LUXOR UNIVERSITY

Faculty of Computers and Information

Fast Secured Emergency System

Luxor University
Faculty of Computers and Information
IT Department

Fast Secured Emergency System

Graduation Project, Part-1

Under Supervision

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ABSTRACT

The Guardian newspaper revealed that the death rate of injured inside the ambulance has increased in a year 2021 up to 160,000 per a year. This is because they are stuck outside hospitals. In addition, patients are also dying soon after finally being admitted to hospital after spending long periods in the back of the ambulance because there is little medical support from paramedics. Therefore, our aim is to build a fast and secured IOT system can gathering and monitoring the patient's status. Our proposed system will able to read data from sensors (body temperature, blood pressure sensor, heart rate pulse., etc.) to be encrypted and compressed. After that, the system will be able to send a secured data to the server system in the hospital to make decision remotely by specialist doctor. In the case that the specialist doctor does not respond, the Chatbot takes over.

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1.1 Abbreviations

IOT	Internet Of Things
SDF	Send Data to Firebase
RDF	Receive Data From Firebase
ECG	Electro CardioGram
SpO2	Pulse Oximeter
NIBP	Non-Invasive Blood Pressure
EEG	Electro EncephaloGram
EMG	Electro MyoGraphy
EOG	Electro OculoGraphy
PCG	Phono CardioGram
BT	Body Temperature
HHI	Human-Human Interface
ISO	International Organization for Standardization
GSM	global system for mobile telecommunications
GPS	global positioning system
ESP	Espressif modules
RFID	Radio-frequency identification
IEEE	Institute of Electrical and Electronics Engineers

MQTT	Message Queuing Telemetry Transport
MAS	Minimalist, Adaptive and Streaming
O-MAS-R	Optimization Minimalist, Adaptive and Streaming R-bit
PWM	Pulse Width Modulation
ICSP	In-circuit serial programming
PRE	proxy re-encryption
PRE-ET	proxy re-encryption with equality test
PCB	printed circuit board
IEC	International Electro-technical Commission

Chapter 1

Introduction

1.1 Motivation

We are encouraged to work on this project to help injured people and emergency cases before arriving at the hospital, as the death rate of injured inside the ambulance has increased in a year 2021 up to 160,000 per a year. This is because they are stuck outside hospitals. In addition, patients are also dying soon after finally being admitted to hospital after spending long periods in the back of the ambulance because there is little medical support from paramedics.

This Project is also relevant to our interests as it mainly involves two fields of computer Engineering like Embedded Systems, Network Programming and Security in General and Cryptography in Specific.

1.2 Aim of Project

The main mission of the system is trying to find the appropriate solution to the case as soon as possible in order to try to keep her alive until reaching the hospital and entering the emergency department and taking the exact measures of the case from specialized doctors.

Also, one of the most important risks that we try to avoid is the presence of non-professional or unauthorized persons to carry out medical procedures for the patient, whether by direct intervention or eavesdropping on the patient’s data while it is being sent to the hospital and manipulating it before reaching the hospital.

1.3 Paper Organization

The rest of the document is divided into three parts: Objectives, Implementation, and Testing. The Objectives chapter lists the need for building the system.

It provides use cases to help the business and technical users with their understanding. It also gives a detailed explanation for each use case to help with design and implementation, and outlines the constraints regarding the software. The Implementation chapter contains the detailed design of the system, including: -

The Context Diagram, Activity Diagram, Sequence Diagram, Flowchart Diagram and System architecture Diagram.

This chapter also includes a detailed explanation for each component as well as the interaction of the class and its components with each other when carrying out certain tasks, besides software's mock screenshots.

1.4 Introduction

Internet of Things (IOT) is the networking of physical objects that contain electronics embedded within their architecture in order to communicate and sense interactions amongst each other or with respect to the external environment. In the upcoming years, IOT-based technology will offer advanced levels of services and practically change the way people lead their daily lives. Advancements in medicine, power, gene therapies, agriculture, smart cities, and smart homes are just a very few of the categorical examples where IOT is strongly established.

IOT is network of interconnected computing devices which are embedded in everyday objects, enabling them to send and receive data.

Over 9 billion 'Things' (physical objects) are currently connected to the Internet, as of now. In the near future, this number is expected to rise to a whopping 20 billion.

Main components used in IOT:

-Low-power embedded systems: Less battery consumption, high performance are the inverse factors that play a significant role during the design of electronic systems.

-Sensors: Sensors are the major part of any IOT applications. It is a physical device that measures and detect certain physical quantity and convert it into signal which can be provide as an input to processing or control unit for analysis purpose.[1]

1.4.1 IOT & Healthcare

Internet of Things is an ever-expanding ecosystem that integrates software, hardware, physical objects, and computing devices to communicate, collect, and exchange data. The IOT provides a seamless platform to facilitate interactions between humans and a variety of physical and virtual things, including personalized healthcare domains. Lack of access to medical resources, growth of the elderly population with chronic diseases and their needs for remote monitoring, an increase in medical costs, and the desire for telemedicine in developing countries, make the IOT an interesting subject in healthcare systems. The IOT has a potential to decrease the strain on sanitary systems besides providing tailored health services to improve the quality of life.

Smart healthcare plays a significant role in healthcare applications through embedding sensors and actuators in patients and their medicine for monitoring and tracking purposes. The IOT is used by clinical care to monitor physiological statuses of patients through sensors by collecting and analyzing their information and then sending analyzed patient's data remotely to processing centers to make suitable actions. For example, Masimo
Radical-7 monitors the patient's status remotely and reports that to a clinical staff. Recently, IBM utilized RFID technology at one of OhioHealth's hospitals to track hand washing after checking each patient. That operation could be used to avoid infections that cause about 90 000 deaths and losing about $30 billion annually.

Generally, in the case of accidents someone has must intimate to the hospital for getting ambulance, but in the case of IOT whenever accidents are takes place, the wearable devices automatically give signal to nearest Wi-Fi router and then hospitals to get the ambulance, based upon her health conditions like heartbeats. IOT can be used to supplement patient treatment through remote monitoring and communication, and to keep track of patients as they move through a healthcare facility. Read on to discover the specifics of these IOT deployments.

Smart sensors, which combine a sensor and a microcontroller, make it possible to harness the power of the IOT for healthcare by accurately measuring, monitoring and analyzing a variety of health status indicators. These can include basic vital signs such as heart rate and blood pressure, as well as levels of glucose or oxygen saturation in the blood. Smart sensors can even be incorporated into pill bottles and connected to the network to indicate whether a patient has taken a scheduled dose of medication. [3]

1.4.2 Security & Healthcare

With the progress and the development of information technology, the internal data in medical organizations have become computerized and are further established the medical information system. Moreover, the use of the Internet enhances the information communication as well as affects the development of the medical information system that a lot of medical information is transmitted with the Internet. Since there is a network within another network, when all networks are connected together; they will form the "Internet".

For this reason, the Internet is considered as a high-risk and public environment which is easily destroyed and invaded so that a relevant protection is acquired. Besides, the data in the medical network system are confidential that it is necessary to protect the personal privacy, such as electronic patient records, medical confidential information, and authorization-controlled data in the hospital. [4]

As a consequence, a medical network system is considered as a network requiring high security that excellent protections and managerial strategies are inevitable to prevent illegal events and external attacks from happening. This study proposes secure medical managerial strategies being applied to the network environment of the medical organization information system so as to avoid the external or internal information security events, allow the medical system to work smoothly and safely that not only benefits the patients, but also allows the doctors to use it more conveniently, and further promote the overall medical quality.

The objectives could be achieved by preventing from illegal invasion or medical information being stolen, protecting the completeness and security of medical information, avoiding the managerial mistakes of the internal information system in medical organizations, and providing the highly-reliable medical information system.

1.4.3 Firebase

1.4.3.1 Firebase definition

- Firebase is a Backend-as-a-Service (Baas).
- Firebase is an app development platform that helps you build and grow apps and games users love. Backed by Google and trusted by millions of businesses around the world.
- Firebase is a new technology for managing large amounts random data. Very fast compared to RDBMS. This research paper focuses on usage of Firebase for Android and aims to familiarize itself with its functions, related concepts names, benefits and limitations. The paper also tries to show some nakedness Firebase features for building an Android app
- Google Firebase may be a Google-backed application development software that allows developers to develop IOS, Android and Web apps. Firebase provides tools for tracking analytics, reporting and fixing app crashes, creating marketing and products experiment.

1.4.3.1.1 The most important features of Firebase

- **Real-time Database** − Firebase supports JSON data and all users connected to it receive live updates after every change.

- **Authentication** − We can use anonymous, password or different social authentications.
- **Hosting** − The applications can be deployed over secured connection to Firebase servers.

1.4.3.1.2 Firebase Advantages

- It is simple and user friendly. No need for complicated configuration.
- The data is real-time, which means that every change will automatically update connected clients.
- Firebase offers simple control dashboard.
- There are a number of useful services to choose.

1.4.3.1.3 Firebase Limitations

- Firebase free plan is limited to 50 Connections and 100 MB of storage.

In the next chapter, we will discuss the environment setup of Firebase.

Firebase - Environment Setup

In this chapter, we will show you how to add Firebase to the existing application. We will need **NodeJS**. Check the link from the following table, if you do not have it already.

Sr.No.	Software & Description
1	**NodeJS and NPM** NodeJS is the platform needed for Firebase development. Check-out our NodeJS Environment Setup.

1.4.3.2 Firebase METHODOLOGY

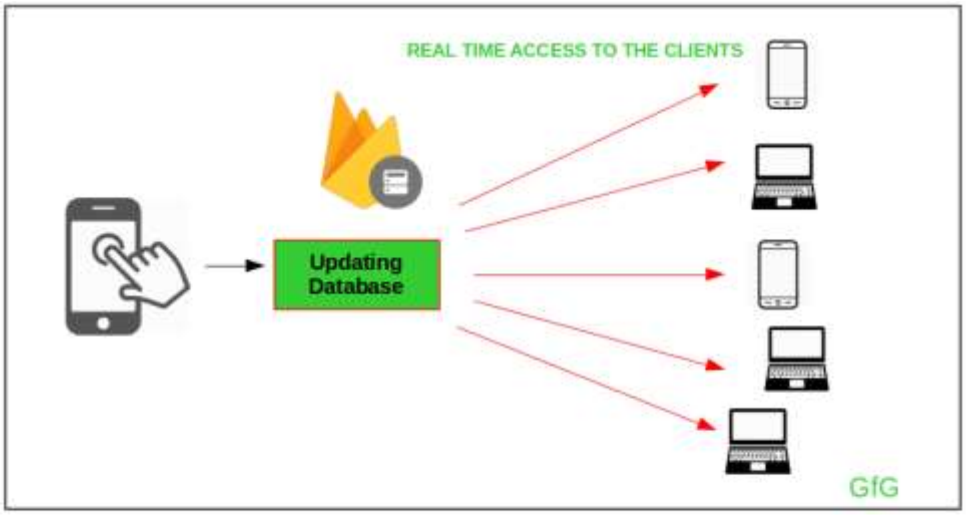
Firebase offers variety of services, including:

Analytics – Google Cloud Analytics for Firebase offers free, unlimited reporting's on as many as 500 or more separate events. Statistics present content on user behavior in IOS and Android applications to enable best decision-making about improving an application performance and marketing

Authentication: Firebase authentication makes it easy for developers to protect authentication systems and improves login and boarding experience for users. This the feature offers an all-in-one identity solution, supporting email accounts and password, phone auth, moreover like Google login, Facebook, GitHub, Twitter and more. More about Authentication in 1.4.3.4

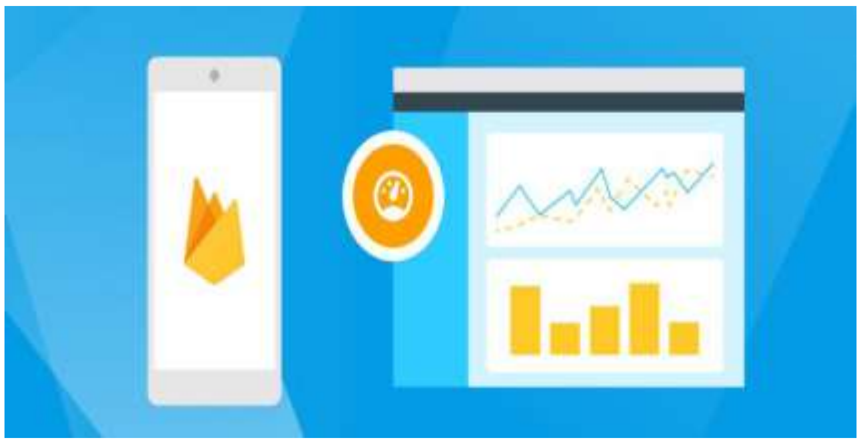
Cloud Messaging: Firebase Cloud Messaging (FCM) may be various messaging tool allowing companies to trust and receive messages on IOS, Android and therefore the web at no cost.

Real-time Database: The Firebase Real-time Database may be a cloud-based NoSQL site that allows data to be stored and synchronized between users in real time. Information is synced to all clients in real time and is always available when the app is offline.



Crashlytics: Firebase C rashlytics may be a real-time crash journalist assisting engineers track, prioritize and fix problems that diminish the quality of their applications. With Crashlytics, engineers spend less time planning and resolving crashes and long construction features for his or her apps.

Performance: The Cloud-Firebase Performance Monitoring feature provides developers with an understanding of application features of their IOS and Android apps to help them decide where to reach and when the performance of their applications is improved.



1.4.3.3 Firebase Use Cases:

Conditions for using Firebase include:

Create on boarding flows: Developers can provide users with a fast, intuitive login process Firebase Verification. allow users to sign in to their apps via Google, Twitter, Facebook or GitHub accounts in but five minutes. Engineers can track each step their ride flow to enhance user experience. Additionally, engineers can

use it Google Analytics Firebase entry events for each step flow ride, create panels to see where users are leaving and using the remote control adjusting to make changes to their operating systems to determine how those changes affect them conversion.

Customize a "welcome back" screen: Engineers can use it to make it your own to stop everything user very easy experience customizable first user-supported screen favorites, usage history, location or language.

Engineers can explain by audience, by section, in user behavior and display targeted content to all audiences.

Gradually unleash new features: Developers can launch new features.

Progressively roll out new features: Developers can introduce new low-risk features by first testing those features in some users to determine how they operate and how users respond. Then, If the engineers are satisfied.

In June 2018, mobile security company Appthority reported thousands of IOS and Android devices mobile applications exposing more than 113 GB of information about 2,271 unprepared Firebase database. As of January 2018, Authority researchers are scanning Android applications that use Firebase systems to store users data or content and updated communication patterns for applications made on Cloud-Firebase domains.

After scanning more than 2.7 million Android and IOS apps, researchers identified 28,502 mobile apps (1,275 IOS and 27,227 Android) that connected and stored data within the Firebase background. Of these, 3,046 apps (600 IOS and pear, 446 Android) store data within 2,271 Firebase poorly designed websites that give anyone the ability to view their content.

The database revealed more than 100 million user data records, including the actual LinkedIn, Firebase, Facebook and company data store tokens; 25 million GPS location records; more than 4 million health information records are protected, such as medical information and chat messages; 2.6 million User IDs and passwords; and 50,000 financial records, including payments, banking and transactions for Bit coin.

Pricing:

Firebase offers a free 1 GB real-time data storage system and two paid subscriptions plans: Flame Plan ($ 25 per month with 2.5 GB of storage) and Blaze Plan (pay-as-you-go, $ 5per GB per storage). All programs include A / B testing, statistics, application identification,

authentication (without phone auth), cloud messaging, Crashlytics, dynamic links, invitations, functionality monitoring, forecasting and remote preparation. The main differences between programs include real-time shared storage website, number of download tasks, Cloud
Firestone bandwidth and more. Internet of Things Engineers share many common usage requirements across a wide range of IoT applications. Data collection, delivery of content with low latency, and to prevent communication between devices and back-up services there are only three of these common requirements.

While meeting common needs are often challenging from time to time, IoT development platforms like Google Firebase provide services and functionality that allows developers to satisfy many of those requirements.

Benefits of Google Firebase:

The Firebase platform as a service includes a NoSQL document data store. Applications store data as JSON objects and interact with the database employing a JavaScript API. Mobile or Android developers have the option of using Android or IOS APIs, too. The information store is intended to scale with application demand,
so there's no have to add servers, partition data or perform other database administration that comes together with maintaining your own database rear. The REST full API includes queries operations but not SQL operations. The query API is ready-made to figure with channels of information. for instance, the "on" operation listens for changes in location and invokes a callback Function if a selected event occurs. There also are queries and operators with SQL-equivalents, like order-By-Key, order-By-Value and order-By-Priority. The limit, limit-
To-First and limit-To-Last query operations can restrict the amount of JSON documents

returned by the query.

In addition to storing dynamic contents within the firebase store, developers can store static content that it will be required within the app in a Firebase managed service. Way of providing static content storage is the same as installing a website; Firebase will do verify domain ownership, provide an SSL certificate and use it throughout Firebase content delivery network. Finally, name service records must be updated to become a map the name of your hosted site.

Another advantage of Firebase is that it provides support for offline operation. Website functions are locally recorded and synchronized with the Firebase site when a network connection is established. Google Firebase includes mobile data protection controls at rest. Data is transmitted using SSL / TLS 2048-bit encryption, and within the site, users are authenticated and may be restricted to certain functions using a set of security rules. Firebase authentication uses an existing login server or client side code. Firebase supports currently usernames / password login such as social login resources like Google, Twitter and Facebook. Custom code can be used if you would like to receive your tokens. In the case of users or in the case of IOT, devices - already authorized, security rules govern the activities they will perform and the data they will access. Safety rules support reading / writing performance, integrated can expect, moreover as a guaranteed job. this can usually determine the correct format of the information element and its data type. New apps automatically provide full read / write access to the site; engineers should ensure that they review safety rules to limit the performance and breadth of information the tool can use. Attackers can gain multiple or higher rights to compromise the integrity or confidentiality of information within a data store.

Google Cloud Firebase provides six price categories with its different services: - Free, Spark, Candle, Bonfire, Blaze and Inferno. Sans Free tier, price from $ 5.00 / month on Spark to $ 1,499.00 / month on Inferno. Three to six stages all include unlimited real-time internet connection support with users, additionally as 1 TB data transfer. The biggest difference between categories is reflected in the final volume of real-time data and transfer grants. Spark, for example, offers 1 GB of storage and 10 GB of transmission while Inferno, the leading tier, offers 300 GB of storage space and allows up to 1.5 TB of transfer data. the three most advanced categories also offer non-public backup options to customers.

Drawbacks Of Google-Firebase:

Firebase is very useful for IOT apps that use data that can use the JavaScript API to access Content and security services. However, developers should look to other tools to increase the back-end performance of their IOT system. Basic server side processing is provided, but more advanced analysis may require uploading IOT data to a different location, such as Hadoop or Spark.

Another challenge is that the Firebase query function is limited. If you need more advanced query functions, consider sending data to an Elastic Search server or collection for more search options. In addition, if visibility and alerts are important when monitoring information distribution, consider tools such as Kibana, Elastic search data display.

1.4.3.4 Firebase Authentication

Most apps need to know the identity of a user. Knowing a user's identity allows an app to securely save user data in the cloud and provide the same personalized experience across all of the user's devices.

Firebase Authentication provides backend services, easy-to-use SDKs, and ready-made UI libraries to authenticate users to your app. It supports authentication using passwords, phone numbers, popular federated identity providers like Google, Facebook and Twitter, and more.

Firebase Authentication integrates tightly with other Firebase services, and it leverages industry standards like OAuth 2.0 and OpenID Connect, so it can be easily integrated with your custom backend.

When you upgrade to Firebase Authentication with Identity Platform, you unlock additional features, such as multi-factor authentication, blocking functions, user activity and audit logging, SAML and generic OpenID Connect support, multi-tenancy, and enterprise-level support.

Firebase Authentication with Identity Platform

Firebase Authentication with Identity Platform is an optional upgrade that adds several new features to Firebase Authentication.

This upgrade does not require any migration—your existing client SDK and admin SDK code will continue to work as before, and you'll gain immediate access to features such as enhanced logging and enterprise-grade support and SLAs. With some additional code, you'll be able to add multi-factor auth, blocking functions, and support for SAML and OpenID Connect providers.

Firebase Authentication with Identity Platform has a different pricing scheme compared to the base product. When upgraded, no-cost (Spark) plan projects will be limited to 3,000 daily active users, and pay-as-you-go (Blaze) plan projects will be charged for usage beyond the free tier of 50,000 monthly active users. Be sure you understand the billing implications before you upgrade.

Features:

Multi-factor authentication	Multi-factor authentication with SMS protects your users' data by adding a second layer of security to your app. Learn how to add MFA to your Apple, Android, and web apps.
Blocking functions	Blocking functions let you run custom code that modifies the result of a user registering or signing in to your app. Learn how to extend Firebase Authentication with blocking functions.
SAML and OpenID Connect providers	Support sign-in using SAML (web only) and OpenID Connect providers not natively supported by Firebase. Learn how to add SAML sign-in to web apps and OpenID Connect sign-in to Apple, Android, and web apps.
User activity and audit logging	Monitor and log administrative access and end-user activity. When you upgrade your project, you automatically enable admin activity audit logs in Cloud Logging. You can also enable user activity logging on the Authentication Settings page of the Firebase console. To learn how to view and analyze your logs, see the Cloud Logging documentation.
Abuse prevention with App Check	App Check helps protect your project from abuse by preventing unauthorized clients from accessing your auth endpoints. To learn how to enable App Check, see the App Check documentation.
Multi-tenancy	Using tenants, you can create multiple unique silos of users and configurations within a single project. See Getting started with multi-tenancy in the Cloud Identity Platform documentation.
Enterprise support and SLA	Upgraded projects get uptime guarantees for Auth services according to the Identity Platform Service Level Agreement (SLA) and access to enterprise-grade support.
Automatic clean-up of anonymous users	You will get the option to enable anonymous accounts to be automatically deleted if they are over thirty days old. Anonymous accounts also will no longer count towards billing and usage quotas.

1.5 Related Works

1. IOT as a service:

Chao Li *, Xiang Pei Hu, Lili Zhang (2017) did a an IOT-based heart disease monitoring system for pervasive healthcare system that can send patient's physical signs to remote medical applications in real time The system is mainly composed of two parts: the data acquisition part and the data transmission part. The monitoring scheme (monitoring parameters and frequency for each parameter) is the key point of the data acquisition part,

and we designed it based on interviews to medical experts. Multiple physical signs (blood pressure, ECG, SpO2, heart rate, blood fat and blood glucose) as well as an environmental indicator (patients' location) are designed to be sampled art different rates continuously.

Four data transmission mode are presented taking patients' risk, medical analysis needs, demands for communication and computing resource int consideration. Finally, a sample prototype is implemented to present an overview of the system. (25)

2. System data and semantification

From big data to smart energy services: An application for intelligent energy management *"VangelisMarinakisa & HarisDoukas"(September 2020).* This paper proposes a high-level architecture of a big data platform that can support the creation, development, maintenance

and exploitation of smart energy services through the utilisation of cross-domain data. The proposed platform enables the simplification of the procedure followed for the information gathering by multiple sources, turning into actionable recommendations and meaningful operational insights for city authorities and local administrations, energy managers and consultants, energy service companies, utilities and energy providers. A web-based Decision Support System (DSS) has been developed according to the proposed architecture, exploiting multi-sourced data within a smart city context towards the creation of energy management action plans. The pilot application of the developed DSS in three European cities is presented and discussed. This "data-driven" DSS can support energy managers and city authorities for managing their building facilities' energy performance. (26)

3. Healthcare system

Smart Road Accident Detection and Communication System

In authors have developed a hardware system to detect car accidents with the help of sensors. The accident is detected by a vibration sensor and gyroscope sensor and immediately emergency contact numbers are notified with the GSM module. Also, the exact location is recognized by the GPS module. Here, gyroscope sensors are used to measure the tilt and lateral orientation of the car, and vibration sensors are used to measure the amount and frequency of vibration of a given object. When the vehicle gets collided, vibrations are produced. Vibrations are detected when they exceed the maximum threshold value of the vibration sensors. Likewise, if the vehicle doesn't hit but only rotates or tilts by any large angle the system will detect the accident from the gyroscope sensor. A heart rate sensor is also used to detect the variations in the heart rate of the driver only when the accident happens. This helps hospitals to know about the driver's condition and therefore they can proceed to help the driver. (27)

4. Biomedical sensors with IOT

Norbahiah Misran, Mohammad Shahidul Islam and others published a paper in (2020) for their project about "IOT Based Health Monitoring System with LoRa Communication Technology" Supporting sensors integrated with IOT healthcare can effectively analyse and gather the patients' physical health data that has made the IOT healthcare ubiquitously acceptable.

The continuous presence of the healthcare professionals and staff as well as the proper amenities in remote areas during emergency situations need to be addressed for developing a flexible IOT based health monitoring system. Development of IOT based health monitoring system allows a personalized treatment in certain circumstances that helps to reduce the healthcare cost and wastage with a continuous improving outcome. We present an IOT based health monitoring system using the My Signals development shield for Arduino Uno. Evaluating the performances and effectiveness of the sensors and wireless platform devices are also the aim of the project. My Signals enables multiple sensors such as temperature, ECG, oxygen saturation and pulse rate to gather the physical data. The aim is to transmit the gathered data from My Signals to a cloud or pc by implementing a wireless system with LoRa. The results show that My Signals is successfully interfaced with the ECG, temperature, oxygen saturation and pulse rate sensors. 36.5-37.5°C body temperature, 60-100 bpm pulse rate, and 96-99% oxygen saturation have been experimented with confidence interval approximation of 95%, 99% and 99%, respectively. The communication with the hyper-terminal program using LoRa has been implemented and an IOT based health monitoring system is being developed in My Signals platform with the expected results getting from the sensors. (28)

5. Intelligent Semanticification Rules Enabled User-Specific Healthcare Framework Using IOT and Deep Learning Techniques

Things or device under the Internet of Things, when connected to the internet, becomes a product, offers various applications and services for end-users. Existing methodologies offer sensor-based IOT based health-care services, to the end-users populated with lots of sensed values all at a time, making the health-care system with least robustness and inefficient due to unsystematic preview of patient's health record. In order to address this issue, a novel semantic-based service framework is proposed in this paper which allows the end user to subscribe for a specific physiological parameter, among all the available sensed data, making the health-care system more efficient. In the SeSem framework, Semantification rules and semantification relationship table are applied to the sensed JavaScript object notation format (JSON) data, in order to semantically separate the JSON data, into a meaningful format. To list the sensed data according to the significance of health issues, a priority is assigned to the sensors in the semantification relationship table. Hence, semantically separated data can be done along with assigned priority. Sensor-based sematic ontology is then applied to the semantically separated data, to transform the sensed data more relevant in terms of particular disease and sensor associated with it. The semantically separated sensed data are then published to the message queuing telemetry transport (MQTT) interface. Using MQTT subscribe, the end-user along with date and time, requests for a particular service, using a Semantic Similarity mapping algorithm, which compares the entire sensed data to that of requested data and responds with a particular physiological parameter request. To make the health care system deploy services in an intelligent way, deep learning algorithm Feedforward Recurrent Neural Networks are applied, which makes the prediction of sensed data based on the latest update when the end-user subscribes for a certain sensed data without specifying date and time. The proposed methodology is evaluated against IOT performance metrics which had shoed showing better results in terms of service-oriented IOT. (31)

6. Internet of Things in Emergency Medical Care and Services

Emergency care is a critical area of medicine whose outcomes are influenced by the time, availability, and accuracy of contextual information. In addition, the success of emergency care depends on the quality and accuracy of the information received during the emergency call and data collected during the emergency transportation. The success of a follow medical treatment at an emergency care unit depends too on data collected during the two phases: emergency call and transport. However, most information received during an emergency-call is inaccurate and the process of information collection, storage, processing, and retrieval, during an emergency-transportation, is remaining manual and time-consuming. Emergency doctors mostly lack patient’s health records and base the medical treatment on a set of collected information including information provided by the patient or his relatives. Hence, the emergency care delivery is more patient-centred than patient-centric information. Wireless body area network and Internet of Technology (IOT) enable accurate collection of data and are increasingly used in medical applications. This chapter discusses the challenges facing the emergency medical care services delivery, especially in the developing countries. It presents and discusses an IOT platform for a patient-centric-information-based emergency care services delivery. The study is focused on a case of road traffic injury. Results of conducted experiments are discussed. Keywords: emergency medical care, Internet of Health Things, road congestion, pervasive/ubiquitous computing, road traffic injury.(32)

1.6 The Essential Question:

The essential question with relevance to the Vision and Mission of the Faculty of Computers and information at Luxor University would be: How Can we, using our education and extra tools and technologies build an IOT Emergency system that play a vital role in emergency department in hospitals to save the lives of many people who do not find an emergency response to their disease and also the necessary health care.

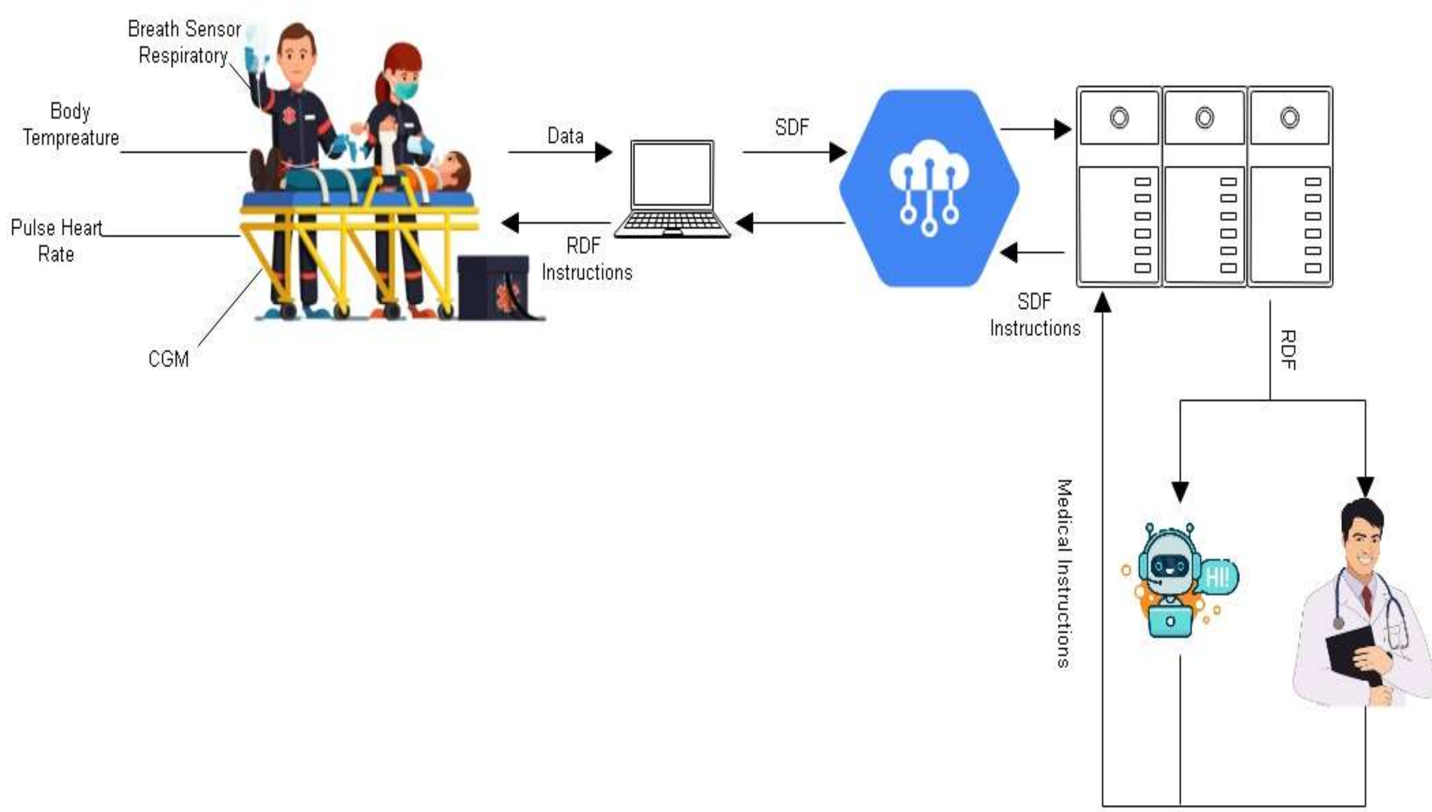


Figure 1. System Architecture

1.7 Biomedical Sensors and other component

We use a smart IoT health Lab practice equipment with IoT technology. It is capable of analyzing up to 13 types (11 basic types) of biomedical signals and transmitting or receiving the data through Wi-Fi or Bluetooth. It also can be remotely monitored from PC and Smart Phone through Hybrid Web.

Product Features

It is possible to learn about implementation and analysis of measurement algorithm based on principle of bio-signal.

Measurement of up to 13 sensors is available including 2 options of GSR and DUST in addition to the basic 11 sensors such as ECG, EEG, EMG+HHI, EOG, PCG, Respiration, NIBP, BT, SpO2, HR and Bio-impedance.

It is convenient to monitor measurement data using 10.1 inch electrostatic touch LCD.

Each sensor module has a rechargeable battery and can be linked with Wi-Fi and Bluetooth.

AVR MCU with Arduino is applied to the sensor module and the receiving module for more various exercises.
In addition to the basic 11 sensor modules, you can select and use additional modules depending on the learning purpose.
Measured sensor values can be monitored on PC and Smart Phone through Hybrid Web.
Provides SMS and e-mail service for specific sensor values by using alarm process and IFTTT.
Supports interface linked with Android and Arduino for comprehensive application practice.
Supports both on-board type and module type at the same time.

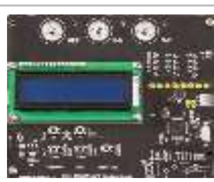
Hardware & Software Specifications

Module	Category	Specifications
10.1 inch Touch LCD	DISPLAY	HDMI 1280x800 IPS Touchscreen
Raspberry Pi 4	CPU	Broadcom BCM2711 1.5Ghz Cortex-A72 quad-core
	Bluetooth	Ver 5.0
	Ethernet	10/100 BaseT
	Wi-Fi	802.11 n
	Storage	Micro-SD
	USB	USB 2.0 2ports, USB 3.0 2ports
	HDMI	HDMI 2 * micro HDMI
Software	Raspberry pi	- Raspbian : Nov 2018 - Kernal : 4.14.98-v 7+ - GCC : 6.3.0
	Server	- Lighttpd : 1.4.45 - PHP : 7.0.33-0+deb9u 3

- Data Collecting Part

Module	Category	Specifications
DAQ	MCU	ATMEGA2560
	Memory	256KB Flash
	Bootloader	Arduino
	Clock Speed	Up to 16MHz
	Debug	SWD & USB
	External ADC	4ch
BLUETOOTH	MCU	ATMEGA2560
	Memory	256KB Flash
	Bootloader	Arduino
	Clock Speed	Up to 16MHz
	Debug	SWD & USB
	Bluetooth	V2.0 UART 9600bps

- ECG Signal Generating Part

Module	Category	Specifications
Biological Signal Generator	Display	LCD
	Button	5EA
	Electrode	3EA
	ECG Rate	80BPM
	Amplitude	1mV
	Accuracy	+-5%

- Bio-Signal Measuring Part

Module	Category	Specifications
Controller	MCU	ATMEGA2560
	Memory	256KB Flash
	Bootloader	Arduino
	Clock Speed	Up to 16MHz
	Debug	SWD & USB
	Bluetooth	V2.0 UART 9600bps
	Supply Voltage	3.7v 500mAh Li-Poly Battery
1. EOG	Measurement Contents	Eye Conduction
	Number of Electrodes	3 Points
	Measurement Range	10mV ~ 30mV
	Filter	Low-pass : 4.5Hz High-pass : 0.5Hz
	Supply Voltage	+-5V
2. PCG	Measurement Contents	Phonocardiogram
	Measurement Sensor	Condenser Mic
	Listening Method	Head-Phone
	Filter	Low-pass : 100Hz High-pass : 0.5Hz
	Supply Voltage	+-5V
3. EMG	Measurement Contents	Electromyogram
	Number of Electrodes	3 Points
	Gain	10,350x
	Differential Input Voltage	2~5mV
	Supply Voltage	+-5V
4. HHI	Measurement Contents	Human Interface
	Number of Electrodes	2 Points
	Output Voltage	220V, 15mA
	Supply Voltage	Li-Poly 3.6V Battery
5. ECG	Measurement Contents	Electrocardiography

	Measure Point	3 Points
	ADC Resolution	24Bits
	Sample rate (Max)	8kSPS
	Input type	Differential, Single-Ended
	Supply Voltage	3.3V

• Bio-Signal Measuring Part

Module	Category	Specifications
6. NIBP	Measurement Contents	Blood Pressure
	Measurement Method	Cuff wearing
	Measurement Range	Pulse Rate : 40~200bpm Systolic Pressure : 60~250mmHg Diastolic Pressure : 40~200mmHg
	Supply Voltage	5V, 12V
7. BT	Measurement Contents	Body Temperature
	Measure	Infra Red Thermometer
	Measurement resolution	0.02℃
	Measure range	-40℃ ~ +125℃
	Power supply	3.3V
8. SpO2	Measurement Contents	Pulse oximeter
	Measure	Optical biosensing
	ADC Resolution	22bit
	Heart rate monitor	
	Power supply	1.8V, 3.3V
9. Respiration	Measurement Contents	Respiration
	Measurement Point	3Points
	ADC Resolution	24Bits
	Sample rate (Max)	8kSPS
	Input type	Differential, Single-Ended
	Power supply	5V
10. Bio-Impedance	Weight-scale measurement	
	Body composition measurement	
	Measure Point	2Points
	Measurement Range	100Ohm ~ 1KOhm
	Accuracy	±1%
	Frequency	Single Frequency(>60hz)
	Power supply	5V
11. EEG	Measurement Contents	Electroencephalogram
	Number of Electrodes	3 Points
	Band width	0.1~50Hz
	Filter	Hi-pass (0.1Hz), Low-pass (50Hz), Notch (60Hz)
	Measurement Range	0.1~3.3V
	Supply Voltage	5V

Chapter 2

Requirement Analysis and Techniques

2.1 Introduction

Project requirements are conditions that must be completed to ensure the success or completion of the project. They provide a clear picture of the work that needs to be done. They are meant to align the project's resources with its objectives. The benefits of effectively gathering project requirements include cost reduction, higher project success rates, more effective change management, and improved communication among stakeholders. For these reasons, in this deliverable, we agreed to consider the following definitions of ISO for requirements elicitation:

- "A requirement is statement that identifies a product (includes product, service, or enterprise) or process operational, functional, or design characteristic or constraint, which is unambiguous, testable or measurable, and necessary for product or process acceptability." (ISO/IEC, 2007)
- "A requirement is a statement that identifies a system, product or process characteristic or constraint, which is unambiguous, clear, unique, consistent, stand - alone (not grouped), and verifiable, and is deemed necessary for stakeholder acceptability." (INCOSE, 2010)

Following the guidelines defined by the mentioned ISO Standards, the characteristics of good requirements are the following:

1. **Necessary**: The requirement defines an essential capability, characteristic, constraint, and/or quality factor. If it is not included in the set of requirements, a deficiency in capability or characteristic will exist, which cannot be fulfilled by implementing other requirements.

2. **Appropriate**: The specific intent and amount of detail of the requirement is appropriate to the level of the entity to which it refers (level of abstraction). This includes avoiding unnecessary constraints on the architecture or design to help ensure implementation independence to the extent possible.
3. **Unambiguous**: The requirement is concisely stated. It expresses objective facts, not subjective opinions. It is subject to one and only one interpretation.
4. **Complete**: The requirement sufficiently describes the necessary capability, characteristic, constraint, or quality factor to meet the entity need without needing other information to understand the requirement.
5. **Singular**: The requirement should state a single capability, characteristic, constraint, or quality factor.
6. **Feasible**: The requirement can be realized within entity constraints (e.g., cost, schedule, technical, legal, or regulatory) with acceptable risk.
7. **Verifiable**: The requirement is structured and worded in such a way that it is possible to verify its accomplishment, as well as the degree of customer's satisfaction regarding its realization.
8. **Correct**: The requirement must be an accurate representation of the entity need.
9. **Consistent**: The requirement does not contradict any other requirement and is fully consistent with all authoritative external documentation.
10. **Comprehensible**: The set of requirements must be written such that it is clear as to what is expected by the entity and its relation to the system of which it is a part.

In this section, a methodology for requirements elicitation is defined to support the design of the IOT environment of the ICONET PI platform.

2.1.1 Types of requirements

Figure 2 depicts the hierarchy of the main types of requirements to be elicited in a project. In this scenario:

1. **Business requirements** describe why the organization is undertaking the project. They state some benefits that the developing organization or its customers expect to receive from the product. Regarding the ICONET project, the "Business requirements" of the IOT layer derives directly from the general scope of the project, thus they are not considered within this deliverable.
2. **User requirements**, often referred to as user needs, describe what the user does with the system, such as which activities users must be able to perform. User requirements are generally used as the primary input for creating system requirements. For this reason, they must be clearly defined, thus providing enough information to guide the project toward the complete fulfilment of the identified needs. Within the case of ICONET project, the "User requirements" will highlight the issues and the needs of remote monitoring of the goods along the logistics chain.
3. **System requirements** are the building blocks developers use to build the system. These are the traditional "shall" statements that describe what the system "shall do." A functional requirement specifies something that users' needs to perform their work. For example, a system may be required to enter and print cost estimates. For these reasons, the system requirements are expressed in technical language, describing a set of system functions in a measurable manner, thus forming the basis for system realization.

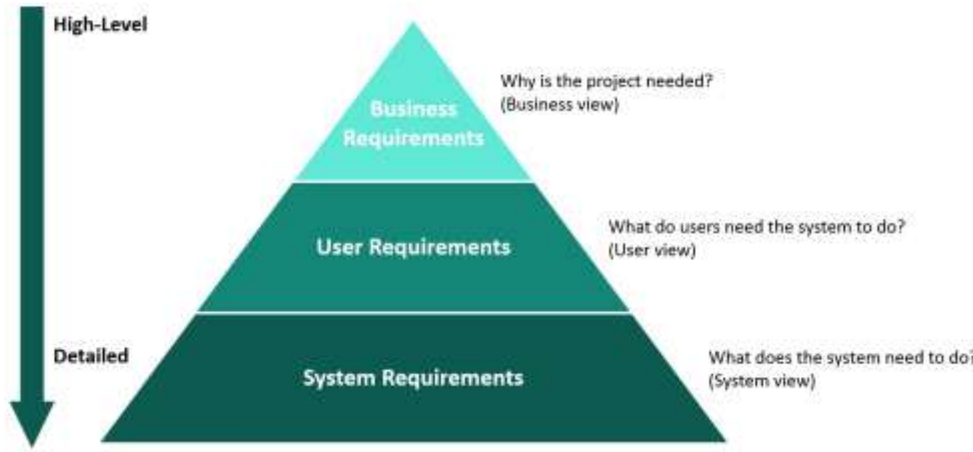


Figure 12. Requirements Hierarchy

To simplify the understanding of the elicitation process, we have divided the requirements in two sections:

1. Sec. 4 - Key drivers and Business requirements where the business requirements are elicited , as well as authorities and policy makers imperatives and high level technology needs are detailed.
2. Sec. 6 - Technical requirement: user and system requirement, where the user and system requirements are elicited, supported by the technical and market information provided in Sec. 5 - State of the Art

2.1.2 Recipients of this document

To implement an effective requirements' elicitation procedure, we need to identify the recipients of our findings regarding IOT between the stakeholders involved in the realisation of the PI grand-challenge but also the external users. In fact, one of the main objective of this document is to realise a blueprint capable to explain the importance of IOT, seen as a PI enabler, thus to support the digitalisation and to optimisation of the logistics processes, making these sustainable, low cost, efficient and reliable (Montreuil,

2011) , thus realising the Zero Emission Logistic chain (SENSE project , 2020). In this scenario, an in depth analysis of the recipients of this document has to be performed to understand the stakeholders that can contribute to the requirement elicitation, as well as can exploit the results of this document: in the following section the categories of recipients are analysed in detail, highlighting their roles and interests in the realisation of an IOT-enabled PI environment.

2.2 Requirement Analysis

2.2.1 Project perspective

2.2.1.1 User perspective:

The two interface types found in our project (fast and secure emergency system)

1. paramedics interface:

   The paramedics can use their interface to enter the patient's data before sending it to the doctor in the hospital, and they can also receive through it the instructions that the doctor sent to be applied to the wounded

2. doctor interface:

   The doctor can receive data from the paramedics and readings from the sensors through his interface, and also send instructions to the paramedics

2.2.1.2 hardware perspectives:

The project relies mainly on hardware more than software, as it consists of the following components:

1. **Sensors:**

2.1.1 ECG: When the heart is beating, the minute action potential difference in the myocardium is measured by the electrode attached to the body surface

2.1.2 SPo2: The percentage of hemoglobin concentration that contains oxygen to the concentration of total hemoglobin in the blood stream is measured by optical method.

2.1.3 EEG: electrical signals from the brain's electrical activity are measured non-invasively

2.1.4 EMG: measures the electrical signal generated when the muscle cells

2.1.5 EOG: Measures minute voltage between retina and cornea caused by eye movement.

2.1.6 PCG: The condenser microphone is used to amplify the heart sound and the value is measured with its waveform and sound.

2.1.7 BT: Measures the temperature of the human body

2. **Devices:**

2.1 PC: 500 GB SSD M.2

RAM eight GB DDR4

Processor Intel core i3

GPU NVidia 2 GB Quadro 2000

2.2 IOT Smart Health lab

2.2.1.3 Software perspectives:

1. Application used send, receive, compress, decompress, encrypt, and decrypt data in the ambulance.

To compress and decompress we use algorithm called Huffman

To encrypt and decrypt we use algorithm called AES

3. ChatBot used to make suggestions of instructions in the case of the doctor did not reply in 3 minutes.

2.2.2 Methodology

For the process of requirements elicitation and analysis, we consider a 4-step iterative methodology as depicted in Figure 2 and described in the following:

1. The requirements discovery is the process of interacting with, and gathering the requirements from, the stakeholders about the required system. This process can be implemented using some techniques, like brainstorming, interviews, scenarios, prototypes, etc., which help the stakeholders to understand what the system will be like.
2. The requirements classification is a very important process to organize the overall structure of the system, by putting related requirements together and decomposing the system into subcomponents of related requirements. This step enables the identification of the existing relationships between such components, which are to guide the selection of the most suitable architectural design patterns.
3. The requirement prioritization and negotiation process concern the sorting requirements in importance, finding, and resolving requirements conflicts through negotiations with the involved stakeholder. Requirements prioritizing procedure is very useful also for the following steps since it allows to focus with attention on the essentials and core features of the system and effectively meet users' expectations.
4. The requirements specification is the process documenting the definitive version of the requirements, exploiting a tabular approach detailed in the following section.

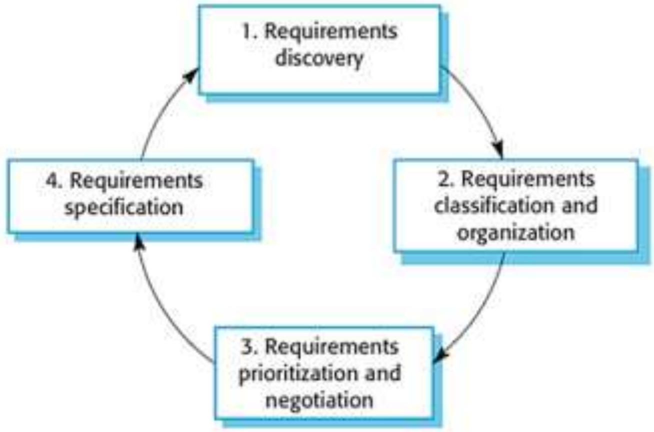


Figure 13. The process of requirements elicitation and analysis

2.2.3 Requirement template

As previously said, each requirement will be mapped in a table line. This section has the objective to define the generalized shape of each requirement. In Table 5 the shape of each line is breakdown, and in the following the meaning of each field detailed.

Req. ID	Req. Name	Req. Type	Description	Dependency		Priority
				BR	TR	Category

In this section, some definitions are provided to support the filling of Table 5:

- Req. ID: this field represents the unique ID assigned to each requirement.
- Req. Name: this field represents the requirement name.
- Req. Type: in this document, each requirement is classified following the type defined in Sec. 3.2.

- Description: in this field a short description of the requirement is provided.
- Dependency: defines the dependency of the considered requirements with the other. Particularly, in this field the dependency of the considered requirement from the business requirements (BR, defined in Sec. 4) and from the technical requirements (i.e., user and system requirements, TR, defined in Sec. 6). Of course, BR can depend by other BRs only, while TR can depend by both BR. and TRs.
- Priority: the proposed prioritisation process considers the MoSCoW methodology (Clegg & Barker, 1994), that defines the following five levels:
    - Must have: Requirements labelled as “Must” are critical to reach the objective of the project.
    - Should have: Requirements labelled as “Should” are important but not necessary for the success of the project.
    - Could have: Requirements labelled as “Could” are desirable but not necessary. o Wish have: Requirements labelled as “Wish” have been agreed by stakeholders as the leastcritical, lowest-payback items, or not appropriate at that time.
- Category: we propose to categorise requirements into the following groups:
    - Functional requirements (Funct.) are the fundamental subject matter of the system and are measured by concrete means like data values, decision-making logic and algorithms.
    - Non-functional requirements (Non-Funct.) are the behavioural properties that the specified

2.2.4 Key drivers and Business requirements

The objective of this section is to elicit a set of business requirements to characterize the realization of a hyperconnected and interoperable IOT environment for the PI. This process will be in charge of evaluating the high-level needs of the actors involved in the realization and consolidation of the PI, toward the optimization of the inefficiencies of the logistics sector, as well as the realization of innovative technology-driven data-models.

The analysis is based on the requirements, needs and imperative of three distinct categories in charge of characterizing different perspectives of the IOT enabled PI environment: business, technology and regulatory. Such type of approach will produce a more comprehensive representation of the complex business spectrum of the industries involved in the realization of PI, of course with the focus on the realization of both the architecture and the components of the IOT-enabled PI environment. In fact, the identification of the needs as well as the inefficiencies in the logistics industry will provide the target spectrum of the IOT elements analysis and design considerations to ensure the value-adding element of the PI concept and its appeal to the logistics users.
In this scenario, the elicitation of the business requirements, produced by the logistics actors, will be enhanced by the definition of a set of high-level technological needs and authorities and policy-makers imperatives.

2.2.5 Logistics operators' business requirements

The business requirements derive from business issues arisen by logistics actors and operators and they will be represented following the guidelines defined in Sec. 3. They clearly refer to reduce their pains and/or increment their gains. Interviewing the logistic stakeholders involved in the ICONET project, as well as some analysis performed in

ICONET deliverables [(Balden, 2020) (Martini, 2020)] and document [(Montreuil, 2011) (SENSE project, 2020)] coming from internet, we have identified the business requirements described in Table 7, while in Table 8 the effective group of stakeholders that has elicited the considered requirement. The requirements are classified as follow:

1. Requirements related to the **infrastructure costs' minimization**, that suggest information regarding the cost of the IOT system and its integrability. The "infrastructure costs' minimization" requirements' ID will be differentiated from the other by considering the prefix "MCR_", thus being shaped as following: MCR_<ID> (where ID is an incremental number).
2. Requirements related to **increase the operational efficiency,** that suggest the actions needed to optimize the inefficiencies in the logistics industry. The "increase the operational efficiency" requirements' ID will be differentiated from the other by considering the prefix "IER_", thus being shaped as following: IER_<ID> (where ID is an incremental number).
3. Requirements related to **increase the market share,** that suggest the actions needed toward the competitivity improvement of the logistics operators. The "increase the market share" requirements' ID will be differentiated from the other by considering the prefix "MSR_", thus being shaped as following: MSR_<ID> (where ID is an incremental number).

Req. ID	Req. Name	Shippers	End costumers	Freight forwarders	Retailers	Shipping companies	Container leasing companies	Carriers	LSPs	Hub operators	Warehouses
MCR_01	**Affordable system**	**X**			**X**	**X**	**X**				**X**

MCR_02	**Affordable integrability**	X	X	X	X			X	X	X	X
MCR_03	**Easy and not invasive installation – Easy maintenance**	X			X	X	X				X
IER_01	**Supply chain visibility at multiple layers**			X	X				X	X	X
MOR_01	**Supply chain digital twin**	X	X		X						X
MOR_02	**Localisation and inventory of goods and products**	X	X		X				X	X	X
IER_02	**Localisation and monitoring of assets**	X			X	X	X	X			X
EMR_01	**Ensure goods integrity and safety**	X	X	X	X	X		X			X

4. Requirements related to **enhance the market offering,** that suggest the actions to improve the service provided to the clients. The “enhance the market offering” requirements’ ID will be differentiated from the other by considering the prefix “MOR_”, thus being shaped as following: MOR_<ID> (where ID is an incremental number).

Req. ID	Req. Name	Req. Type	Description	Dependency BR	TR	Priority Category
RE_01	**Sensor installation**	Tec.	The paramedic places the sensors on the body of the injured person, as he puts each sensor in its correct place	-	-	Must Funct.
RE_02	**Reading Sensor Data**	Tec.	The sensors take vital readings from the patient's body	-	RE_01	Must Funct.
RE_05	**Sending Data**	Tec.	After the application finishes the compression and encryption processes, it sends the data from the ambulance to the hospital and vice versa	-	RE_04	Must. Funct.
RE_06	**Receiving Data**	Tec.	The system server located in the hospital receives the data sent from the application located in the ambulance, or vice versa	-	RE_05	Must Func
RE_07	**Analysis data**		The Doctor and Chatbot analysis data	-	RE_06,RE_07,RE_08	Must Func
RE_8	**Give medical instructions**	Tec	After analyzing the data, the doctor gives medical instructions to the paramedic, and if he is late at that time, the chatbot takes over	-	RE_09	Must Func
RE_9	**Fast**	Tec	The system must be very fast to ensure the survival of infected people	-	-	Must Non-Func
RE_10	**security**	Tec	The system must be well secured so that patient data is not vulnerable to hacking	-	-	Must Non-Func

2.3 Techniques

2.3.1 Smart IoT health lab: This is a healthcare practice equipment with IoT technology. It is capable of analyzing up to 13 types (11 basic types) of biomedical signals and transmitting or receiving the data through Wi-Fi or Bluetooth. It also can be remotely monitored from PC and Smart Phone through Hybrid Web.

2.3.2 Application components:

- **Login page:** This page has the user Email and password.
- **Patient data page:** In this page, the paramedic can enter the data about patient (name, age, gender…)
- **Server side:** In this page, the doctor can see the data that sent from the ambulance and can chat with the paramedics.
- **Chat-bot Page:** A user can talk to the bot, by selecting the doctorbot, the bot responds with the predefined question about that patient, then the bot send instruction to the paramedic.

2.3.3 Chatterbot Works

Chatterbot is a Python library designed to make it easy to create software that can engage in conversation.

An untrained instance of Chatterbot starts off with no knowledge of how to communicate. Each time a user enters a statement, the library saves the text that they entered and the text that the statement was in response to. As Chatterbot receives, more input the number of responses that it can reply and the accuracy of each response in relation to the input statement increase.

The program selects the closest matching response by searching for the closest matching known statement that matches the input, it then chooses a response from the selection of known responses to that statement.

Chapter 3

Risk and Functional and Non-Functional Requirements

3.1 Problem Statement /Constraint

3.1.1 Problem Statement

- Every day, many people die on the way to hospital because the paramedic doesn't know that the patient need to quick intervention
- Many injured people can be died before arriving to the hospital because there are insufficient data about the patient , his medical history and his illness (Ex: Urgent surgery)
- The lack of existence appropriate doctor when the patient arrives to the hospital

→Therefore, our aim is to build a IOT system can collect and monitoring the patient's condition and send the data using IOT and can make decision if necessary.

- (pneumothorax occurs when the air leaks into the space between your lung and chest wall. This air pushes on the outside of your lung and makes it collapse so the patient need to install tube for chest by make a hole in the chest quickly")

3.1.2 Constraint

- Paramedic and doctor should have the application and the internet
- the receptionist should have the website and the internet
- Paramedic should know how to use the sensors
- Paramedic should write the patient's medical history and some information that the doctor need to know about it before the check in the application

3.2 Project Plan

October	November	December	January	February	March	April	May	June
Gathering Information								
	Analysis (Define Requirements, Problems and Tasks)							
		Design						
				Implementation				
							Testing and maintenance	

Figure 16. Project Plan

3.3 Quality Assurance Plan:

This part of the documentation will speak about the executing process and how will make sure that the quality objectives are met. It is focused on process improvement.

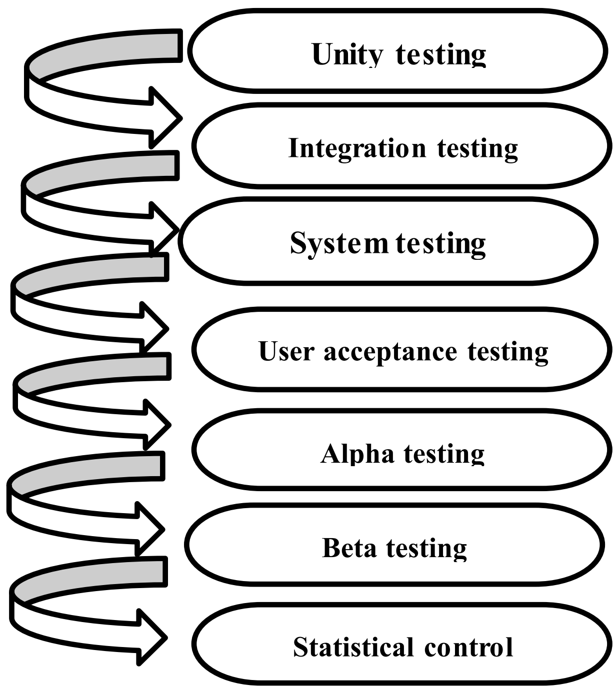


Figure 17. the Quality Assurance Phases

3.3.1 Unity Testing:

In this stage of testing, we will take every components of our project such as ChatBot, application and sensors to ensure that every single unit of a software system in order to make sure that it meets the original requirements and functions as expected.

3.3.2 Integration Testing:

In this stage of testing, we will take every components of our project such as ChatBot, application and sensors to verify whether the combined units work together as a group.

3.3.3 System Testing

In this stage, a complete software system is tested as a whole. This stage serves to verify the data's compliance with the functional and technical requirements and overall quality standards.

3.3.4 User Acceptance Testing

Where the data is validated against the end user requirements and for accuracy. This step helps the team decide if the data is ready to be shipped or not. The acceptance stage might be followed by an alpha and beta testing. Allowing a small number of actual users to try out the software before it is officially released.

3.3.5 Alpha Testing

In this part, a group of testers in our team test the data to ensure efficiency of data and fix errors.

3.3.6 Beta Testing

In this stage of testing, the application has been sent to some users to test the system efficiency and its outputs are correct or not and retrieve feedback to our team.

3.3.7 Statistical control

Statistical control is based on analyzes of objective and subjective data. Many organizations use statistical process control as a tool in any quality improvement effort to track quality data. Product quality data is plotted statistically to distinguish common cause variance or special cause variance. Data can be taken from areas examined from a sample, a batch of portion, and then statistical differences are analyzed and plotted. Control can then be carried out on the part in the form of rework or scrap, or control can be performed on the process that made the part, ideally eliminating the defect before more parts are made like it.

Chapter 4

Proposed System and Methodology

4.1 System Use-Cases

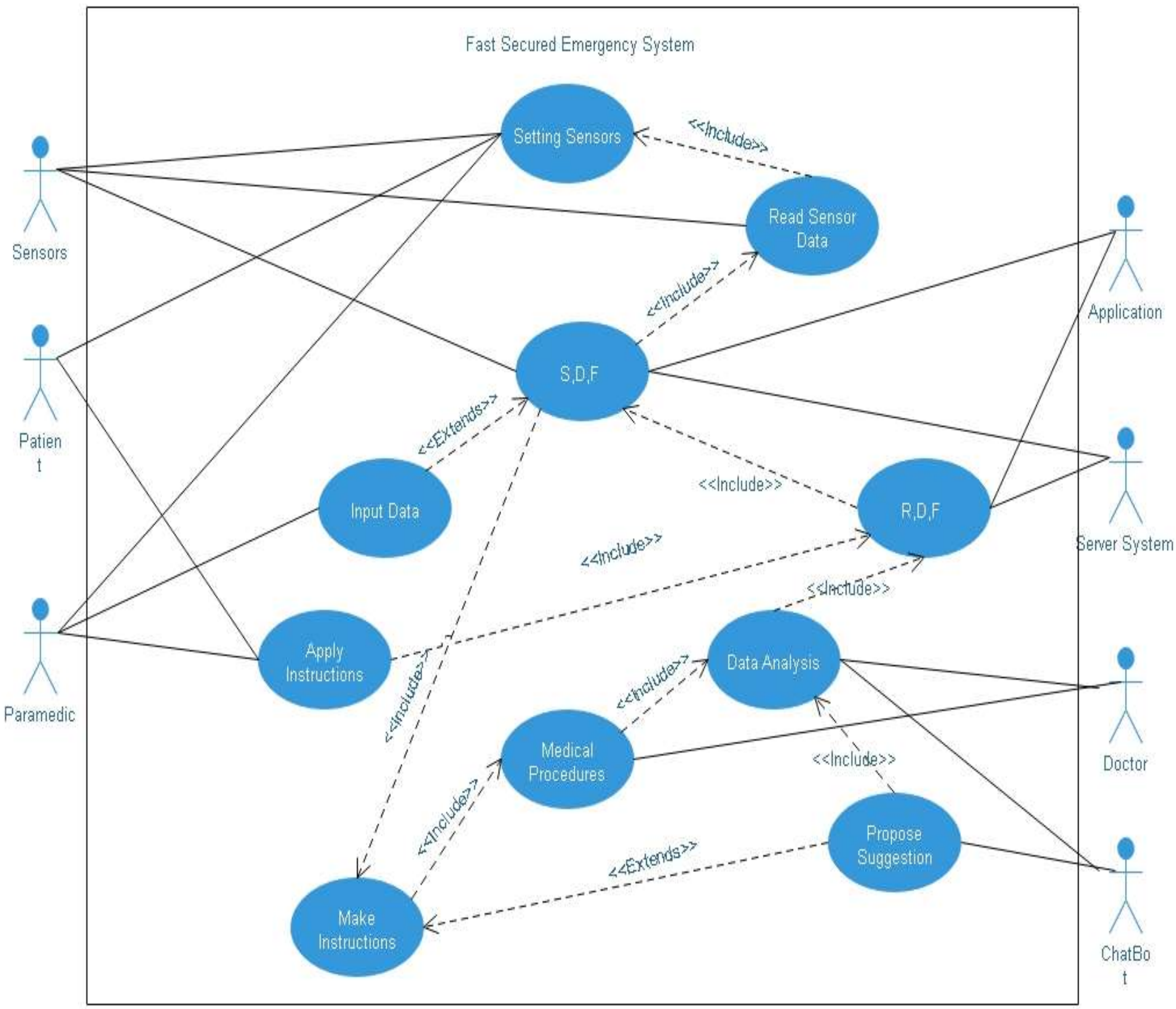


Figure 18. System Use case

4.2 Use Case Description (Use case scenario)

4.2.1 Setting Sensors

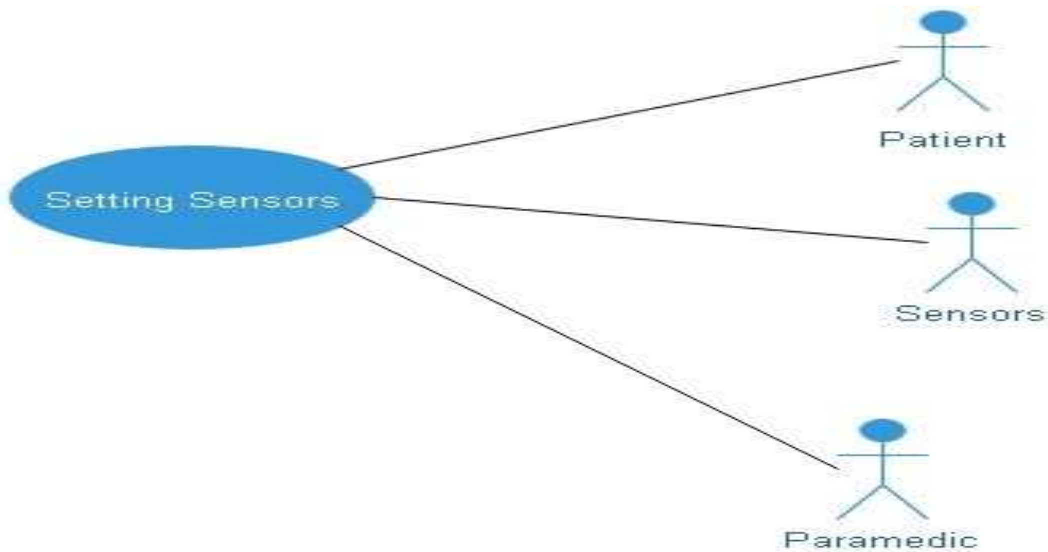


Figure 19. Setting Sensors use case

Use case name	Setting Sensors
Use-Case Number	1
Application	Fast and Secure Emergency System
Actor(s)	Paramedics/ Patients/Sensors
Description	When the ambulance arrives at the injured, and then the paramedics put the injured inside the ambulance, then the paramedic installs the sensors in their correct position on the body of the injured.
Pre-conditions	No Precondition
Post-conditions	Read Sensors Values

Basic Flow	1. Placing the injured person in the ambulance 2. Place the sensors on the patient's body 3. The paramedic makes sure of the correct locations for the sensors

4.2.2 Read Sensors

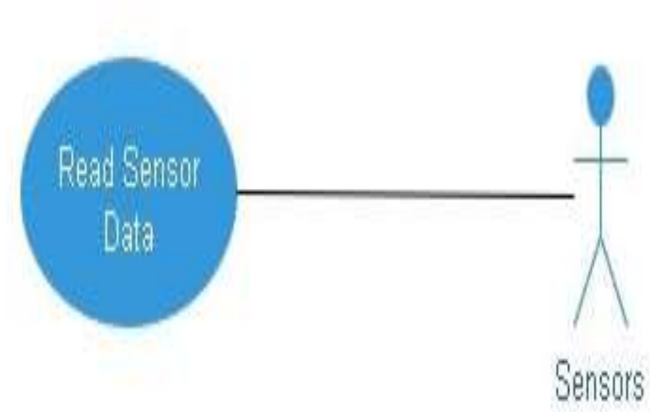


Figure 20. Read **Sensors use case**

Use case name	Read Sensors
Use-Case Number	2
Application	Fast and Secure Emergency System
Actor(s)	Sensors
Description	After the paramedic makes sure that the sensors are in the correct position on the patient's body, then the sensors measure the vital values of the injured person and then send the values to the application for compress, encryption and transmission in ambulance

Pre-conditions	Place the sensors on the patient
Post-conditions	Compression, encryption and transmission
Basic Flow	1. Take a reading of the values 2. Send values to apply compression, encryption and transmission in ambulance

4.2.3 Input User Data

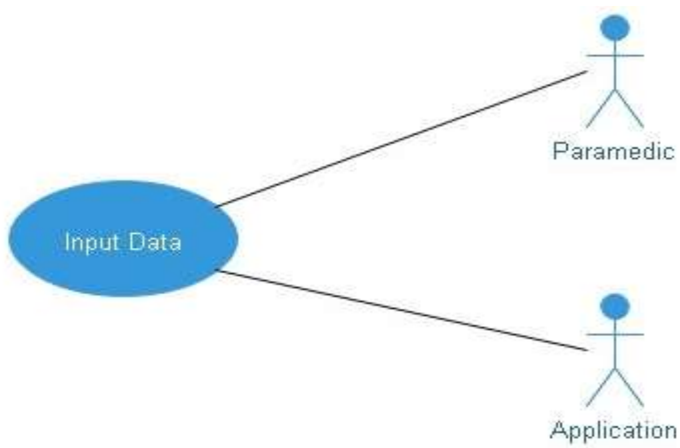


Figure 21. Input User Data use case

Use case name	Input User Data
Use-Case Number	3
Application	Fast and Secure Emergency System
Actor(s)	Application / Paramedics
Description	After the paramedic places the sensors on the injured person, he enters the patient's personal data, such as name, age, national number, medical history, etc. if the paramedic found this data

Pre-conditions	No Precondition
Post-conditions	Compression, encryption and transmission
Basic Flow	The paramedic puts the patient's data

4.2.4 SDF Data

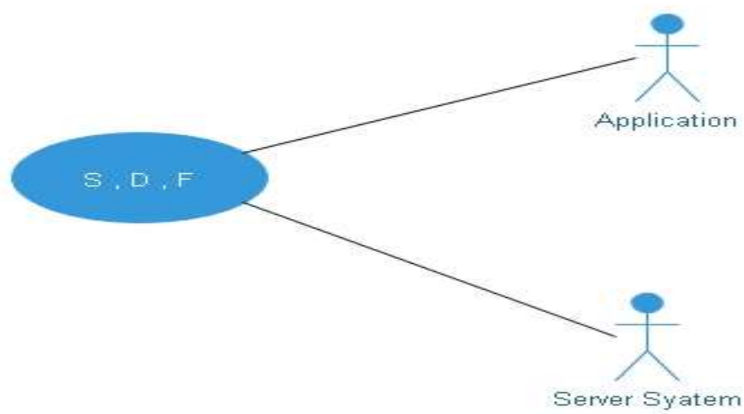


Figure 22. SDF Data use case

Use case name	SDF
Use-Case Number	4
Application	Fast and Secure Emergency System
Actor(s)	Application / System Server
Description	The SDF process takes place in two places. The first is in the application in the ambulance, and the other is in the system server located in the hospital. In the first case, the application receives readings from all the sensors on the body of the injured

	person and also the data entered by the paramedic Then it Send this data to the system server firebase . In the other case, the system server receives medical instructions from the doctor or chatbot in case the doctor is late, and then the system server send these medical instructions to the ambulance Firebase.
Pre-conditions	Put the sensors on the injured person, read their values, and enter the injured person's data in the case of the application in the ambulance. In the case of the system server located in the recipient is to receive the patient's personal and vital data
Post-conditions	In the case of the application in the ambulance, the system server located in the hospital . In the case of the system server located in the hospital, the application in the ambulance receives the medical instructions and implement the instructions.
Basic Flow	**In Ambulance** o Receive values from sensors o Taking the personal data of the injured person o Collect personal data and sensor values of the injured person o Send data to the hospital **In Hospital** o Receive medical instructions from the doctor

	○ In case the doctor is late, the system server receives instructions from the chatbot ○ Send data to the ambulance

4.2.5 RDF Data

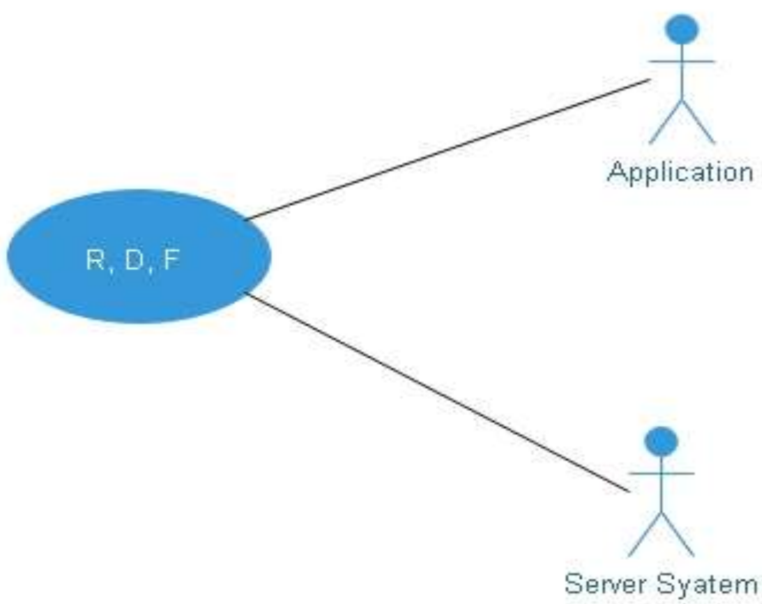


Figure 23. RDF Data use case

Use case name	RDF Data
Use-Case Number	5
Application	Fast and Secure Emergency System
Actor(s)	Application / Server System
Description	The RDF process is carried out on two sides, the first side in the hospital and the second side in the ambulance On the first side,

	the system server receives the data sent from the ambulance using Firebase. On the other hand, the application receives medical instructions sent from the hospital using Firebase.
Pre-conditions	In the case of the application in the ambulance, it is the process of sending medical instructions In the case of the system server is to send infected data
Post-conditions	In the case of a system server, it is the process of analyzing the infected data by the doctor and the chatbot ,In the case of the application in the ambulance, the apply medical instructions
Basic Flow	**In Hospital** o Receiving the data sent from the ambulance o Analysis data **In Ambulance** o Receiving the data sent from the hospital o Implement instructions

4.2.6 Data Analysis

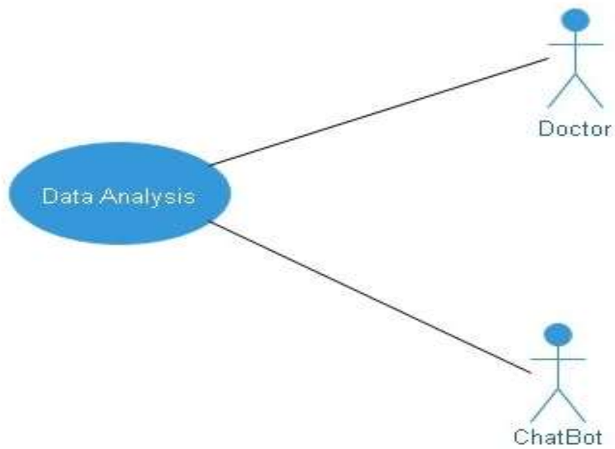


Figure 24. Data Analysis use case

Use case name	Data Analysis
Use-Case Number	6
Application	Fast and Secure Emergency System
Actor(s)	Doctor/Chatbot
Description	As soon as the data sent from the ambulance is received, both the doctor and the chatbot analyze the data.
Pre-conditions	RDF Process
Post-conditions	Make instructions
Basic Flow	1. Doctor read data 2. Doctor / Chatbot analysis data

4.2.7 Medical Instructions

Figure 25. Medical Instructions use case

Use case name	Medical Instructions
Use-Case Number	7
Application	Fast and Secure Emergency System
Actor(s)	Doctor
Description	After the doctor analyzes the patient's data received from the ambulance, he performs medical procedures to treat the case, and if the doctor is late in responding, the medical suggestion submitted by chatbot is taken.
Pre-conditions	Analysis Data
Post-conditions	SDF Process
Basic Flow	1. Diagnosis of the patient. 2. Make medical Instructions

4.2.8 Propose Suggestions

Figure 26. Propose Suggestions use case

Use case name	Propose Suggestions
Use-Case Number	8
Application	Fast and Secure Emergency System
Actor(s)	Chatbot
Description	After the chatbot analyzes the casualty data received from the ambulance, it makes medical suggestions, and they are saved until needed.
Pre-conditions	Analysis Data
Post-conditions	RDF Process
Basic Flow	1. Determine the first aid for the condition of the injured 2. Medical Instructions

4.2.9 Apply instructions

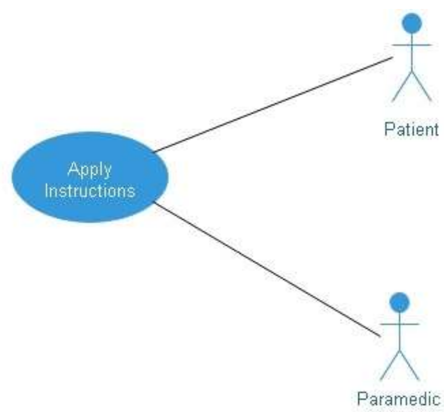


Figure 27. Apply instructions use case

Use case name	Apply instructions
Use-Case Number	9
Application	Fast and Secure Emergency System
Actor(s)	Paramedics / Patient
Description	Once the data is received from the hospital, the application in the ambulance decrypts and compresses the received data, and then the application displays the medical instructions to the paramedic, then the paramedic then implements these instructions accurately and carefully on the injured
Pre-conditions	RDF Process
Post-conditions	None
Basic Flow	Receive Data from hospital Firebase

4.3 Context Diagram

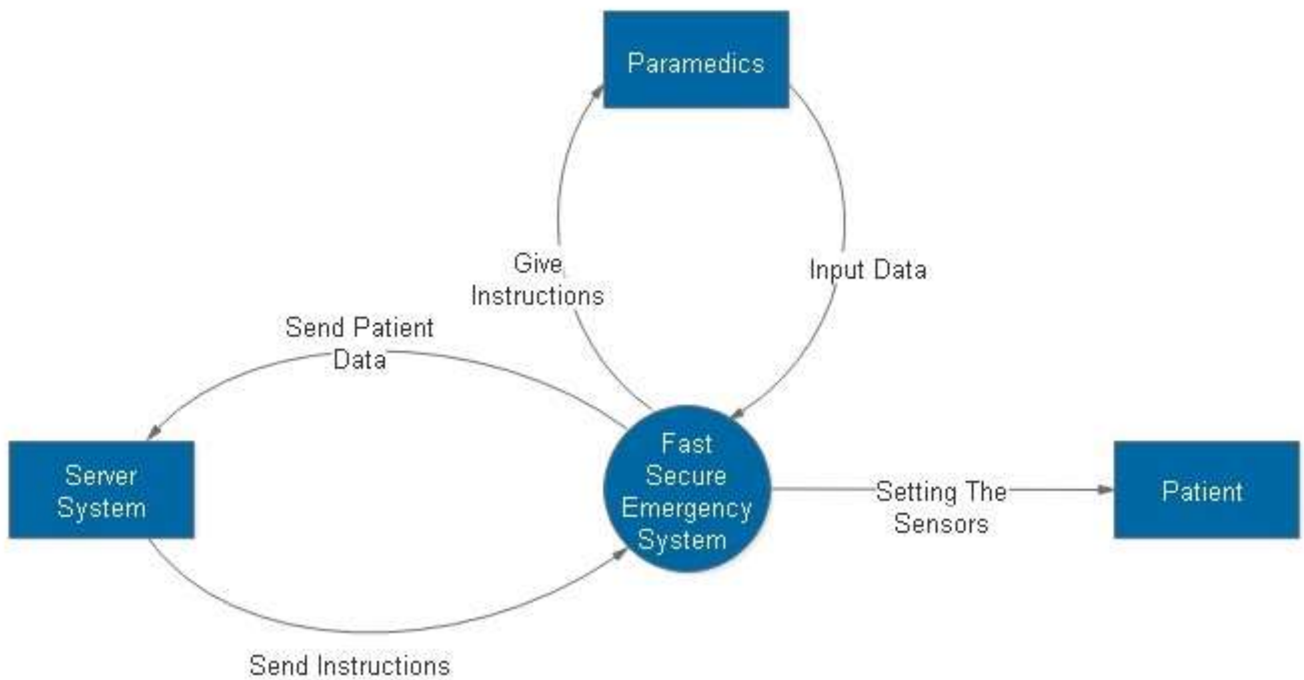


Figure 28. Context Diagram

4.4 Architecture Diagram

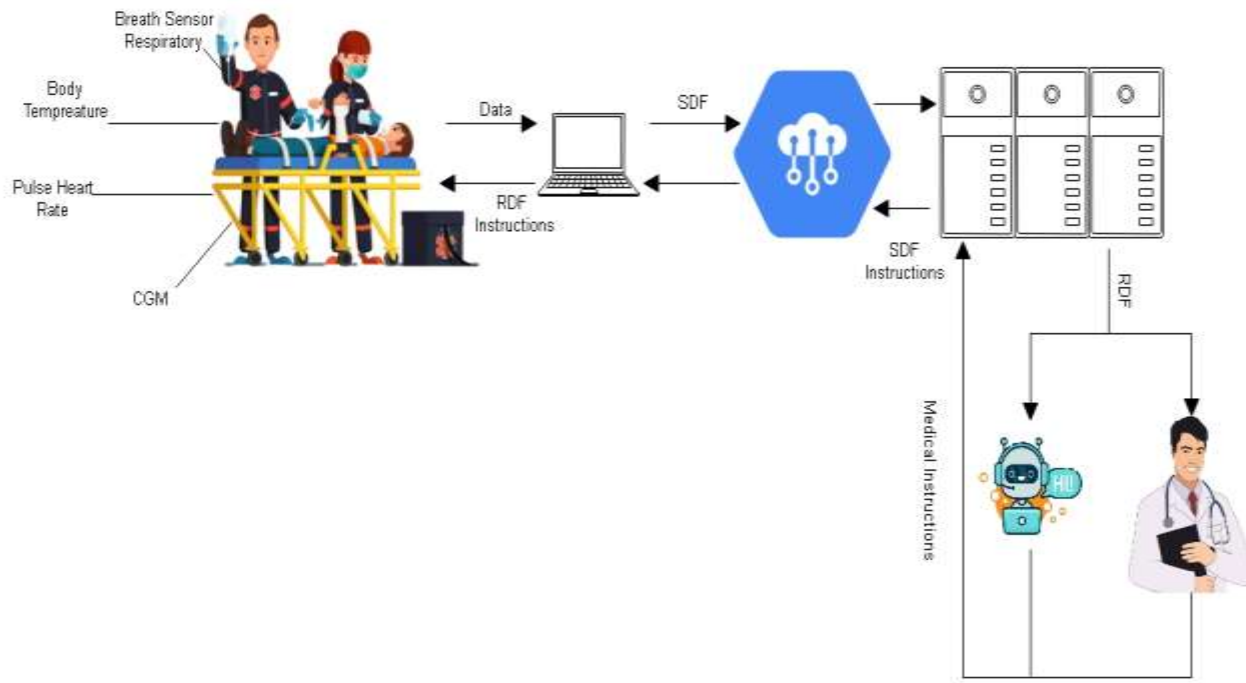


Figure 29. Architecture Diagram

4.5 Interaction Diagram (Sequence Diagram)

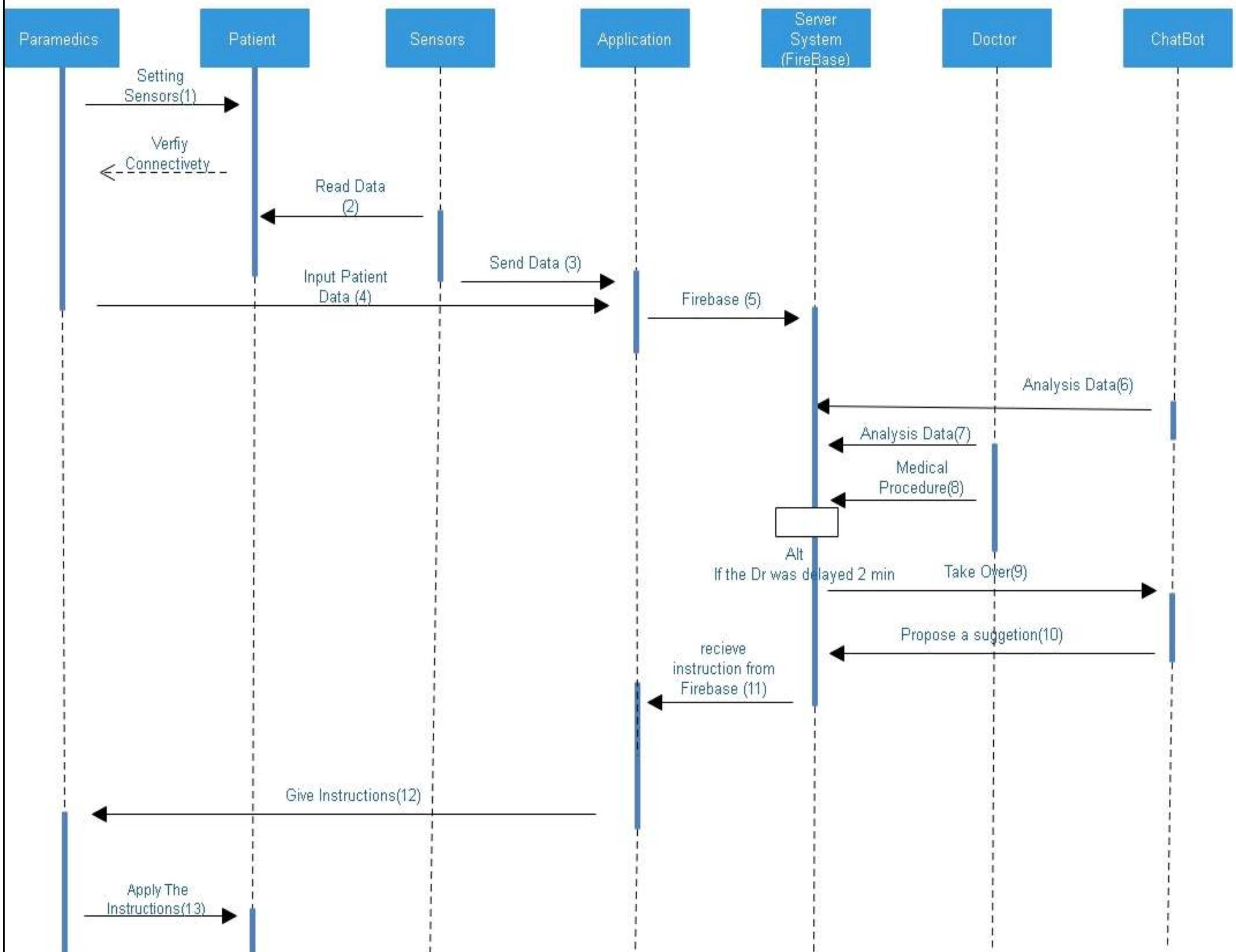


Figure 30. User Sequence diagram

4.6 FlowChart Diagram

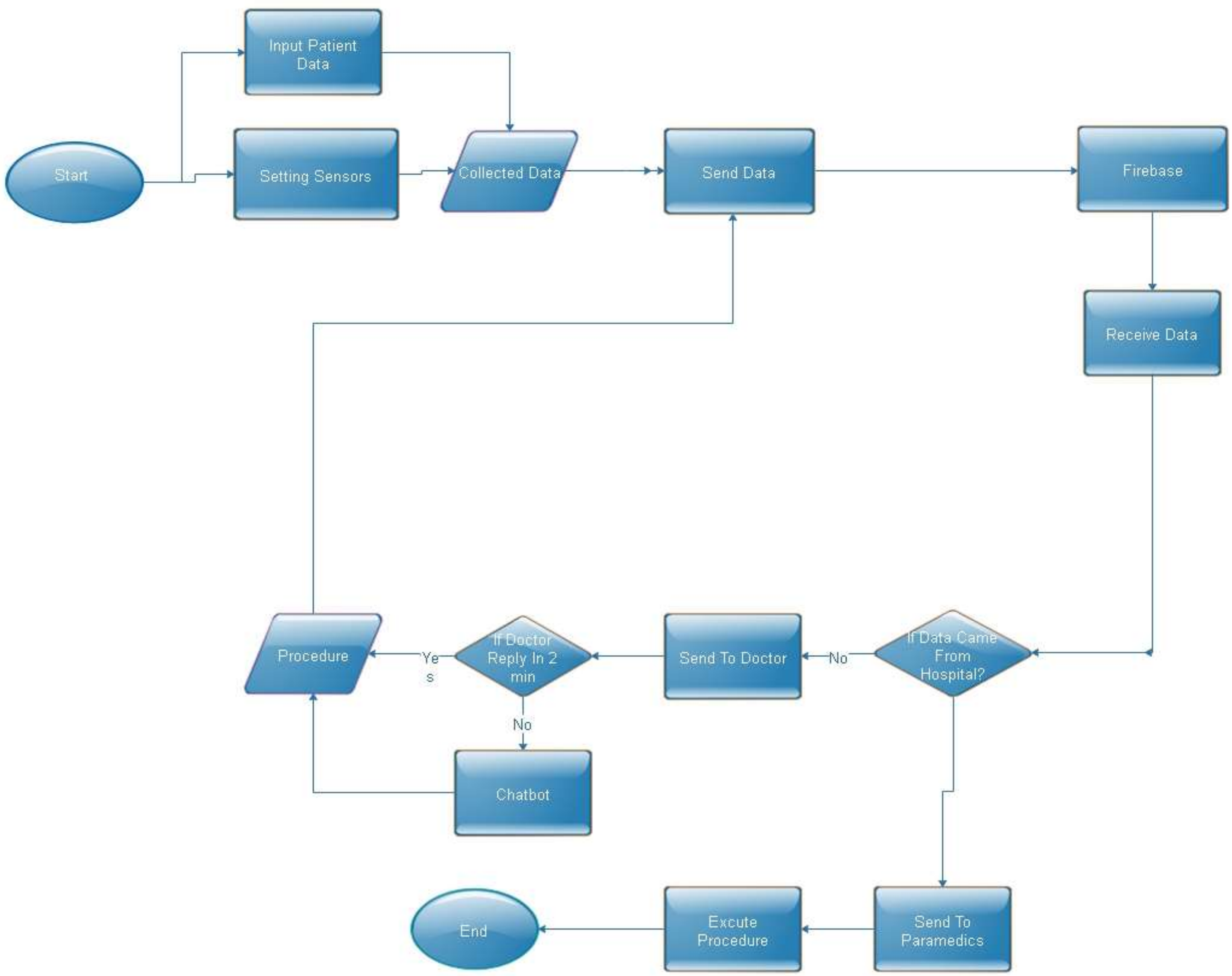


Figure 31. Flowchart Diagram

4.6 Activity Diagram

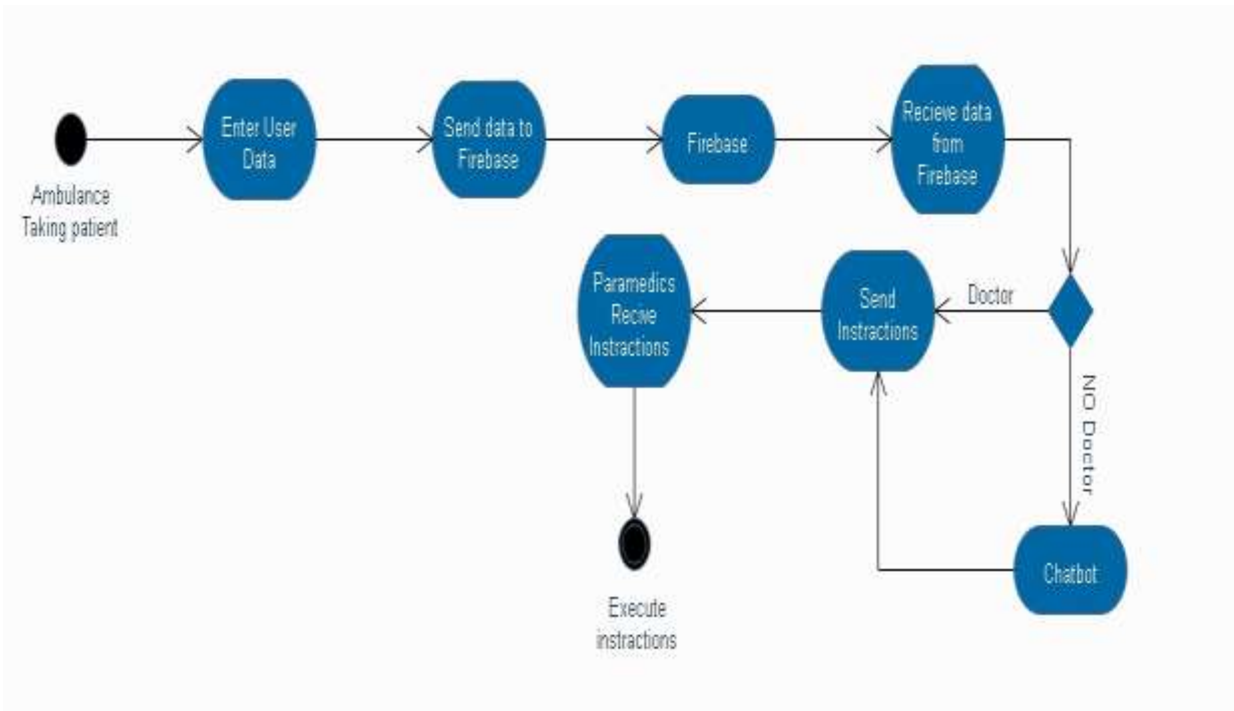


Figure 32. Activity Diagram

Chapter 5

Implementation and Testing

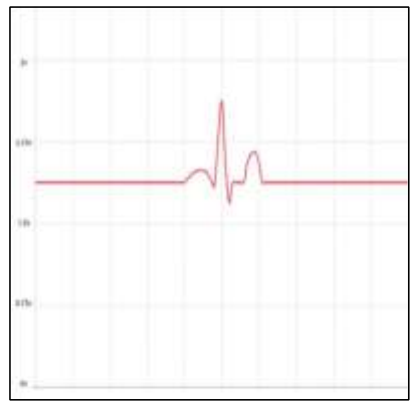
Implementation and Testing (Design mockup)

5.1 Measure & Interlock Sensors

1 . ECG (Electro CardioGram)

When the heart is beating, the minute action potential difference in the myocardium is measured by the electrode attached to the body surface, and the change curve over time is expressed in mV.

Used Module

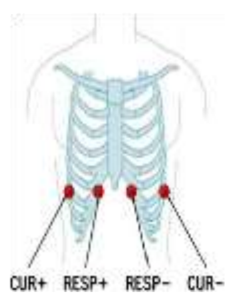


Waveform (mV)

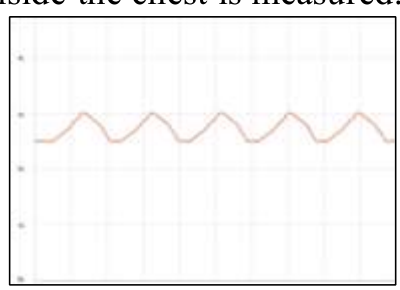
Location of Electrodes

2. Respiration

The change in impedance due to changes in volume inside the chest is measured.



Used Module



Waveform (BPM)

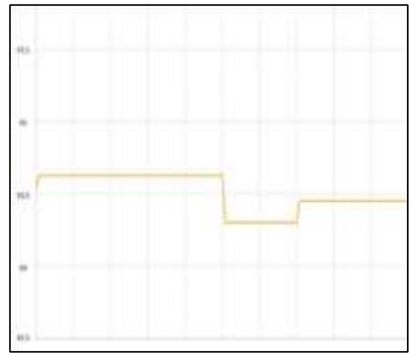
Location of Electrodes

3. SpO2 (Pulse Oximeter)

The percentage of hemoglobin concentration that contains oxygen to the concentration of total hemoglobin in the blood stream is measured by optical method.

Measurement Method

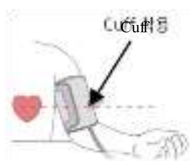
Used Module



Waveform (%)

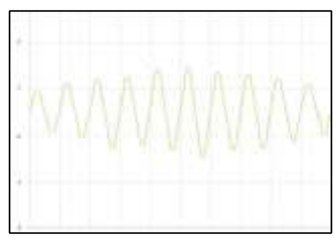
4. NIBP (Non-Invasive Blood Pressure)

NIBP is the way to measure blood pressure that we see easily around ourselves. If you put a cuff on your forearm and use an air pump to put air into the cuff, the cuff swells and blocks the artery. Systolic blood pressure and diastolic blood pressure are determined while listening to the vortex sounds that occur when the blood flows as the cuff is decompressed step by step.



Measurement Method

Used Module



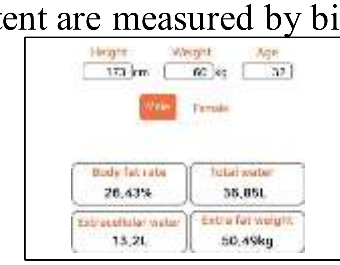
Waveform (mmHg)

5. Bio Impedance

Of the constituents of the human body, the substances measurable by impedance are water and fat. Body fat and body water content are measured by bio-impedance.

Grabbing Bio Sensor

Used Module

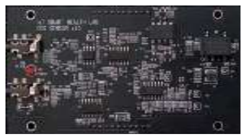


Measured Value Display

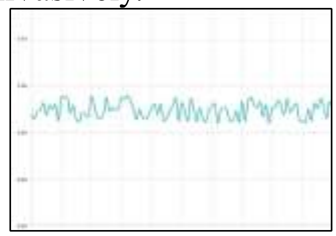
6. EEG (Electro EncephaloGram)

Using an electrode attached to the surface of the head, electrical signals from the brain’s electrical activity are measured non-invasively.

Measurement Method



Used Module



Waveform (Hz)

7. EMG (Electro MyoGraphy)

Attaches an electrode to the surface of the skin and measures the electrical signal generated when the muscle cells are activated electrically and neurologically.

Measurement Method

Used Module

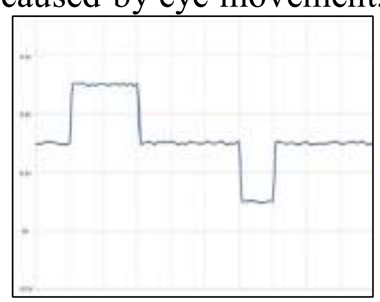
Waveform (v)

8. EOG (Electro OculoGraphy)

Measures minute voltage between retina and cornea caused by eye movement.

Measurement Method

Used Module



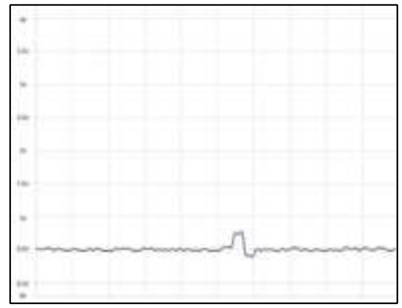
Waveform (V)

9 . PCG Phono CardioGram

The condenser microphone is used to amplify the heart sound and the value is measured with its waveform and sound.

Measurement Method

Used Module



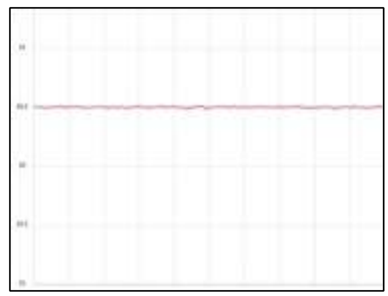
Waveform (BPM: Beat Per Minutes)

10. BT (Body Temperature)

Measures the temperature of the human body.

Measurement Method

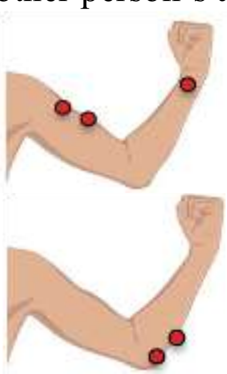
Used Module



Waveform (°C)

11. HHI (Human-Human Interface)

Experiment of interlocking between two persons. When an electrical signal is detected in the movement of one person's arm, an electrical signal is generated in the other person's arm.



Measurement Method

Used Module

Waveform (V)

5.2 Application Mockup

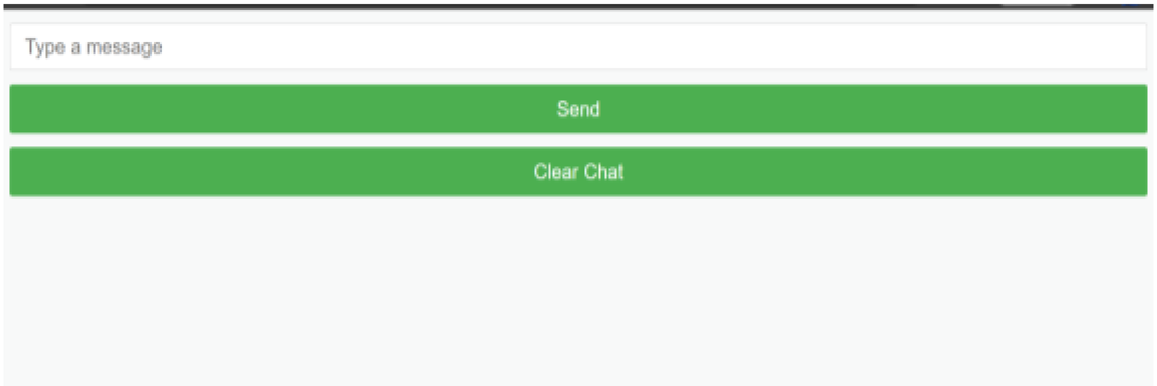
5.2.1 Home Page

5.2.2 Login page

5.2.3 Patient Data Page

5.2.4 Server Side Page

5.2.5 Chat Page



5.2.6 DoctorBot Page

Conclusion

Our main objective is to improve and develop services provided by paramedics and emergency hospitals on the scope of university hospitals. Many patients die in the way to the hospital because of lack of information or Paramedic's Knowledge of the necessary intervention for the patient's status

Therefore, we created a system Based on IOT capable of gathering, monitoring the patient's status and read data from sensors (body temperature, blood pressure sensor, heart rate pulse…etc.). Then identify potential diseases, hospital preparedness and the right and proper doctor for this status, then compress and encrypt these data using strong algorithms (AES & Huffman algorithm) to maintain the confidentiality and security of patients and non-tampering data on the way to hospital

The system will be able to send a secured data to the server system in the hospital to make decision remotely by specialist doctor. In the case that the specialist doctor does not respond, the system capable of response and giving appropriate instructions using ChatBot automatically

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