Ain Shams University
Faculty of Computer and Information Sciences
BIOINFORMATICS PROGRAM

Mobile Ventilator

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Acknowledgement

All praise and thanks to ALLAH, who provided us the ability to complete our work. We would like to express our thanks to our supervisor **Tamer Mostafa Abdelkader**

While we were preparing this project, various information that we found helped us and we are glad that we were able to complete this project and understand many things. The preparation of our project was an immense learning experience, and we inculcated many personal qualities during this process like responsibility, punctuality, confidence, and others.

Finally, we express our sincere gratitude to our parents and families who have always been so helpful and supportive throughout the school years, sharing all our joys, sorrows, fatigues, and everything.

Hopefully, we can give them back even a small part of it.

Abstract

Mechanical ventilators are machines that act as bellows to move air in and out of your lungs. Your respiratory therapist and doctor set the ventilator to control how often it pushes air into your lungs and how much air you get. You may be fitted with a mask to get air from the ventilator into your lungs.

- Ventilation: Exchange of air between the lungs and the air (ambient or delivered by a ventilator), in other words, it is the process of moving air in and out of the lungs. Its most important effect is the removal of carbon dioxide (CO2) from the body, not on increasing blood oxygen content. Ventilation is measured as minute ventilation in the clinical setting, and it is calculated as respiratory rate (RR) times tidal volume (Vt). In a mechanically ventilated patient, the CO2 content of the blood can be modified by changing the tidal volume or the respiratory rate.
- Oxygenation: Interventions that provide greater oxygen supply to the lungs, thus the circulation. In a mechanically ventilated patient, this can be achieved by increasing the fraction of inspired oxygen (FiO 2%) or the positive end-expiratory pressure (PEEP).
- PEEP: The positive pressure that will remain in the airways at the end of the respiratory cycle (end of exhalation) is greater than the atmospheric pressure in mechanically ventilated patients. For a full description of the use of PEEP, please review the article titled “Positive End-Expiratory Pressure (PEEP).”
- Tidal volume: Volume of air moved in and outside the lungs in each respiratory cycle.

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List of Figures

Note: Always number your figures and include a caption under each one.

List of Abbreviations

Abbreviation	Stands For
BVM	A bag valve mask
DC	Direct Current
SpO2	Oxygen saturation
AC	Alternating Current
OXI	Oxygen percentage
TEMP	Temperature
BPM	Heart rate (beats per minute)

Chapter 1
Introduction

1.1 Motivation

Anew corona viral /COVID-19 is an epidemic started in December 2019 in China and expanded to all worlds so still now. It caused an acute respiratory syndrome in humans and many syndromes in blood, lung, gastrointestinal and senses . On the 8th of August 2020, the number of COVID-19 deaths in the world, according to (worldometers.2020) were 728,533 cases and the number of COVID-19 confirmed cases was 19,783,575. Many reasons were caused expanded the COVID-19. The opening the flying between country specially from China to other country, don't take procedures about safe from many counties, and refrain from wearing a mask (ICNARC ,2020). Symptoms of COVID 19 are developers and forked, may appear in two to 14 days after exposure. This time is called the incubation period. Public signs and symptoms can involve, fever, tiredness, cough, and lose a taste or smell or them. Other signs can include muscle aches, chest pain, sore throat, runny nose, headache, nausea, vomiting and diarrhea, and, rash. The severity of COVID-19 symptoms can range from very mild to severe. People who are older have a higher risk of dangerous illness from COVID-19, and the risk increases with age and chronic diseases. Like, heart failure, coronary artery disease, cancer, chronic obstructive pulmonary disease , weakened immune system , type 2 diabetes ,and chronic kidney disease.(Alfredo al., 2020 &De lusignan,2020). No therapy is recommended to treat COVID-19. The U.S. National Institutes of Health lately recommended the corticosteroid dexamethasone for people with sharp COVID-19 who require supplemental oxygen or mechanical

ventilation. The FDA has granted emergency use license for the antiviral drug Remdesivir to treat severe COVID-19 (FDA, 2020). Recently, many drug companies discovered the Vaccine of COVID-19. The number of specific doctors did not enough to cure the huge numbers of patents especially, with epidemic Corona. Most common symptoms of COVID-19 included fever if their temperature registers 100.4°F (38°C) or higher; Shortness of breath, Cough, Headache, Body aches, Weakness, Chills, and initial systolic blood pressure was significantly high, although diastolic blood pressure significantly decreases in severity cases compared to mild COVID-19 cases. (Huang, et al, 2020) & (Zhang et al,2020) & (Verma S, et al.,2021).

There are many lung diseases affecting the air way sand and various diseases similar the covid-19 in symptom. Pneumonia means lung inflammation. There are many reasons caused pneumonia can be caused by several infectious agents' bacteria, viruses, or fungi. When a person has pneumonia, the alveoli are loaded with fluid and pus, which makes breathing painful and limits oxygen intake (Li et al. 2020). Pneumonia is the largest infectious cause of death in adults and children. Approximately, claiming the lives of 2.5 million, including 672,000 children, in 2019. (WHO,2020). The infection of Gram-negative bacteria is the principal cause of acute lung injury (Huang et al. 2021). Although, it is generally believed that cold stimulation is related to the susceptibility of respiratory system infection, and cold stimulation (Joo et al. 2016). However, especially in seasons with large temperature differences, the probabilities of respiratory diseases are directly and significantly increased, especially for children and the elderly with weak immunity in the cold environment of real life (Shakoor et al. 2021). Frequent and intensive changes in temperature and environment can lead to respiratory diseases such as the common cold and pneumonia. In a cold environment, the incidence of

pneumonia increased significantly (Chen et al. 2019&Qian et al. 2021). Asthma is a long-term disease of the lungs. It causes your airways to get inflamed and narrow, and it makes it hard to breathe. Severe asthma can cause trouble talking or being active. You might hear your doctor call it a chronic respiratory disease. Some people refer to asthma as "bronchial asthma." Asthma is a serious disease that affects about 25 million Americans and causes nearly 1.6 million emergency room visits every year. With treatment, you can live well. Without it, you might have to go to the ER often or stay at the hospital, which can affect your daily life. The doctor will start with a physical exam and ask about your symptoms and medical history.

You'll have tests to see how well your lungs work, which may include:Spirometry. This simple breathing test measures how much air you blow out and how fast.

Peak flow. These measure how well your lungs push out air. They're less exact than spirometry, but they can be a good way to test your lungs at home, even before you feel any symptoms. A peak flow meter can help you figure out what makes your asthma worse, whether your treatment is working, and when you need emergency care.

Methacholine challenge. This and similar tests involve using triggers or challenges. Adults are more likely to have this test than children. You might get it if your symptoms and spirometry test don't clearly show asthma. During this test, you inhale a chemical called methacholine before and after spirometry to see if it makes your airways narrow. If your results fall at least 20%, it is possible that you have asthma. Your doctor will give you medicine at the end of the test to reverse the effects of the methacholine. Our project is focusing into three diseases Covid19

, Pneumonia, and Asthma .They have many different in symptom like oxygen levels, body temperature and blood pressure (FDA, 2020)& (WHO,2020.

1.2 Problem Definition

Most of ages including fetus, baby, adult, aged suffer from breathlessness.
Some fetus after pregnancy has lung deformation.
Some babies suffering from hereditary diseases such as pneumonia which is shrinking of alveoli volume (adult and aged may have pneumonia).
Some adult suffering from the very bad habit which is smoking we trying to recuperate those people.
Some aged people suffering from Asthma which is one of the long-term diseases which cause wheezing and chest tightness, it also may be a hereditary disease.
All these kinds of people suffer a lot and needs ventilation process.
There are many lung diseases affecting the airways and various diseases similar the covid-19 in symptom, Pneumonia, and Asthma. The number of specific doctors did not enough to cure the huge numbers of patents especially, with epidemic Corona

1.3 Objective

Ventilator is an Oxi-mechanical device for lung diseases used to recuperate people who suffer from breathlessness we have choose some of these diseases as a template in our database which are (Asthma, pneumonia, and Covid-19)

1. Build software that assists doctor in classification of disease
2. Give the patient the suitable ventilation amount
3. Help patients to find the diagnosis and breathe oxygen
4. Decreased the cost of medical service
5. Build software that assists doctor without hospital

1.4 Document Organization

- **Chapter 2 (Background):**

In this chapter, we define the project field, its scientific background, and other existing similar systems in this field.

- **Chapter 3 (System Analysis and Design):**

This chapter describes the functional requirements, users of this system, and all system analysis diagrams and the specifications of each one.

- **Chapter 4 (Implementation):**

This chapter describes in detail the algorithms and the techniques that we used to implement this Project.

- **Chapter 5 (User Manual):**

This chapter contains full instructions and advice on how to use the Web Application.

- **Chapter 6 (Conclusions and Future Work):**

This chapter contains our conclusion after the implementation of this project and what we have reached, furthermore at the end we tell you about our future vision for this project.

- **References:** The Papers, books, and links used in the implementation.

Chapter 2

Background

Introduction

What is a mechanical ventilator?

A mechanical ventilator is a machine that helps a patient breathe (ventilate) when they are having surgery or cannot breathe on their own due to a critical illness. The patient is connected to the ventilator with a face mask or hollow tube (artificial airway) that goes in their mouth and down into their main airway or trachea. They remain on the ventilator until they improve enough to breathe on their own.

The machine makes sure that the body receives adequate oxygen, and that carbon dioxide is removed. This is necessary when certain illnesses

prevent normal breathing.
What are the benefits of mechanical ventilation?
The main benefits of mechanical ventilation are the following:
• The patient does not have to work as hard to breathe – their respiratory muscles rest.
• The patient's as allowed time to recover in hopes that breathing becomes normal again.
• Helps the patient get adequate oxygen and clears carbon dioxide.
• Preserves a stable airway and preventing injury from aspiration.
It is important to note that mechanical ventilation does not heal the patient. Rather, it allows the patient a chance to be stable while the medications and treatments help them to recover.

What is disease that is treated by ventilator?
1) Pneumonia
2) Asthma
3) Covid-19
What is pneumonia?
Pneumonia is swelling (inflammation) of the tissue in one or both lungs. It's usually caused by a bacterial infection. It can also be caused by a virus, such as coronavirus (COVID-19).
Symptoms of pneumonia
• rapid heartbeat
• high temperature
• feeling generally unwell
• sweating and shivering
• loss of appetite
• Decrease Oxygen Level
Pneumonia Person Temperature
1) Child 38.5 or slightly higher Celsius

2) Adult 40 to 40.5 Celsius
3) Old Age 40 to 41 Celsius
Pneumonia Person Heart Rate
1) Child More than 150 BPM
2) Adult More than 150 BPM
3) Old Age More than 150 BPM
Pneumonia Person Oxygen Percentage
1) Child 90% to 95% SPo2
2) Adult 90% or Lower SPo2

3) Old Age 90% or Lower SPo2

What is Asthma?

Asthma is a condition in which your airways narrow and swell and may produce extra mucus. This can make breathing difficult and trigger coughing, a whistling sound (wheezing) when you breathe out and shortness of breath.

Symptoms of Asthma

• Shortness of breath
• Chest tightness or pain
• rapid heartbeat
• High Temperature
• Decreases oxygen level
• Asthma Person Temperature
• 1)Child 20 to 21.6 Celsius
• 2)Adult 20 to 21.6 Celsius
• 3)Old Age 20 to 21.6 Celsius
• Asthma Person Heart Rate
• 1)Child 69 to 94 BPM
• 2)Adult 120 to 150 BPM
• 3)Old Age 120 to 150 BPM
• Asthma Person Oxygen Percentage
• 1)Child 97% or Higher SPo2
• 2)Adult 95% or Higher SPo2
• 3)Old Age 90% or Lower SPo2

What is Covid-19?

Coronavirus disease 2019 (COVID-19), the highly contagious infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has had a catastrophic effect on the world's demographics resulting in more than 2.9 million deaths worldwide, emerging as the most consequential global health crisis since the era of the influenza pandemic of 1918.

Symptoms of Covid-19

• Shortness of breath
• Chest tightness or pain
• rapid heartbeat
• High Temperature
• Decreases oxygen level

Covid-19 Person Temperature

Credit Hours New Programs
1)Child 39 or Higher Celsius
2)Adult 37.8 or Higher Celsius
3)Old Age 37.8 or Higher Celsius
Covid-19 Person Heart Rate
1)Child More than 100 BPM
2)Adult More than 100 BPM
3)Old Age More than 100 BPM
Covid-19 Person Oxygen Percentage
1)Child 92% or Lower SPo2
2)Adult 92% or Lower SPo2
3)Old Age 92% or Lower SPo2

Normal Person Temperature (Celsius) Heart Rate (BPM) and
Oxygen Level (SPo2)
Normal Person Temperature
4) Child 36.2 to 36.8 Celsius
5) Adult 36.1 to 37.2 Celsius
6) Old Age 36.1 to 37.2 Celsius
Normal Person Heart Rate
4) Child 100 to 150 BPM
5) Adult 60 to 100 BPM
6) Old Age 60 to 100 BPM
Normal Person Oxygen Percentage
4) Child 97% to 99% SPo2
5) Adult 95% or higher SPo2
6) Old Age 95% or higher SPo2
Normal Tidal Volume that person need in Ventilation
1) Child 4 to 6 ml/kg
2) Adult 6 to 8 ml/kg
3) Old Age 6 to 8 ml/kg

Motivation

The main aim
We choose mobile ventilator because of many reasons as we saw many people suffer from breathlessness and other diseases that make them to go for supervision under consultation of doctors to get recuperated using

hospital ventilator so, we decided to combine a mini-ventilator with minimal cost and mobility ease as it can be in mainly two places (emergency or home) beside other places but not like intensive care in hospital as they uses advanced and costive technology for ventilation processes.

The achievement aims

we will mainly use hardware component (microprocessor and some sensors) with computer interface program (mobile app or desktop app) and wireless local access network chip we chooses mobile app to pursuit patient situation remotely and by storing data we can send it to the doctor, we providing some option to the end user by using oximeter he/she will choose the option that works with case under this situation . and in we will fix some of the most effective errors of the previous ventilator one of these problems is:- the uncontrol of mechanical process of ventilation that causes lung alveoli rupture using modern mask with two valves controlled with sensor and metallic plates with 2ml thickness

Objective

1. Production of Mechanical Ventilator that is high efficiency and cost effective
2. Integrated Ventilator that measures the human Heart Rate (BPM), Temperature (Celsius) and Oxygen Percentage in blood (Spo2)
3. Help doctor to diagnose the disease of patient
4. Using Data analysis Techniques to Analyze the Data and predict the disease
5. Ventilator Data displayed through mobile application that doctor can check it anytime and any where to help him to take decisions

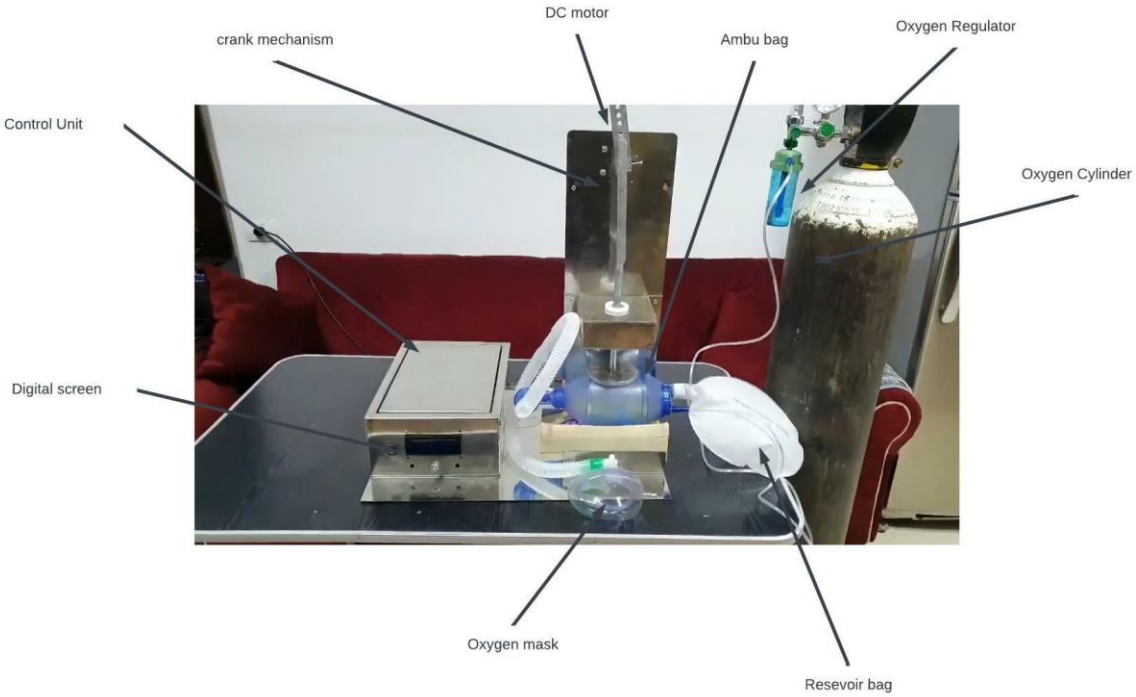
Work Plan

1 research about the project (2 week)
2 Embedded system (1 months)
3 Mechanical design and stimulation (3 months)
4 Studying Android studio (3 week)
5 Android stimulation (2 months)
6 study sdk tool with embedded systems (2 months)
7 integrates the whole system (1 week)

References
1. https://pubmed.ncbi.nlm.nih.gov/16934168/
2. https://www.nhs.uk/conditions/pneumonia/
3. https://my.clevelandclinic.org/health/articles/15368-mechanical-ventilation
4. https://www.mayoclinic.org/diseases-conditions/asthma/symptoms-causes/syc20369653
5. https://www.ncbi.nlm.nih.gov/books/NBK554776/

Chapter 3
Analysis and Design

3.1 System Overview



Automatic detection and classification of ventilation problem and play a crucial role in assisting doctor with an accurate diagnosis.

Ventilator is an Oxi-mechanical device for lung diseases used to recuperate people who suffer from breathlessness we have choose some of these diseases as a template in our database which are (Asthma, pneumonia, and Covid-19)

3.1.1 System Architecture

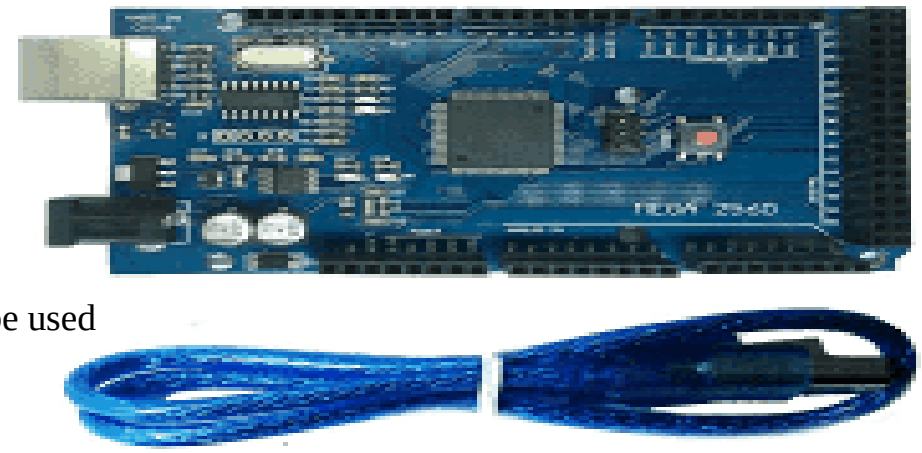
- Power supply
- Arduino Mega
- Motor Driver
- Dc Motor (can be replaced later by stepper motor) (challenge)
- Heartbeat Sensor
- Temperature sensor
- Oxygen sensor
- LCD Screen
- Ambo bag
- Tidal Volume control (plates) (challenge)
- DHT11

Power supply

A power supply is an electronic circuit that converts the voltage of an alternating current (AC) into a direct current (DC) voltage

Arduino Mega

- The Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs

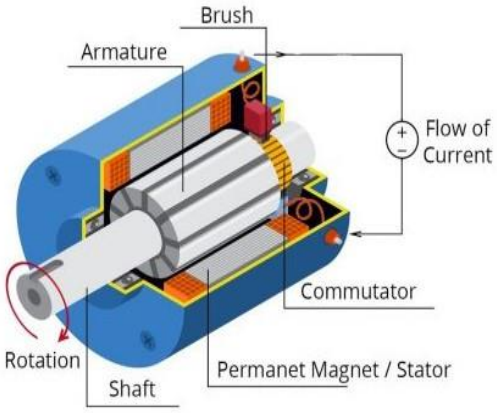


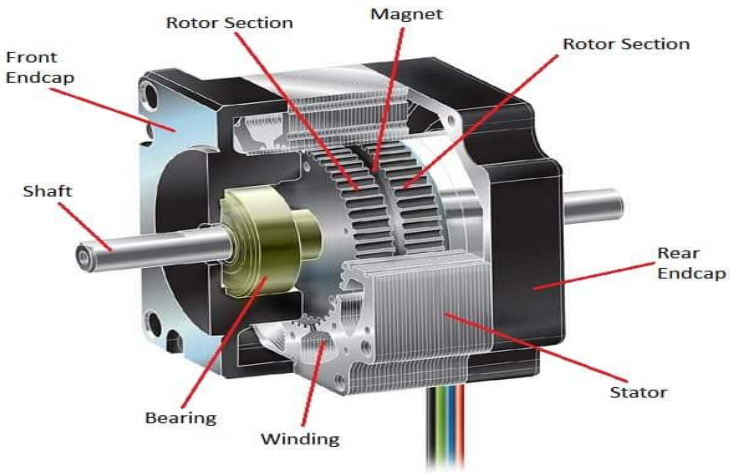
Motor Driver

Motor drivers acts as an interface between the motors and the control circuits. Motor requires high amount of current whereas the controller circuit works on low current signals. So, the function of motor drivers is to take a low-current control signal and then turn it into a higher-current signal that can drive a motor.

Motor

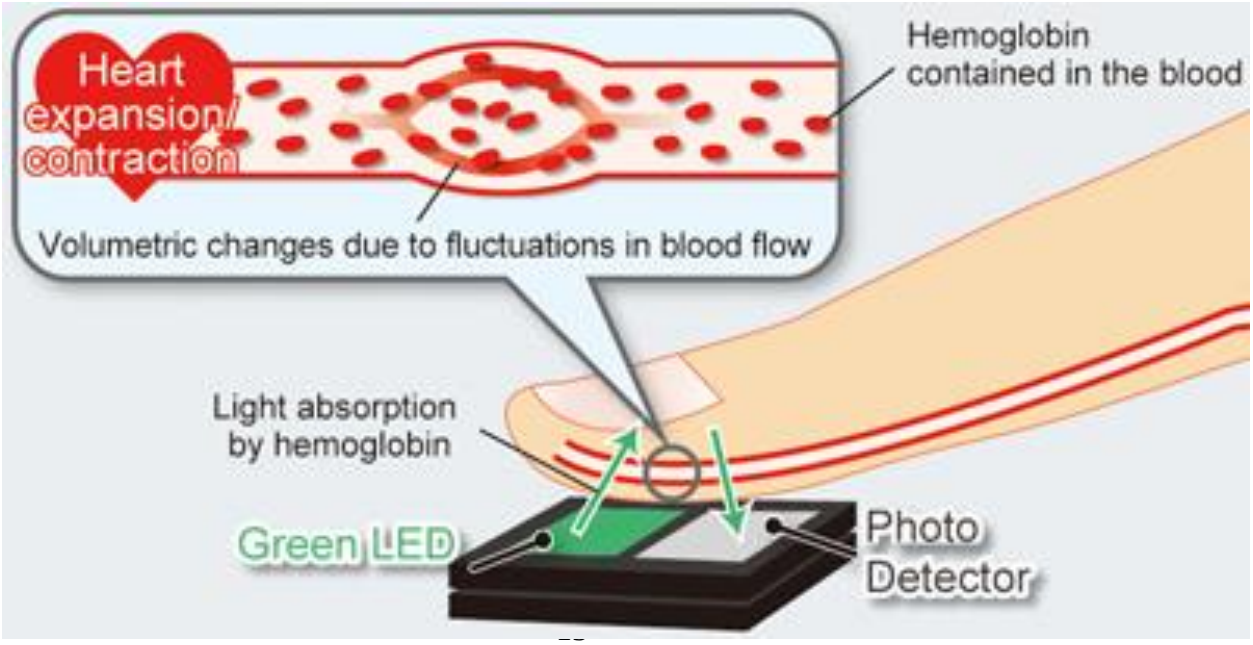
A ***DC motor*** is any of a class of rotary electrical motors that converts direct current (DC) electrical energy into mechanical energy.





Sensing Heartbeat Sensor

- **Heartbeat Sensor:** An optical heart rate sensor measures pulse waves, which are changes in the volume of a blood vessel that occur when the heart pumps blood.

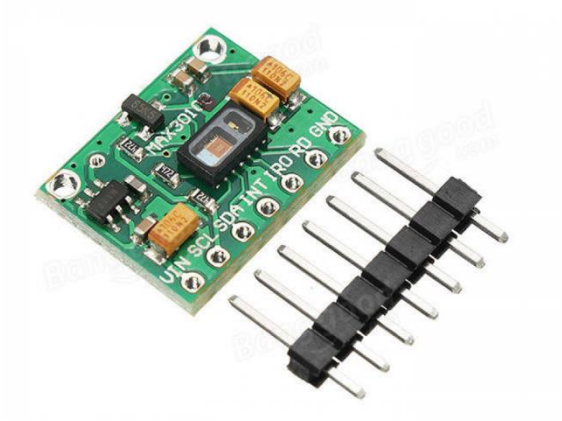


Temperature sensor

LM35 is used to measure precise centigrade temperature. The output of this sensor changes describes the linearity. The output voltages of this sensor are linearly comparative to the Celsius temperature. The output voltage range of this sensor is from -55° to +150°C

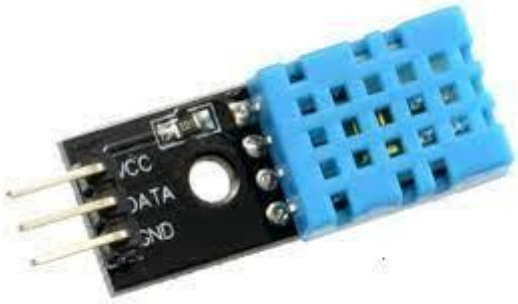
Oxygen sensor

MAX30102 Sensor shines both the light through the skin and measures the reflection with the photodetector. This method of pulse detection through light is called Photoplethysmogram. The working of the sensor can be divided into two parts one is heart rate measurement and another is blood oxygen level measurement.



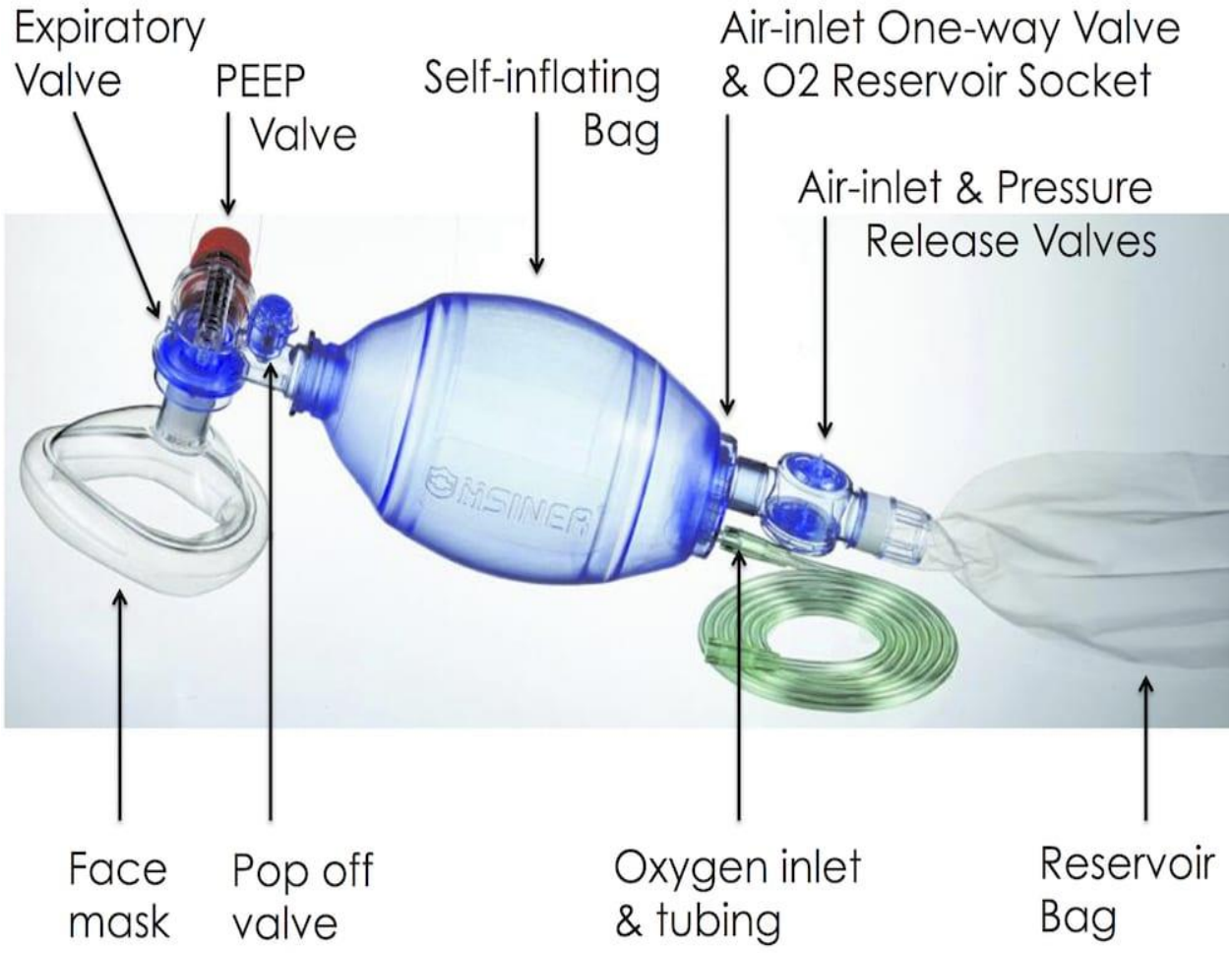
DHT11

It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin



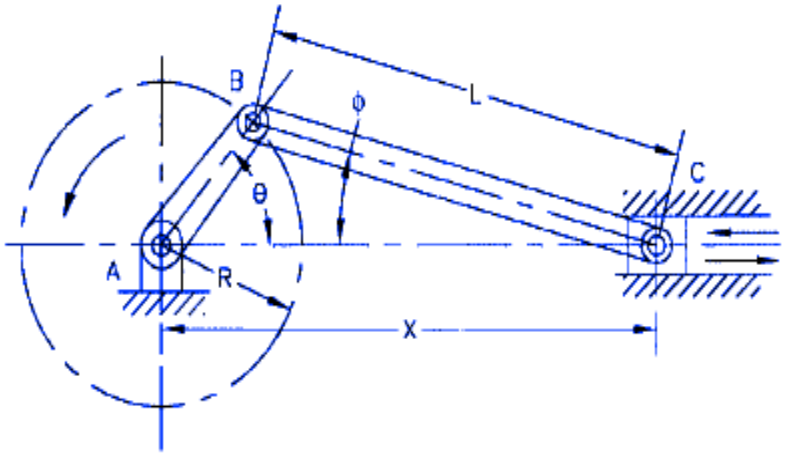
Ambu Bag

A bag valve mask (BVM), sometimes referred to as an Ambu bag, is a handheld tool that is used to deliver positive pressure ventilation to any subject with insufficient or ineffective breaths. It consists of a self-inflating bag, one-way valve, mask, and an oxygen reservoir.



Crank Mechanism

A crank is an arm attached at a right angle to a rotating shaft by which circular motion is imparted to or received from the shaft. When combined with a connecting rod, it can be used to convert circular motion into reciprocating motion, or vice versa.



Communication

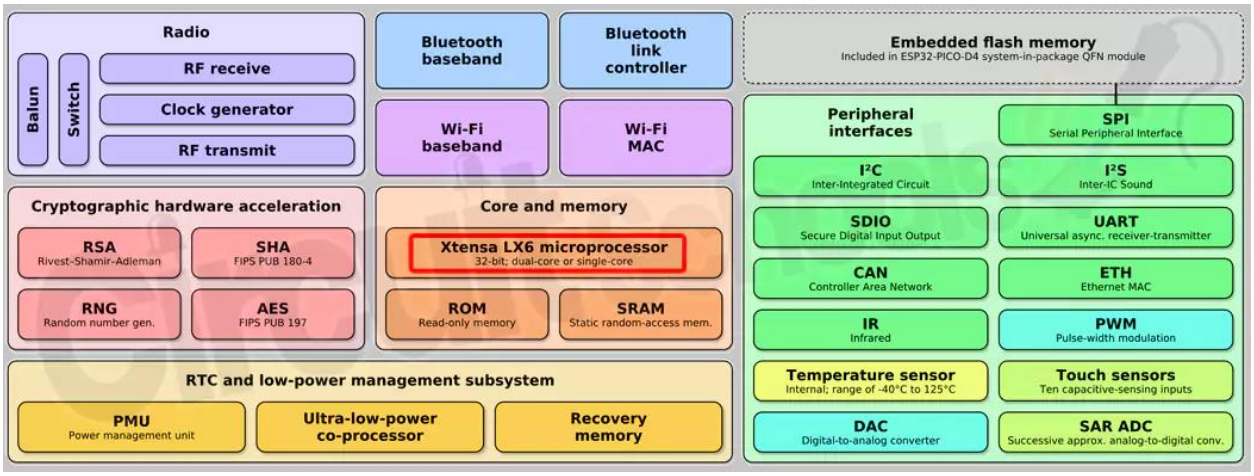
What is ESP32?

ESP32 is a series of low-cost,low-power system on a chip microcontrollers with integrated Wi=fi and dual mode bluetooth.

What is ESP32 is used for?

ESP32 can perform a complete standalone system or as a slave device to a host MCU , reducing communication stack overhead on the main application processor. ESP can interface with other systems to provide WI-FI and Bluetooth functionality through its SPI / SDIO or I2C / UART interfaces

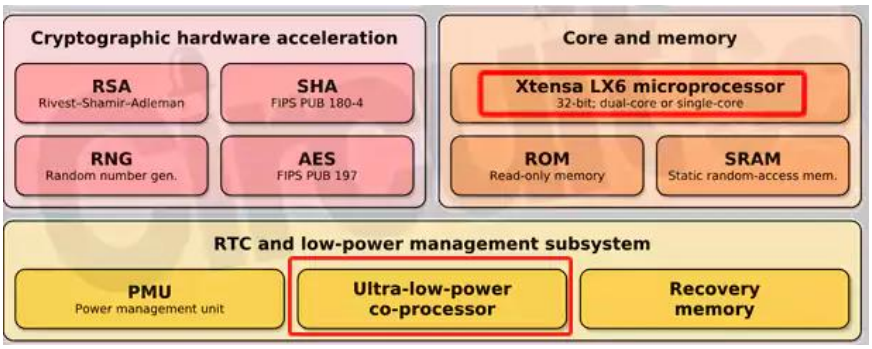
ESP32 Architectural Block diagram



Wireless Connectivity:

The ESP32 SoC chip has WiFi connectivity, being compatible with 802.11 b / g / n in the 2.4GHz band, reaching speeds of up to 150 Mbits/s. It also includes Bluetooth communication compatible with Bluetooth v4.2 and Bluetooth Low Energy (BLE)

Core:



As you can observe from the above core block image, it has an ultra-low-power co-processor that is used to perform analog-digital conversions and other operations while the device is operating in deep sleep low-power mode. In this way, a very low consumption by the SoC is achieved.

It is important to note that these processors offer great typical advantages of a digital signal processor:

Operating frequency: 240 MHz (executes instructions 15 times faster than an Arduino UNO board)

It allows to perform operations with real numbers (numbers with commas) very efficiently.

Allows you to multiply large numbers instantly.

Memory

In most of the microcontrollers based on Arduino, there are three types of memories

. Program memory: to store the sketch.

. SRAM memory: to store the variables that are used in the code.

. EEPROM memory: to store variables that do not lose their value even when the device is turned off.

In ESP32 this does not happen, in fact there are more types of memories that are usually classified into internal and external.

The internal memories are those that are already included in the SoC, and the external are those that can be added to expand the capacity of the system.

Many ESP32- based development boards add external memory for a better performing system.

ESP32 Internal memories and their functions:

. ROM memory (448 KiB): this memory is write-only, that is, you cannot reprogram it. This is where the codes that handle the Bluetooth stack, the Wi-Fi physical layer control, some general-purpose routines, and the bootloader to start the code from external memory are stored.

. Internal SRAM memory (520 KiB): this memory is used by the processor to store both data and instructions. Its advantage is that it is much easier for the processor to access than the external SRAM.

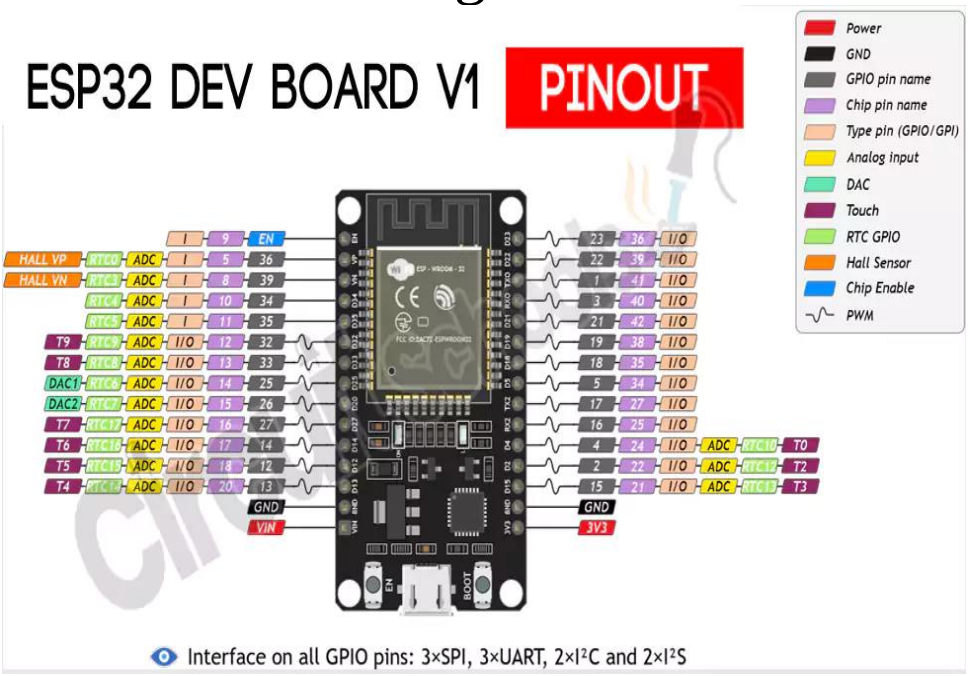
. RTC SRAM (16 KiB): this memory is used by the co-processor when the device operates in deep sleep mode.

. Efuse (1 Kilobit): 256 bits of this memory are used by the system itself and the remaining 768 bits are reserved for other applications.

. Flash embedded (Embedded flash) : This memory is where our application code is stored. The amount of memory varies depending on the chip used:

1. 0 MB (chips ESP32-D0WDQ6, ESP32-D0WD, ESP32-S0WD)
2. 2 MB (chip ESP32-D2WD)
3. 4 MB (Chip ESP32-PICO-D4)

ESP32 Pinout diagram and Pins:



Digital pins

The ESP32 has a total of 34 digital pins. These pins are like Arduino digital pins which allows you to add LED display, OLED display, sensors, buttons, buzzers, etc. to our projects.

Most of these pins support the use of internal pull-up, pull-down, and high impedance status as well. This makes them ideal for connecting buttons and matrix keyboards, as well as for applying LED control techniques such as the well-known Charlieplexing.

ESP32 WROOM module has 25 GPIO pins out of which there are only input pins, pins with input pull up and pins without internal pullup

Input only pins:

- GPIO 34
- GPIO 35
- GPIO 36
- GPIO 39

Pins with pull up INPUT_PULLUP

- GPIO14
- GPIO16
- GPIO17
- GPIO18
- GPIO19
- GPIO21
- GPIO22
- GPIO23

Pins without internal pull up

- GPIO13
- GPIO25
- GPIO26
- GPIO27
- GPIO32
- GPIO33

ADC (Analog to digital converters):

Some of the pins listed in the pinout diagram can also be used to interact with analog sensors, same as analog pins of an Arduino board.

For this, the ESP32 has a 12-bit (0-4096 resolution which means when voltage observed is 0 the value is 0 and when max voltage like 3.3v is observed the value

goes to 4096), 18-channel analog to digital converter, which means you can take readings from up to 18 analog sensors.

This allows you to develop very compact connected applications, even when using multiple analog sensors

Analog input pins:

- ADC1_CH0 (GPIO 36)
- ADC1_CH1 (GPIO 37)
- ADC1_CH2 (GPIO 38)
- ADC1_CH3 (GPIO 39)
- ADC1_CH4 (GPIO 32)
- ADC1_CH5 (GPIO 33)
- ADC1_CH6 (GPIO 34)
- ADC1_CH7 (GPIO 35)
- ADC2_CH0 (GPIO 4)
- ADC2_CH1 (GPIO 0)
- ADC2_CH2 (GPIO 2)
- ADC2_CH3 (GPIO 15)
- ADC2_CH4 (GPIO 13)
- ADC2_CH5 (GPIO 12)
- ADC2_CH6 (GPIO 14)
- ADC2_CH7 (GPIO 27)
- ADC2_CH8 (GPIO 25)
- ADC2_CH9 (GPIO 26)

DAC (Digital to Analog Converters):

PWM signals are used on most Arduino boards to generate analog voltages. The ESP32 has two 8 bits digital to analog converters.

This allows two pure analog voltage signals to be generated. These converters can be used to:

. Control an analog circuit

. Manipulate the intensity of an LED

. Can even add a small amp and speaker to your project to play a song

DAC Pins:

- DAC1 (GPIO25)
- DAC2 (GPIO26)

3.1.2 Functional Requirements:

- **Workflow of the software in ventilations session**

SOFTWARE

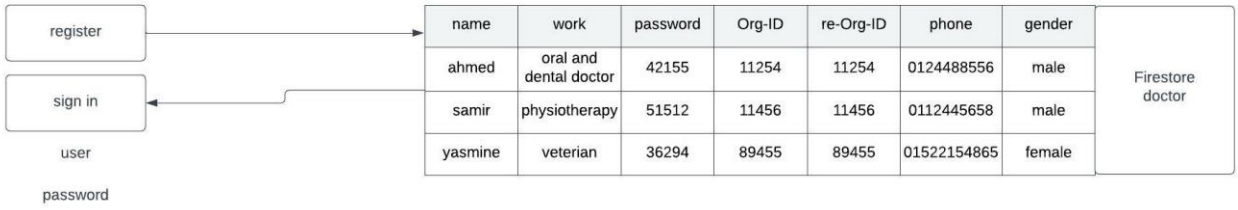
1. User login into software (mainly the doctor)
2. Adding new patient in the system with patient content
3. Getting hardware sensor reading (OXI% ,PBM , TEMP)
4. Customizing the Oxygen percentage needed for ventilation
5. Set the parameters of symptoms that appears on the patient.
6. Visualization of data retrieved from the ventilator on diagrams (chart)

3.1.3 Nonfunctional Requirements

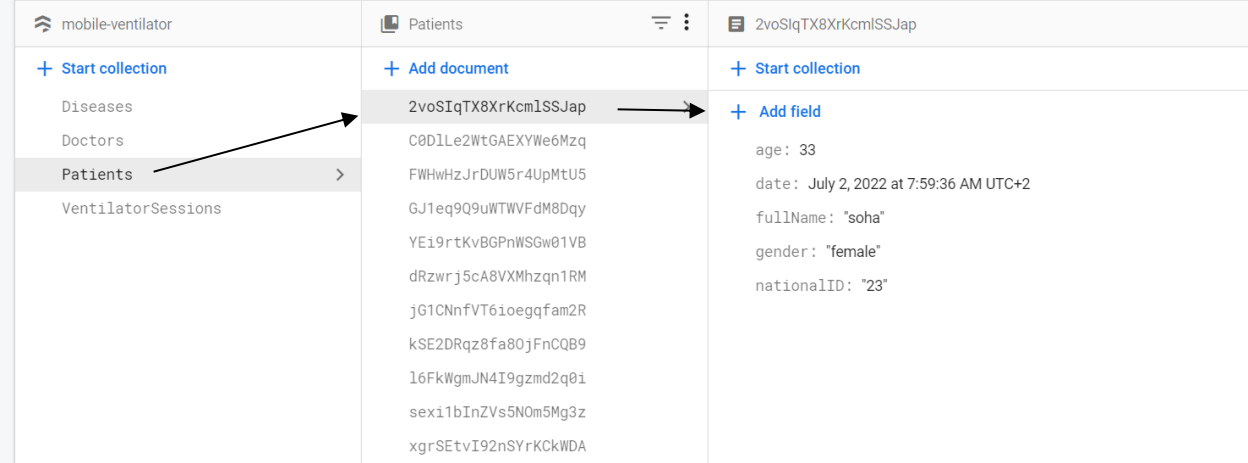
HARDWARE

1. Safety Information transmission should be securely transmitted to the server without any changes.
2. Reliability As the system provides the right ventilation, it must be assured that the system is reliable in its operations and for securing sensitive details.
3. Service The machine is always available 24 hours
4. Mobility The machine is easy to carry.

SOFTWARE



1. The patient content mostly like the doctor content but there are some extra Parameters as you this in this figure a snapshot for the API firebase a patient properties but the is not VALIDATION on data except that I needed for another processes



As we can see the relation that the doctor and patient underneath a person class parameter with contains the same parameters in both I called the (Super class) as we will see in the diagrams.

2. As we see in the following design it show the view of patient content (a specific one) show the attributes of all data of this patient across a time plan from start to end date that this patient have been in all sessions,
This patient ventilation session you can delete it or print it this is the work flow of a specific patient printing file along all of his sessions

Mobile Ventilator Report

Date	National ID	Heart Rate	Oxygen Percentage	Ventilator OXI	Illness	Symptoms	Organization ID	Doctor Name
Jul 2, 2022 7:39:36 AM	17	124	0.019684372	60	New Target	{Breathing Noisily=normal, Stubborn Cough=few, Coughing Up Blood=normal, Difficulty Breathing=normal, Lingering Chest Pain=sudden, Mucus=few spit}	123	Mahmoud
Jul 2, 2022 6:41:20 AM	17	100	0.73	10	New Target	{Stubborn Cough=few, Breathing Noisily=normal, Coughing Up Blood=normal, Difficulty Breathing=normal, Lingering Chest Pain=sudden, Mucus=sputum}	123	Mahmoud

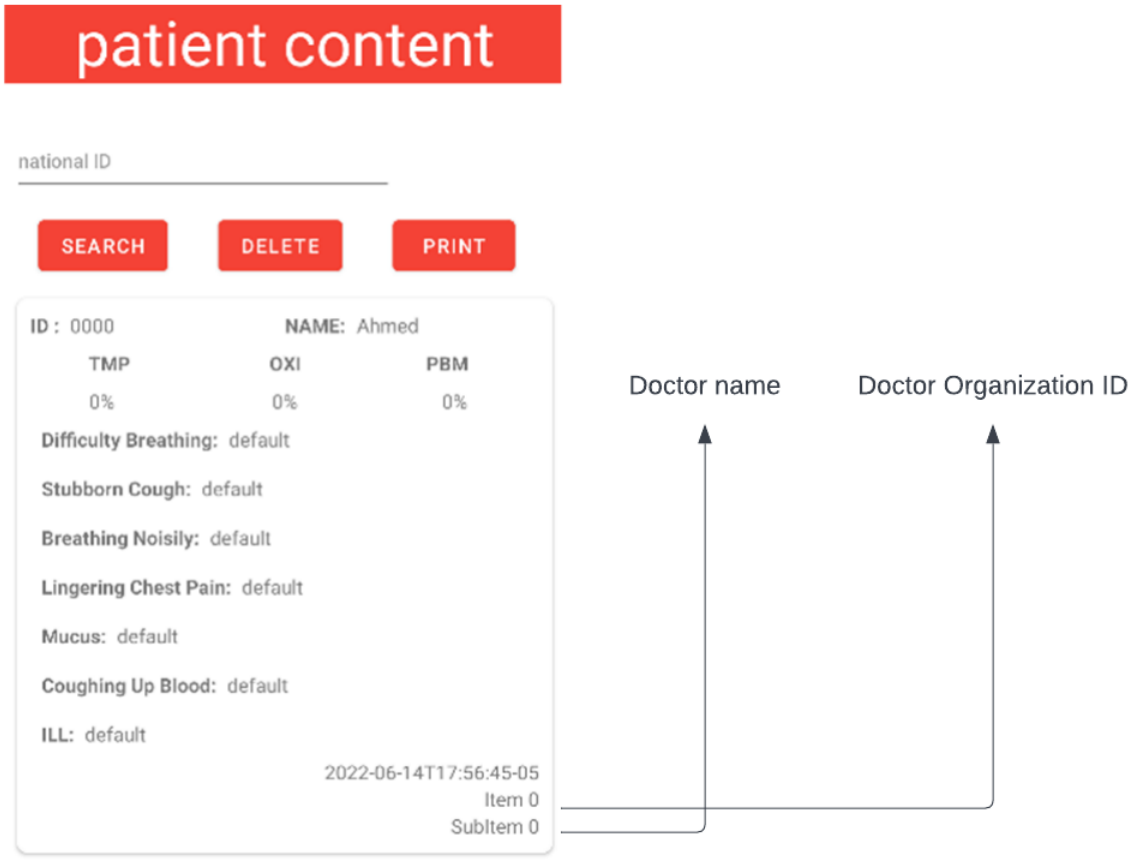
but when you want to delete it will be removed from the Firestore can not be retrieved anymore.

3.1.4 System Users

A. Intended Users:

SOFTWARE

This section we are talking about the doctor only that can use it, a group of doctors can use it for all on their own direction, everyone has their own ventilation sessions As we see there are no backends management validation developments because we work on a storage ABI (Google Firebase) it is just send and retrieving data the validity of data works in the code only as we see in the following diagram every doctor has his own sessions, that he/she has all responsibility on it.



B. User Characteristics

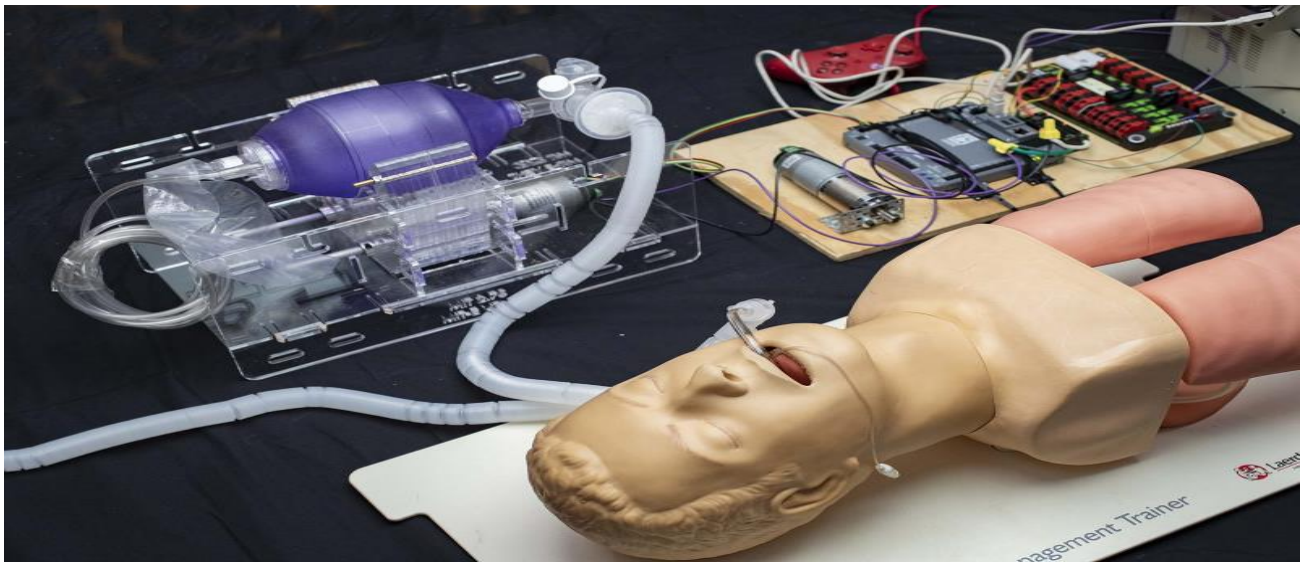
Characteristics of doctors must be:

- the type of chart distribution (NOT ALL) but some of it at least to know how the hardware part interacts with the software there is a plots that emphasize the daily work flow of data in ventilation session with hardware part.
- Doctor must have a good experience in determining symptoms as they will be needed in future updates for machine learning development prediction and classification techniques that will be work on the printing data.
- Must know what is the percentage of ventilator that works on it
  That will be produced for ventilation process for not hurting the patient that Maximizing the oxygen percentage over the needed one may cause overhead or patient death.

HARDWARE

The users that can use machine to help patient to ventilate:

- **Doctors** can use the system to assist them diagnosis type of disease.



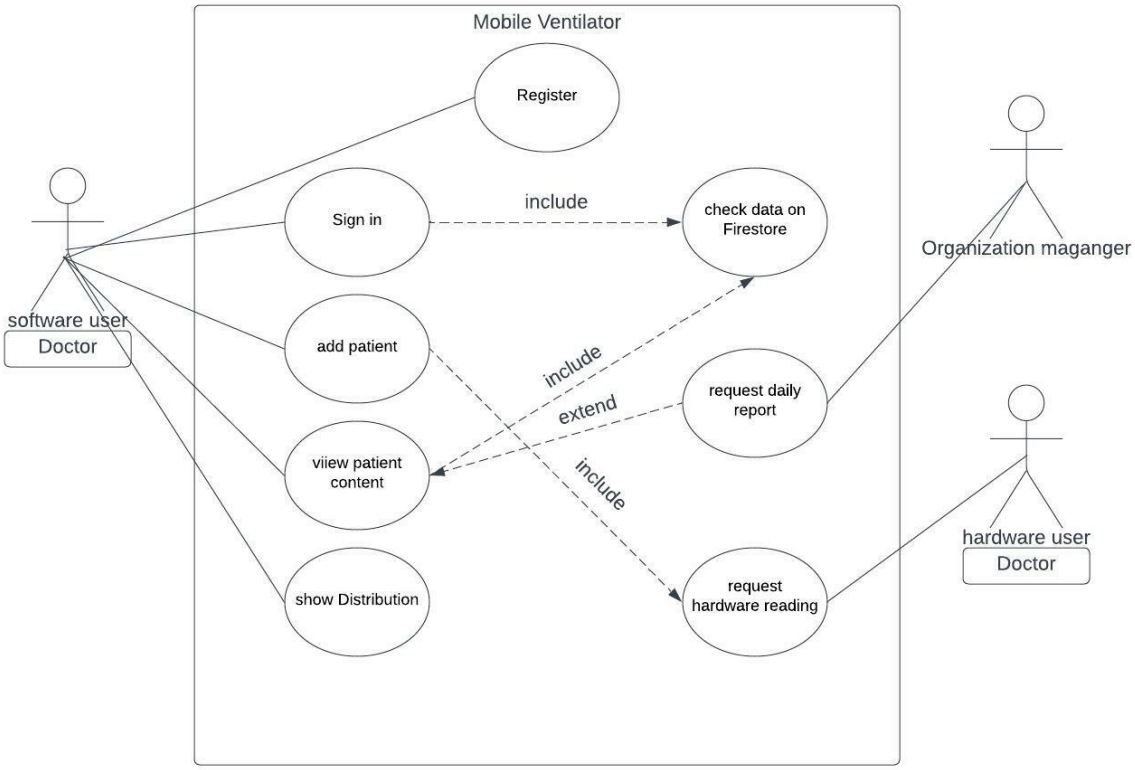
2.2 System Analysis & Design

3.2.1 Use Case Diagram

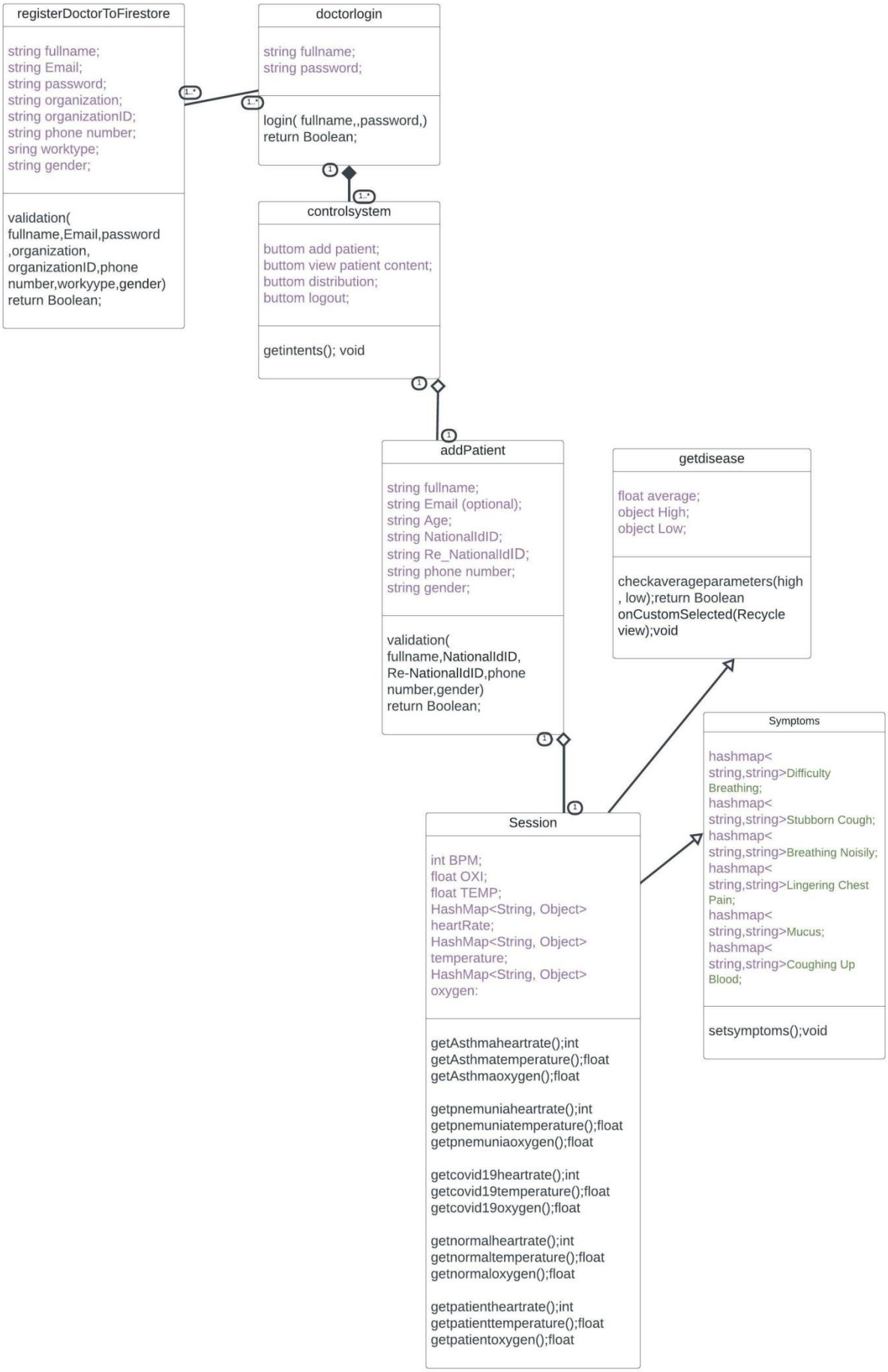
- (CASE 1) Registration requirements for the doctor to control the app processes

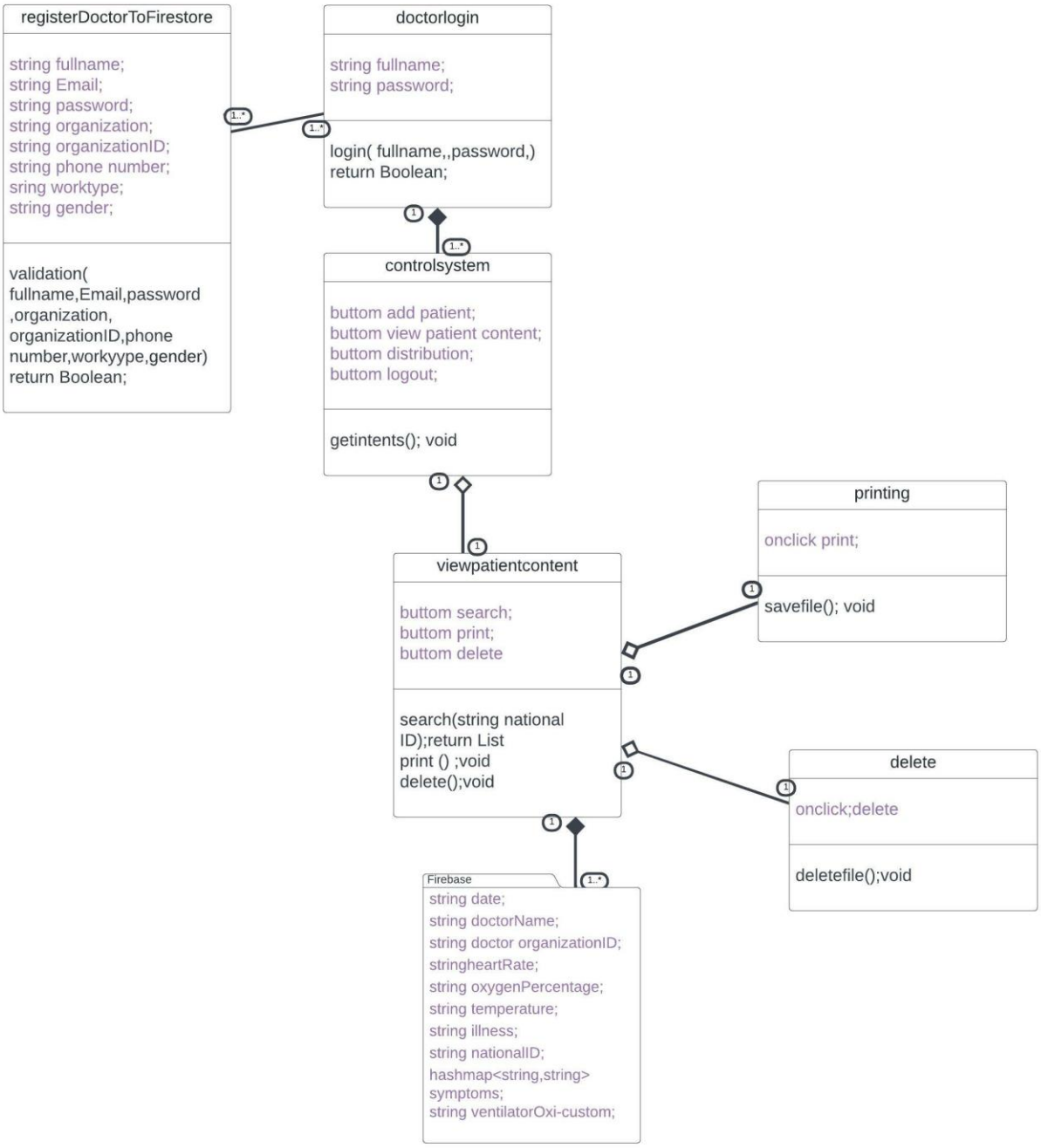
  For the ventilation session adding all of his/her data to the app to be store for another processes later.
- (CASE 2) Sign in needed for checking the app security for no accessing anybody else on the data or make it be corrupted need to check on the data of doctor before starting any other processes on the firestore to make sure that everything is secured.

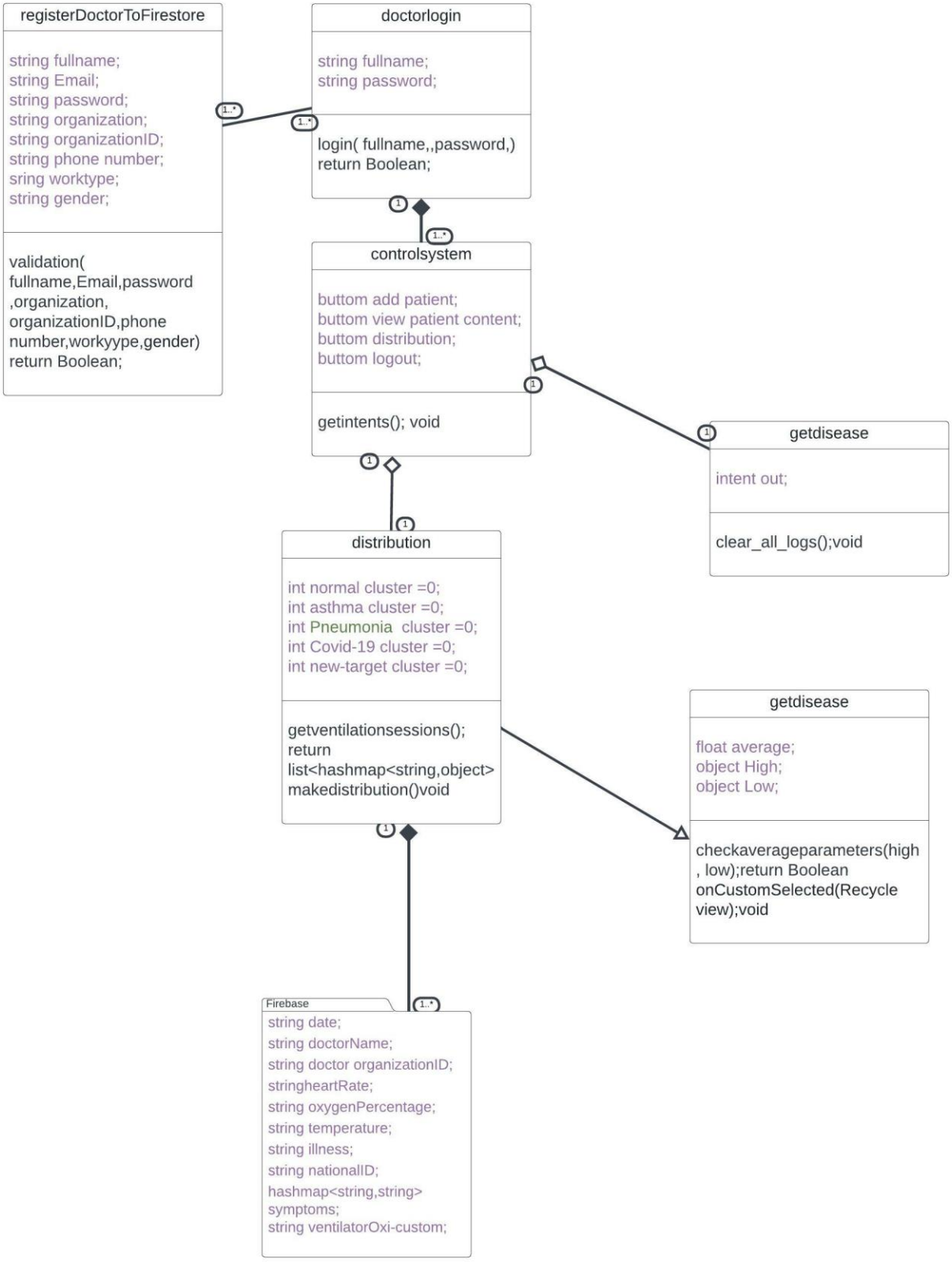
- (CASE 3) as I said firebase API store everything about the Doctors , patient , Diseases and even all session done the every doctor registered that include and all data on it.
- (CASE 4) Adding new patient requires the hardware readings at real time of one run it sending a request to the doctor who works on the ventilator to run it and get the readings once done doctor can customizing the ventilation percentage for patient and another attributes and session is done.
- (CASE 5) view patient content requires (CASE 3) for retrieving patient data across all ventilation sessions that he had done before relatively you can delete these all session or print it for making hospital or organization report for later actions.
- (CASE 6) showing distribution it is just showing how is the daily cases in the classification of the patients in ventilation sessions.
- (CASE 7) request daily report for (CASE 5) it may be a later process for visualization of patients data and a case study of it for also future updates that we will talk later.
- (CASE 8) request hardware readings as I said in (CASE 4) it run only at real time of project it get (OXI , PBM ,TEMP)


Mobile Ventilator
Register
Sign in
include
check data on Firestore
add patient
include
extend
request daily report
viiew patient content
include
show Distribution
request hardware reading
software user
Doctor
Organization maganger
hardware user
Doctor

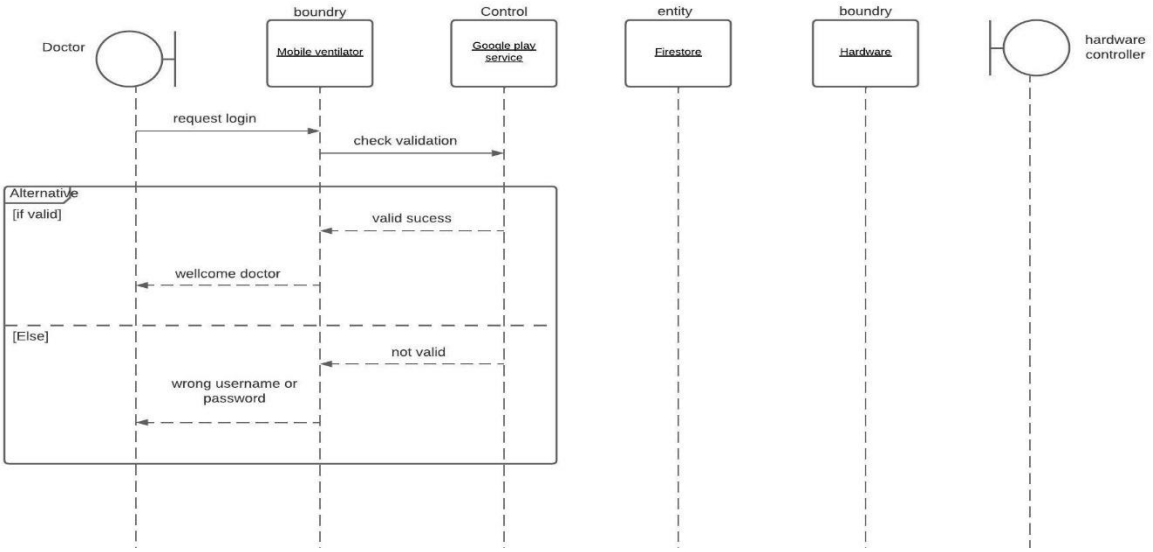
2.2.2 Class Diagram

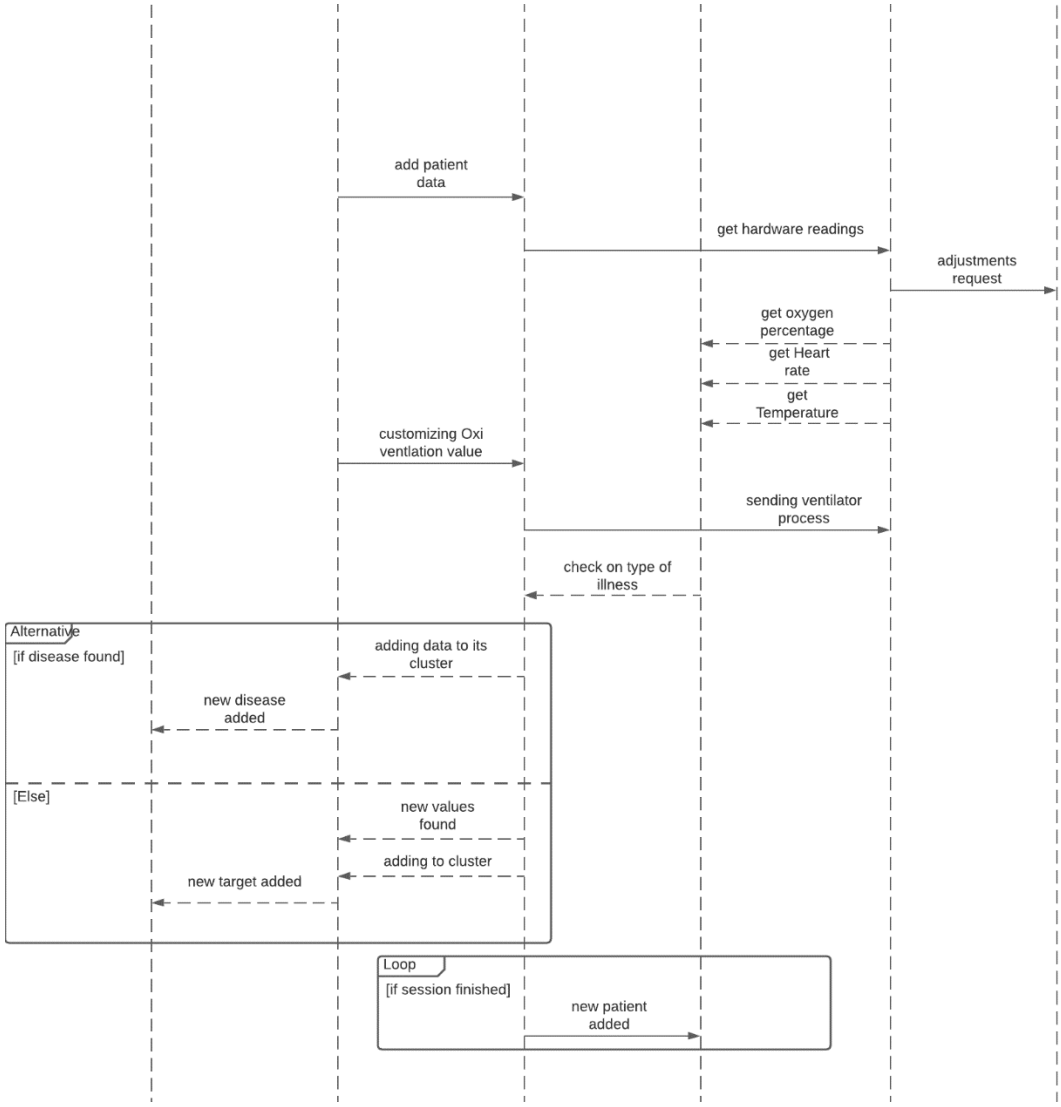


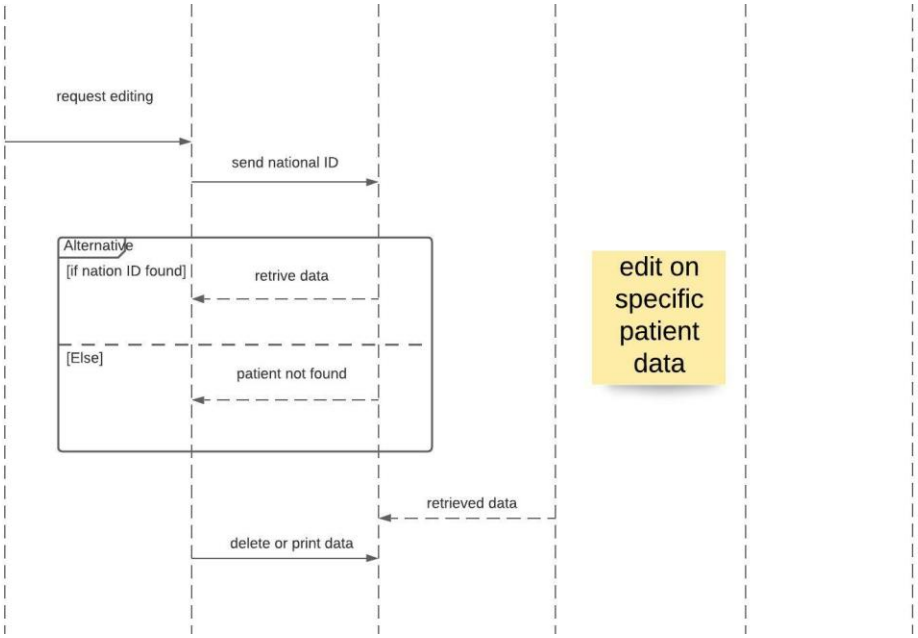

registerDoctorToFirestore
string fullname;
string Email;
string password;
string organization;
string organizationID;
string phone number;
sring worktype;
string gender;
validation(
fullname,Email,password
,organization,
organizationID,phone
number,workyype,gender)
return Boolean;
doctorlogin
string fullname;
string password;
login(fullname,,password,)
return Boolean;
controlsystem
buttom add patient;
buttom view patient content;
buttom distribution;
buttom logout;
getintents(); void
printing
onclick print;
savefile(); void
viewpatientcontent
buttom search;
buttom print;
buttom delete
search(string national
ID);return List
print () ;void
delete();void
delete
onclick;delete
deletefile();void
Firebase
string date;
string doctorName;
string doctor organizationID;
stringheartRate;
string oxygenPercentage;
string temperature;
string illness;
string nationalID;
hashmap<string,string>
symptoms;
string ventilatorOxi-custom;


registerDoctorToFirestore
string fullname;
string Email;
string password;
string organization;
string organizationID;
string phone number;
sring worktype;
string gender;
validation(fullname,Email,password ,organization, organizationID,phone number,workyype,gender) return Boolean;
doctorlogin
string fullname;
string password;
login(fullname,,password,) return Boolean;
controlsystem
buttom add patient;
buttom view patient content;
buttom distribution;
buttom logout;
getintents(); void
getdisease
intent out;
clear_all_logs();void
distribution
int normal cluster =0;
int asthma cluster =0;
int Pneumonia cluster =0;
int Covid-19 cluster =0;
int new-target cluster =0;
getventilationsessions(); return list<hashmap<string,object> makedistribution()void
getdisease
float average;
object High;
object Low;
checkaverageparameters(high , low);return Boolean onCustomSelected(Recycle view);void
Firebase
string date;
string doctorName;
string doctor organizationID;
stringheartRate;
string oxygenPercentage;
string temperature;
string illness;
string nationalID;
hashmap<string,string> symptoms;
string ventilatorOxi-custom;

2.2.3 Sequence Diagrams







3.2.4 Database Diagram:

- These diagrams only works on storage and retrieved data so here
  Not access on external databases it is just storage.
  1st: doctor database has an attributes for registration as I said before
  If further an (Organization ID) as a primary key for data movement
  2nd: patient database consists of mainly the same attributes but is has another primary key and foreign key for the first table (doctor table)
  3rd for accessing data of adding a new patient I must have the primary key of the doctor that access the realtime patient for now
  4th: relation here are (one and only one) doctor in realtime to (many) he can adding many patients.
  5th: the disease database is a stock also it may have no relation with patient database but the doctor need it for program calculation the relation here is

(one and only one) doc can do this in real time but (many) at the diseases data base so the doctor can call all of the data at once several time.

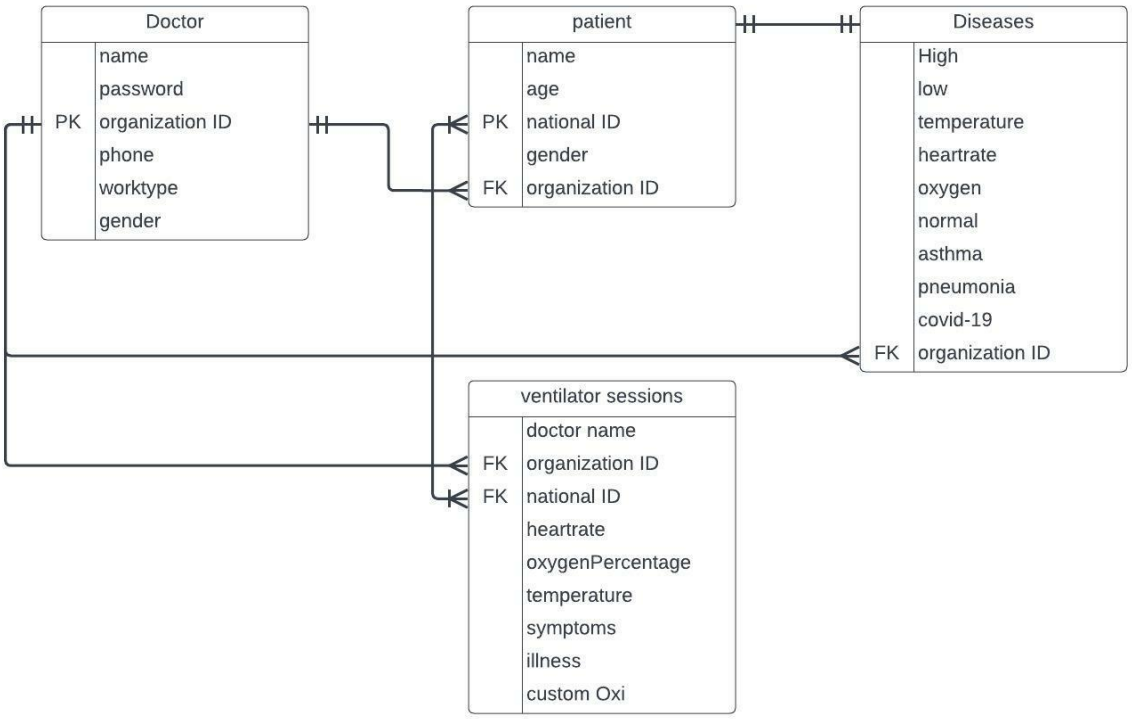
6th: ventilator sessions database is a final store and initial retrieve

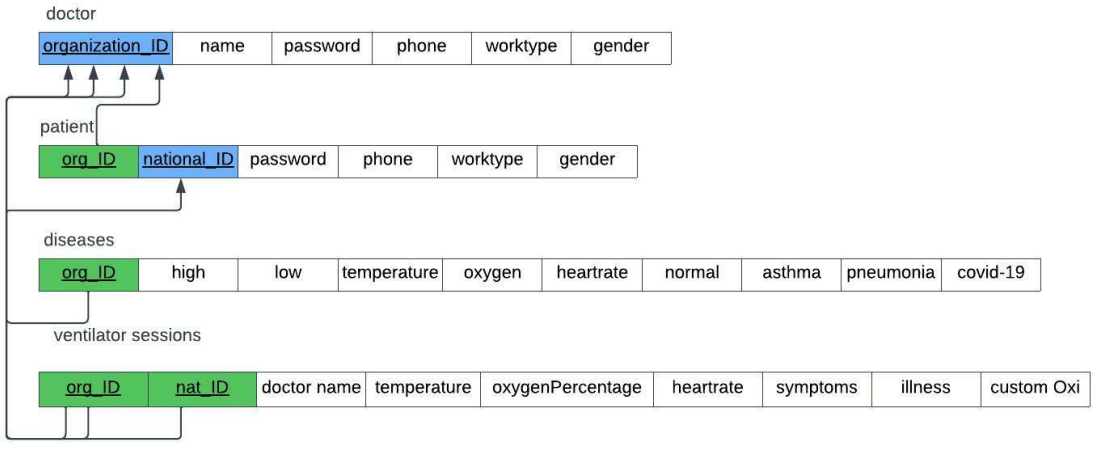
, Final for the patient database as I am done adding all data will be stored in ventilator sessions database so I need to store alse the primary key of patient database in it, secondary the initial retrieve will act on calling specific patient

For deletion or printing ,so I need to get the primary key from ventilator session of the patient to retrieve his data.

7th: final , I putted doctors primary key into ventilator session to push doctors name for supervision and consultation of every patient.

- The schema diagrams show the strong and weak entities and relation
  To make back workflow for this of several primary and secondary keys
  For appointing the main key that control all of these entities.


Doctor
name
password
PK organization ID
phone
worktype
gender
patient
name
age
PK national ID
gender
FK organization ID
Diseases
High
low
temperature
heartrate
oxygen
normal
asthma
pneumonia
covid-19
FK organization ID
ventilator sessions
doctor name
FK organization ID
FK national ID
heartrate
oxygenPercentage
temperature
symptoms
illness
custom Oxi


doctor
organization_ID
name
password
phone
worktype
gender
patient
org_ID
national_ID
password
phone
worktype
gender
diseases
org_ID
high
low
temperature
oxygen
heartrate
normal
asthma
pneumonia
covid-19
ventilator sessions
org_ID
nat_ID
doctor name
temperature
oxygenPercentage
heartrate
symptoms
illness
custom Oxi

Chapter 4
Implementation

- SOFTWARE:
    1. registerDoctorToFirestore () this the function the make a check on the validation set of the doctor before upload data on FIREBASE.
    2. FirebaseFirestore.getInstance().collection() this function the retrieve or uploading data in firestore
    3. validFields() this check on the validity of the username or password of the user.
    4. login(String userName, String password) this makes comparison for the input data and the retrieved one from the firsstore
    5. onCreate(Bundle savedInstanceState) this makes an instance to the activity that I will work on it.
    6. clearForm() this clear the textview data after logging out or moving to the next page.
    7. gotopatientpage(View view) this function make an intent action for a specific buttom for moving or making an instance.
    8. private boolean validation() this make validation on patient data retrieved or uploaded.
    9. private void savePatient() this make instance after validation is done and uploading data to firestore
    10. publicPatientSessionAdapter(Patientpatient, ArrayList<VentilatorSession> list) this continue after upload the normal data of the patient ,make the session of hardware part getting all data of it.
    11. PdfWriterManager(File file, ArrayList<VentilatorSession> sessions) This function print data of the patient session as a EXAMPLE.pdf.
    12. private void printSessions() this the function print itself.
    13. private void deletePatientData(String nationalID)this delete all session of a specific patient.
    14. private void getPatientByNationalID(String nationalID) this get patient national ID from firestore to make edition (DELETE OR PRINT).
    15. private void getPatientSessions(String nationalID) gets all sessions in a recycle view to show before doing something.
    16. private void getDiseases() this gets all of the diseases I had for making two type of calculation:1st-check on the session retrieved values in

boundary or out of it and the 2nd one to check on the distribution of sessions.

- A K-means algorithm I tried to find some external library for making a data classification on the data of diseases I have the all sessions on firebase I retrieved .

attributes	temp	oxi	pbm
p1	37.5	0.88	115
p2	38.2	0.93	118
p3	38.5	0.89	119
p4	36.5	0.98	125
p5	39.4	0.95	152
p6	41.2	0.73	148
asthma	44.5	0.64	98
pneumonia	48.3	0.58	93
covid-19	41	0.99	89
normal	37.2	0.78	70

C1-asthma	C2-pneumonia	C3-covid-19	C4-normal	canother
1	4	2	10	5
2	10	1	5	0
3	2	8	5	2
4	3	5	2	0
5	8	7	1	4
6	6	12	4	8
4	5	1	5	12
5	7	0	14	30
6	9	1	3	2
2	6	2	5	1

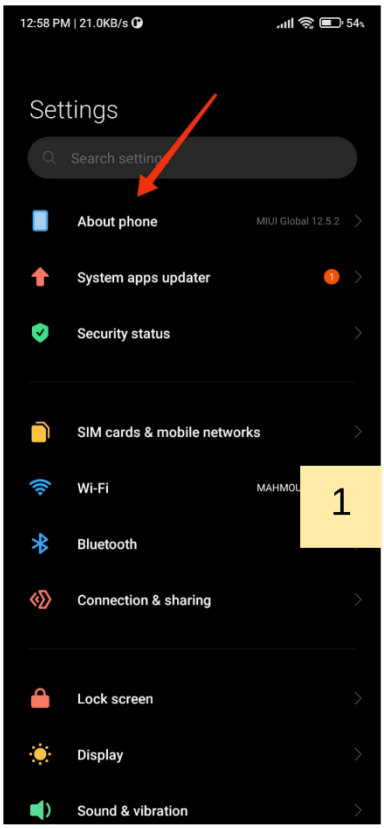
I searched a lot till I found (OPEN-CV,JAVA-ML,JYTHON tool for insertion of SKLEARN library) but they are all failed so I tried to do it manual but for one iteration only do I decide to make it one iteration every time I called DISTRIBUTION BUTTOM I get all as I said and making a 5 clusters for the data of diseases I have stored on firebase and the data and the out of bound I found that I have 3D data as shown in figure that needs a model called PCA DIMESIONALITY REDUCTION getting the best view for scattering data in 3D plot needs more difficult work to reach.

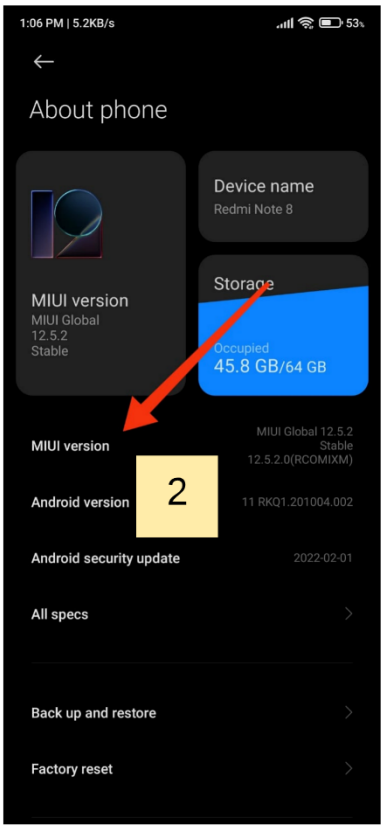
$$|p_1 - q_1| + |p_2 - q_2| + \cdots + |p_n - q_n|$$

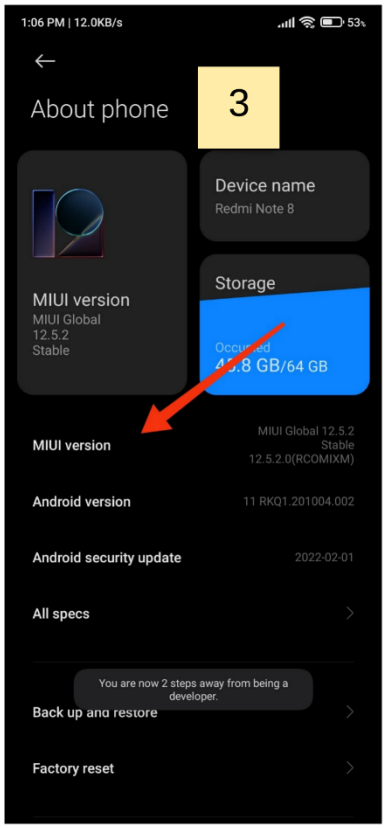
So as show in figure I combined my diseases data with all session data to make 5 cluster for maximum one iterations and exploiting it on a PIECHART.

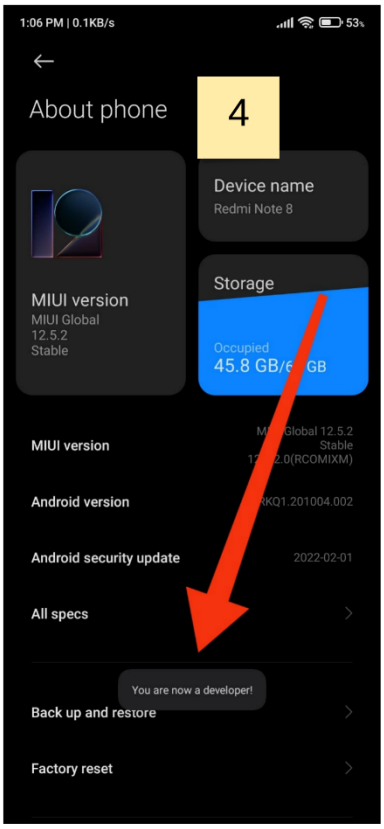
Chapter 5

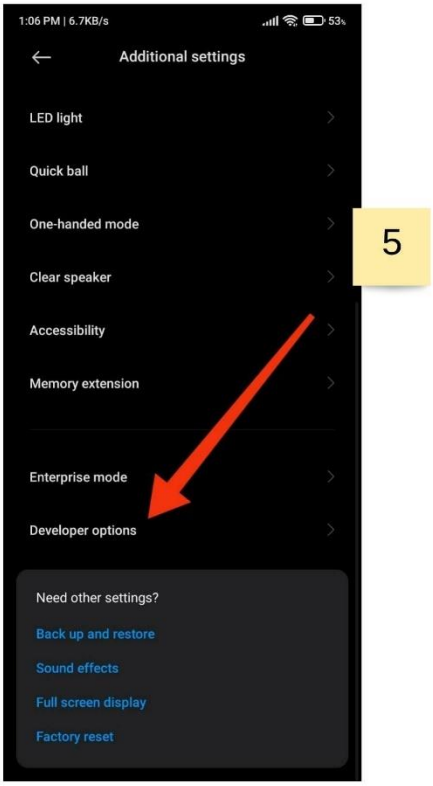
User Manual


12:58 PM | 21.0KB/s
Settings
Search setting
About phone
MIUI Global 12.5.2
System apps updater
Security status
SIM cards & mobile networks
Wi-Fi
Bluetooth
Connection & sharing
Lock screen
Display
Sound & vibration
1


1:06 PM | 5.2KB/s
About phone
Device name
Redmi Note 8
MIUI version
MIUI Global
12.5.2
Stable
Storage
Occupied
45.8 GB/64 GB
MIUI version
MIUI Global 12.5.2
Stable
12.5.2.0(RCOMIXM)
Android version
11 RKQ1.201004.002
Android security update
2022-02-01
All specs
Back up and restore
Factory reset
2


1:06 PM | 12.0KB/s
About phone
3
Device name
Redmi Note 8
MIUI version
MIUI Global
12.5.2
Stable
Storage
Occupied
45.8 GB/64 GB
MIUI version
MIUI Global 12.5.2
Stable
12.5.2.0(RCOMIXM)
Android version
11 RKQ1.201004.002
Android security update
2022-02-01
All specs
You are now 2 steps away from being a developer.
Back up and restore
Factory reset


1:06 PM | 0.1KB/s
About phone
4
Device name
Redmi Note 8
MIUI version
MIUI Global
12.5.2
Stable
Storage
Occupied
MIUI version
Android version
Android security update
2022-02-01
All specs
You are now a developer!
Back up and restore
Factory reset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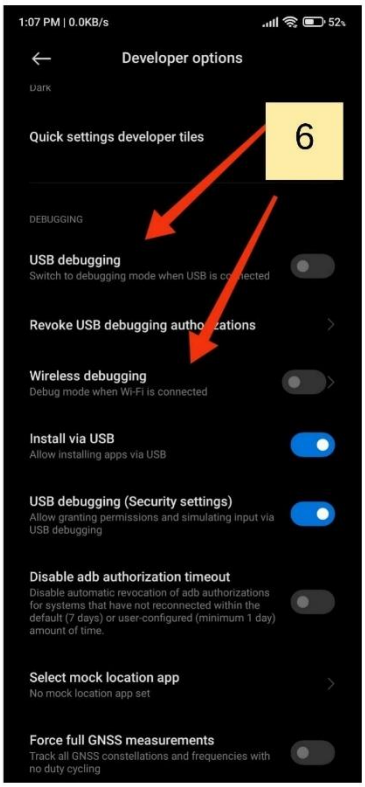
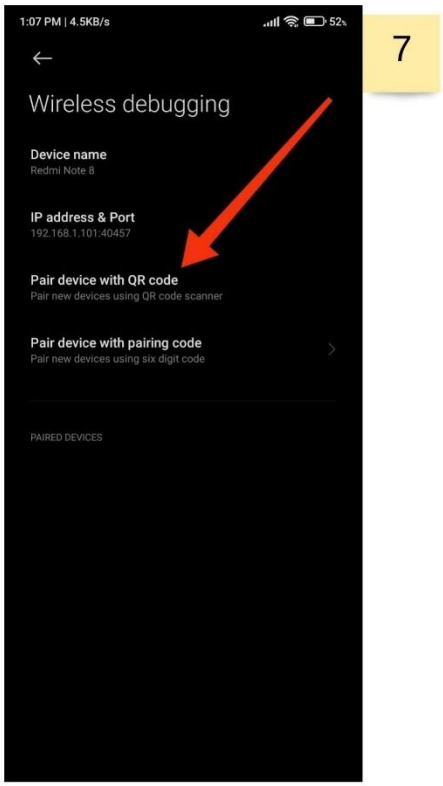
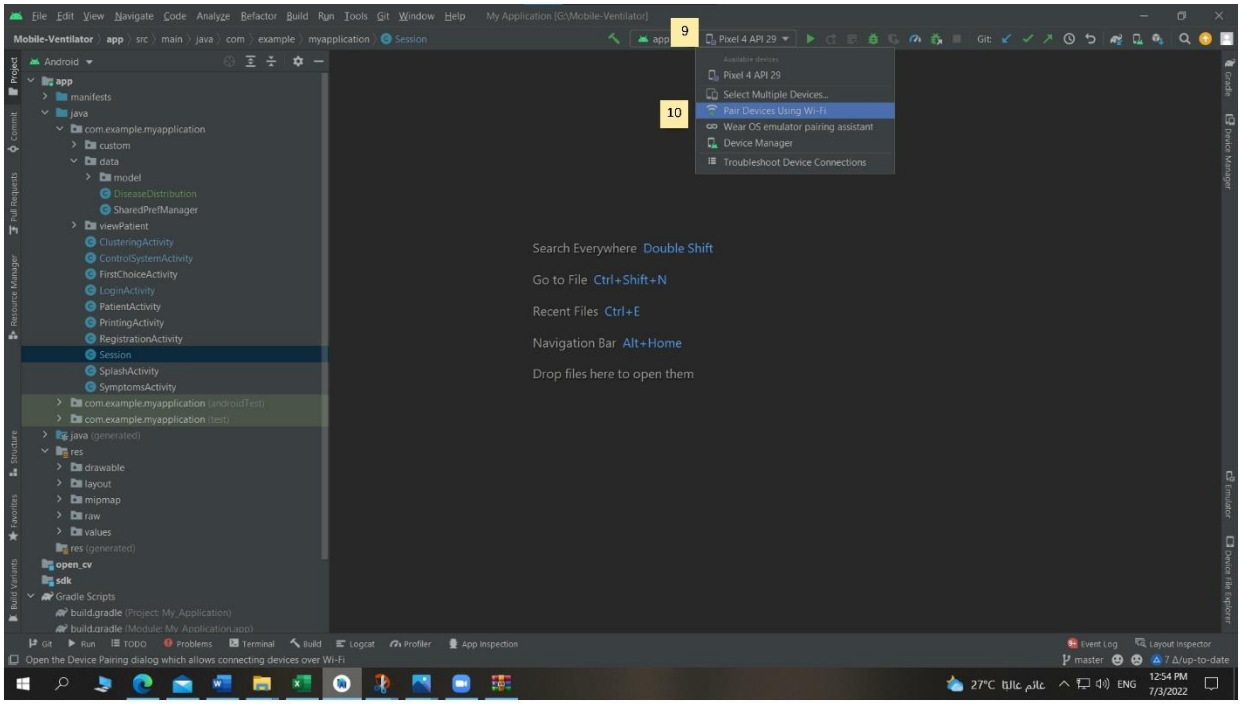
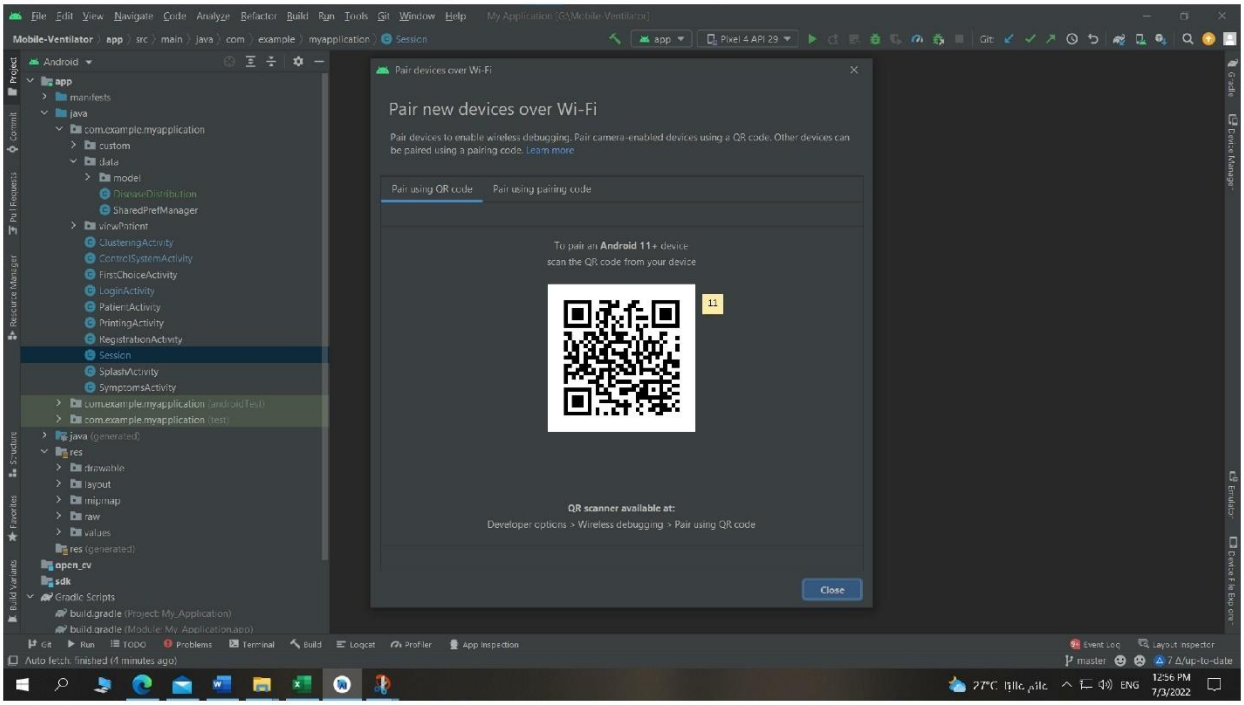
Additional settings
LED light
Quick ball
One-handed mode
Clear speaker
Accessibility
Memory extension
Enterprise mode
Developer options
Need other settings?
Back up and restore
Sound effects
Full screen display
Factory reset
5

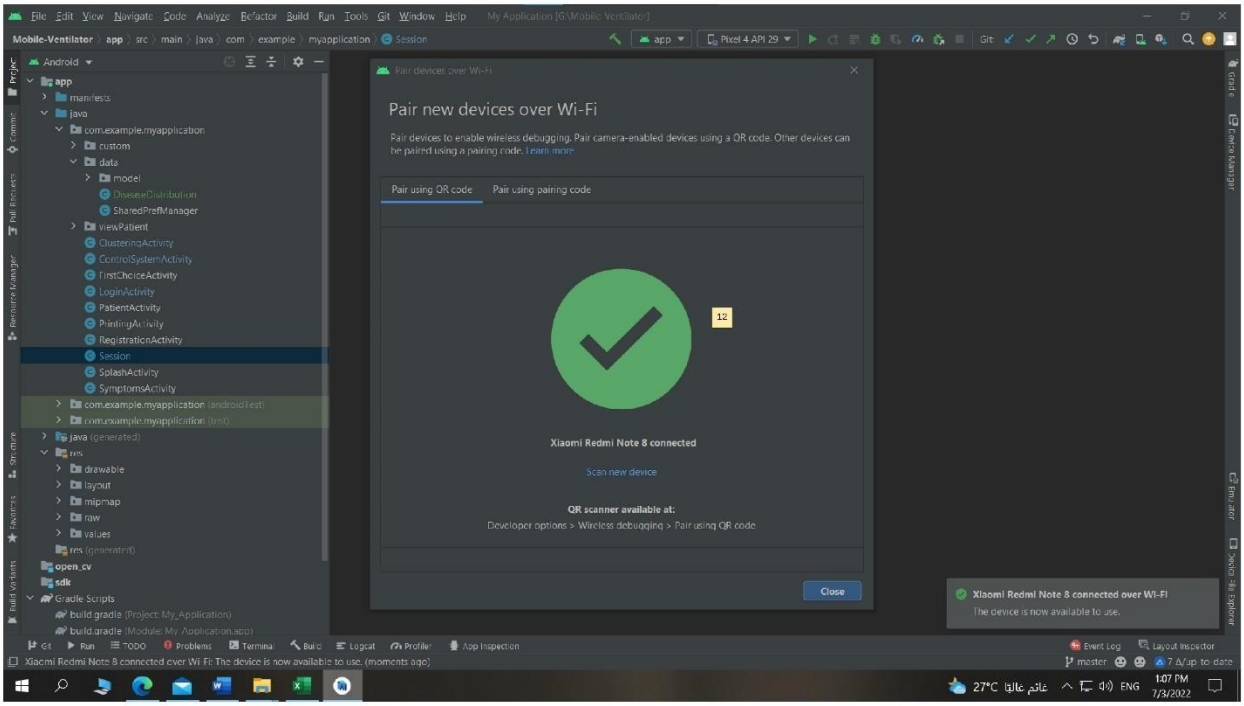

1:07 PM | 0.0KB/s
Developer options
Quick settings developer tiles
6
DEBUGGING
USB debugging
Revoke USB debugging authorizations
Wireless debugging
Debug mode when Wi-Fi is connected
Install via USB
Allow installing apps via USB
USB debugging (Security settings)
Allow granting permissions and simulating input via USB debugging
Disable adb authorization timeout
Select mock location app
No mock location app set
Force full GNSS measurements
Track all GNSS constellations and frequencies with no duty cycling

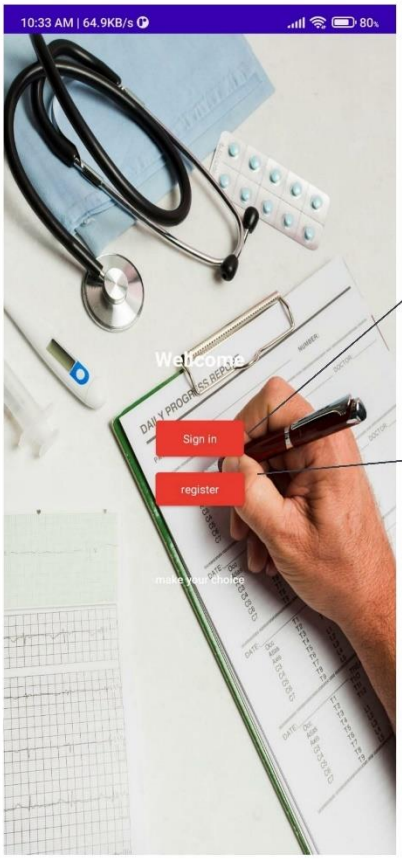

1:07 PM | 4.5KB/s
Wireless debugging
Device name
Redmi Note 8
IP address & Port
192.168.1.101:40457
Pair device with QR code
Pair new devices using QR code scanner
Pair device with pairing code
Pair new devices using six digit code
PAIRED DEVICES
7


1:07 PM | 1.3KB/s
8
Scan QR code
Pair device over Wi-Fi by scanning a QR code


9
Pixel 4 API 29
10
Pair Devices Using Wi-Fi
Wear OS emulator pairing assistant
Device Manager
Troubleshoot Device Connections
Search Everywhere Double Shift
Go to File Ctrl+Shift+N
Recent Files Ctrl+E
Navigation Bar Alt+Home
Drop files here to open them
Open the Device Pairing dialog which allows connecting devices over Wi-Fi

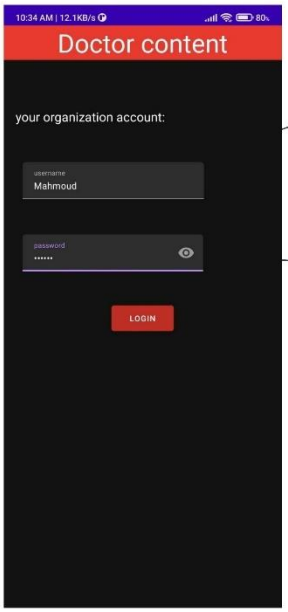

Pair devices over Wi-Fi
Pair new devices over Wi-Fi
Pair devices to enable wireless debugging. Pair camera-enabled devices using a QR code. Other devices can be paired using a pairing code. Learn more
Pair using QR code
Pair using pairing code
To pair an Android 11+ device
scan the QR code from your device
11
QR scanner available at:
Developer options > Wireless debugging > Pair using QR code
Close


Pair new devices over Wi-Fi
Pair devices to enable wireless debugging. Pair camera-enabled devices using a QR code. Other devices can be paired using a pairing code. Learn more
Pair using QR code
Pair using pairing code
12
Xiaomi Redmi Note 8 connected
Scan new device
QR scanner available at:
Developer options > Wireless debugging > Pair using QR code
Close
Xiaomi Redmi Note 8 connected over Wi-Fi
The device is now available to use.



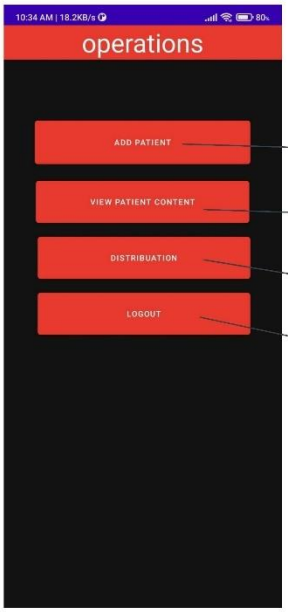
2-sign in after registeration

1-doctor registeration for controlling software



3- type you user name

4-type your password

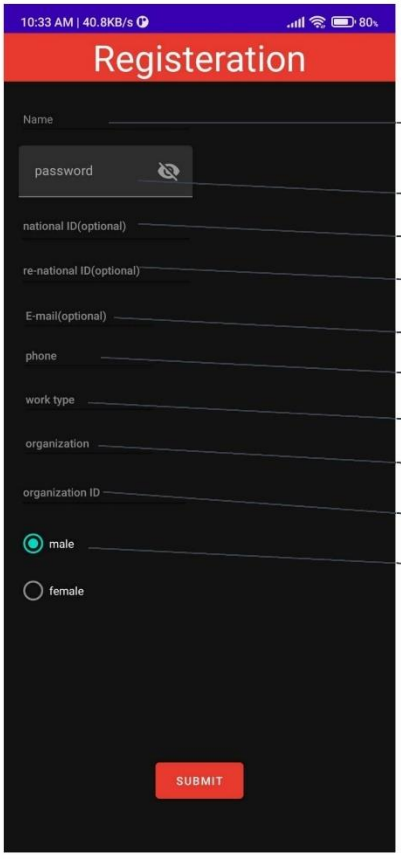


Adding new patient

view data of a specific patient

view the case of all ventilation session

logout when you done



type your name

type a unique password

type national ID in your card

re enter it

type your mail if exist

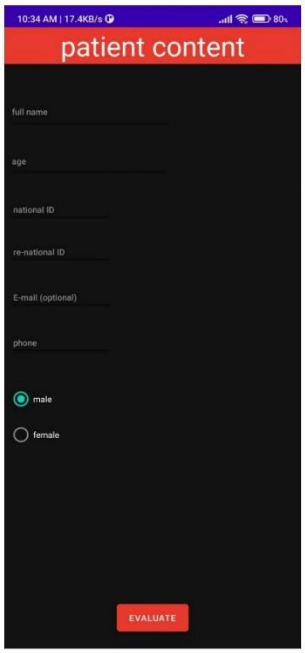
your phone home or work

your section in organization

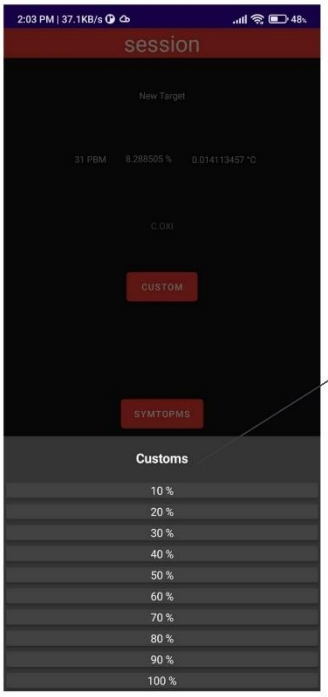
your organization or hospital

your organization ID

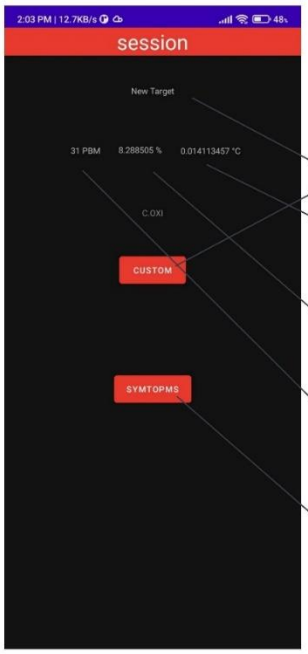
your gender



this page is most likely the registeration page of the doctor



list of percentage customization for ventilation it will be set on any reading values retrived for ventilation session



customize oxygen percentage for ventilation session

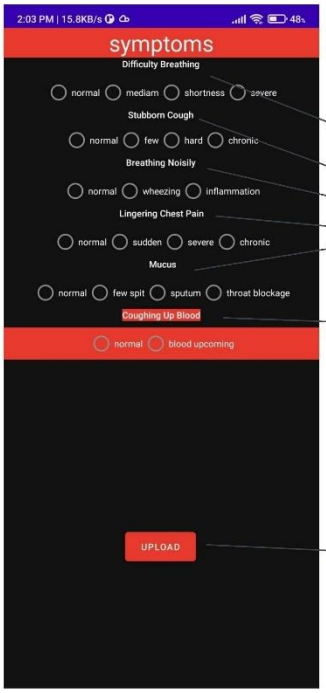
type of disease that patient had according to the parameters and calcualtion of the ventilator

getting TEMP of patient from hardware

getting OXI percentage of patient from hardware

getting BPM of patient from hardware

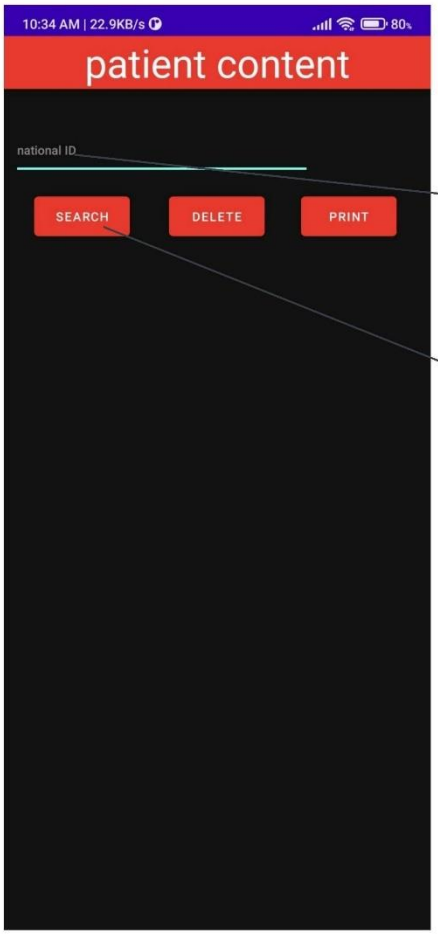
then go to symtopms activity to see the patient feature



those are the most common parameters of symptoms on any lung diseases

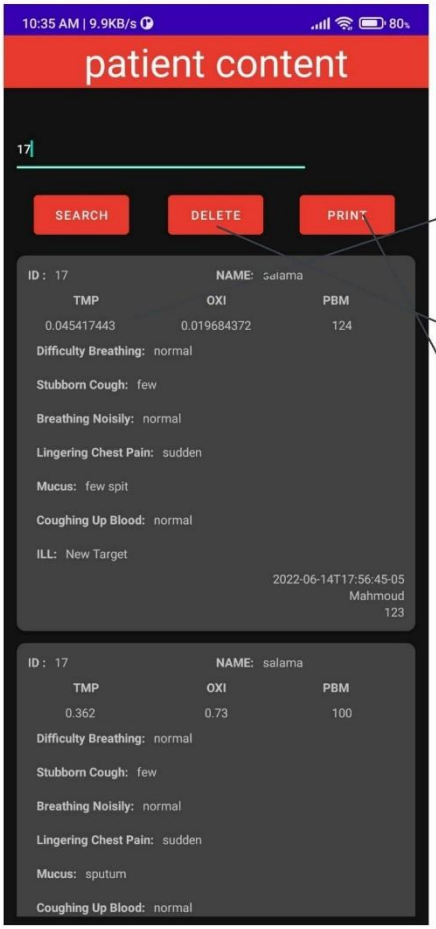
these symptoms means a severe case must go for surgery

after you done upload the session



here you want to search for a specific patient of his all ventilation sessions by his national ID

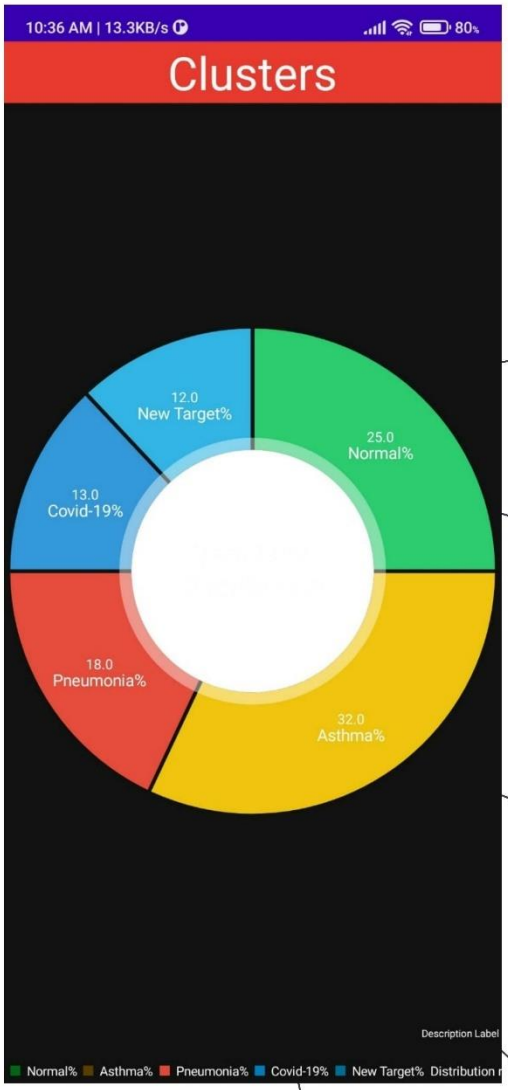
after you type it click search for it



this is the view of data file of all ventilation session of patient

you may selet to delete all of this patient session

or you can print it and the file as i showed before it will found on the download in the internal storage



this the most important part in the software that explain how the hardware and software integrated piechart of total 100%

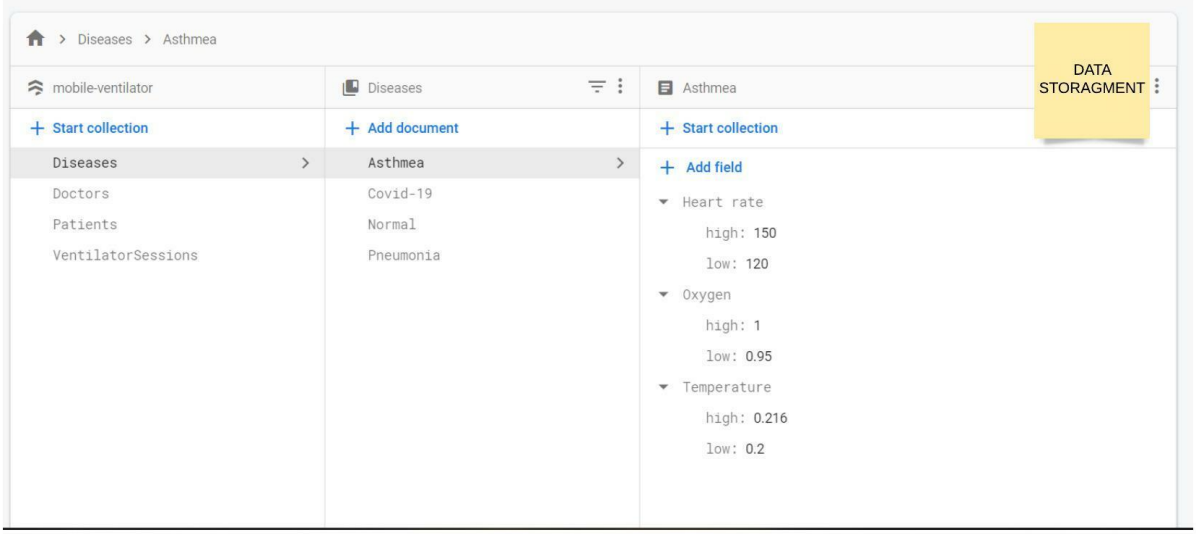
asthma percentage of the total number of ventilation sessions

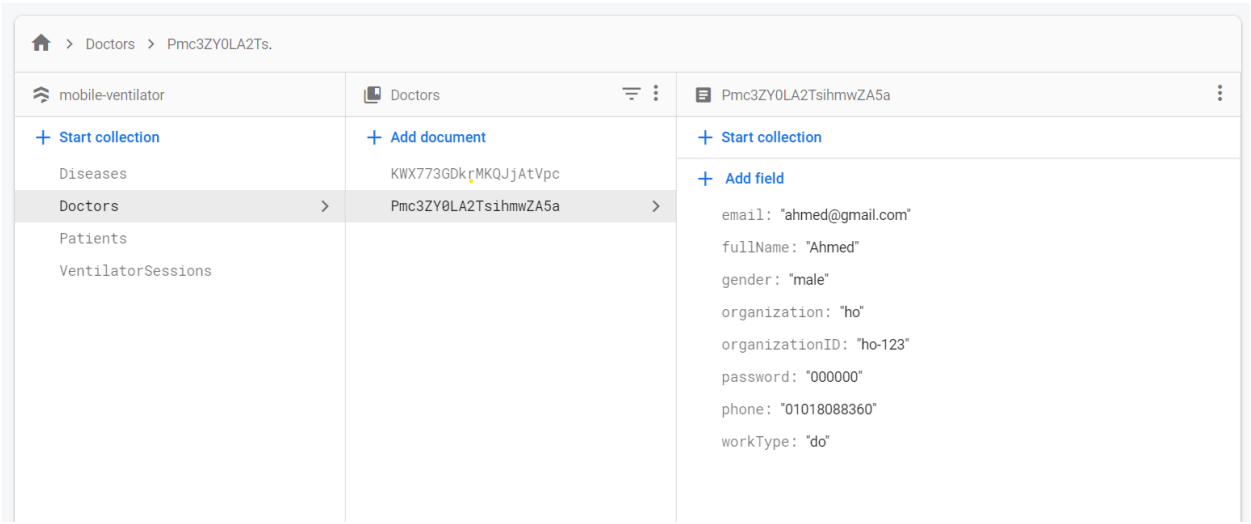
pneumonia percentage of the total number of ventilation sessions

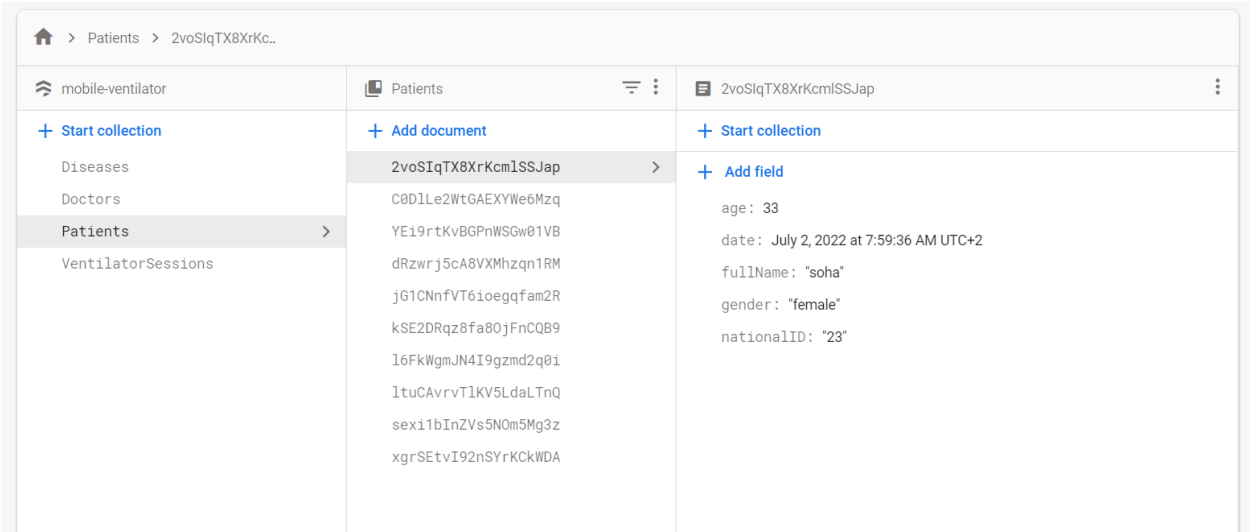
Covid-19 percentage of the total number of ventilation sessions

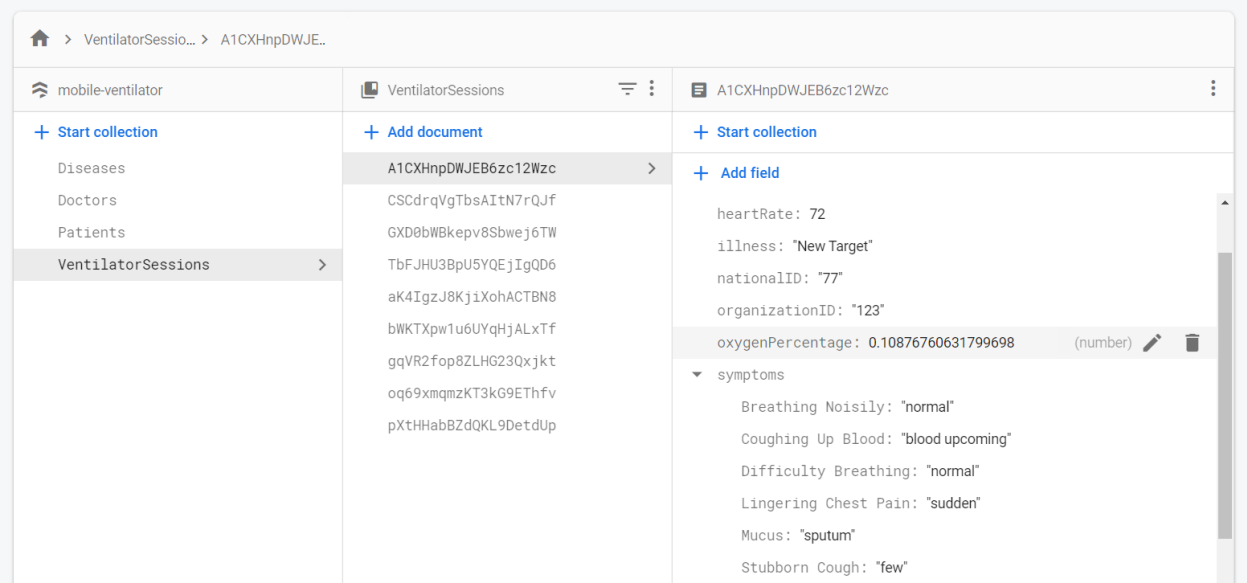
normal percentage of the total number of ventilation sessions

new target percentage of the total number of ventilation sessions this part means the session attribute out of bound of my internal data


Diseases > Asthmea
DATA STORAGMENT
mobile-ventilator
Start collection
Diseases
Doctors
Patients
VentilatorSessions
Diseases
Add document
Asthmea
Covid-19
Normal
Pneumonia
Asthmea
Start collection
Add field
Heart rate
high: 150
low: 120
Oxygen
high: 1
low: 0.95
Temperature
high: 0.216
low: 0.2


Doctors > Pmc3ZY0LA2Ts.
mobile-ventilator
Start collection
Diseases
Doctors
Patients
VentilatorSessions
Doctors
Add document
KWX773GDkrMKQJjAtVpc
Pmc3ZY0LA2TsihmwZA5a
Pmc3ZY0LA2TsihmwZA5a
Start collection
Add field
email: "ahmed@gmail.com"
fullName: "Ahmed"
gender: "male"
organization: "ho"
organizationID: "ho-123"
password: "000000"
phone: "01018088360"
workType: "do"


Patients > 2voSIqTX8XrKc..
mobile-ventilator
Start collection
Diseases
Doctors
Patients
VentilatorSessions
Patients
Add document
2voSIqTX8XrKcmlSSJap
C0DlLe2WtGAEXYWe6Mzq
YEi9rtKvBGPnWSGw01VB
dRzwrj5cA8VXMhzqn1RM
jG1CNnfVT6ioegqfam2R
kSE2DRqz8fa8OjFnCQB9
l6FkWgmJN4I9gzmd2q0i
ltuCAvrvTlKV5LdaLTnQ
sexi1bInZVs5NOm5Mg3z
xgrSEtvI92nSYrKCkWDA
2voSIqTX8XrKcmlSSJap
Start collection
Add field
age: 33
date: July 2, 2022 at 7:59:36 AM UTC+2
fullName: "soha"
gender: "female"
nationalID: "23"


VentilatorSessio...
A1CXHnpDWJE..
mobile-ventilator
Start collection
Diseases
Doctors
Patients
VentilatorSessions
VentilatorSessions
Add document
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CSCdrqVgTbsAItN7rQJf
GXD0bWBkepv8Sbwej6TW
TbFJHU3BpU5YQEjIgQD6
aK4IgzJ8KjiXohACTBN8
bWKTXpw1u6UYqHjALxTf
gqVR2fop8ZLHG23Qxjkt
oq69xmqmzKT3kG9EThfv
pXtHHabBZdQKL9DetdUp
A1CXHnpDWJEB6zc12Wzc
Start collection
Add field
heartRate: 72
illness: "New Target"
nationalID: "77"
organizationID: "123"
oxygenPercentage: 0.10876760631799698
(number)
symptoms
Breathing Noisily: "normal"
Coughing Up Blood: "blood upcoming"
Difficulty Breathing: "normal"
Lingering Chest Pain: "sudden"
Mucus: "sputum"
Stubborn Cough: "few"

Chapter 6

Conclusions and Future Work

6.1 Conclusions

- 1st we made I portable hardware ventilation with minimum cost and cheap print for the patient rather than the advanced one in the intensive care
- 2nd combining all information we want about the percentage of propagation of every diseases may be our firestore doesn't contains enough features that because it is a DEMO version of it not a final PRODUCT.
- 3rd we are able to collect multiple patient data trying to help then to share intension to whole over the across UNICEF or another organization trying to To advice how to avoid a specific type of disease according to the numerical data we calculated .
- 4th it may be a case study on machine learning algorithms for classification and making prediction on every type of disease in the future how it may effect on the human being and living organisms.

6.2 Future Work

SOFTWARE

1. We can extend our diseases data for all type of lung diseases and how can customizing he best fit oxygen percentage for the patient avoid errors for not hurting the patient or saving garbage data.
2. Inserting more visualizations chart for helping doctor that making decision on how can be this type of disease can effect on the patient.
3. Making the real BACKEND SOFTWARE with other developer that can handle the data error and also making a DISKTOP software for various attributes ,libraries ,ease ,reliability of sharing data or knowledge
4. Numerous future updates may be working on this type of products it just need a good management and development.

HARDWARE

1. We can diagnose s more diseases
2. Making the system more accurate by using servo motor instead dc motor (for accuracy)
3. Make the project cost effective

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