2 sensor has been used to detect the SpO2 level and heart rate. As a result, we present a microcontroller-based oxygen supply control device with the goal of reducing the time and care-taker requirement to oxygenate the patient by providing controlled delivery. Sensor will send the output to microcontroller, inbuilt with ADC (Analog-to- Digital Converter). Servo motor is used to control the flow meter valve to deliver necessary oxygen to the patient during abnormal detection of blood oxygen saturation level. The output is sent to an LCD display unit, which keeps track the SpO2 level. In order to avoid hypoxemia adverse effects in the patient's body, a real-time monitoring of the patient SpO2 is provided. Thus, this project helps in taking care of patients at the right time and to avoid difficulties.

TABLE OF CONTENTS

CHAPTER NO	TITLE	PAGE NO
	ABSTRACT	i
	LIST OF ABBREVIATION	iv
	LIST OF FIGURES	v
1	INTRODUCTION	1
	1.1 SpO2 AND HEART RATE MONITORING	1
	1.1.1 BLOOD OXYGEN SATURATION	1
	1.1.2 MEASURING BLOOD OXYGEN SATURATION	2
	1.1.3 MEASURING PULSE RATE	2
2	LITERATURE SURVEY	3
3	AIM AND SCOPE	10
	3.1 AIM	10
	3.2 SCOPE	10
4	MATERIALS AND METHODS	11
	4.1 METHODOLOGY	11
	4.1.1 BLOCK DIAGRAM WITH OF BLOOD OXYGEN SATURATION MEASUREMENT AND OXYGEN SUPPLY CONTROL	11
	4.2 HARDWARE USED	12
	4.2.1 POWER SUPPLY MODULE	12
	4.2.2 ARDUINO UNO KIT	13
	4.2.3 MICROCONTROLLER MODULE	14
	4.2.4 MAX30100 SENSOR	15
	4.2.5 16 X 2 LCD DISPLAY	16

	4.2.6 SERVO MOTOR	17
	4.2.7 OXYGEN FLOWMETER	18
	4.3 SOFTWARE USED	19
	4.3.1 VISUAL STUDIO	19
	4.3.2 ARDUINO	20
5	RESULTS AND DISCUSSION	21
	5.1 RESULTS	21
	5.2 DISCUSSION	24
6	SUMMARY AND CONCLUSION	25
	6.1 SUMMARY	25
	6.2 CONCLUTION	25
	REFERENCES	26
	APENDICES	30

LIST OF ABBREVIATION

ABBREVIATION	EXPANSION
ALC	AMBIENT LIGHT CANCELLATION
AVR	ADVANCED VIRTUAL RISC
EEPROM	ELECTRICALLY ERASABLE -PROGRAMMABLE -READ ONLY MEMORY
SRAM	STATIC RANDOM ACCESS MEMORY
LCD	LIQUID CRYSTAL DISPLAY
LED	LIGHT EMITTING DIODE
IOT	INTERNET OF THINGS
WHMS	WEARABLE HEALTH MONITORING
DSP	DIGITAL SIGNAL PROCESSOR
ADR	ACTIVE DATA REPRESENTATION
VS	VISUAL STUDIO

LIST OF FIGURES

FIGURE NO	NAME OF THE FIGURE	PAGE NO
4.1	Block Diagram of Blood Oxygen Saturation Measurement and oxygen supply control	11
4.2	Power Supply Module	12
4.3	Arduino Uno	13
4.4	Microcontroller Module	15
4.5	MAX30100 Sensor	16
4.6	16 X 2 LCD Display	17
4.7	Servo Motor	18
4.8	Oxygen flow meter	18
5.1	Hardware set up of blood oxygen saturation measurement and oxygen supply control	22
5.2	Measuring blood oxygen saturation level	22
5.3	Blood oxygen saturation level predicted as normal	23
5.4	Blood oxygen saturation level predicted as abnormal	23
5.5	Oxygen supply control set up	23

CHAPTER 1

INTRODUCTION

Nearly one crore people above the age of 60 years in India are bed-ridden and require round-the-clock care, found a survey conducted by the Indian government. The survey covered 1,00,000 bed-ridden patients of the total 2.5 million people in the age group of 60 and above. This shows the extent of how much a technological solution is required to monitor the bed ridden patients round the clock. The normal human Blood oxygen saturation is 95%-99%. Blood oxygen saturation maintenance is major consideration for effective and safe handling of the patient. Mistakes regarding this can lead to life-threatening condition for the patient. In order to overcome this problem and provide proper monitoring of the patients , we have developed a project in which the heart rate and the blood oxidation levels are constantly measured using the MAX30100 sensor. These two parameters are displayed on a LCD display. When the blood oxidation levels of a patient becomes critical then the oxygen supply is opened to the patient. Thus, this project helps in taking care of patients at the right time and to avoid difficulties.

1.1 SpO2 AND HEART RATE MONITORING

The calculation of oxygen saturation in the blood is called oximetry, and it's generally expressed as a percentage (a normal reading is typically 97 percent or higher). A pulse oximeter sensor is a non-invasive instrument that monitors a person's heart rate and oxygen saturation in their blood.

1.1.1 Blood Oxygen Saturation

Hemoglobin, the oxygen-carrying pigment in red blood cells that gives them their red color and transports oxygen to the tissues, is used to determine blood oxygen saturation. There are two types of hemoglobin. The first is oxidized (oxy-) hemoglobin, abbreviated as HbO₂ (also known

as "oxygen-loaded" hemoglobin). The second form is reduced-oxygen (deoxy-) hemoglobin, which has lower oxygen content. Blood oxygen saturation (SpO_2) is the ratio of oxy-hemoglobin to deoxy-hemoglobin. This can also be expressed as: $SpO_2 = HbO_2 / (Hb + HbO_2)$.

1.1.2 Measuring Blood Oxygen Saturation

Hb absorbs more visible red light (and reflects less). Infrared light is absorbed more (and reflected less) by HbO_2 . Since blood oxygen saturation can be measured by comparing the values of Hb and HbO_2 , shining both a red and an infrared LED through a body part (such as a finger or wrist) and comparing their relative intensities is one tool. There are two different approaches to this: Transmissive oximetry is the measurement of light transmitted by tissue, while reflectance oximetry is the measurement of light reflected by tissue.

1.1.3 Measuring Pulse Rate

Blood is pumped into your body as your heart beats. Blood is squeezed into capillaries with each heartbeat, causing their volume to slightly increase. The volume decreases between heartbeats. This change in volume has an effect on the amount of light that can pass through the tissue, such as red or infrared light. Despite the small size of the fluctuation, it can be measured with a pulse oximeter using the same setup that is used to measure blood oxygen saturation.

CHAPTER 2

LITERATURE SURVEY

Claire Lochner, et al. (2014) Pulse oximetry is a non-invasive medical sensing tool for calculating pulse rate and arterial blood oxygenation that is used all over the world. Due to their rigid shape and area-scaling sophistication, traditional pulse oximeters use costly optoelectronic components that limit sensing locations to finger tips or ear lobes. We present a pulse oximeter sensor made of organic materials that can be used on flexible substrates in this paper. Organic light-emitting diodes (OLEDs) that emit green (532 nm) and red (626 nm) light are combined with an organic photodiode (OPD) that is sensitive to those wavelengths. Spin-coating and printing methods are used to deposit the active layers of the sensor, which are made from solution-processed materials. At 1 kHz, the all-organic optoelectronic oximeter sensor is interfaced with traditional electronics, and the acquired pulse rate and oxygenation are calibrated and compared to a commercially available oximeter. With 1 percent and 2 percent errors, the organic sensor reliably tests pulse rate and oxygenation.

Dong Yang, et al. (2015) The arterial blood oxygen saturation (SpO₂) and heart rate, which are people's vital signs, are measured using Photoplethysmography technology in this article. We created a device that measures human SpO₂ and heart rate in a non-invasive, continuous, and portable way. The PPG signal is obtained using micro-optoelectronic sensors, and the wearable watch communicates with a PC or cell phone via wireless Bluetooth 4.0. The theory of Photoplethysmography is that blood volume changes the reflection or transmission of light in the micro vascular tissue. We use a MEMS method to quantify the motion information and cancel the disturbance since the motion noises are in the same frequency band as the physiological signal. In the future,

cardiovascular disease will be tracked and projected.

Madhan Mohan, et al. (2016) the heart rate and arterial oxygen saturation are measured using pulse oximeters (SpO₂). The noise caused by movement has a significant impact on the photoplethysmographic (PPG) signals from pulse oximeters. The ambient light signal has an effect on the signal. For the calculation of arterial oxygen saturation, obtaining a clean signal is important (SpO₂). To eliminate noise from the signal, an Adaptive Noise Cancelling (ANC) technique is used in this article. During the data acquisition process, data from a tri-axial accelerometer is also obtained. The adaptive filter algorithm is based on the Normalized Least Mean Square (NLMS). The data from a tri-axis accelerometer provides directional information along all three axes. They are added together and used as a reference noise signal by the adaptive filter. The coefficients in the filter are modified depending on the error signal, and they are updated until the error is as small as possible. The oxygen saturation is determined from the clean signal by finding the normalized ratio of ratios. Adaptive noise cancellation using an accelerometer has been found to minimize arterial oxygen saturation errors. The average result for the algorithm in question is about 0.2409. The result is also found to be in agreement with the pulse oximeter used as a reference.

Mohammad Salah Uddin, et al. (2017) in the field of remote monitoring, the popularity of the Internet of Things is growing by the day. Vehicle or asset tracking, children's pets monitoring, vehicle management, parking management, water and oil leakage, energy grid monitoring, and other remote monitoring systems are examples. In this paper, we propose an intelligent patient monitoring system that uses sensor-based connected networks to automatically monitor patients' health. The biological activities of a patient are collected using a variety of sensors. The relevant biological data is then sent to the Internet of Things cloud. The machine is more

intelligent in that it can identify a patient's vital condition by analyzing sensor data and sending push alerts to physicians, nurses, and hospital in-charge staff. Doctors and nurses benefit from this system because they can monitor their patients without having to visit them in person. With restricted access, patients' families may also benefit from this scheme.

Paul Benni, et al. (2018) the validation methodology for the NIRS-based FORE-SIGHT ELITE® tissue oximeter (CAS Medical Systems, Inc., Branford, CT, USA) for cerebral and somatic tissue oxygen saturation (StO₂) measurements in adult subjects that was submitted to the US Food and Drug Administration (FDA) for clearance for clinical use is identified. The FDA proposed using Deming regression and bootstrapping statistical validation approaches, and this validation approach evolved from a history of NIRS validations in the literature. For cerebral validation, somatic StO₂ measurements were compared to a weighted 70:30 reference (REF CXS) of co-oximeter internal jugular venous and arterial blood saturation of healthy adult subjects during a regulated hypoxia series, with a sensor placed on the forehead. With informed consent, 25 subjects successfully completed the cerebral validation study. The difference in bias and precision (1 SD) between cerebral StO₂ and REF CXB was 0.14 3.07 percent. The somatic validation analysis was successfully performed by 24 participants with informed consent. Somatic StO₂ had a bias and precision of 0.04 4.22 percent as compared to REF CXS, with the average of flank, quadriceps, and calf StO₂ measurements better representing the global whole body REF CXS. The NIRS validation methods presented may be a reliable way to evaluate and qualify NIRS monitors for clinical use.

Sachi Marathe, et al. (2019) the design and implementation of a mobile patient-monitoring device using four sensors in one system is demonstrated in this paper. In the past, healthcare providers in crisis areas measured vital signs manually, registered them on paper, and

communicated over the radio, but when the number of patients rose dramatically, it caused confusion among the healthcare providers. Since technological advances have resulted in rising healthcare costs, the proposed mobile sensor-based device would not only be technologically advanced but also cost effective. Electrocardiogram (ECG) module, blood pressure sensor, temperature sensor, and pulse oximeter module are the four main sensors in the device. Using Arduino, the sensors will be combined into a single device. The data obtained from the sensors will be sent to a Wi-Fi module named NodeMCU ESP8266, which will upload the data to the cloud, where it can be accessed by the healthcare provider. We calculated and summarized the four critical parameters for ten separate patients in this article.

Samah Alharbri, et al. (2019) to obtain oxygen saturation (SpO₂) readings, photoplethysmography (PPG)-based pulse oximetry instruments usually use red and infrared illuminations. Furthermore, the existence of motion artifacts severely limits the effectiveness of physiological pulse oximetry measurements. A mixture of green and orange illuminations from a multi-wavelength optoelectronic patch sensor (mOEPS) was investigated in the current study in order to enhance robustness to subject movement in the extraction of SpO₂ measurement. The experimental protocol with 31 healthy subjects was split into two sub-protocols with the aim of evaluating SpO₂ measurement. The data for the first sub-protocol were obtained from 15 subjects who were free to shift their hands while at rest. The datasets for the second sub-protocol, which included 16 subjects, were obtained while they were cycling and walking. In both sub-protocols, the findings showed strong agreement with SpO₂ measurements ($r = 0.98$). The findings point to a reliable and cost-effective approach to physiological tracking, with the possibility of providing health monitoring without restricting user movement.

Ting Zhang, et al. (2014) over the last few years, wearable sensor-based healthcare systems have gotten a lot of attention from the research community and the industry. Unobtrusive, low-cost, and accurate healthcare services have the ability to change the future of healthcare as healthcare costs rise and the population ages. They are easy to use and can be done from the comfort of one's own home or in the community. Bio-signal tracking, signal analysis, and biofeedback are among the features of these devices. Sensors, data aggregators, and data processing units are among the subsystems connected by wired or wireless communication modules. The systems' development goals include improving output accuracy, making the device smaller, extending battery life, and lowering product costs. In comparison to conventional wired or other wireless networking modules, Bluetooth low energy (BLE) is advantageous for these design goals. Bluetooth low energy devices are attracting more scientists and engineers to research, and products like wearable sport bands, smart toothbrushes, and intelligent watches are changing people's lives. We present an overview of current Bluetooth low energy technology in this paper.

Yu Fu, et al. (2019) the demands of sport monitoring research are increasingly growing, thanks to the rapid growth of information technology. Internet of Things (IoT), which are based on sensor technology and digital communication technology, are becoming increasingly relevant in today's sport training and everyday activities. Sensor-based sport tracking techniques allow people to use wearable sport devices to track their own physiological parameters, with a specific emphasis on blood oxygen saturation and pulse measurement. We will use a near-infrared portable tissue oximeter with a detector module based on the STM32 microprocessor to calculate these two parameters. Near -infrared spectroscopy (NIRS) is becoming a common research tool for non-invasively measuring tissue oxygen (O₂) levels. The most popular instruments are continuous-wave spectrometers, which include semi-

quantitative changes in oxygenated and deoxygenated hemoglobin in small blood vessels (arterioles, capillaries and venules). We were able to obtain the blood oxygen saturation and pulse parameters by measuring with near-infrared technology. The portable device will send the data to the remote coaches or doctors via GPRS/ Wi-Fi/ Zigbee networks after obtaining the above two parameters. The specialist decision-making system processes the data of the blood oxygen saturation and pulse measured by the detection module in order to provide coaches and doctors with information about the athlete's condition. Furthermore, the data can be sent to players', coaches', and doctors' smart phones via GPRS/ Wi-Fi networks, where the blood oxygen saturation and pulse data of the athletes can be displayed according to the needs of remote users. The results of the tests show that the measurement accuracy is good and the device is stable.

Zhiyuan Lu, et al. (2015) the prototype of a pulse oximeter for mobile healthcare is presented in this paper. A reflection pulse oximeter is integrated into the back cover of a smart handheld system in this prototype, allowing for easy measurement of heart rate (HR) and SpO₂ (estimation of arterial oxygen saturation) for home or mobile applications. To overcome the effect of ambient light and interferences caused by embedding the sensor into a flat cover, novel and miniaturized circuit modules including a chopper network and a filtering amplifier were developed. A system based on adaptive trough detection is proposed for improved HR and SpO₂ estimation, with sufficient simplification for mobile device implementation. A photoplethysmogram validation scheme that is both fast and efficient is also proposed. To calibrate and validate our oximeter, we conducted clinical experiments. With no substantial difference reported by paired t-tests ($p = 0.182$ for SpO₂ measurement and $p = 0.496$ for HR measurement), our prototype oximeter will achieve comparable performance to a clinical oximeter. This pulse oximeter's

design allows for quick and simple calculation of SpO₂ for mobile healthcare.

CHAPTER 3

AIM AND SCOPE

3.1 AIM

- To supply the necessary oxygen supply to the patient by controlling flow meter valve based on the patient blood oxygen saturation level.
- Here SpO₂ sensor has been used to detect the blood oxygen saturation and heart rate.
- Therefore we introduce microcontroller based flow meter valve controller with the goal that aims to reducing the time and care-taker requirement to oxygenate the patient by providing controlled delivery.

3.2 SCOPE

- It is essential to oxygenate to the appropriate SpO₂ value to prevent hypoxemia.
- Maintaining blood oxygen saturation level is seldom necessary for the bedridden patients

CHAPTER 4

MATERIALS AND METHODS

4.1 METHODOLOGY

We proposed a sensor based oximetry and motor driver unit to control flow meter valve in this project. Here we use MAX30100 sensor, has optical sensor of red and IR LED combined with photodetector which measures the light absorbance of pulsing blood and are processed to calculate a blood oxygen saturation level. The measured signal (SpO_2) is sent to the ATmega328 microcontroller through an I2C interface. The received signal is displayed on the 16X2 LCD display and will further processed and sent to the motor driver for controlling the motor shaft right-left rotation, which will open and close the oxygen flow meter valve to provide the oxygen supply automatically.

4.1.1 Block Diagram of Blood Oxygen Saturation Measurement and Oxygen Supply Controller

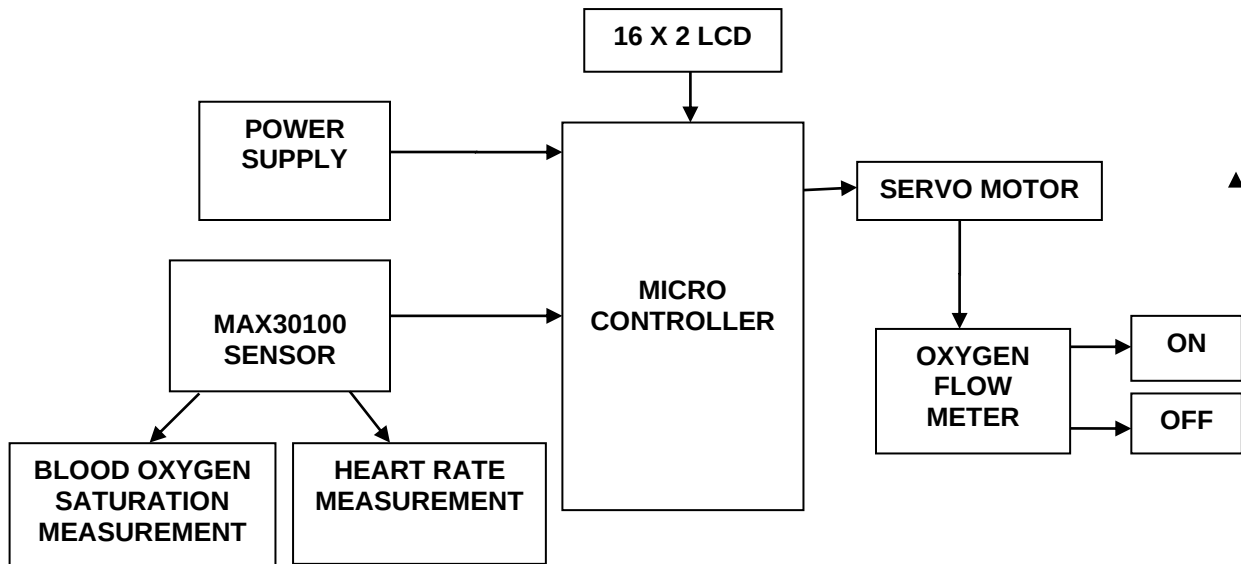


Fig: 4.1: Block Diagram of blood oxygen saturation measurement and Oxygen Supply Control

This project is to provide proper monitoring of the patient, we have developed a project in which the heart rate and the blood oxygen saturation levels are constantly measured using the MAX30100 sensor. These two parameters are displayed on a LCD display. When the blood oxygen saturation level of a patient becomes critical then the oxygen supply is opened to the patient and then when it becomes normal the oxygen supply is closed to the patient.

4.2 HARDWARE USED

4.2.1 Power Supply Module

The power supply circuit includes a step-down transformer that converts 230 volts to 12 volts. 4 diodes are used to form a bridge rectifier in this circuit, which delivers pulsating dc voltage and is then fed to a capacitor filter, which eliminates any A.C components present even after rectification. The filtered DC voltage is fed into the regulator, which produces a steady DC voltage of 12 volts. The needed power is 5V DC, so 17V AC power must first be converted to DC power before being stepped down to 5V DC. One of the power electronic converters known as a Rectifier will convert AC power to DC. Rectifiers come in a variety of shapes and sizes, including half-wave, full-wave, and bridge rectifiers. The bridge rectifier is commonly used for converting AC to DC because of its advantages over the half and full wave rectifiers.

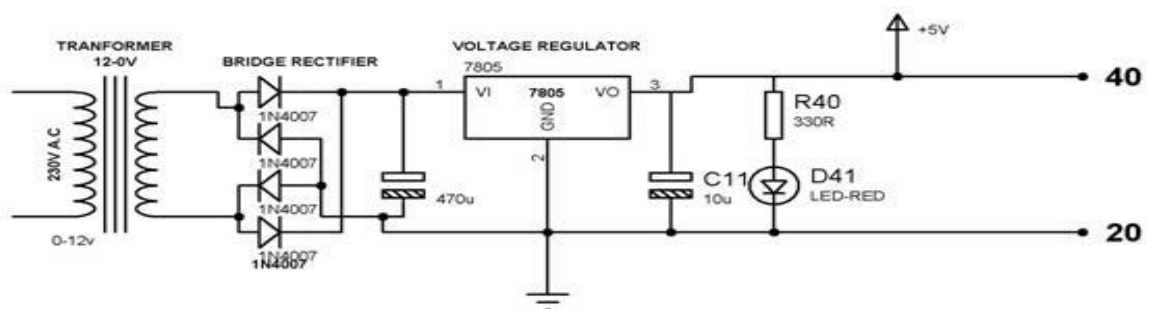


Fig: 4.2: Power Supply Module

4.2.2 Arduino Uno Kit

The Arduino Uno is a microcontroller board that is based on the ATmega328 microcontroller (datasheet). It has 14 digital input/output pins (six of which can be used as PWM outputs), six analogue inputs, a 16 MHz ceramic resonator, a USB connector, a power jack, an ICSP header, and a reset button. Its designs provide features that aid the microcontroller in any way possible. To use it, simply plug it into a device with a USB cable or power it with an AC-to-DC adapter or battery. It is available in two different versions: Arduino Uno and Genuino Uno, which may vary depending on the region.

Memory:

The ATmega328 has 32 KB of memory (with 0.5 KB used for the bootloader). There's also 2 KB of SRAM and 1 KB of EEPROM on board (which can be read and written with the EEPROM library). Output and Input Using the pin Mode (), digital Write (), and digital Read () modes, each of the Uno's 14 digital pins can be used as an input or output. They are powered by 5 volts. Each pin has a 20-50 ohm internal pull-up resistor (disconnected by default) and can provide or receive a maximum of 40 mA.

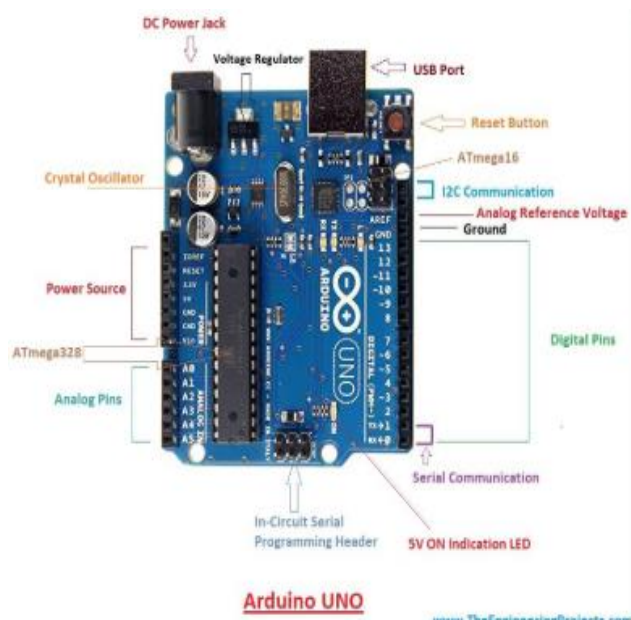


Fig: 4.3: Arduino Uno

4.2.3 Microcontroller Module

The ATmega-328 is a microcontroller based on the Advanced Virtual RISC (AVR) architecture. It can handle data of up to eight (8) bits. The ATmega-328 has 32KB of internal memory. There are a number of other features on this microcontroller. You can also read Introduction to PIC16F877a (a PIC Microcontroller) before comparing the two Microcontrollers' functions. Electrically Erasable Programmable Read Only Memory (EEPROM) is available on the ATmega 328 (EEPROM). This property indicates that even if the microcontroller's electric supply is disconnected, it can still store data and produce results after being reconnected to the power supply. Furthermore, the ATmega-328 has a 2KB Static Random Access Memory (SRAM) (SRAM). Other attributes will be discussed at a later time. The AT mega 328 has a variety of features that make it the most common computer on the market today. Advanced RISC architecture, good performance, low power consumption, real timer counter with separate oscillator, 6 PWM pins, programmable Serial USART, programming lock for software protection, throughput up to 20 MIPS, and so on are some of the features. The ATmega-328 is the most widely used microcontroller in Arduino. Even if the microcontroller is removed, it can still store data and produce results after being supplied with power. Furthermore, the ATmega-328 has a 2KB Static Random Access Memory (SRAM). Other attributes will be discussed at a later time. The ATmega 328 has a variety of features that make it the most common computer on the market today. Advanced RISC architecture, good performance, low power consumption, real timer counter with separate oscillator, 6 PVM pins, programmable Serial USART, programming lock for software protection, throughput up to 20 MIPS, and so on are some of the features. The ATmega-328 is the most widely used microcontroller in Arduino.

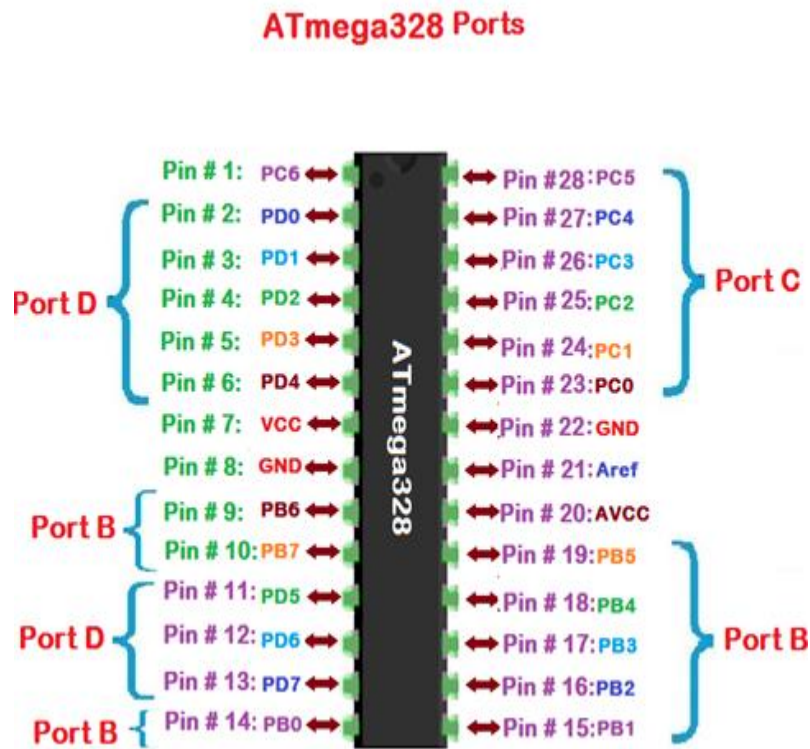


Fig: 4.4: Microcontroller Module

4.2.4 MAX30100 Sensor

MAX30100 is a sensor that integrates a pulse oximeter and a heart rate monitor. It's an optical sensor that detects the absorbance of pulsing blood through a photodetector after emitting two wavelengths of light from two LEDs – a red and an infrared one. This particular LED color combination is designed to allow data to be read with the tip of one's finger. The digital output data is stored in a 16-deep FIFO within the system, and it is completely configurable via software registers. It interacts with a host microcontroller via an I2C digital interface. Ambient light cancellation (ALC), 16-bit sigma delta ADC, and proprietary discrete time filter cover the pulse oximetry subsystem in the MAX30100. It operated at ultra-low voltage, making it more suitable for battery-powered systems. The MAX30100 requires a power supply that is between 1.8 and 3.3 volts. Wearable devices, fitness assistant devices, medical monitoring devices, and other devices will all benefit from it. The MAX30100 utilizes 1.8V and

3.3V power supplies, and it can be powered down by software with little standby current, enabling the power supply to remain connected at all times.



Fig: 4.5: MAX30100 Sensor

4.2.5 16 X 2 LCD Display

They share the same basic technologies, with the exception that random images are made up of a large number of tiny pixels, while other displays have larger components. Depending on the polarizer arrangement, LCDs may be turned on (positive) or off (negative). A character positive LCD with a backlight, for example, will have black lettering on a backlight-colored background, whereas a character negative LCD will have a black background with letters that are the same color as the backlight. Optical filters are used to give white and blue LCDs their distinctive look. When an electrical current is applied to a liquid crystal molecule, it tends to untwist. This is the principle behind LCDs. This creates a difference in the angle of light passing through the polarized glass molecule, as well as a change in the angle of the top polarizing filter. As a result, a small amount of light will pass through the polarized glass and into a specific region of the LCD. As a result, the particular region will become darker than the rest. The LCD operates on the concept of light blocking. A mirrored mirror is arranged at the back of the LCDs as they are being built. A polarized glass with a polarizing film is applied to the bottom of the unit, and an electrode plane

made of indium-tin oxide is kept on top. A common electrode must enclose the entire LCD field, and liquid crystal matter must be placed above it.

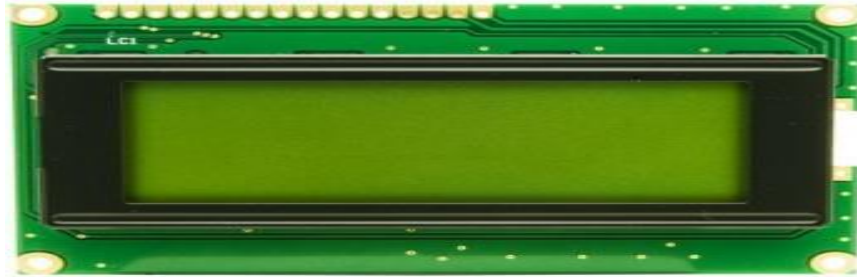


Fig: 4.6: 16 X 2 LCD Display

4.2.6 Servo Motor

A servomotor is a closed-loop servomechanism that controls its motion and final position using position feedback. The location commanded for the output shaft is represented by a signal (analogue or digital) that is fed into the power. To provide position and speed feedback, the motor is connected to a position encoder. Only the position is calculated in the most specific case. The calculated output position is compared to the command position, which is the controller's external input. If the output position is different from what is expected, an error signal is produced, causing the motor to rotate in either direction to move the output shaft to the correct position. The error signal decreases as when the positions reach zero, and the motor stops. The simplest servomotors use a potentiometer to position sensing and bang-bang motor control; the motor typically rotates at full speed (or is stopped). Although this type of servomotor is not generally used in industrial motion control, it is the framework for the relatively inexpensive servos used in radio-controlled models. The speed of the output shaft is determined via optical rotary encoders, and the motor speed is controlled by a variable-speed drive in more specialized servomotors.



Fig: 4.7: Servo Motor

4.2.7 Oxygen Flow Meter

Oxygen flow meters are primarily used to monitor oxygen flow and humidification. Its accuracy and reliability would have a direct effect on the patient's personal safety. It can not only reliably calculate the instantaneous flow of oxygen, but it can also keep healthcare staff informed about the state of a patient's oxygen absorption. The use of an oxygen flow meter has expanded to all levels of medical facilities, including township hospitals.



Fig: 4.8: Oxygen Flow Meter

4.3 SOFTWARE USED

4.3.1 Visual Studio

Microsoft Visual Studio is used as an IDE in this project.

Visual Studio Code incorporates the ease of use of a source code editor with advanced developer features such as IntelliSense code completion and debugging.

It is, first and foremost, an editor who stays out of your way. Visual Studio Code is available for macOS, Linux, and Windows, so you can get started right away. Visual Studio Code's core feature is a lightning-fast source code editor that's ideal for day-to-day use. Syntax highlighting, bracket-matching, auto-indentation, box-selection, snippets, and more are all available in VS Code, which supports hundreds of languages. You can navigate your code with ease thanks to intuitive keyboard shortcuts, simple customization, and community-contributed keyboard shortcut mappings. When it comes to serious coding, you'll also benefit from resources that understand more code than just blocks of text.

IntelliSense code completion, rich semantic code comprehension and navigation, and code refactoring are all integrated into Visual Studio Code. When the coding becomes difficult, the tough turn to debugging. We made it happen because debugging is always the one element that developers lack the most in a leaner coding experience. You can walk through source code, inspect variables, view call stacks, and run commands in the console with Visual Studio Code's interactive debugger.

VS Code also integrates with build and scripting software to help you complete basic tasks faster. With Git support in VS Code, you can deal with source control without having to leave the editor, including displaying pending changes diffs. Customize every feature to your taste and add as many third-party plugins as you like. Although most scenarios work right out of the box, VS Code develops with you, and we allow you to customize your experience to fit your particular needs. VS Code comes with

enhanced built-in support for Node.js development, including JavaScript and TypeScript, and is powered by the same underlying technologies as Visual Studio.

Web technologies such as JSX/React, HTML, CSS, SCSS, Less, and JSON are all well-represented in VS Code.

Visual Studio Code incorporates the best of internet, native, and language-specific technology in its architecture. VS Code uses Electron to combine web technologies like JavaScript and Node.js with native app speed and versatility. VS Code makes use of a newer, faster version of the same industrial-strength HTML-based editor that powers the “Monaco” cloud editor, Internet Explorer's F12 Tools, and a variety of other projects. VS Code also uses a tools service architecture that allows it to integrate with many of the same technologies that power Visual Studio, such as Roslyn for.NET, TypeScript, the Visual Studio debugging engine, and others.

A public extensibility model in Visual Studio Code enables developers to create and use extensions, as well as customize their edit-build-debug experience.

4.3.2 Arduino

The Arduino software is used in this project. Beginners will find the Arduino programme simple to use, but experienced users will find it versatile. It's compatible with Mac, Windows, and Linux. It is used by teachers and students to create low-cost science instruments, to demonstrate chemistry and physics concepts, and to begin learning programming and robotics. Designers and developers create immersive prototypes, while musicians and artists use it to create installations and try out new instruments. Makers, for example, use it to create many of the projects on display at the Maker Faire. Arduino is a valuable platform for learning new skills. Anyone - children, hobbyists, artists, programmers - can get started tinkering by following the step-by-step instructions in a kit or sharing ideas with other Arduino members online. For physical computing, there are a range of

other microcontrollers and microcontroller platforms to choose from. Similar features can be found in Parallax Basic Stamp, Netmedia's BX-24, Phidgets, MIT's Handy board, and many other programmes. Inexpensive - Arduino boards are relatively inexpensive compared to other microcontroller platforms. The least expensive version of the Arduino module can be assembled by hand, and even the pre-assembled Arduino modules cost less than \$50. Both of these programmes condense the complicated aspects of microcontroller programming into an easy-to-use bundle. While Arduino simplifies the process of working with microcontrollers, it has some advantages over other systems for teachers, students, and interested amateurs.

- Cross-platform – The Arduino Program (IDE) is compatible with Windows, Macintosh OSX, and Linux. The majority of microcontroller systems are only compatible with Windows.
- Easy-to-use programming environment - The Arduino Software (IDE) is simple to use for beginners while still being versatile enough for advanced users. It's based on the Processing programming environment, which is convenient for teachers since students learning to programme in that environment would be familiar with how the Arduino IDE works.
- Open source and extensible software - The Arduino software is available as open source tools that professional programmers can extend. People who want to learn more about the language should use C++ libraries, and those who want to learn more about the technical specifics should move from Arduino to the AVR C programming language. Similarly, if you want to, you can use AVR-C code directly in your Arduino programmes.
- Open source and extensible hardware - The Arduino boards' plans are made available under a Creative Commons license, enabling professional circuit designers to build their own version of the module, expanding and enhancing it. The breadboard version of the module can be built by even beginner users to learn how it works and save money.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 RESULTS

In this project, we are using arduino software to detect whether the blood oxygen saturation level is normal or critical and to control the oxygen flow meter valve by using a servo motor to deliver necessary oxygen supply to the patient. The measured parameters are displayed on LCD display.

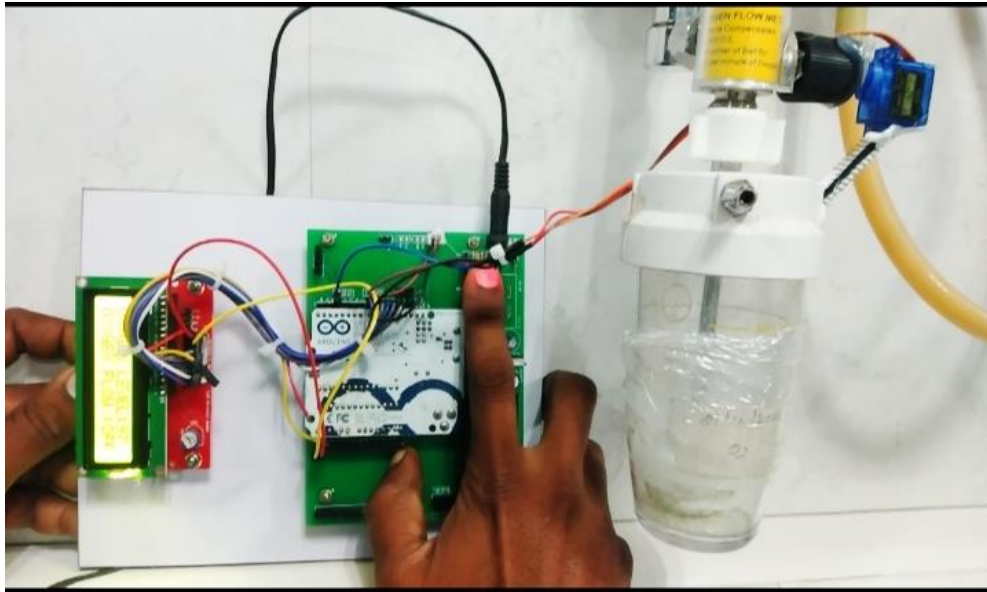


Fig: 5.1: Hardware Set Up Of Blood Oxygen Saturation Measurement and Oxygen Supply Control

The above fig 5.1 is the captured image of working prototype of blood oxygen saturation measurement and automated control of oxygen supply based on oxygen saturation level.

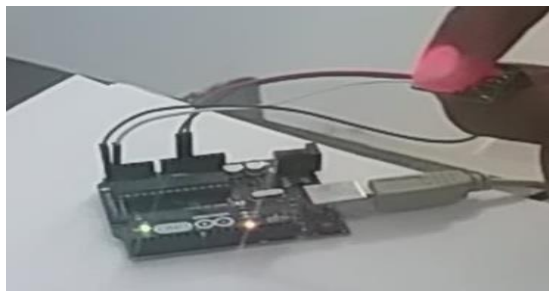


Fig: 5.2: Blood Oxygen Saturation Measurement

The above fig 5.2 represents the patient finger placed on the MAX30100 sensor for blood oxygen saturation measurement.



Fig: 5.3: Blood Oxygen Level Predicted As Normal

The above fig 5.3 represents the measured oxygen saturation level as normal (Oxygen Level: 97%) and status of oxygen supply control (Oxygen Flow: OFF).



Fig: 5.4: Blood Oxygen Level Predicted As Abnormal

The above fig 5.4 represents the measured oxygen saturation level as abnormal (Oxygen Level: 93%) and status of oxygen supply control (Oxygen Flow: ON).



Fig: 5.5: Oxygen Supply Control Set Up

The above fig 5.5 represents the oxygen flow meter interfaced with motor to control the flow meter valve to deliver oxygen supply based on the blood oxygen saturation detection.

5.2 DISCUSSION

A development in electronics and sensors technology yields several advantages for biomedical applications. This section provides about a review of applications of ambient sensors and systems used in this project. There may be a chance to Hyperoxia associated with increased mortality of simple manual flow meter ventilated patients achieving normoxia after admission. This suggests that Hyperoxia in the post-intubation period could be injurious. Furthermore mechanical ventilation devices are very expensive. The manual flow meter using simple oxygen support is not enough for hypoxia control. This application eliminates both drawbacks. This project is mainly to provide oxygen according to target saturation rates, and to monitor the saturation rate to keep it within target range. The target range for a normal adult is 95% to 98%. After the successful implementation and testing of coding the output was achieved.

CHAPTER 6

SUMMARY AND CONCLUSION

6.1 SUMMARY

In this project, pulse oximetry was once designed and developed. A small prototype which acquires with a sensor, positioned on the patient finger, the blood oxygen saturation level and heart rate. The literature review enabled an appropriate method of selection for the sensor utilized in order to achieve SpO₂ signal recognition for controlling the flow meter valve.

The MAX30100 sensor used in this project has the capability of monitoring real time blood oxygen saturation level of the patient and obtaining reliable data output. The filtered data has been used to control the flow meter valve and the output signal will be displayed on the LCD display.

6.2 CONCLUSION

This project proposes an oxygen control setup to develop as a consumer electronics product with low computational cost and high accuracy outcomes for automatically monitoring and recognizing the critical parameters of bedridden patients. Moreover, this system can be utilized for all patients monitoring and is also very promising for real-time applications because of the fast processing time. It is useful for diseased bedridden patients. The application to effectively implemented in this project can be further developed to use as a product in real time it can be further analyzed for higher accuracy. Thus, by implementing this in real time will help all the diseased bedridden patients to effectively monitor the oxygen supply to them.

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APENDICES

```
#include <Wire.h>
#include "MAX30100_PulseOximeter.h"
#include <LiquidCrystal.h>
LiquidCrystallcd(13, 12, 11, 10, 9, 8);
#define REPORTING_PERIOD_MS 1000
PulseOximeter pox;
uint32_t tsLastReport = 0;
unsigned int heart=0, oxidation=0;
int flag=0,timer=0;
constintinterruptPin = 2;
constintsolenoid_valve = 7; // Connect your button to pin #13
volatile unsigned int Pulse_State_1 = 0; //,Pulse_State_2=0;
volatile unsigned long int Consumption_Pulse_Count_1 = 0,
Live_Usage_Count_1 = 0;
volatile float Pulse_Count_1 = 0; //,Pulse_Count_2=0;
volatile float Count_For_LPM = 2.84;
volatile float Count_Per_Liter = 170;
volatile float Live_Flow_1 = 0;
volatile double Consumption_1 = 0,cost=0;
volatile unsigned int Consumption_1_convert_int = 0, cost_convert_int = 0,
con_convert = 0;
volatile unsigned int read_Consumption_1 = 0, read_cost_1 = 0;
volatile int write_Consumption_1_1 = 0, write_Consumption_1_2 = 0,
write_cost_1_1 = 0,
write_cost_1_2 = 0;
volatile int read_Consumption_1_1 = 0, read_Consumption_1_2 = 0,
read_cost_1_1 = 0,
read_cost_1_2 = 0, read_date = 0;
volatile unsigned intLive_Flow_Timer = 0, Consumption_Timer = 0,
Live_Usage_Timer = 0,
Write_Date_Timer = 0;
```

```

volatile intLeakage_Timer = 0, No_Flow_Timer = 0, Open_Tap_Timer = 0,
water_flow = 0,
Leakage_detected = 0, Open_Tap_detected = 0, No_Flow_detected = 0;
volatile int Valid_Live_Flow_Flag_1 = 0, Valid_Live_Usage_Flow_Flag_1 = 0;
volatile intlpm_int=0;
volatile unsigned intcon_int=0;
char oxi[10];
void onBeatDetected()
{
//  Serial.println ("Beat!");
}
void setup ()
{
Serial.begin (9600);
Serial.print("Initializing pulse oximeter.");
// Initialize the PulseOximeter instance
// Failures are generally due to an improper I2C wiring, missing power supply
// or wrong target chip
If (!pox.begin()) {
Serial.println("FAILED");
for(;;);
} else {
Serial.println("SUCCESS");
}
pox.setIRLedCurrent(MAX30100_LED_CURR_7_6MA);
// Register a callback for the beat detection
pox.setOnBeatDetectedCallback(onBeatDetected);
lcd.begin(16, 2);
delay(1000);
lcd.setCursor(0, 0);
lcd.print(" OXYGEN FLOW ");
lcd.setCursor(0, 1);
lcd.print(" CONTROL SYSTEM ");

```

```

delay(1000);
lcd.setCursor(0, 0);
lcd.print("");
lcd.setCursor(0, 1);
lcd.print("");
lcd.setCursor(0, 0);
lcd.print("OXYGEN LEVEL:");
lcd.setCursor(0, 1);
lcd.print("OXYGEN FLOW :");
pinMode(interruptPin, INPUT_PULLUP);
lcd.setCursor(13, 0);
lcd.print("90 ");
delay(100);
pinMode(solenoid_valve, OUTPUT);
delay(100);
attachInterrupt(digitalPinToInterrupt(interruptPin), interrupt, RISING);
TCCR1A = 0;// set entire TCCR1A register to 0
TCCR1B = 0;// same for TCCR1B
TCNT1 = 0;//initialize counter value to 0
// set compare match register for 1hz increments
OCR1A = 1562;// = (16*10^6) / (1*1024) - 1 (must be <65536)//100ms
timer(15624 for 1
second)
// turn on CTC mode
TCCR1B |= (1 << WGM12);
// Set CS10 and CS12 bits for 1024 prescaler
TCCR1B |= (1 << CS12) | (1 << CS10);
// enable timer compare interrupt
TIMSK1 |= (1 << OCIE1A);
sei();//allow interrupts
}
void loop()
{

```

```

// Make sure to call update as fast as possible
pox.update();
if (millis() - tsLastReport > REPORTING_PERIOD_MS) {
    // Serial.print("Heart rate:");
    // Serial.print(pox.getHeartRate());
    Serial.print("bpm / SpO2:");
    oxidation = pox.getSpO2();
    // Serial.print(oxidation);
    // Serial.println("%");
    tsLastReport = millis();
}
// itoa(oxidation,oxi,2);
// lcd.setCursor(13, 0);
// lcd.print(oxi);
timer++;
if(timer >= 10)
{
    timer = 0;
    if (oxidation >= 80)
    {
        flag = 0;
    }
    else if (oxidation < 79)
    {
        flag = 1;
    }
}
if((flag == 0))
{
    digitalWrite(solenoid_valve, LOW);
    Serial.println("Normal oxidation detected");
    lcd.setCursor(13, 1);
    lcd.print("OFF ");
}

```

```

delay(2000);
}

    else if((flag == 1))
{
digitalWrite (solenoid_valve, HIGH);
Serial.println("Abormaloxdiation detected");
Serial.println("Switch on the oxidation supply");
lcd.setCursor(13, 0);
lcd.print("0 ");
lcd.setCursor(13, 1);
lcd.print("ON ");
delay(5000);
}
}
ISR(TIMER1_COMPA_vect)
{
Live_Flow_Timer++;
if (Live_Flow_Timer>= 1)
{
Live_Flow_Timer = 0;
Live_Flow_1 = (float)(Pulse_Count_1 / Count_For_LPM);
Pulse_Count_1 = 0;
if (Live_Flow_1 > 0)
{
Valid_Live_Usage_Flow_Flag_1 = 1;
}
// lcd.setCursor(1, 14);
// lcd.print(Live_Flow_1);
}
}
void interrupt()
{
if (Pulse_State_1 == 0)

```

```
{  
  Pulse_State_1 = 1;  
  Pulse_Count_1 += 1;  
  Consumption_Pulse_Count_1++;  
}  
else  
  Pulse_State_1 = 0;  
}
```