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Smart Device For Peace

Of Mind

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Abstract

Monitoring and healthcare systems have become more in demand in recent years as these systems provide a comprehensive solution for patient care and monitoring. It combines geolocation technology, real-time tracking, and physiological monitoring, which has led to important developments in this field and a good number of tracking systems. Some startups have also worked on the system, but they have not helped or cared for children with autism in particular. Parents of autistic children in Algeria face many challenges in caring for their children, fear of losing them, and struggle to deal with their children's unexpected outbursts. To deal with these problems and deepen the study, a questionnaire was distributed to caregivers of children with autism. 91.8% of the respondents stated that they have difficulty taking care of their children all the time, and 93.9% of the respondents confirmed that their children suffer from anxiety and stress attacks. Based on the results obtained, a smart bracelet connected to the mobile application was developed. This smart locator aims to track individuals who need special attention and care. Using advanced geolocation technologies such as GPS and IoT, the system can accurately monitor a person's real-time location and also include the ability to monitor patients' health status. By collecting various physiological data, such as heart rate, body temperature, and movement patterns, by means of sensors built into the system. In addition, the system includes the ability to predict the stress and anxiety levels of a child with autism, and to achieve this, machine learning algorithms analyze the collected data and identify patterns and indicators of stress and anxiety. By detecting and predicting these conditions early on, appropriate interventions can be initiated to manage and mitigate the distress experienced by the child, and it reached the highest classification accuracy of 98% for estimating the child's stress level.

Keywords: GPS, Geolocation, Internet of Things (IoT),Machine Learning,Smart GPS Tracker and Health Monitoring System,Smart Bracelet.

الملخص

أصبحت أنظمة المراقبة والرعاية الصحية أكثر طلبًا في السنوات الأخيرة، حيث توفر هذه الأنظمة حلاً شاملاً للعناية بالمريض ومراقبته. فهي تجمع بين تقنية تحديد الموقع الجغرافي والتتبع في الوقت الفعلي والمراقبة الفسيولوجية، مما أدى إلى ظهور تطورات مهمة في هذا المجال وعدد لا بأس به من أنظمة التتبع، كذلك عملت بعض الشركات الناشئة على النظام ولكنها لم تساعد أو تعتني بالأطفال المصابين بالتوحد خاصة. يواجه آباء الأطفال المصابين بالتوحد في الجزائر العديد من تحديات في رعاية أطفالهم والخوف من فقدانهم كما أنهم يكافحون للتعامل مع انفعالات أطفالهم الغير متوقعة. للتعامل مع هذه المشاكل وتعميق الدراسة تم توزيع استبيان على مقدمو الرعاية للأطفال المصابين بالتوحد، صرح 91.8٪ من المستجيبين بأنهم يعانون من صعوبة في رعاية أطفالهم طوال الوقت، كما أكد 93.9٪ من المستجيبين أن أطفالهم يعانون من نوبات قلق وتوتر. بناءً على النتائج التي تم الحصول عليها، تم تطوير سوار ذكي متصل بتطبيق الهاتف المحمول. يهدف محدد المواقع الذكي هذا إلى تتبع الأفراد الذين يحتاجون إلى عناية ورعاية خاصة. باستخدام تقنيات تحديد الموقع الجغرافي المتقدمة مثل GPS وIoT، يمكن للنظام مراقبة موقع الشخص في الوقت الفعلي بدقة، ويتضمن أيضًا القدرة على مراقبة الحالة الصحية للمرضى. من خلال جمع البيانات الفسيولوجية المختلفة، مثل معدل ضربات القلب ودرجة حرارة الجسم وأنماط الحركة، بواسطة أجهزة استشعار مدمجة في النظام. بالإضافة إلى ذلك، يتضمن النظام القدرة على التنبؤ بمستويات التوتر والقلق لدى الطفل المصاب بالتوحد، ولتحقيق ذلك تقوم خوارزميات التعلم الآلي بتحليل البيانات التي تم جمعها وتحديد أنماط ومؤشرات التوتر والقلق. من خلال اكتشاف هذه الحالات والتنبؤ بها في وقت مبكر، يمكن الشروع في التدخلات المناسبة لإدارة وتخفيف الضيق الذي يعاني منه الطفل، وقد وصلت إلى أعلى دقة في التصنيف بقيمة 98٪ لتقدير مستوى إجهاد الطفل.

الكلمات الرئيسية: GPS تحديد الموقع الجغرافي، إنترنت الأشياء IoT، التعلم الآلي، نظام تعقب GPS الذكي ونظام المراقبة الصحية، سوار ذكي.

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Nomenclature

2G Second Generation: 2G is wireless telephone technology based on digital communication including GSM offer auxiliary services such as data and SMS (Short Message Service). 2G protocols support high bit rate voice and limited data communications that are widely using in all over the world.

4G Fourth Generation: 4G is emerging technology that integrates different modes of wireless communications and it is the name of technologies for high-speed wireless communications designed for fast data services and interactive TV through mobile network.

5G Fifth Generation: 5G is new global standard for broadband cellular networks, and is the planned successor to the 4G networks, by offering higher speeds and greatly reduced latency, while avoiding the risk of network saturation linked to the increase in digital uses (smartphones, tablets, connected objects).

fifth-generation: 5G technology standard for broadband cellular networks, and is the planned successor to the 4G networks which provide connectivity to most current cellphones.

AI Artificial intelligence: is an area of research in which computers, robots, and other technologies are programmed to exhibit human-like intelligence, as characterised by cognitive skills such as learning and adaptation, as well as decision-making capabilities.

ASD Autism Spectrum Disorder: The autism spectrum is a neurodevelopmental disorder characterized by difficulties in social interaction, verbal and nonverbal communication, and the presence of repetitive behavior and restricted interests. Other common signs include unusual responses to sensory stimuli, and an insistence on sameness or strict adherence to routine.

ASPD Antisocial Personality Disorder: (infrequently APD) is a personality disorder characterized by a long-term pattern of disregard of, or violation of, the rights of others as well as a difficulty sustaining long-term relationships. Lack of empathy and a contemptuous attitude are often apparent, as well as a history of rule-breaking that can sometimes include law-breaking, a tendency towards chronic boredom and substance abuse, and impulsive and aggressive behavior.

GND refers to Ground.

GPIOs General Purpose Input/Output.

GPRS General Packet Radio Service: A packet oriented mobile data service extension to GSM networks that offers data transfer rates of up to 114 kbps.

GPS Global Positioning System: A global navigation system that uses satellite technology and portable receiving units to determine latitude and longitude positioning on Earth accurately.

GSM Global System for Mobile Communications: is a standard developed by the European Telecommunications Standards Institute (ETSI) to describe the protocols for second-generation (2G) digital cellular networks used by mobile devices such as mobile phones and tablets.

IP-67 International Protection Rating: This IP Code categorizes the degrees of protection provided against the intrusion of hard objects, accidental contact, dust, and water in electrical enclosures

ML Machine learning: is a field of computer science that studies algorithms and techniques for automating solutions to complex problems that are hard to program using conventional programing methods.

MMS Multimedia Messaging Service: It is a telecommunications standard for sending messages that include multimedia data (images, audio, video)

PTT PTT Push to Talk: It is a two-way communication service that works like a walkie-talkie using a button switch.

RF Random Forest is one of the most popular and commonly used algorithms by Data Scientists. Random forest is a Supervised Machine Learning Algorithm that is used widely in Classification and Regression problems. It builds decision trees on different samples and takes their majority vote for classification and average in case of regression.

SCL refers to Serial Clock.

SDA refers to Serial Data.

SMS Short Messaging Service: It is a text messaging communication service standardized in the GSM mobile communication system.

Vin Vin refers to Input voltage.

General Introduction

1. **Context**
   Nowadays, the healthcare and position monitoring systems became more and more demanding. One of the fields, which today use this kind of tracking, is the patient control like autistic, We proposed the development of a smart locator that helps keeping track person and monitoring status of patients, prediction of stress and anxiety level.

2. **Problematic**
   Despite the increasing prevalence of Android phones equipped with Global Positioning System (GPS) capabilities, relying solely on them to track the location of our loved ones can be problematic. Users often forget to carry their phones with them, leading to potential lost opportunities for tracking. Among the problems we are trying to solve we mention :

   - Difficulty locating concerned groups Children in general, autistic children.
   - Difficulty of predicted the status of stress and anxiety prevailing among children with autism and tyrant on their behavior.
   - Frequent elopement of patients,patients often elope or wander away from care facilities and their homes, presenting a significant challenge for caregivers and their families.
   - Difficulty in real-time health status tracking. There is a need for a system that enables caregivers to monitor the health status of individuals at any given time and from anywhere.

3. **Objectives**
   Our developed a smart GPS tracker and health monitoring system, that solves the mentioned problematic. The solution composed of three sub systems:

   - **Geolocation System Based on GPS:** solves tracking and monitoring problem, it enables track the patients in real time, in form of mobile application.
   - **Smart Healthcare Prediction System Based on Ml:** it gives the opportunity to predict the stress and anxiety level for autism kids using machine learning.
   - **Prototype of Smart bracelet:** Prototype of device based on IoT, allows to monitor the patients status and location in real time.

4. **Thesis Structure**
   The thesis is structured into four chapters, each covering different aspects of the research and implementation:

   - **Chapter 01:** The first chapter provides an introduction to the general concepts and terms used throughout the thesis. It covers topics such as Geolocation, GPS, Internet of Things,and machine learning approaches.

This chapter sets the foundation for the rest of the thesis and helps the readers understand the key concepts and terminology.

- **Chapter 02:** The second chapter focuses on presenting different cases related to the research topic, specifically autism. It also discusses relevant startups working in these areas and includes references to scientific research conducted in the field. This chapter serves to provide a comprehensive overview of the existing work and initiatives related to the chosen research focus.
- **Chapter 03:** The third chapter provides a detailed overview of the system being proposed in the thesis. It describes the functionality of the system from various perspectives and angles, highlighting its key features and capabilities. This chapter serves to give readers a clear understanding of how the system works and what it aims to achieve.
- **Chapter 04:** The fourth chapter delves into the implementation of the system. It begins by describing all the software tools and IoT (Internet of Things) materials used in the implementation process. Additionally, it presents the results obtained from applying the prediction system developed in the thesis. This chapter focuses on the practical aspects of the research and showcases the outcomes of the implemented system.

Chapter 1

GENERALITIES

1.1 Introduction

In recent years, the fields of geolocation technology, Internet of Things (IoT) and forecasting systems have made significant advances, revolutionizing various industries and sectors. One such application is in the field of GPS trackers and health monitoring.
Smart GPS tracker and health monitoring system allows locate position and healthcare surveillance using the Internet of Things (IoT) and machine learning, in a very effective way within a short time.
This system includes multiple technologies such as geolocation technology which helps for tracking people, and patients. Moreover, it include machine learning which provide healthcare prediction.
In this chapter, we're going to talk about Geolocation and its technologies, after that we will cover the Internet of Things technologies, then we are going to explain the machine learning main concept and its algorithms.

1.2 Geolocation

1.2.1 Definition of Geolocation

Geolocation is a process for positioning an object, a vehicle, or a person on a plan or map using its geographical coordinates. This operation is performed using a terminal capable of being located using a satellite positioning system and a GPS (Global Positioning System) receiver for example, or using other techniques in addition, the terminal is able to publish, in real time or delayed, its latitude/longitude geographic coordinates Originally, geolocation is the location of an object on a map using positions geographical[20].

1.2.2 Geolocation Techniques

1.2.2.1 Geolocation by Satellite

A mobile device's current position is determined via satellite geolocation by using Cartesian coordinates. The Global location System (GPS), as well as the GLONASS, are the two most well-known satellite location networks[20]. With satellite geolocation, the current position on the earth's surface of a terminal equipped with a compatible chip is calculated using the signals emitted by the satellite constellation intended for this purpose. This location is

converted into latitude, longitude and sometimes altitude and can then be physically represented on a map.

1.2.2.2 Geolocation by Global System for Mobile communication (GSM)

This technique allows the GSM terminal to be positioned based on certain information about the GSM antennas to which the terminal is connected. GSM location accuracy can range from 200 meters to several kilometers depending on whether the terminal is in an urban or rural area. There are several techniques[20]:

- Observed Time Difference or EOTD (Extended Observed Time Difference): the terminal calculates the elapsed time between the transmission and reception of a query sent to the antenna and from this can calculate the distance.
- Arrival time (arrival time).
- Arrival angle.
- Cell ID.

The GSM method currently used most frequently is the cell ID (identification of the radio cell).

1.2.2.3 Geolocation by WI-FI

Precise geolocation via WiFi, allows objects or people to be located both outside and inside buildings. The accuracy is in the order of a meter[20], there are databases containing many WiFi hotspot identifiers along with their geographic location. These databases can be owned by companies or private communities who publish them for free. These bases are built using a method called ”war driving,” which involves driving through city streets with a Wi-Fi enabled smartphone or laptop connected to a satellite tracking receiver in order to obtain the maximum number of Wi-Fi identify hotspots.

1.3 Global Positioning System (GPS)

1.3.1 Definition of GPS

The Global Positioning System (GPS) is a satellite navigation system operated by the United States.
The system consists of a constellation of nominally 24 satellites in medium altitude earth orbit (MEO), as well as a worldwide ground network to monitor and control the satellites. The GPS program began in the early 1970s and the system was declared fully operational in 1995. Internationally, the GPS constellation is considered to be just one component within the global collection of navigation satellites that is referred to as the global navigation satellite system (GNSS)[33].

1.3.2 Elements of GPS

The three pieces that make up GPS work together to produce location data,The three segments of GPS are:[27]

- **Space (Satellites):** The space segment consists of the 24-satellite Each GPS satellite transmits a signal, which has a number of components: two sine waves, two digital codes, and a navigation message. The codes and the navigation message are added to the carriers as binary biphase modulations . The carriers and the codes are used mainly to determine the distance from the user's receiver to the GPS satellites. The navigation message contains, along with other inform- ation, the coordinates (the location) of the satellites as a function of time.
- **Ground Control:** The control segment of the GPS system consists of a worldwide net- work of tracking stations, with a master control station (MCS). The primary task of the operational control segment is tracking the GPS satellites in order to determine and predict satellite locations, system integrity, behavior of the satellite atomic clocks, atmospheric data, the satellite almanac, and other considerations. This information is then packed and uploaded into the GPS satellites.
- **User Segment:** The user segment includes all military and civilian users. With a GPS receiver connected to a GPS antenna, a user can receive the GPS signals, which can be used to determine his or her position anywhere in the world. GPS is currently available to all users worldwide at no direct charge.

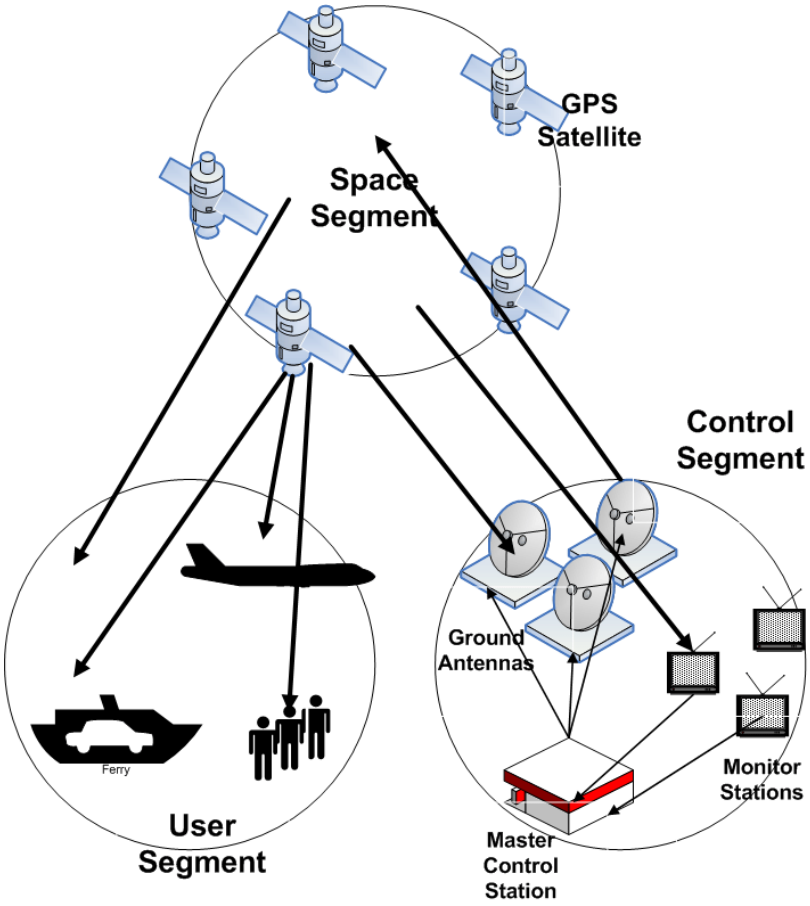


Figure 1.1: GPS Segments.[46]

1.3.3 How Does GPS Technology Work?

trilateration is the method used by GPS to determine the device's location. GPS devices receive signals from GPS satellites, which emit electromagnetic waves. By measuring the distances from multiple satellites and knowing

their precise positions, the device can calculate its position.
Receiving signals from two satellites provides latitude and longitude coordinates, but there is an ambiguity in the exact location. Additional satellite signals are needed to resolve this ambiguity. During an initialization period, the receiver gathers signals from multiple satellites to improve accuracy and eliminate false hypotheses.
For precise positioning, at least four satellite signals are required. The third signal helps determine altitude above sea level, while the fourth signal synchronizes the device's internal clock. By simultaneously receiving signals from four satellites, the device can calculate its coordinates in three-dimensional space, with time serving as the fourth dimension.[26].

1.4 Global System for Mobile Communication(GSM)

1.4.1 Definition of GSM

The European Telecommunications Standards Institute (ETSI) has produced the pan-European digital cellular standard known as GSM (the Global System for Mobile Communications). It is the most widely used second-generation cellular system in the world[24]. Wireless communication networks all across the globe employ the GSM standard. The IS-95 (CDMA) standard, on the other hand, competes with it in North America. In Canada, there is a GSM network that is run by Microcell (FIDO)[23].

1.4.2 GSM Network Architecture

Four main systems make up the GSM architecture. The GSM architecture's main elements are as follows[23]:

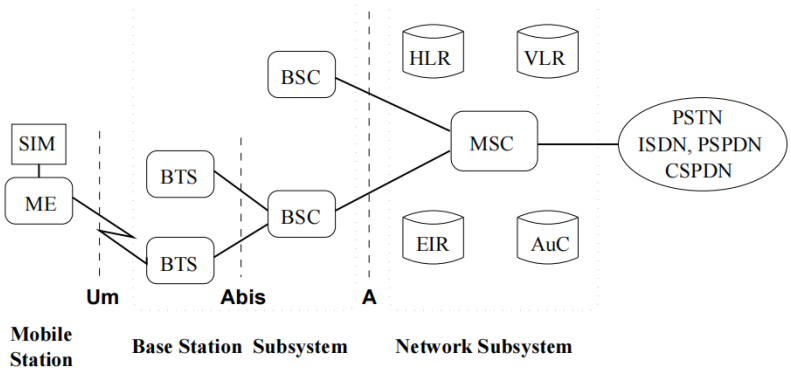


Figure 1.2: Architecture of the GSM Network.[24]

- The Network Switching System (NSS)
- The Mobile Station (MS)
- The Base Station System (BSS)
- The Operations and Support System (OSS)

1.4.2.1 Network Switching System (NSS)

This subsystem's main role is to handle communications between users, whether they are fixed telephone network users, ISDN network users, or other users who might be subscribers.

- **Mobile Services Switching Center (MSC):** This element can be considered as the heart of a cellular system since it manages calls and everything related to the identity of subscribers, their registration and their location. The MSC essentially acts as a node of a switched network.
- **Home Location Register (HLR):** Given that it keeps long-lasting records on users, the HLR is regarded as the most important database, containing subscriber information belonging to the area served by the mobile services switch (MSC).
- **Visitor Location Register (VLR):** VLR is database temporarily contains subscriber information who visit an area served by an MSC other than the one to which they are subscribers. This information comes from the HLR to which the subscriber is registered Note that the VLR is always associated with an MSC.
- **Equipment Identity Register (EIR):** The list of all usable terminals is contained in the EIR register. It is possible to deny access to the network to a terminal that has been reported lost or stolen by consulting this registry.
- **Authentication Center (AuC):** A copy of the secret key that is recorded on each subscriber's SIM is stored in the AuC, a secure database. This key is used to encrypt the supplied data and to confirm the subscriber's legitimacy.

1.4.2.2 Mobile Station (MS)

The mobile station is composed of the mobile terminal and of the subscriber identity module (SIM). The mobile terminal is the device used by the subscriber. Each mobile terminal is identified by a unique IMEI (International Mobile Equipment Identity) code. This code is checked each time it is used and allows the detection and prohibition of stolen terminals. The SIM is a smart card that contains in its memory the IMSI code (International Mobile Subscriber Identity), which identifies the subscriber as well as the information relating to the subscription (services to which the subscriber is entitled).

1.4.2.3 Base Station System (BSS)

The Base Station Controller (BSC) and Base Transceiver Station (BTS) are the two components that make up the Base Station Subsystem[24].

- **The Base Transceiver Station (BTS):** The BTS houses the radio transceivers for the cell and is in charge of MS radio connection procedures.
- **The Base Station Controller (BSC):** The BSC's role is to manage radio resources (channel configuration, handover). one or more base stations (BTS), in addition to establishing the physical link (via interface A) between the BTS and the mobile service switch (MSC, Mobile Switching Center), which we will see in the next section.

1.4.2.4 Operations and Support System (OSS)

Only the base station controller (BSC) is connected to this subsystem, which is connected to the other network subsystem components. The OSS regulates and manages traffic at the BSS through a network overview .

1.5 General Packet Radio Service(GPRS)

1.5.1 Definition of GPRS

The general packet radio service (GPRS) is a standard for packet data in GSM systems from the European Telecommunications Standards Institute (ETSI). By integrating GPRS technology with the current GSM network[16], the Internet and other packet data networks may now be accessed wirelessly much more easily and effectively thanks to GPRS, a new bearer service for the GSM network. It uses the packet radio concept to send user data packets between GSM mobile stations and outside packet data networks in an effective manner. From GPRS mobile stations, packets may be sent directly to packet-switched networks. The latest version of GPRS supports X.25 networks as well as Internet Protocol (IP)-based networks, such as the public Internet [21].

1.5.2 Architecture of GPRS

GPRS is intended to be a GSM network expansion. It offers a useful method for moving packets of data via wireless networks. Figure I depicts the architecture of the GPRS network.
The architecture of GPRS consists of two types of GPRS Support Nodes (GSNs), The Serving GSN (SGSN) and the Gateway GSN (GGSN)[34].

- **Serving GPRS Support Node (SGSN):** The SGSN connects the GPRS core network and the radio access network, and switches the packets to the correct base station controller (BSC) via the Gb interface. The base transceiver station (BTS) is only a relay station without protocol functions. It performs the modulation of the carrier frequencies and demodulation of the signals[16].
- **Gateway GPRS Support Node (GGSN):** The Gateway GPRS Support Node (GGSN) is the node, which is accessed by the packet data network based on the IP addressee of the user data. It contains routing information for attached GPRS users[45].

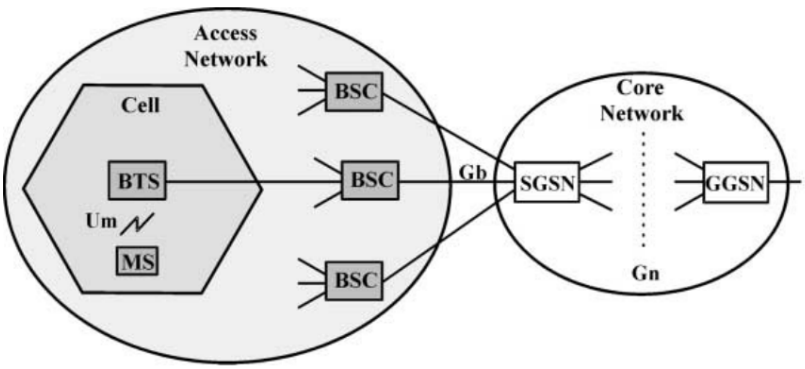


Figure 1.3: GPRS Architecture.[16]

1.6 Internet of Things

The Internet of Things (IoT), which is on the verge of becoming a fully-fledged universal worldwide computer network where everyone and everything will be connected to the Internet, is a prospective advance that might result from ongoing technological developments. IoT is always changing. Because of people's limitless imaginations[29].

1.6.1 What is Internet of Things?

A new technology paradigm known as the Internet of Things (IoT), often referred to as the Internet of Everything or the Industrial Internet, is envisioned as a global network of devices and items that are capable of communicating with one another[17], the IoT is "a world-wide network of interconnected objects uniquely addressable, based on standard communication protocols.'[35].
The IoT describes the next generation of the Internet, through which physical things can be accessed and identified the definition of IoT varies. However the The fundamentals of IoT imply that objects in an IoT can be uniquely identified in virtual representations. within a In IoT, all things can exchange data and, if necessary, process them according to predefined schemes[31].

Figure 1.4: Internet of Things.[49]

1.6.2 Characteristics of IoT

The following essential characteristics define the Internet of Things (IoT)[49]:

- **Interconnectivity:** In terms of the Internet of Things, everything may be connected to the global information and communication infrastructure.
- **Connectivity:** Network compatibility and accessibility are made possible via connectivity. Accessibility involves joining a network, while compatibility gives everyone the common capacity to use and create data.
- **Things-related services:** The IoT is capable of providing thing-related services within the constraints of things, such as privacy protection and semantic consistency between physical things and their associated virtual things. In order to provide thing-related services within the constraints of things, both the technologies in physical world and information world will change.
- **Heterogeneity:** IoT devices are heterogeneous in nature. Through multiple networks, they may communicate with additional devices or service platforms.
- **Dynamic changes:** the Device states change dynamically.
- **Enormous scale:** At least an order of magnitude more devices than those linked to the existing Internet will need to be controlled and interact with one another.

- **Safety:** Our data's security and the security of our physical safety are included in this. Making a scalable security paradigm is necessary to protect endpoints, networks, and the data .

1.6.3 Architecture of IoT

A key requirement of the IoT is that network elements must be interconnected. IoT system, the architecture must ensure the functioning of the IoT that connects the physical and virtual worlds. Shaping the Internet of Things The architecture includes many factors such as networks, communication, processes, etc. in the architectural design IoT, extensibility, scalability and device functionality should be considered. Because of Objects can move and need to interact with each other in real time, the IoT architecture needs to adapt devices dynamically interact with each other and support communication between them.In addition, the IoT must be decentralized and heterogeneous[31]. Today's IoT is characterized by the loss of a unified architecture. This is due to the different views of different stakeholders[58].
Where,there are several different IoT architectures proposed by vendors[18],such as architecture of three layers and architecture of four layers and five layers , and according to our interest we will use architecture of four layers.

1.6.3.1 Architecture of Four Layers

This architecture is good because it covers all aspects of IoT security and privacy. From a technical point of view, the IoT architecture consists of a variety of network communication devices and technologies.Four layers IoT architecture consiste,namely Sensing layer, network layer, service layer and application layer, as show in figure 1.6 [58].

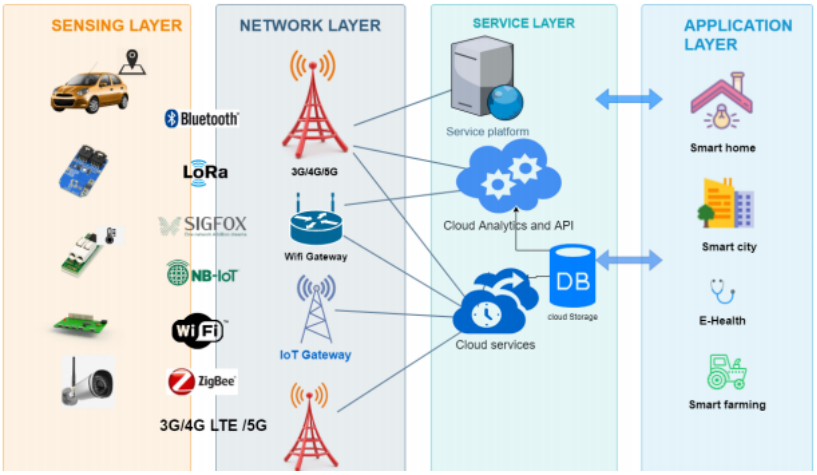


Figure 1.5: Architecture of Four Layers.[58]

- **Sensing Layer:** the sensory layer in IoT consists of intelligent object sensors or smart tags that autonomously perceive their surroundings and enable seamless data exchange. Connectivity options such as LAN, PAN, and WAN facilitate the connection between sensors and gateways or backend servers, enabling efficient data transmission and integration within the IoT ecosystem[31].
- **Network Layer:** In the Internet of Things (IoT), the network layer is responsible for connecting devices and facilitating their interaction with the environment. It plays a crucial role in enabling data sharing among these devices, which is essential for intelligent event management and processing within the IoT ecosystem. A strong and dependable network infrastructure is vital to ensure efficient data sharing and enable devices to provide services that enhance the functionality and effectiveness of IoT applications[31].

- **Service Layer:** The service layer in the architecture handles data processing, storage, and analytics. It integrates with cloud platforms or edge computing resources for efficient handling of large-scale data.[31].The management service within this layer focuses on secure information handling, utilizing tools like analytics, security controls, and device management. It also includes business and process rule engines. Data management is an important component, allowing effective flow, access, integration, and control of information. Implementing data management in this layer helps protect privacy by minimizing the processing of unnecessary data.[49].
- **Application Layer:** the Internet of Things (IoT) encompasses a wide range of interconnected devices that often lack uniformity and adhere to different standards, posing compatibility challenges. To address this, the interface layer provides a standardized mechanism, implemented through APIs or application frontends, to enable seamless communication and interaction among IoT devices. This layer simplifies the management and interconnection of diverse devices, promoting interoperability within the IoT ecosystem[49]

1.6.4 IoT protocols

IoT technology stack includes IoT protocols as an essential component. Hardware is meaningless without IoT protocols and standards. This is due to the fact that IoT protocols are what allow for communication that is, the data exchange or the transmission of commands among all those different devices.With the Internet of Things (IoT), the protocols define the complexity of application[28].
IoT Protocols must consume low power, should be highly reliable and devices must be able to connect to Internet. IoT covers a huge number of devices, so for communication between devices standard protocols are needed that[57].

Protocol	**Layer**
IEEE 802.15.4	Perception Layer
RFID	Perception Layer
LoWPANs	Network Layer
ZigBee	Network Layer
Z-wave	Network Layer
LoraWLAN	Network Layer
Sigfox	Network Layer
NB-IoT	Network Layer
LTE CAT 1	Network Layer
Cellular	Network Layer
WiFi	Network Layer
Message Queue Telemetry Transport (MQTT)	Application Layer
Constrained application protocol (CoAP)	Application Layer
Extensible messaging and presence protocol (XMPP)	Application Layer
Advanced message queuing protocol (AMQP)	Application Layer

Table 1.1: Most common protocols in IoT[28].

1.7 Artificial Intelligence (AI)

Artificial Intelligence (AI) is defined as the theory and development of computer systems able to perform tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages (Oxford Dictionary) [43]. As characterized by cognitive skills such as learning and adaptation, as well as decision-making capabilities.

Other definition: (J.L.Laurière): "Etude des activités intellectuelles de l'homme pour lesquelles aucune méthode n'est a priori connue. (Tout ce qui n'a pas encore été fait en Informatique - quand on sait le faire, ce n'est plus de l'IA ...)" [48]

1.8 Machine Learning (ML)

Machine Learning (ML) is a field of computer science that studies algorithms and techniques for automating solutions to complex problems that are hard to program using conventional programming methods [52]. That broadly aims to enable computers to "learn" without being directly programmed [54].

It has origins in the artificial intelligence movement of the 1950s and emphasizes practical objectives and applications, particularly prediction and optimization. Computers "learn" in machine learning by improving their performance at tasks through "experience". In practice, "experience" usually means fitting to data; hence, there is not a clear boundary between machine learning and statistical approaches [22].

1.9 Artificial Intelligence vs Machine Learning

Artificial Intelligence (AI) is a much broader field of study than machine learning (ML). AI is all about making machines intelligent using multiple approaches, whereas ML is essentially about one approach making machines that can learn to perform tasks. An example of an AI approach that's not based on learning is developing expert systems.
Although intelligence is hard to define, it is clear that ML is a subfield of AI as we show in Figure 1.6. A vast majority of people believe that AI and ML are the same due to a strong belief that ML is the only viable approach to achieving AI's goals [52].

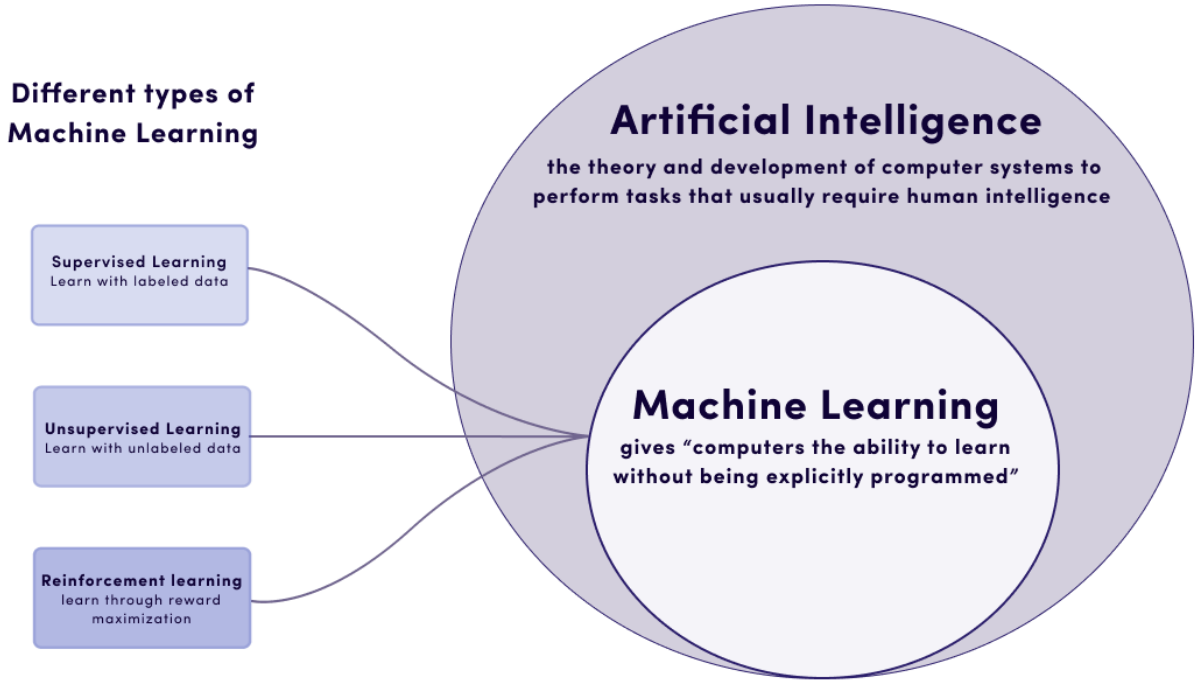


Figure 1.6: Difference between AI and ML [5]

1.10 Types of Machine Learning

Based on the methods and way of learning, machine learning is divided into mainly three types Figure 1.7, which are:

- Supervised Learning
- Unsupervised Learning
- Reinforcement Learning

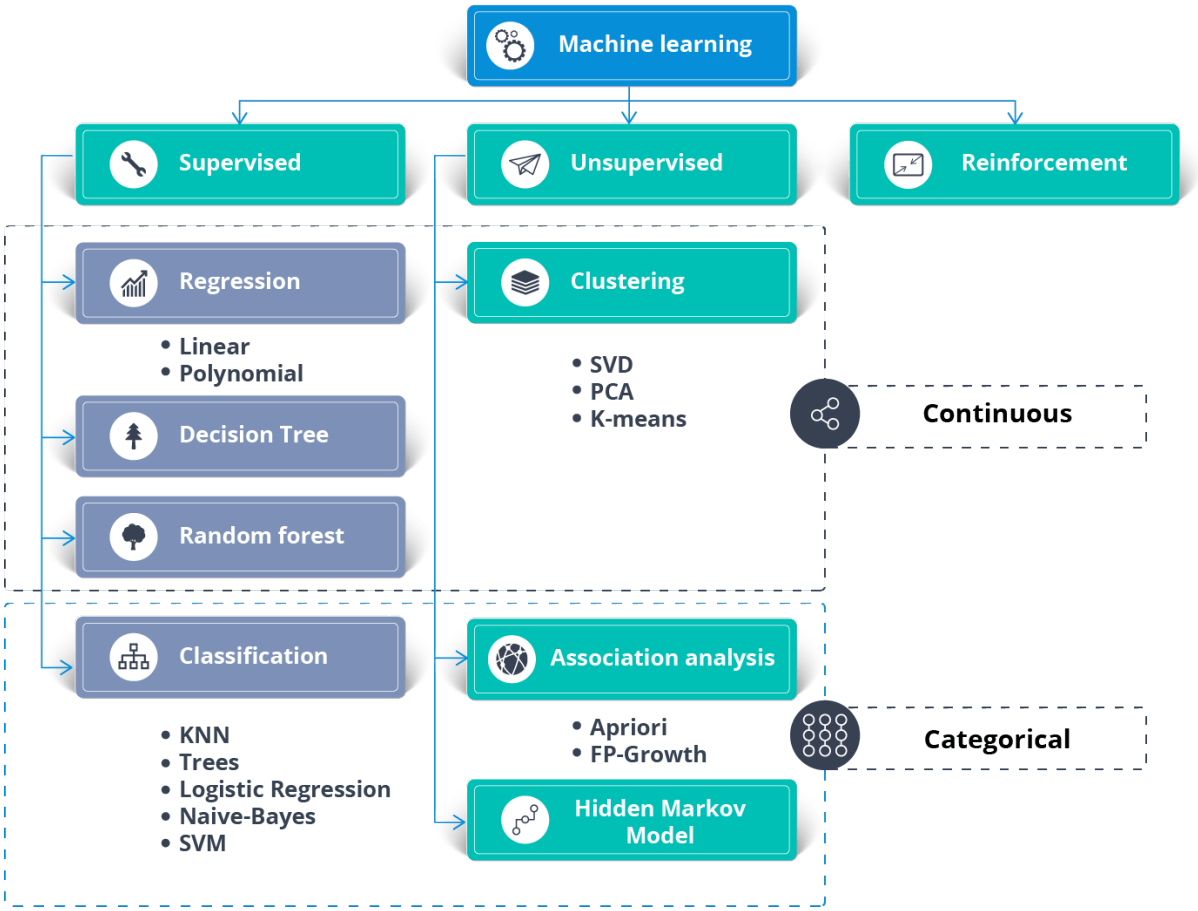


Figure 1.7: Types of Machine Learning Algorithms [8]

1.10.1 Supervised Learning

As its name suggests, Supervised machine learning is the machine learning task of learning a function that maps an input to an output based on example input-output pairs. And based on the training, the machine predicts the output. The supervised machine learning algorithms are those algorithms that need external assistance, the workflow is given in Figure 1.8.

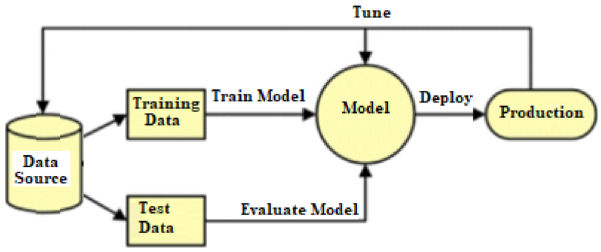


Figure 1.8: Supervised Learning Workflow [42]

The input dataset is divided into train and test dataset. The training dataset has an output variable that needs to be predicted or classified. All algorithms learn some kind of patterns from the training dataset and apply them to the test dataset for prediction or classification. [42]

One standard formulation of a supervised learning task is a classification problem: the learner has to learn a function (approximate its behavior), assigning a vector to one of several classes by considering several input-

output examples of the function.[19]

1.10.2 Unsupervised Learning

Unsupervised Learning is so named because, unlike supervised learning, there are no correct answers and no teacher as shown in Figure 1.9. Algorithms are left to their own devices to uncover and provide fascinating data structures. [42]

Given the huge amount of data, the machine may identify trends of similarity. The algorithm will identify clusters or groups of similar items or similarity of new item with existing group, etc. [52]

Unsupervised learning techniques extract only a few characteristics from the data. When new data is introduced, it employs previously learnt characteristics to identify the data's class. Its primary applications are clustering and feature reduction.

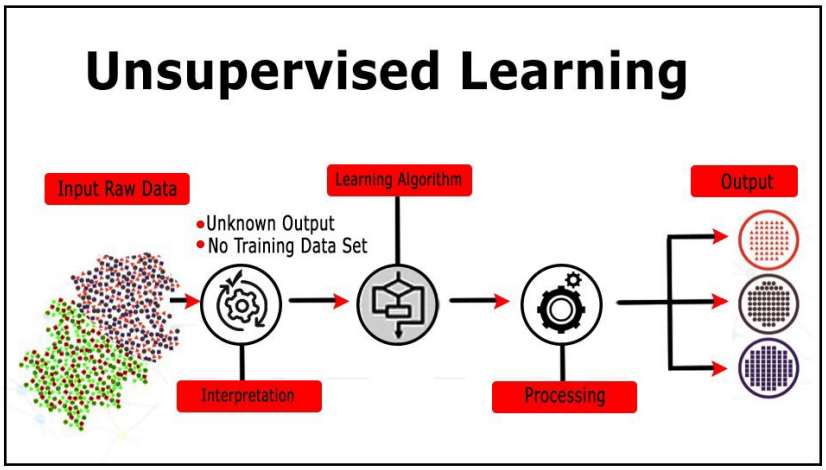


Figure 1.9: Unsupervised Learning [42]

1.10.3 Reinforcement Learning

Reinforcement learning is a branch of machine learning that studies how software agents should behave in a given environment in order to maximize some concept of cumulative reward. Because the agent is rewarded for every good activity and penalized for every negative action, the reinforcement learning agent aims to maximize the benefits. Figure 1.10 illustrates the action-reward feedback loop of a generic reinforcement learning model.

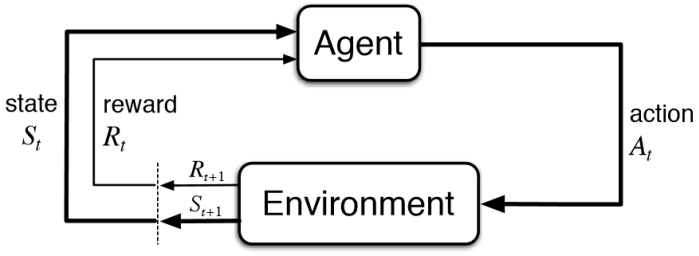


Figure 1.10: Reinforcement Learning [42]

Reinforcement learning and supervised and unsupervised learning is one of three fundamental machine learning

paradigms.[42]

Because of how it works, reinforcement learning is used in a variety of domains, including game theory, operations research, information theory, and multi-agent systems.

1.11 Supervised Machine Learning Categories

Within the domain of supervised learning, machine learning algorithms can be divided based on types of output or target variables being used for prediction into:

- Regression
- Classification

1.11.1 Regression

Regression is used when the target value to be predicted is continuous or numerical in nature [56] as shown in Figure 1.11, the regression algorithm's task is to find the mapping function to map input variables (x) to continuous output variables (y).

For example: regression algorithms are used to predict continuous values such as price, marks, salary, age, and so on.

Figure 1.11: Regression [56]

1.11.2 Classification

Classification is employed when the goal variable is a discrete value or categorical in nature [56]. A computer program is trained on a training dataset and then categorizes the data in distinct class labels depending on the training.

As demonstrated in Figure 1.12, this method is used to forecast discrete variables such as male/female, true/false, spam/not spam, and if a client would churn out.

Figure 1.12: Classification [56]

Classification tasks can further be broken down into two categories: binary class and multi-class, as shown in Figure 1.13

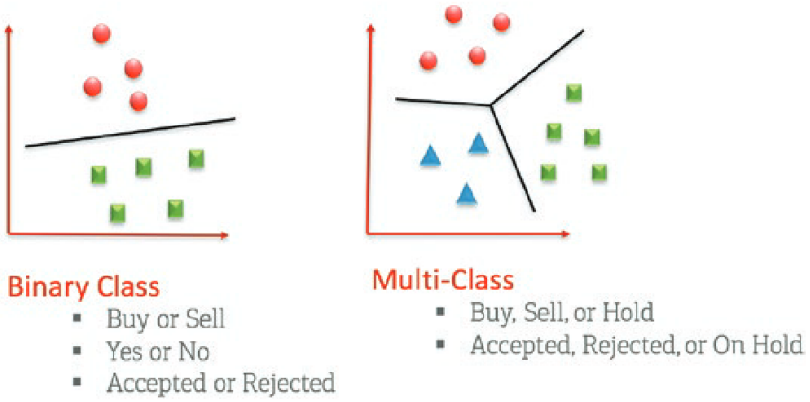


Figure 1.13: Types of classes [56]

1.11.2.1 Binary Classification

Binary Classification is used when the goal or output variable has just two categories. As a result, each record in the data can only belong to one of the two categories.[56] As an example:

- True or False
- Group A vs Group B
- To sell or Not to sell
- Whether positive or Unfavorable
- Acceptance or Rejection

1.11.2.2 Multi-class Classification

When the goal or output variable has more than two categories, it is referred to as multi-class classification. As therefore, there may be multiple categories inside the data, and each record may belong to any of them.[56] As an example:

- Yes or No, or Maybe
- Group A, B, or C
- Category 1 or 2 or 3 or 4 or other
- Rank 1; Rank 2; Rank 3; Rank 4; Rank 5

1.12 Classification Algorithms in Machine Learning

1.12.1 K-Nearest Neighbors Classifier Algorithm

K-nearest Neighbors (KNN) Classification is a nonparametric approach in which the model maintains observations from the training set for test set classification. It is classified as lazy learning since it does not learn anything during the learning phase. It predicts the class of a new input data by looking for its K nearest neighbors (using the Euclidean distance, or others) and selecting the nearby majority class. [39]

A comparison of KNN classification for two neighborhood sizes ((a) K = 1 and (b) K = 20) on two Gaussian-based data clouds. As shown in Figure 1.14 KNN tends to overfit becoming local in tiny neighborhoods, whereas KNN generalizes for bigger K disregarding small agglomerations of patterns.

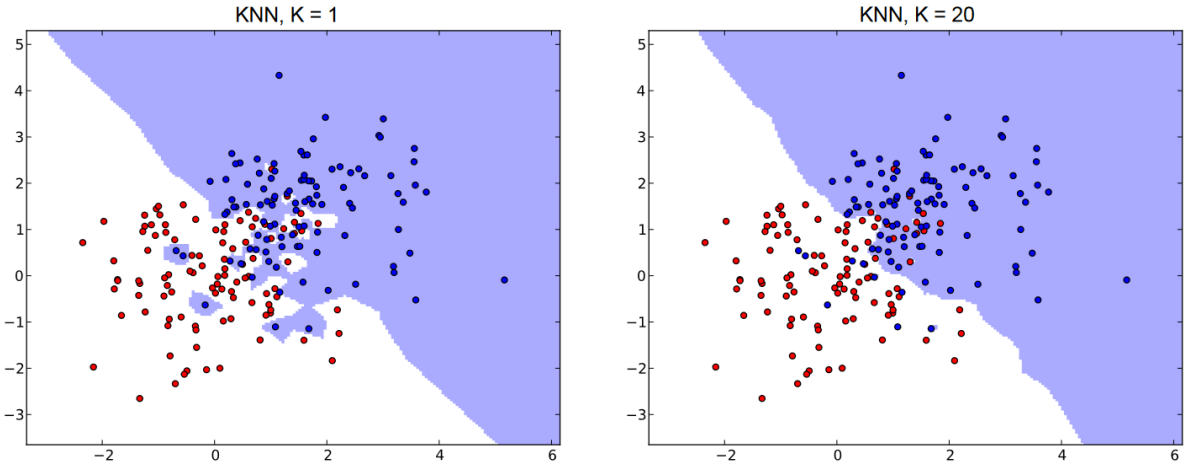


Figure 1.14: Comparison of KNN classification for two neighborhood sizes ((a) K=1 and (b) K=20) [39]

Predicting the result based on the nearest single neighbor (K=1) is obviously a unique case. A greater value of K is frequently used in order to avoid being influenced by a single erroneous data/label.

1.12.2 Support Vector Machine Algorithm

Another most widely used state-of-the-art machine learning technique is Support Vector Machine (SVM). It is a linear classifier method that finds the boundary between many data categories, each of which occupies a separate region of the plan Figure 1.15. The goal is to correctly classify a new point into the relevant category. To determine this boundary, training data must be provided so that SVM can predict his most likely position.[32]

It basically, draws margins between the classes. The margins are designed in such a way that the distance between the margin and the classes is as little as possible, hence decreasing classification error.

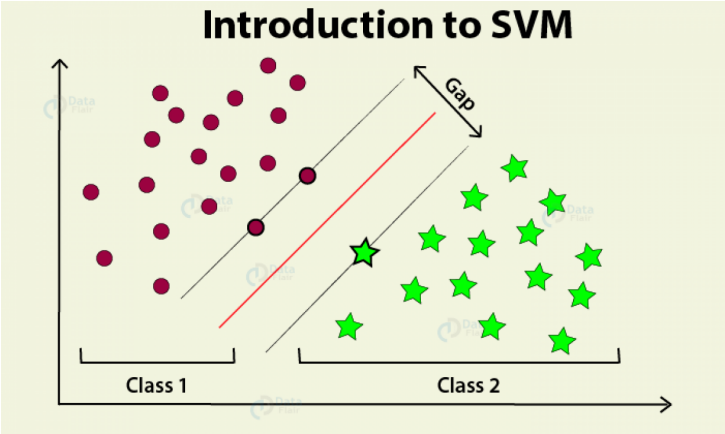


Figure 1.15: Support Vector Machine [42]

1.12.3 Decision Tree Algorithm

A decision tree is a graph that represents decisions and their outcomes as a tree as shown in Figure 1.16.

The graph's nodes represent an event or choice, while the graph's edges indicate the decision rules or conditions. Each tree is made up of nodes and branches. Each node represents an attribute in a classification group, and each branch indicates a value that the node can take. To forecast a result, a decision tree simulates a hierarchy of tests. [42]

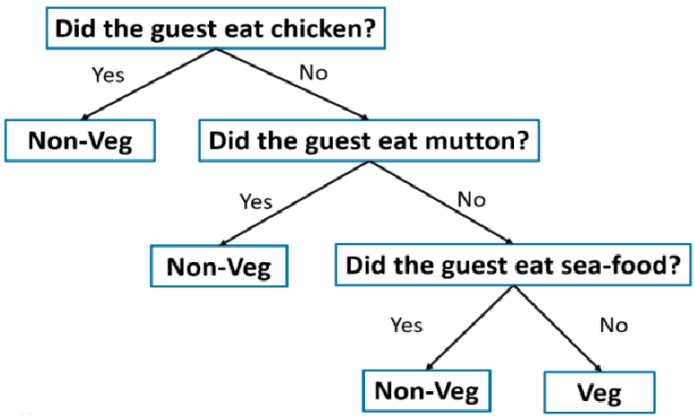


Figure 1.16: Decision Tree Algorithm [42]

1.12.4 Random Forest Classifier Algorithm

A Random Forest (RF) Classifier is an ensemble classifier that produces multiple decision trees Figure 1.17, using a randomly selected subset of training samples and variables, thus forming a forest. Considered among the most accurate learning algorithms, RF reduces the variance observed in DT.

This algorithm attempts to find out the best feature from all the features at random [32]. So this classifier has become popular within the remote sensing community due to the accuracy of its classifications.

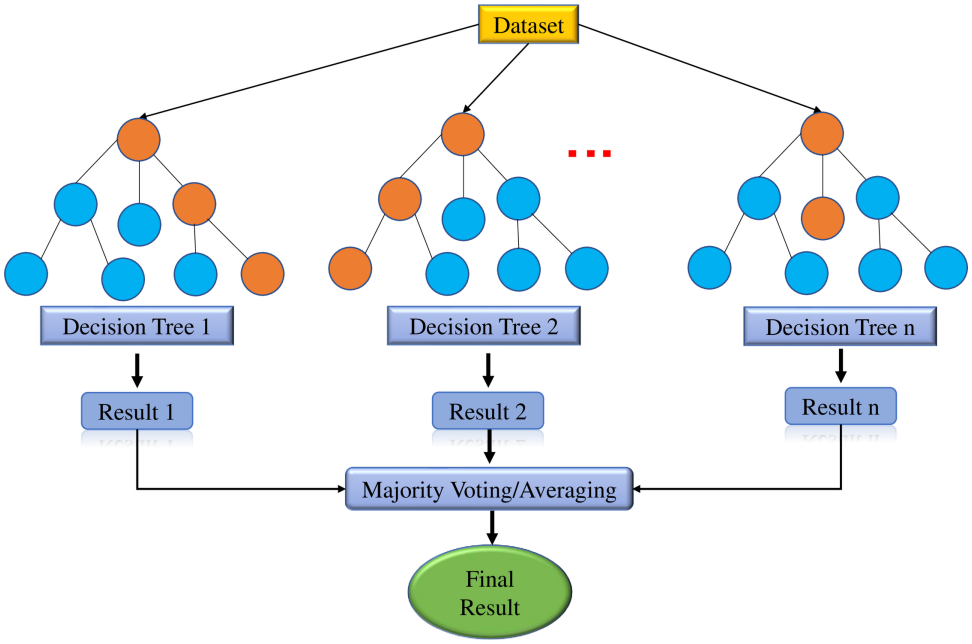


Figure 1.17: Random Forest Classifier [50]

1.13 Machine Learning Life Cycle

Machine Learning has given computer systems the ability to automatically learn without being explicitly programmed.
But how does a machine learning system work?

So, it can be described using the life cycle of machine learning. The machine learning life cycle is a cyclic process to build an efficient machine learning project. The main purpose of the life cycle is to find a solution to the problem or project.
The machine learning life cycle involves seven major steps, which are given below [9]:

- Gathering Data
- Data Preparation
- Data Wrangling
- Analyse Data
- Train the Model
- Test the Model
- Deployment

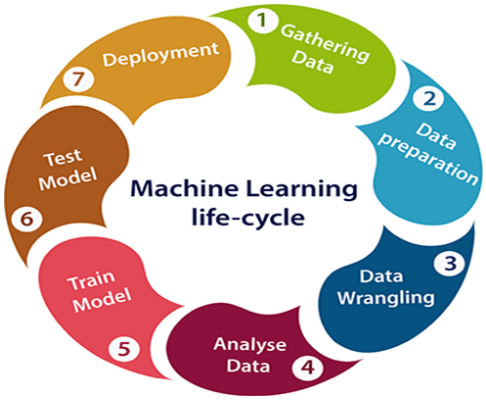


Figure 1.18: Machine learning life cycle [9]

1.14 Conclusion

In conclusion, this chapter provided definitions of keywords and technologies that will be utilized in our Smart GPS tracker and health monitoring system. We discussed geolocation technologies, with a particular focus on GPS as the most commonly used technology. We also explored the Internet of Things (IoT), highlighting their relevance to our solution. Furthermore, we delved into machine learning, its main concepts and Algorithms with a particular focus on classification Algorithms.

In the next chapter, we will shift our attention to our system and explore its distinctive features and advantages over existing solutions, we will evaluate the existing tools and highlight the unique aspects of our approach that set it apart from the rest. Moreover, we will discuss scientific research on the fundamentals of machine learning detection and prediction.

Chapter 2

Related Works

2.1 Introduction

In Algeria specifically Biskra, remotely monitoring model production not pre-well considered or used for autism, so GPS tracking solution was a critical issue to consider.
In this chapter we are going to talk about different cases to applicate this technology, introduce some start-ups working on the same project and their services, conducting comparative analysis to demonstrate the added value and effectiveness of our system in addressing the challenges faced by current solutions.
Additionally, we will discuss the information retrieved from our questionnaire, then describes also the researches and related work on stress detection, prediction using machine learning techniques.

2.2 Cases of Study

Despite users who have android phones equipped with Global Positioning System, progress day by day, which we rely on primarily as a tool to locate our relatives. Still, however relied on them to remember to carry it when they leave, because we lose and leave things behind all the time, this is maybe not the accurate solution for different cases.

2.2.1 Autism

Nowadays time, one or both parents goes to work, and a toddler will has many activities to do while they're in school or outside home, so they can't predict or determined if their loved ones will be targeted or not.

Child with autism spectrum disorder (ASD) is not out of the category, those with developmental disorders face major challenges, as likelihood of experiencing co-occurring psychiatric conditions, anxiety disorders, and attention-deficit hyperactivity disorder, who may be prone to becoming lost away from their own home all the time, and as their additional needs increase, high dependency conditions or physical, emotional or behaviour difficulties often need additional support and monitoring to keep them away from dangerous situations from or to them. Nearly most of the children with ASD try to wander or run off, even when there's an adult supervising them, for their curiosity to explore or when overwhelmed. Children with ASD get fixated on exciting things, and they want to explore them right away, and they run away from you, unaware of the danger.

Maybe they are found safe most of the time, but some find themselves in dangerous situations. In such scenarios, tracking the live location of children is very important for their safety and security.

On another side not far from this, the whole response from the kids and their behaves it not easy to be predictable, and you can't be aware of all that comes next from them and most important, it makes even harder for whom he's their only child to take care, the urge to need to understand them, communicate, and make safe around space for them to act as much as possible to ordinary people with some freedom and security without neglect them. [2]

2.2.2 Discussion

While we set out to process our autism questionnaire illustrated in Appendix A.1 for finding out some quick tit-bits of information about autism child. The results shown in 2.1 were different for each representative, depending on whether he was a doctor, family, or caregiver for autism kids, as 91.8% responders declared they are suffering from hard time to take care over their own kids all the time, and 71.4% who experienced losing them frequently, while 28.6% says no.

Moreover, 93.9% of the respondents confirmed that the case of their children with autism show anxiety and stress attacks that dominate their behaviour most of the time, and this is often difficult to deal with or predict it.

This highlights the predominance and prevalence of autistic children's seizures in society. Additionally, the results showed a great response and desire of 95.9% to try to buy a monitor and health care device for autistic children.

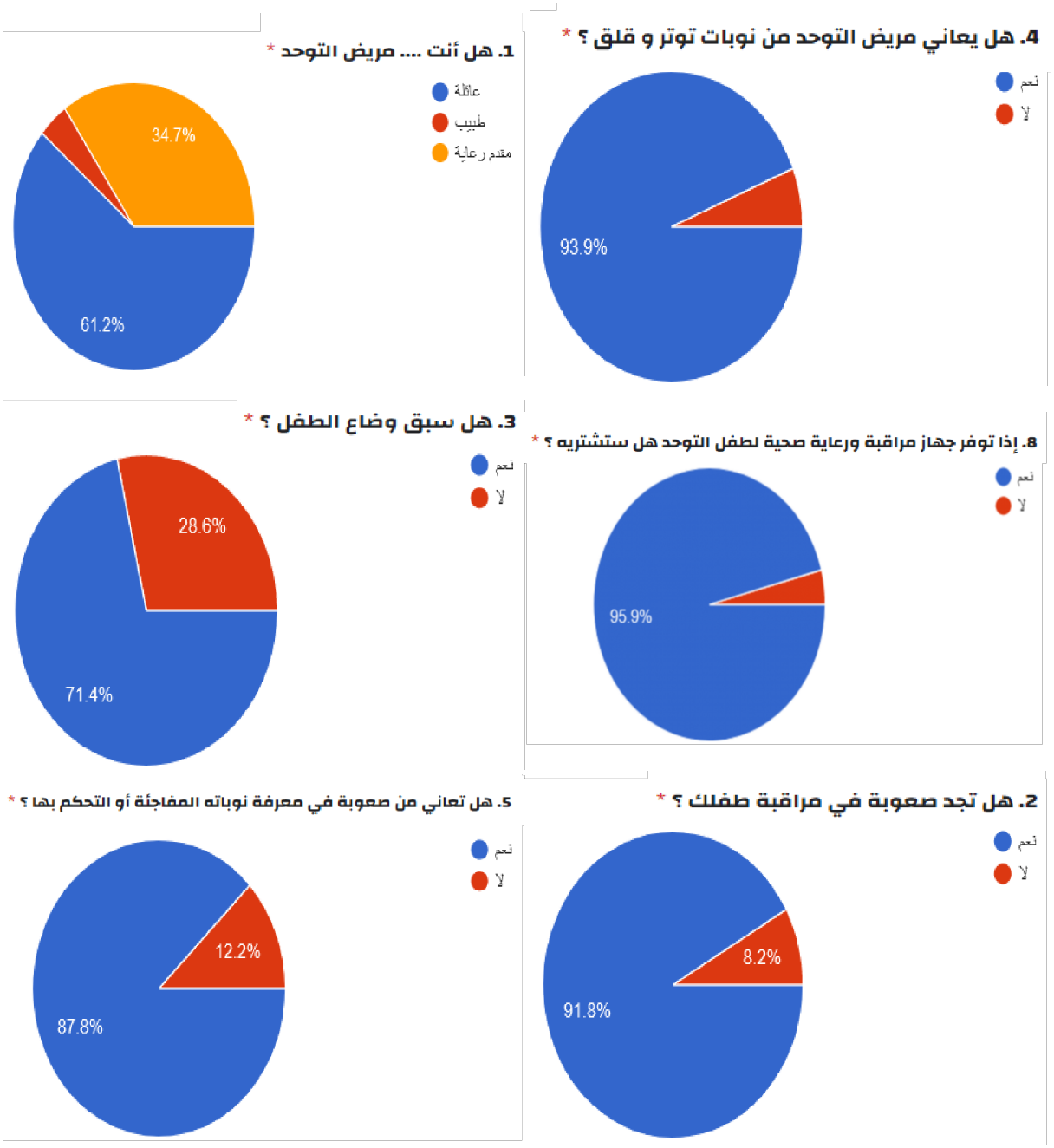


Figure 2.1: Survey Results

Due to development in the field of technology Global Positioning System (GPS) solutions are increasingly used, and we could see through the study observed that use of GPS tracking devices that attaches a bag or clothing, or that can be worn on the wrist or around the neck, ankle, is the perfect way to get the exact location of the child, your special needs kids, etc. . . , is the best possible manner to help in caring, monitoring, to diminish some burden, and give you greater control over their safety, as you can set area limits and be notified if they leave the set zone, accessed GPS tracking and health data via smartphones and more easy-going features.

2.3 GPS Tracking Solutions

A good number of tracking systems, supply with a wide range of tracking facilities, have so far been developed. Goes to the existing solutions, we will make a comparison between some provided services.

2.3.1 RingOn

A wearable Personal Safety device sized for a child's finger that serves as a GPS tracker and a panic button in one. This Smart GPS ring-shaped help parents track their kids, and monitor their safety via the app who comes with easy setting.

RingOn will allow children to alert parents and all predefined five recipients in real-time when they need help, and in other hand parents can see the exact location of their children and hear a live audio stream, and in an safe situation your child moves the toggle to trigger, you just need to choose design and personalize your child's ring in demand. [12]

Figure 2.2: RingOn [12]

2.3.2 Silvertree

The Silvertree Reach is personal health and safety modern wearable wellness device for active older adults, comes with connected app (iOS & Android)

Start setup your silvertree profile with simple prompts for you and your loved one to follow and complete, as care partner or subscriber and benefit from all features like fall detection alerts where automatic notifications sent to the assigned care team when a hard fall is detected, a more the digital medical ID gives secure access to medical information in an emergency, different sensors use (Accelerometer, Gyroscope), step counting, etc. [13]

Figure 2.3: Silvertree Reach [13]

2.3.3 4G TK905

TK-Star TK905 is a powerful GPS tracker that can be used for vehicles, equipment, containers, etc. The device features vibration, movement and over speeding alert, you can setting-up geofencing zone, he comes with good battery life, and more. You can manage the device settings using device management platform. It comes with server can store the data for half year, so you can check the historical routes in app or web platform at any time.[1]

Figure 2.4: 4G TK-Star TK905[1]

2.3.4 Osmile ED1000

Smart wearable GPS device as a keychain, Very convenient for patients who live alone and seniors with health issues, can continuously use for days, allows Heart rate monitoring, Steps, Medicine Reminder, continuously, and support 4G/5G nano SIM card network to function. As the sensors can be used to monitor various aspects of the outside world (The gyroscope etc...) there is fall detection alarm which connect to an emergency response.

Most importantly, with an Osmile app system requirement support both Android and IOS, it gives you real time location of the wearer, and notify you if they are in or out of the geo-fence predefined setups.

Apart from that, there is an SOS one-key call for help, and phone call function, to maintain a two ways communication between wearer and Osmile app at all time. [11]

Figure 2.5: Osmile ED1000 [11]

2.3.5 GF-07

Personal magnetic GPS for Car, Motorcycle, Kids, and you can carry it in your bag, pocket, etc.... It works with the GSM network by sending and receiving SMS, comes with SOS Vibration Alarm, website but in Chinese language, you can see the location details in any browser using Google Maps link message.

The most important thing for this device, you need a 2G network supported SIM card and a micro SD card only to work, and then there is some limit instructions messages to do with GPS number.[4]

Figure 2.6: GF-07. [4]

2.3.6 Nabi Z7

From the latest generation brand Nabi, this GPS smartwatch is available to simplify your daily life, it is a water-resistant smartwatch available to protect, easily follow the movements of your little one, and know where he is at any time of the day.

Grab The barcode and QR code present in the watch, download the free setracker2 app to assist with registering a user account. communicate with the child whenever you want, both by voice call and video call.

The watch also includes maths games, a camera, a photo album, a flashlight. [10]

Figure 2.7: Nabi Z7 [10]

2.4 Discussion

In the last section we described some working on the GPS tracking system, in this section we are going to make a comparison between all of them and describe their way of functioning, it could be illustrated in a table as shown Table 2.1.

	Ringon	Gf-07	Silvertree Reach	4GTK905	NabiZ7	Osmile ED1000
Real-time tracking	✓	✗	✓	✗	✓	✓
Connectivity	IoT	GSM /GPRS	IoT	IoT	GSM /GPRS	4G/5G
Power	Battery (up to) 24 hours	Battery (up to) 2-3 day	Battery (up to) 14 days	Battery (up to) 7 days	Battery (up to) 24 hours	Battery (up to) 3 days
Form	Wearable	Not wearable	Wearable	Not wearable	Wearable	Wearable
Where to be used	Kids	Car, Motorcycle ,Kids, Elderly persons	Older adults, care partners	Cars, Equipment ,Container, Cargo	Kids	Dementia ,Alzheimer
Strap	Buckle	✗	Buckle	✗	Buckle	✓
Monitoring	Web/App (Ios/ Android)	Web	App(Ios/ Android)	Web	App(Ios/ Android)	App (Ios/ Android)
Pairing multiple user	✓	✗	✓	✗	✓	✓
Gps Geofencing	✓	✗	✗	✓	✗	✓
SOS Alarm	✓	✗	✓	✗	✓	✓
Healthcare	✗	Fall detection	✗	HeartRate, Fall detection	✗	✗
Waterproof	✓	✓	✓	✓	✓	✓
Subscription plans	✓	✗	✓	✓	✗	✓
Source	Imported	Imported	Imported	Imported	Imported	Imported

Table 2.1: The Analysed Products.

- As it's shown in the table, techniques have been surveyed on GPS based tracking and monitoring system and some evaluation criteria have been used in the evaluation of these techniques, we reach with :
  - None of the existing solutions represent a viable solution towards solving all problem.
  - All the analysed products provide a **real-time tracking system as well as our proposed solution.**
  - **Connectivity :** Several IoT network protocols like Wi-Fi and Bluetooth are used to connect devices over the network from the three technology startups : RingOn Reach, Silvertree, 4G-TK905, and ED1000 keychain who use 5g/4g. Moreover, each of GF-07 and Nabi z7 have recourse to GSM/GPRS with more features such as Multimedia Messaging Service (MMS), Push To Talk (PTT). **About our proposed solution we are going to use IoT technology with GSM/GPRS** with minimal requirement of resources, to get of use both benefits of offline and online services, as well as reducing the energy consumed If Wi-Fi is available we will use it, and we will not resort to GPRS, and vice versa. Thus, we will make sure to follow the child all the time, and the problem of the presence or absence of the Internet will not be an obstacle.
  - **Power :** All the GPS tracking devices resort battery as a source of power with different life up to if it charged and used appropriately. **In our proposed solution, we are going to use battery as a source**

of energy.

- **Form :** The two single study Silvertree Reach and Nabi Z7 used a truly wearable GPS device in a wristwatch form, while come to the others, there's wearable ring form of RingOn, keychain of Osmile ED1000, conversely to GF-07, and 4G TK905. **In our proposed solution, we are going to use a wearable form of bracelet.**
- On almost all of them, the hardware wouldn't work on those patients, or with special needs, can easily be forgotten, if it attached to specific clothes, bags or put it away for a moment. Relied on the person itself remembering to carry the GPS device when he left the house not ensuring solution, even could the one with special care need can take it off. Not to mention that some like the 4G-TK905 is not just could be forgotten as they are not incorporated into clothing or worn on the body, but it litterary track your one if it inside means of transportation only, it manages maybe to work with school bus tracking them, or your car place, not when they on legs.
- Simply, most GPS devices with one purpose can't be accurate for another cases.Therefore, reusability is the limitation of these techniques. **About our proposed solution, we are going to manage to provide a suitable GPS tracker for autistic children**
- **Monitoring :** Except the all, GF-07 doesn't come with tracing app, it only sees the location through Google Map or 4G-TK905 with web. **About our proposed solution, we also included a suitable app with site web services.**
- The technology provides multiple user GPS management to pairing multiple user, also SOS alarm and button, When can for children inform their parents that they are in danger and vice versa in case of geofencing exit of predefined zone for un patient out of home, hospital etc..., **we are headway to provide both of SOS alarm and pairing multiple user for single person in our proposed solution.**
- **Healthcare :** Each technology distinguishes oneself from the other in health assistance, where both Silvertree and Osmile ED1000 added services like heart rate monitoring and fall detection contrary to the rest. **We are providing in our solution a health monitoring system with heart rate, body temperature, oxygen level monitoring, not only that, but we added stress and anxiety prediction alert for autism case.**
- All existing solutions tool up with **waterproof (IP-67) as well our.**
- The solutions that do have a good device are extremely expensive, and need a monthly paid subscription. **Our proposed solution comes with all features along with another optionally paying services.**
- **Source :** Despite being imported and not made in Algeria, the aforementioned technology did not help or care for autistic children, unlike what we developed.

2.5 Scientific Researches

We discuss related work on stress detection and prediction using machine learning techniques:

2.5.1 Machine Learning and IoT for Stress Detection and Monitoring

2.5.1.1 Principle

This paper [32] proposes a patient stress detection and monitoring system based on machine learning and the Internet of Things (IoT), which consists of three layers: collection, service, and artificial intelligence. The system consists of a medical kit on top of the patient's hand Figure 2.8 that uses two sensors (MAX30100, GSR) to measure the patient's physiological data (oxygen saturation, heart rate, and galvanic skin response) before sending the data to a Firebase server that runs interactively with a mobile application and artificial intelligence layer, as shown in Figure 2.9.

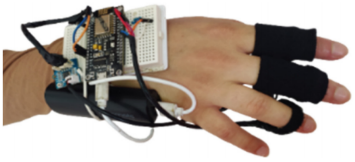


Figure 2.8: Medical Kit [32]

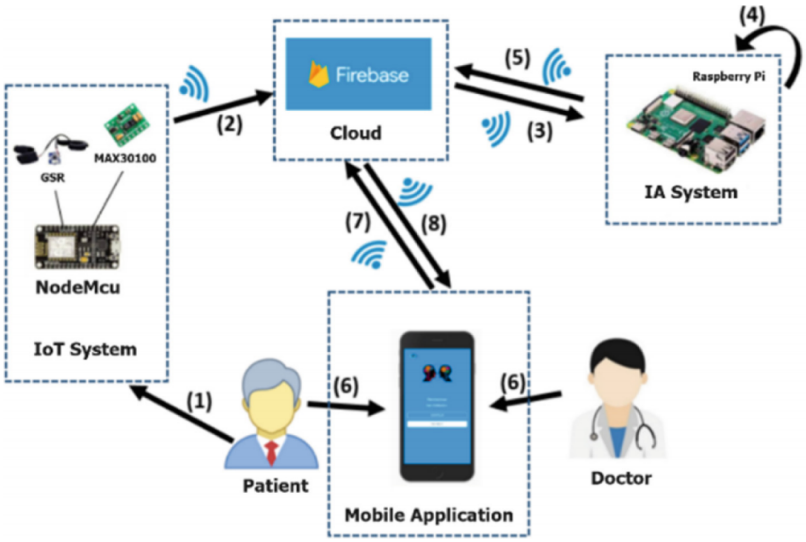


Figure 2.9: Illustrative Scenario [32]

2.5.1.2 Method

The dataset was collected from physicians on 25 volunteers (11 males/14 females, mean age = 45 ± 10 years). Patients were divided into two categories: "stressed" and "not stressed".

Five machine learning algorithms (logistic regression, K nearest neighbors, support vector machines, decision trees, and random forests) were implemented using holdout and K-fold cross-validation on a Raspberry board installed in the clinic, as shown in Figure2.10.

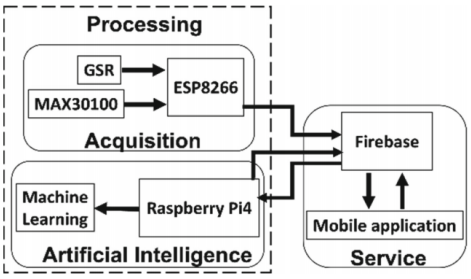


Figure 2.10: Stress Detection System based on ML techniques [32]

2.5.1.3 Results

The result is to make predictions with the Random Forest classifier which has the apparent highest classification accuracy that reaches 87% Table 2.2.

Classifier	Holdout	Cross-Validation			
		3-folds	5-folds	7-folds	10-folds
Logistic Regression	84.83	83.89	84.36	84.36	84.36
K-Nearest Neighbors	85.78	–	–	–	–
Support Vector Machine	86.83	85.31	85.31	85.31	84.83
Decision Tree	83.41	84.36	86.23	84.83	84.83
Random Forest	84.62	86.73	87.26	86.73	86.26

Table 2.2: Table of accuracies result on the 5-classification task [32]

Then the results are displayed on a dashboard with real-time and historical data, as well as the patient's stress level, through a developed mobile application.

2.5.2 Stress Prediction Model Using Machine Learning

2.5.2.1 Principle

This research [47] presented a model for stress prediction using machine learning. Therefore, the major goal of this study is to better understand the various factors that cause stress and pinpoint their most important contributing characteristics so that suitable action may be made to deal with them.

2.5.2.2 Method

Data were collected from 653 students of different universities in India using Likert scale 5. Assign a numerical score from 1 to 5 based on the option selected. Use the following range values to assign numeric rating values to different categories.

- 1-2.33 = Low pressure
- 2.34-3.67 = Medium load
- 3.68-5 = High pressure.

By applying various data visualization techniques and random forest regression algorithms using Python commands. [47]

2.5.2.3 Results

As a result of this investigation [47], 15 significant influencing factors were identified from a list of 25 features as shown in Table 2.3 and a stress level prediction with an R-squared value of 0.8042 was performed using the random forest regression algorithm.

Rank	Name of feature
1	Anxiety/nervousness
2	Work stress (hard time at work/ college)
3	Unhealthy influence through social media
4	Relationship at work/school/college (strained relationships at work)
5	Workload (neglecting tasks due to high workload)
6	Disturbed sleep cycle
7	Technology obligations (want to leave technology but cannot due to work)
8	Job awareness
9	Vocal expression (ability to describe our own feelings)
10	Digital distraction (social media and devices, a distraction from real life)

Table 2.3: Table of Top 10 Features that cause stress [47]

2.5.3 Stress Detection by Machine Learning and Wearable Sensors

2.5.3.1 Principle

The main objective of this work [30] is to detect ”interpersonal stress” using machine learning methods, with the ultimate goal of improving their quality of life.

This study used the publicly available multimodal dataset WESAD. Collect sensor data such as electrocardiogram (ECG), body temperature (TEMP), respiration (RESP), electromyography (EMG), and electrodermal activity (EDA) for three physiological states: neutral (baseline), stress, and recreation.

2.5.3.2 Method

Five machine learning algorithms (Random Forest, K Nearest Neighbors, Linear Discriminant Analysis, AdaBoost, and Support Vector Machines) were used and their performance was compared.

Two types of classification were performed, three-class (neutral, stressful, recreational) and binary classification (stressed vs non-stressed), and F1 scores and accuracy were measured.
The WESAD dataset is highly imbalanced, so the F1 score is chosen as the baseline and accuracy. [30]

2.5.3.3 Results

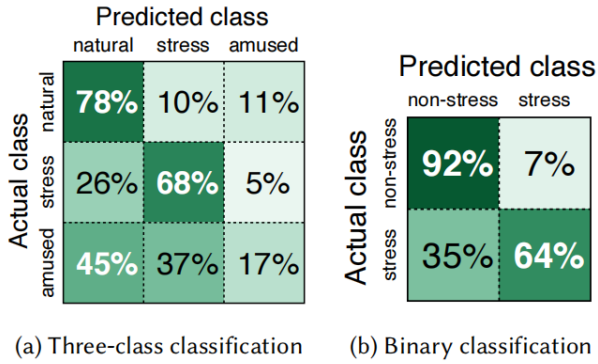
The performance of different classifiers based on both binary and three-class classification is shown in Table 2.4.

	Binary		Three class	
	F1-score	Accuracy	F1-score	Accuracy
Random Forest	**83.34**	**84.17**	**65.73**	**67.56**
Support Vector Machine	75.88	76.01	59.64	59.56
k-Nearest Neighbour	74.71	77.26	58.14	65.00
Linear Discriminant Analysis	74.70	78.47	50.44	67.06
AdaBoost	81.18	82.24	63.82	64.34

Table 2.4: Summary of the stress classification results using leave-one-participant-out approach [30]

It was observed that the Random Forest model performed better for both three-class (neutral vs. stress vs. amused) and binary classification with F1-scores of 83.34% and 65.73% respectively.

Confusion matrices for three-class and binary classification using Random Forest were plotted. From Figure 2.11



(a) Three-class classification (b) Binary classification

Figure 2.11: Confusion Matrices using Random Forest [30]

2.5.4 Introducing WESAD, a Multimodal Dataset for Wearable Stress and Affect Detection

2.5.4.1 Principle

The main goal of this paper [55] is to introduce WESAD, a multimodal dataset for wearable stress and affect detection. This multimodal dataset includes physiological and movement data of 15 subjects during a laboratory study, recorded by wrist-worn and chest-worn devices Figure2.12. The following sensor modes are included: blood volume pulse (BVP), electrocardiogram cardiogram (ECG), electrodermal activity (EDA), electromyogram (EMG), respiration (RESP), body temperature (TEMP), and three-axis acceleration (ACC).

For benchmarking, they used standard physiological and motor features as well as common machine learning methods.

Figure 2.12: Placement of the RespiBAN and the ECG, EDA, EMG, and TEMP sensors. [55]

2.5.4.2 Method

Five machine learning algorithms are applied and compared: decision tree (DT), random forest (RF), AdaBoost (AB), linear discriminant analysis (LDA), and k nearest neighbors (kNN). Since the entire data processing chain was implemented in Python, they used the scikit-learn implementation of the above classifier.[55]

2.5.4.3 Results

They used accuracy and F1-score as evaluation metrics. All models were evaluated using the leave-one-subject-out (LOSO) cross-validation (CV) procedure. Hence, the results indicate how a model would generalize and perform on data of a previously unseen subject.

On a three-class (baseline vs. stress vs. amusement) we achieved classification accuracies of up to 80%. Considering a binary classification problem (stress vs. non-stress), accuracies of up to 93% were reached. [55]

2.5.5 SaYoPillow: Blockchain-Integrated Privacy-Assured IoMT Framework for Stress Management Considering Sleeping Habits

2.5.5.1 Principle

The main idea of this work [51] is to propose a Smart-Yoga Pillow (SaYoPillow) Figure2.13 to aid in the understanding of the link between stress and sleep, as well as to completely realize the concept of "Smart-Sleeping" by proposing an edge device. Which is a smart wearable that does not require user input and has a completely automated response control system that does not jeopardize the user's convenience. It also tries to educate the user on the advantages and necessity of getting enough sleep, as well as the link between sleep and stress.

Secure data transfer from the cloud to any third-party application is also suggested. A user interface is provided to allow the user to control the accessibility and visibility of the data.

Figure 2.13: Proposed SaYoPillow [51]

2.5.5.2 Method

A Machine Learning Neural Network Model was developed and evaluated in SaYoPillow with the NSRR Sleep Study Dataset to minimize computation complexity and boost efficiency. They proposed a Machine Learning based Fully-Connected Neural Network (FCNN) model with a linear stack of 1 input layer, 2 hidden layers, and 1 output layer with 10 neurons each used to establish the relationship between the physiological parameters and stress levels, as shown in Figure 2.14

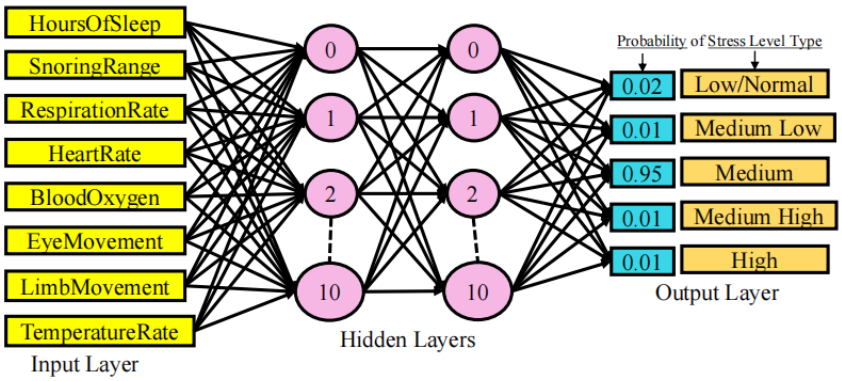


Figure 2.14: FCNN Model Representation in SaYoPillow [51]

2.5.5.3 Results

The implementation in SaYoPillow was performed using TensorFlow, and the analyzed stress levels are sent securely to the cloud for secure storage. The accuracy and loss of the models are approximately 96% and 1% as shown in Figure **??**.

The stress prediction is performed at the User Interface by taking in the total stress levels detected for every 15 minutes and comparing the observed stress levels as mentioned in Algorithms [51].

The characteristics of SaYoPillow are represented in this Table:

Characteristics	Specifics
Data Acquisition	NSRR Sleep Study Dataset
Data Analysis Tool	TensorFlow Lite
Classifier	FCNN
Stress level Classification	5
Total number of predictions	15000
Accuracy	96%
Correct Predictions	14400
Incorrect Predictions	600
Classification Error	0.04
Confidence Interval	0.04 +/- 0.00313

Table 2.5: Characteristics of SAYOPILLOW[51]

2.6 Discussion

In the last section, we summarized some articles presenting stress detection and prediction using machine learning. In this section we are going to make a comparison between all of them, it could be illustrated in a table as shown in Table 2.6.

Article	Machine Learning and IoT for Stress Detection and Monitoring		Stress Prediction Model Using Machine Learning	Stress Detection by Machine Learning and Wearable Sensors		Introducing WESAD, a Multimodal Dataset for Wearable Stress and Affect Detection		SaYoPillow: Blockchain Integrated Privacy Assured IoMT Framework for Stress Management Considering Sleeping Habits
Ref	[32]		[47]	[30]		[55]		[51]
Year	2022		2021	2021		2018		2020
Dataset	Their own data set, collected by a doctor from 25 volunteered		Real data, collected from 653 students of various colleges in India	ataset for wearable stress and affect detection WESAD		ataset for wearable stress and affect detection WESAD		NSRR Sleep Study Dataset
Dataset available	✗		✗	✓		✓		✓
Dataset balanced	✓		✗	✗		✗		✓
ML algorithme	Random forest classifier		Random forest regressor	Random forest classifier		Linear discriminant analysis	AdaBoost DT	Fully-Connected Neural Network (FCNN)
Classification	Binary		Three-class	Binary	Three-class	Binary	Three-class	Five-class
Accuracy Obtained	87%		83%	83.34%	65.73%	93%	80%	96%
Devices Used	MAX30100	GSR	/	Chest-worn		Wrist and chest-worn		Sayopillow
Features	Oxygen saturation, Heart rate	Property of the human body (sweat)	15 significant influencing factors were identified from a list of 25 features as shown in section 2.5.2.3	Electrocardiogram, Body temperature, Respiration, Electromyogram, Electrodermal activity		Blood volume pulse, Electrocardiogram, Electrodermal activity, Electromyogram, Respiration, Body temperature, Three axis acceleration		Heart Rate, Respiration Rate, Blood Oxygen range, REM period, Limb movement, Body Temperature, Snoring Range, Sleep Duration

Table 2.6: Comparison table between articles

Table[2.6] illustrates a comparison between five articles presented in the previous sections, after the table, we conclude:

- **Dataset and availability:** Articles [32] and [47] collected their own dataset that is not available, meaning we cannot use it. As for articles [30], [55], and [51], the datasets are available, as [30] and [55] used the same dataset, which is called WESAD, and the dataset used in Article 5 is called NSRR. For our proposed solution we will choose between these two datasets according to their properties.
- **Dataset balaced:** The WESAD dataset [55] is unbalanced, unstructured, and very difficult to use, as opposed to the NSRR dataset [51] that is balanced and organized in a single file. Which makes us choose it to work on in our proposed solution.
- **ML algorithme:** The majority of articles [32], [47] and [30], after comparing several algorithms, concluded that the Random Forest RF algorithm is the most accurate, while the article [55] found that Linear discriminant analysis and AdaBoost DT are the most accurate, and [51] used the FCNN algorithm. For our proposed solution, we will compare 3 basic classification algorithms in ML (Random Forest (RF), k-Nearest Neighbor (KNN), and Support Vector Machine (SVM)).
- **Classification and Accuracy:**The classifications differed between binary, three-class, and five-class, and there are those who classified binary and three-class together. In our solution, it is better for the levels of stress (categories) to be many, and this is consistent with the dataset of Article [51] with five-class (Low/Normal, Medium Low, Medium, Medium High, and High) with the highest accuracy 96% among the other articles, and this supports our decision to use the dataset of Article [51]
- **Devices and Features:** The article [32] used max30100 and GSR with features are Oxygen saturation (spo2), Heart rate (bpm), and The property of the human body (sweat), the articles [30][55] used the wrist and chest-worn device which introduces many features, while the article [47] did not use a device or sensors, conducted a survey to be the input is responses of the questions (which are predictors or features that determine stress score). As article [51] proposed a Smart-Yoga Pillow (SaYoPillo) with many features. For our proposed solution, our device contains a MAX30102 and a temperature sensor to obtain heart rate, Oxygen saturation, and Body temperature, according to the research (A Sensitivity Analysis of Biophysiological Responses of Stress for Wearable Sensors in Connected Health) [36].

2.7 Conclusion

In this chapter, we introduced some related works, made comparisons, and discuss some startups which are working on the project and their technologies.
The next chapter will delve into our proposed solution and provide a detailed conception of our approach.

Chapter 3

Conception

3.1 Introduction

In this chapter, we are going to introduce our solution, then delve into more details. We are going to describe the smart GPS tracker and health monitoring system's architecture with its functionality, including the needed diagrams UML.

3.2 General Architecture of System

This section describes the project's general architecture, which is made up of two primary parts:

- **Server:** The system comprises three main components: a geolocation system, healthcare system, and a database. These components are deployed on a cloud infrastructure, and enables the storage of all the transmitted data.
- **Users:** The system includes three primary components: Web Application System, Mobile Application System, and Smart Bracelet.
  - **Smart Bracelet:** It is a device equipped with sensor.
  - **Web Portal System:** It allows the administrator to manage the products and oversee the orders, and allows for user web purchase the smart bracelet.
  - **Mobile Application System:** A mobile application system allows caregivers to track a patient's location and monitor their health condition, including a feature for autism smart stress prediction for valuable tool for enhancing patient care and safety.

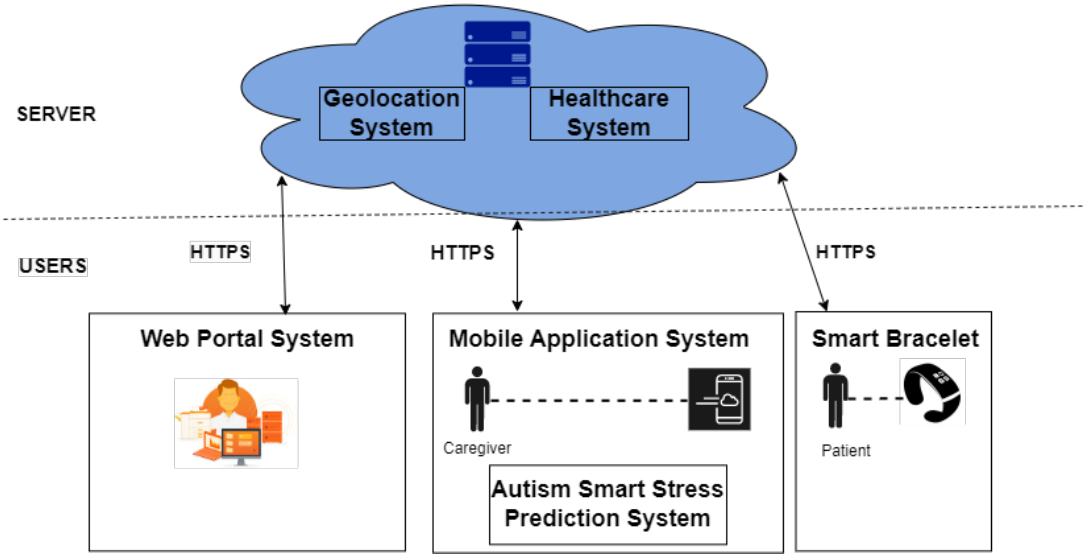


Figure 3.1: The Architecture General of System.

3.3 Detailed Architecture of System

In this section, we provide a detailed description of the system's architecture. Figure 3.2 illustrate the detailed architecture.

1. **Smart Bracelet:** The smart bracelet consists of four basic elements as follows:
   - **GPS Module:** Through it, the patient's location can be tracked in real time, as shown in algorithme1. This module provides latitude and longitude coordinates, and it works in conjunction with the microcontroller.
   - **GSM/GPRS Module:** In the event of the inability to connect to the internet, we use GSM/GPRS module to send the location in the form of link to a caregiver phone directly, also it allows to send latitude and longitude to cloud server using GPRS .
   - **Healthcare Module:** It provide us with health information of the patients such as heart rate, temperature, blood oxygen, and it works in conjunction with the microcontroller. As shown in algorithme2
   - **Microcontroller:** Is in charge of executing instructions, processing data, and interacting with various modules: GPS, healthcare sensors, GSM/GPRS. It collects data from these modules and sends it to the cloud server by IoT protocol for further analysis and storage, It also contains a **embedded web server** that provides to caregivers an accessible web page to modify ssid and password of WiFi network inside smart bracelet. This allows the smart bracelet to perform various functions such as sending data, etc... In addition to modifying the WiFi settings, the web page also allows caregiver to register up to three phone numbers, this phone numbers are used to send location links to the caregiver. Figure 3.3 illustrate the architecture of web server.
2. **Web Portal:** This module is represented by the web platform, where the admin has the ability to view and manage all the smart bracelets products. The platform displays comprehensive information about each product, including its specifications. The admin also has the option to add, delete another admin or supervisor who can oversee and manage all the orders.
   Caregiver requests a smart bracelet, they can confirm their request through the platform, as shown in algorithm7.

3. **Mobile Application:** This module is designed for caregivers and it retrieves data from a cloud server and displays it on a mobile application. The mobile application enables caregivers to track the patient's location in real-time and monitor their health condition, as shown in algorithms6 and 4, also through this application the caregiver could access to web server page that are explained more in section 1. One of the key features of the application is the ability for caregiver to set a specific geographical area. If the patient moves beyond this defined area, the caregiver will receive alert notification for patient's movement is out of boundary, according to the algorithm3 this feature ensures the patient's safety and allows for prompt intervention if necessary, all those functionality comes under data processing. Additionally, the application incorporates an **autism smart stress prediction system**, this system utilizes artificial intelligence and machine learning techniques to assess the patient's stress and anxiety level, by analyzing various indicators and data such as heart rate variability, etc.. This empowers caregivers to better understand and address the patient's emotional well-being. explained more in section 3.4.

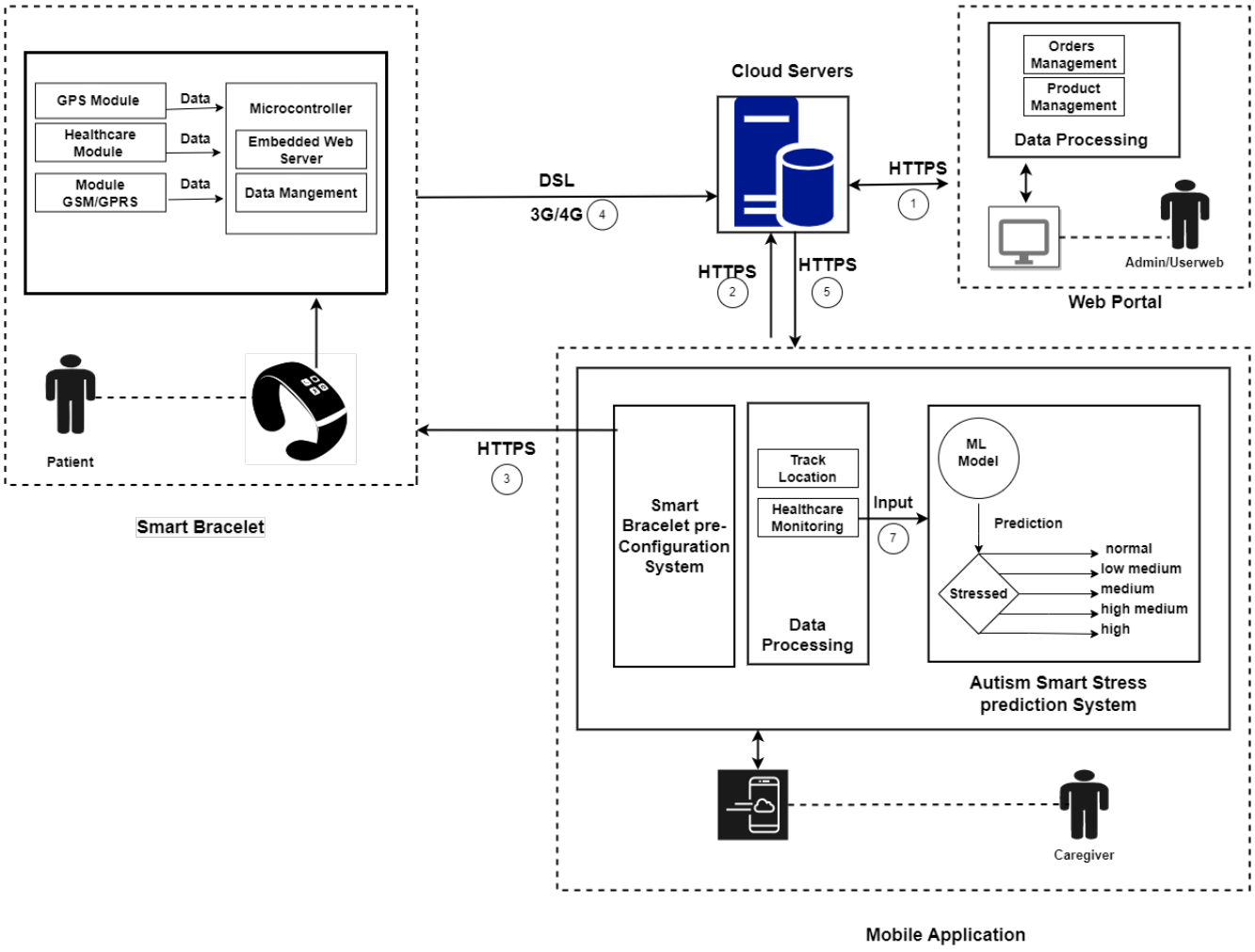


Figure 3.2: The Detailed Architecture of System.

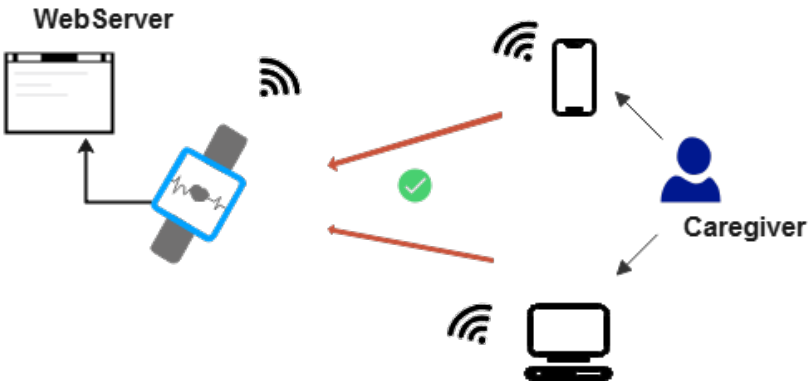


Figure 3.3: Web Server Architecture

3.4 Autism Smart Stress Prediction System

The ML process starts with features extraction from Dataset (body temperature, blood oxygen, heart rate, and stress level) and then applying three ML algorithms for choosing the better accuracy. Models are generated after the training phase and predict the stress level as shown in Figure 3.4. Thenceforth, there are supplied with input data from the Cloud server representing the patient's physiological measurements to predict his stress state.

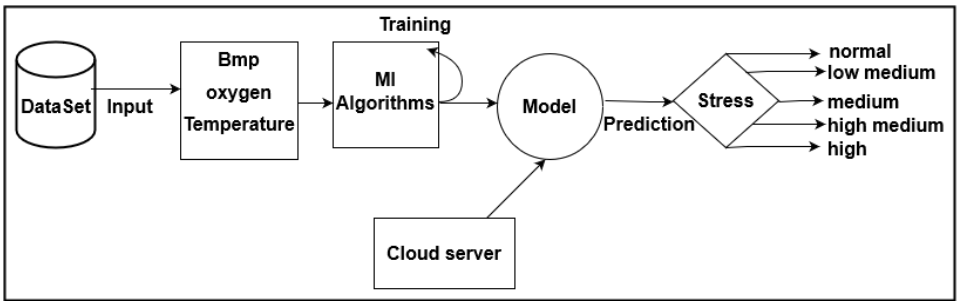


Figure 3.4: Autism Smart Stress Prediction System Pipeline

3.4.1 Data collection

Data collection is the first step of our system. It allows us to acquire data from the real world, and to design a database of examples (learning examples), which will be used in the following steps. we will collect as much data as possible, which is a collection of healthcare data for stress prediction. The process of collecting this dataset was difficult as most datasets were multimodal, but we managed to find a free balanced one we can to modified on the Kaggle platform [14], which didn't contain much data, just a satisfying amount.

The dataset contains multiple columns, among which we need, We deleted the columns that we do not need and left (body temperature, blood oxygen, heart rate, and stress level "5 levels"). The body temperature column in Fahrenheit (F°), and we changed it to Celsius (C°). The result is a balanced dataset as shown in Figure[3.5] with size 14Ko (630 lines and 4 columns).

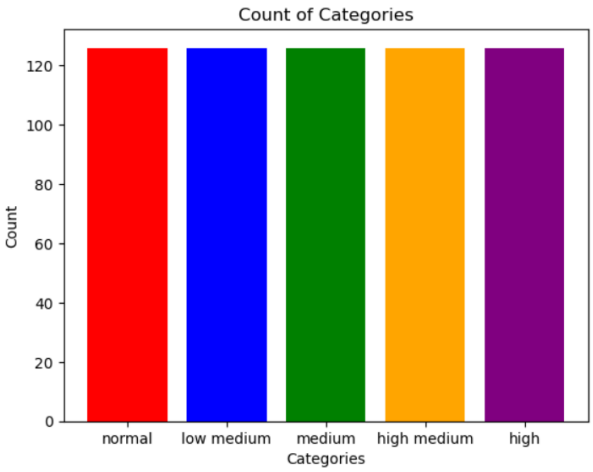


Figure 3.5: Count of categories

3.4.2 Data Preparation

After collecting the data, we need to prepare it for further steps. The data is balanced and error-free, to prepare it we can be divided the task into a few general, significant steps:

3.4.2.1 Correlation Matrix

This is an important step in pre-processing machine learning pipelines. Since the correlation matrix is a common tool used to compare the coefficients of correlation between different features in a dataset. It allows us to identify variables that have high degrees of correlation and allows us to reduce the number of features we may have in a dataset.[3] **So what is a correlation coefficient?**

Correlation Coefficient

Is a value between -1 and +1 that denotes both the strength and directionality of a relationship between two variables.

- The closer the value is to 1 (or -1), the stronger the relationship.
- The closer a number is to 0, the weaker the relationship.

A negative coefficient will demonstrate that the relationship is negative; that is, as one number increases, the other will decrease. Similarly, a positive coefficient indicates that as one value increases, so does the other.[3]

3.4.2.2 Data Normalization

In this step, we would be to normalize the features. This involves scaling of features to ensure that they fall within a uniform range. In the absence of normalization, the features with larger magnitudes will have a greater weight innately.

First, we split the dataset into Features/Target as shown in Figure 3.6. next, to prevent algorithms from getting biased, we resize the distribution of features so that the mean of the observed values is 0 and the standard deviation is 1 with **StandardScaler** from **sklearn**.

3.4.2.3 Data Splitting

The data splitting method can be implemented once we specify a splitting ratio, such as 80/20, 70/30, 60/40, and even 50/50 are also used in practice. But a commonly used ratio is 80/20, which means 80% of the data is for training and 20% for testing. The 80/20 split draws its justification from e well-known **Pareto principle** [37], which is a familiar saying that asserts that 80% of outcomes (or outputs) result from 20% of all causes (or inputs) for any given event.

We will Split the dataset into training sets 80% and testing sets 20% with convert the data frame to a NumPy array. as shown in this Figure: 3.6.

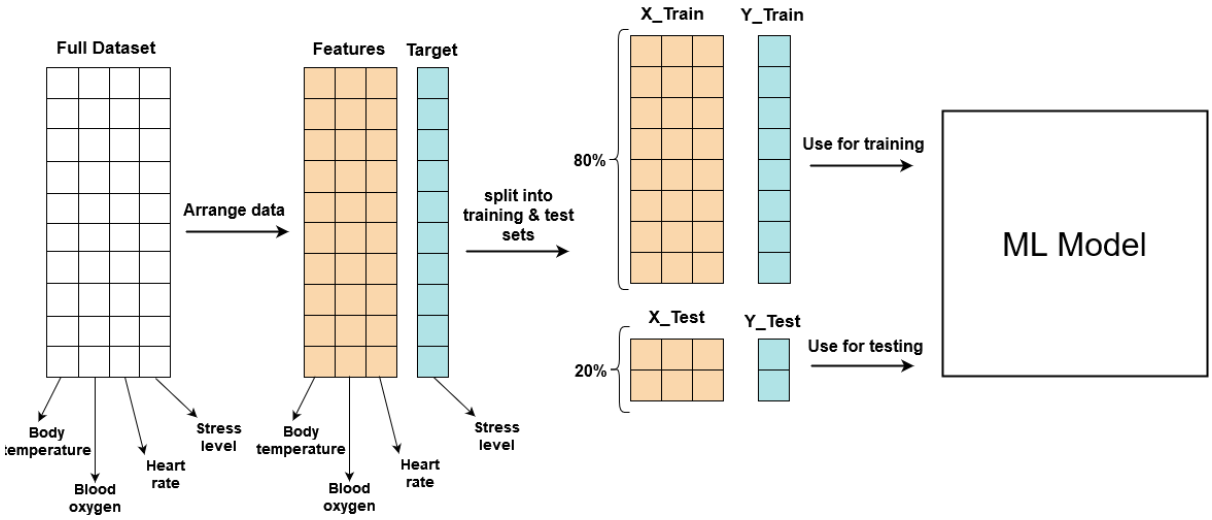


Figure 3.6: Train Test Split

3.4.3 Classification and Training

For the purpose of stress detection and prediction, we will use three supervised machine learning classification algorithms namely Random Forest (RF), k-Nearest Neighbor (KNN), and Support Vector Machine (SVM) which are explained in the first Chapter. Then we will compare their performance to decide which is best for us.

The following figures show the training steps for each algorithm with our dataset and the five-class (normal, low medium, medium, high medium, and high)

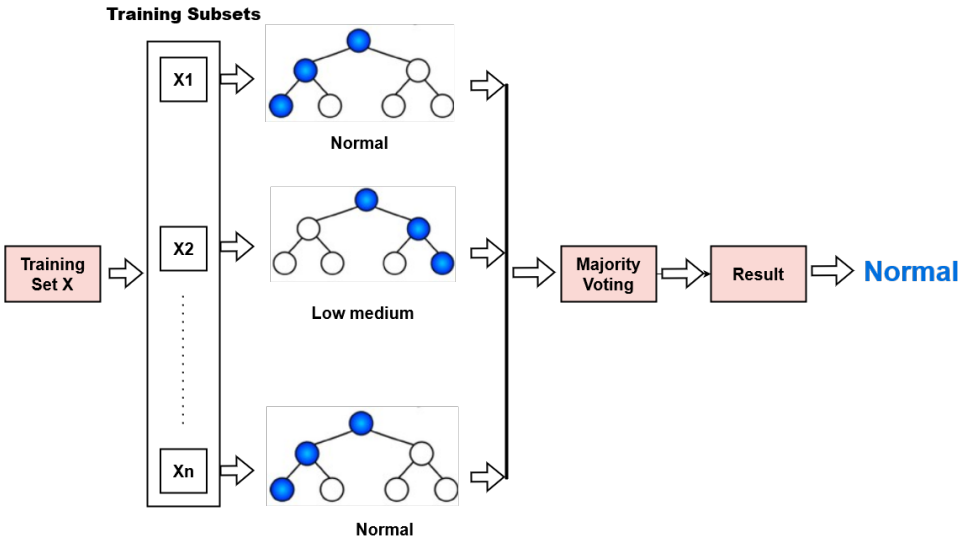


Figure 3.7: Training Random Forest model

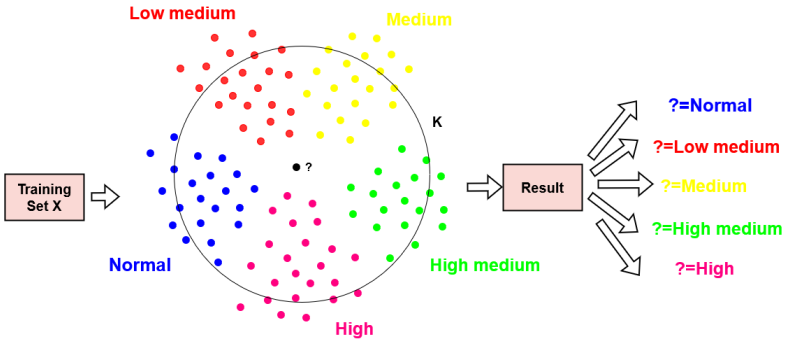


Figure 3.8: Training k-Nearest Neighbor model

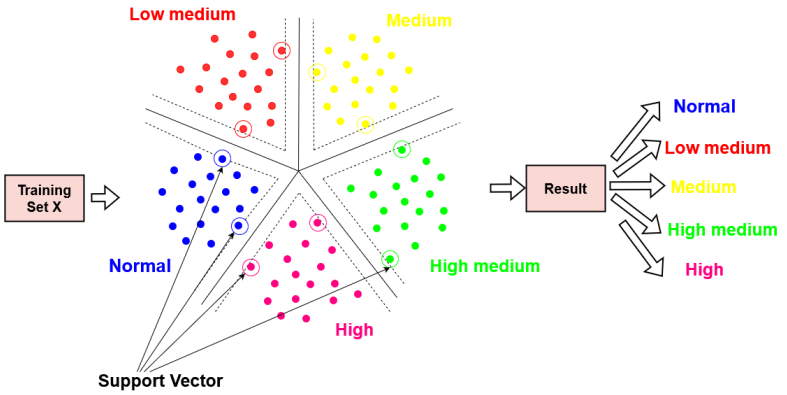


Figure 3.9: Training Support Vector Machine model

We will test our models and we calculate the accuracy.

3.4.4 Confusion Matrix and Evaluation Metrics

Model evaluation is an important level in the model's development. The best accuracy metric for evaluating your machine learning model is determined by our dataset and ML tasks. Figure 3.10 depicts several evaluation metrics based on the type of tasks (classification, regression, etc.), each of which has its own metrics.

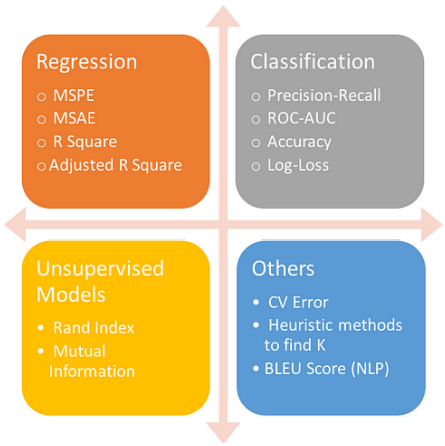


Figure 3.10: Choosing the Right Metric for Evaluating Machine Learning Models

In our proposed solution, we are going to shed light on the confusion matrix and evaluation metrics used for classification, exactly multi-class classification (five-class).[44]

In the case of five-class the metrics defined for multi-class classification. The confusion matrix (see Figure 3.11) has a dimension 5 × 5 where N=5 is the number of different classes (normal, low medium, medium, high medium, and high).

		Predicted Class	
		Positive	Negative
Actual Class	Positive	TP	FN
	Negative	FP	TN

		Predicted Class			
		C_1	C_2	...	C_N
Actual Class	C_1	$C_{1,1}$	FP	...	$C_{1,N}$
	C_2	FN	TP	...	FN
	...	...	...	...	...
	C_N	$C_{N,1}$	FP	...	$C_{N,N}$

Figure 3.11: Binary and Multi-class classification problem confusion matrix.[44]

Where:

- **TP= True positive**, It refers to the number of predictions where the classifier correctly predicts the positive class as positive.
- **TN= True negative**, It refers to the number of predictions where the classifier correctly predicts the negative class as negative.
- **FP= False positive**, It refers to the number of predictions where the classifier incorrectly predicts the negative class as positive.
- **FN= False Negative**, It refers to the number of predictions where the classifier incorrectly predicts the positive class as negative.

Accuracy refers to the whole number of instances that may be classified correctly.

$$Accuracy = \frac{CorrectPredictions}{TotalPredictions} = \frac{\sum_{i=1}^{N} TP(C_i)}{\sum_{i=1}^{N}\sum_{j=1}^{N} C_{i,j}} \tag{3.1}$$

Precision measures the amount of predicted TP that is truly related to the TP class.

$$Precision(C_i) = \frac{TP(C_i)}{TP(C_i) + FP(C_i)} \tag{3.2}$$

Recall measures the quantity of TP instances, which are correctly identified by the classifier.

$$Recall(C_i) = \frac{TP(C_i)}{TP(C_i) + FN(C_i)} \tag{3.3}$$

F-score: Precision and recall can be combined into a single score that seeks to balance both concerns, called the F-score or the F-measure.

$$F - score(C_i) = 2 * \frac{Precision(C_i) * Recall(C_i)}{Precision(C_i) + Recall(C_i)} \tag{3.4}$$

3.5 Pseudocodes of System

3.5.1 Location Function

This function is responsible for obtaining latitude, longitude, speed data, after authentication, it sends this information to cloud server. Furthermore, when the caregiver calls the patient's phone number, it sends the location in the form of a link to the caregiver's phone.

Algorithm 1: Location Function

Input: Link : "https://www.google.com/maps/place/"

`/* Transmitting a patient's location to a caregiver through an SMS link */`

Output: Message, Latitude, Longitude, Speed

while *location* **do**

- getLatitude();
- getLongitude();
- getSpeed();
- **if** *Authentication* **then**
  - setLatitude();
  - setLongitude();
  - setSpeed();
- **end**
- **if** *Call* **then**
  - Link $\leftarrow$ $Link$ + **getLatitude()** + "," + **getLongitude()** ;
  - **array** Nums $\leftarrow$ **getNums()** ;
  - message $\leftarrow$ **Send**$(Nums, Link)$;
- **end**
- `/* Nums is the phone number of caregiver */`

end

3.5.2 Healthcare Sensor Function

This function is responsible for collecting the heart rate, oxygen level, and temperature data. After authentication, it sends this information to the cloud server. In case the patient is wearing the smart bracelet(beat), the actual data is sent. However, if the patient is not wearing the bracelet, it sends a value of 0 for each of the parameters to indicate the absence of data.

Algorithm 2: HeartRate Function.

Output: HeartRate, Oxcygen, Temperature

while *beat* **do**

- `/* Represent if a patient wears a bracelet or not */`
- getheartrate();
- gettemperateur();
- getbloodoxygen();
- **if** *(Authentification)* **then**
  - setheartrate();
  - settemperateur();
  - setbloodoxygen();
- **end**

end

3.5.3 Geofencing Function

This function is designed to alert the caregiver whenever the patient moves outside of a predefined geographical area. It continuously monitors the patient's location using the GPS coordinates and compares it to the specified area boundaries. If the patient's location falls outside of the designated area, the function triggers a notification to inform the caregiver about the patient's movement. This helps the caregiver stay updated and take appropriate actions if the patient deviates from the specified area.

Algorithm 3: GeofencingZone

Output: Alert Notification
while *OutGeofence* **do**
    /* The patients is moves outside of geographical area. */
    Show Alert(" **Beware patient is out of geofencing zone !!** ");
end

3.5.4 Healthcare Monitoring Function

The algorithm provided a describes to the function for monitoring the health parameters (heart rate, oxygen level, and temperature) of a device based on its bracelet code. The outputs of the function are the heart rate, oxygen level, and temperature readings. The algorithm begins by obtaining the bracelet code through the getBraceletcode() function. It then checks if the device is online. If the device is online, the algorithm calls three separate functions: ShowHeartRate(), ShowTemperature(), and ShowBloodOxygen(), passing the device ID as a parameter to each function. These functions are responsible for retrieving and displaying the respective health parameter readings associated with the provided bracelet code.

Algorithm 4: Heart Monitoring Function.

Input: Bracelet$_code$
/* Used for individual identification purposes for bracelet */
Output: HeartRate, Oxygen, Temperature
$bracelet_code = getBracelet_code()$;
if *(Device*$_Online$*)* **then**
    $ShowHeartRate(bracelet_code)$;
    $ShowTemperateur(bracelet_code)$;
    $ShowBloodOxygen(bracelet_code)$;
end

3.5.5 Path Historique Function

This function provided describes a function for retrieving and displaying the historical path of a device based on its bracelet code. The output of the function is the path taken by the device. The algorithm begins by calling the getPath() function, passing the device ID as a parameter. This function returns an array called devicePath, which contains the historical path data of the device. Next, the algorithm enters a loop to iterate through each element in the devicePath array. Inside the loop, the ShowPathOnTheMap() function is called, which displays the path on a map.

Algorithm 5: Path Historique Function

Input: Bracelet$_c ode$
Output: Path
array devicePath = getPath(bracelet$_c ode$)
for $devicePath$ **do**
    ShowPathOnTheMap();
end

3.5.6 Track Location Function

This function is responsible for retrieving the location of patients based on their device ID and displaying it on a map. The outputs of the function are the latitude and longitude coordinates. The algorithm begins by obtaining the device id through the getBraceletcode() function. It then checks if the device is online. If the device is online, the algorithm calls the ShowLocationOnTheMap() function, passing the device ID as a parameter. The ShowLocationOnTheMap() function is responsible for retrieving the latitude and longitude coordinates associated with the provided device ID and displaying them on a map.

Algorithm 6: Track Location Function

Input: Bracelet$_c ode$
Output: Latitude, Longitude
bracelet$_c ode()\bar{g}etBracelet_c ode()$
if *Bracelet*$_O nline$ **then**
    $ShowLocatoinOnTheMap(bracelet_c ode());$
end

3.5.7 Command Function

This function provided describes a function for processing a new command of caregiver for smart bracelet. It takes inputs such as the full name, email, phone number, city, country, and postal code. The outputs of the function are either a confirmation or cancellation. The algorithm begins by checking if the product exists. If the product exists, it proceeds to check if it is a new command. If it is a new command, the algorithm checks for payment. If payment is successful, it executes the confirmation function. Otherwise, it executes the cancel function. Overall, this algorithm outlines a basic flow for processing a new command, including product existence, new command validation, and payment confirmation.

Algorithm 7: New Command Function

Input: Full Name, Email, Phone, City, Country, Postal Code

Output: Confirmation, Cancel

if *ProductExist* **then**

  if *New*$_{C}ommande$ **then**

    if *Payment* **then**

      $Confirmation()$;

    else

      $Cancel()$;

    end

  end

end

3.6 Diagrams of System

In this section, we are going to provide a presentation of our project with a diagram use case and diagram sequence, also diagram of class for more understanding.

- **Step1**
  - The user web visits the website and places an order for the bracelet by providing necessary details and completing the purchase process.
- **Step2**
  - The administrator accesses the system by logging in with authorized credentials.
  - Within the system, the administrator has the capability to manage products. This includes adding new products, updating existing product information such as descriptions or prices, and deleting products if necessary.
  - The administrator also has the authority to manage other administrators' information in the system. They can add new administrators, update their details (such as name, contact information, or access privileges), or remove administrators from the system.
  - Additionally, the administrator can review and consult the orders placed by caregivers.
- **Step3**
  - The caregiver(user mobile application) goes through a registration process to create a new account within the system. They provide their personal information, such as name, contact details, and information of the patient such as code bracelet for individual identification purposes used in function live track location patient and monitoring healthcare, as show in algorithm6 and 4.
  - Once registered, the caregiver logs into the system using their credentials, gaining access to the features and functionalities.
  - The caregiver modify the Wi-Fi settings of the bracelet, allowing it to connect to the desired network for data transmission and communication.
  - Furthermore, the caregiver can update the phone number associated with the bracelet's SMS, ensuring that location of patients are received promptly in link.

- **Step4**
  - The device, once activated, establishes a secure connection with the system by logging in using its unique credentials.
  - In regular intervals, the device sends real-time data to the system. This data includes the device's current latitude, longitude, and speed, enabling accurate tracking and monitoring of the patient's location and movement.
  - Additionally, the device transmits vital signs such as heart rate, blood oxygen level, and temperature, providing essential health information for monitoring and analysis.
- **Step5**
  - The caregiver, logged into the system, has the ability to add new patients by providing their relevant details such as name, code, and phone number.
  - The caregiver monitor the locations of the registered patients in real-time, ensuring their safety and security.
  - Furthermore, the caregiver actively monitor the health status of the patients by accessing the data transmitted by the device.

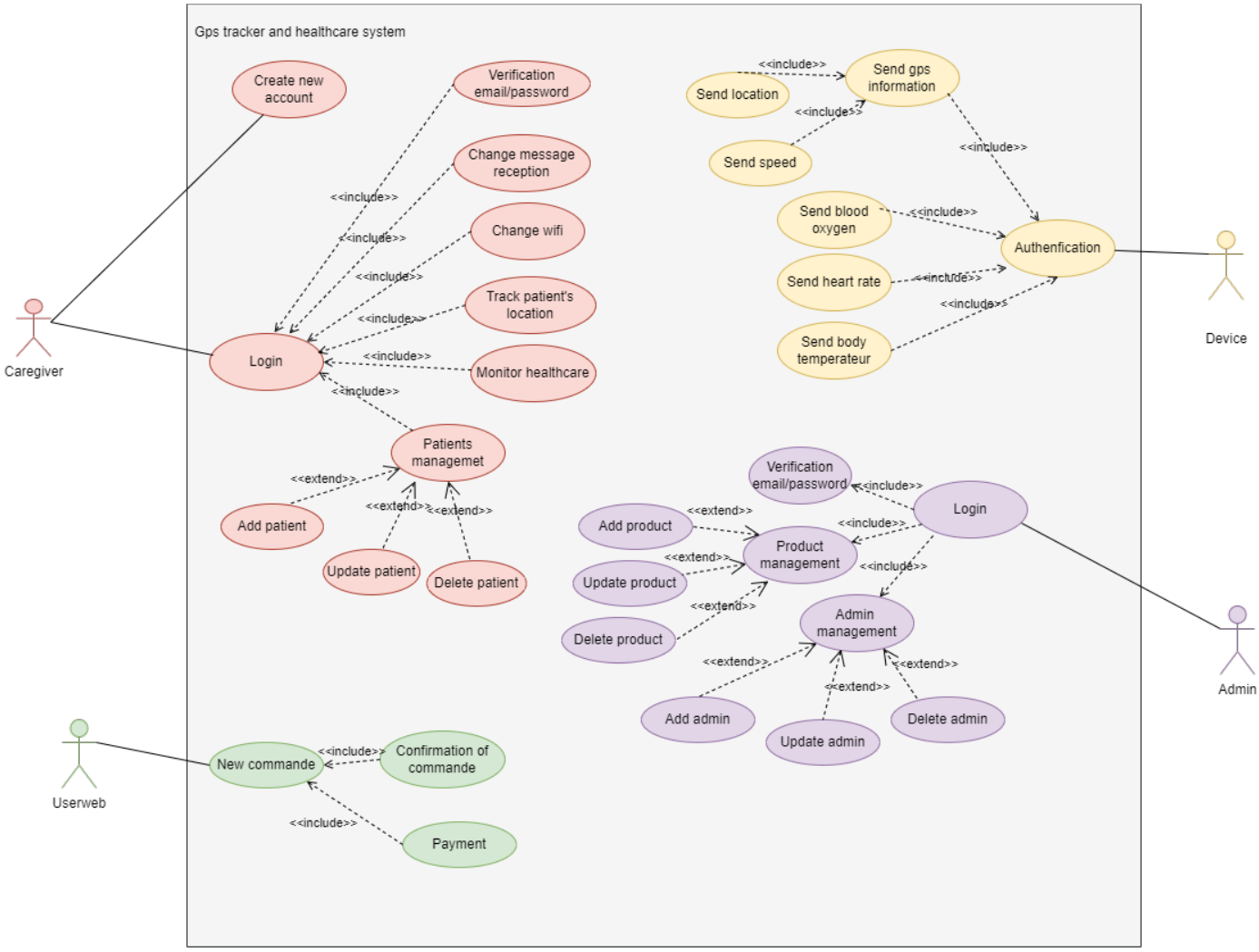


Figure 3.12: Use Case Diagram of The System.

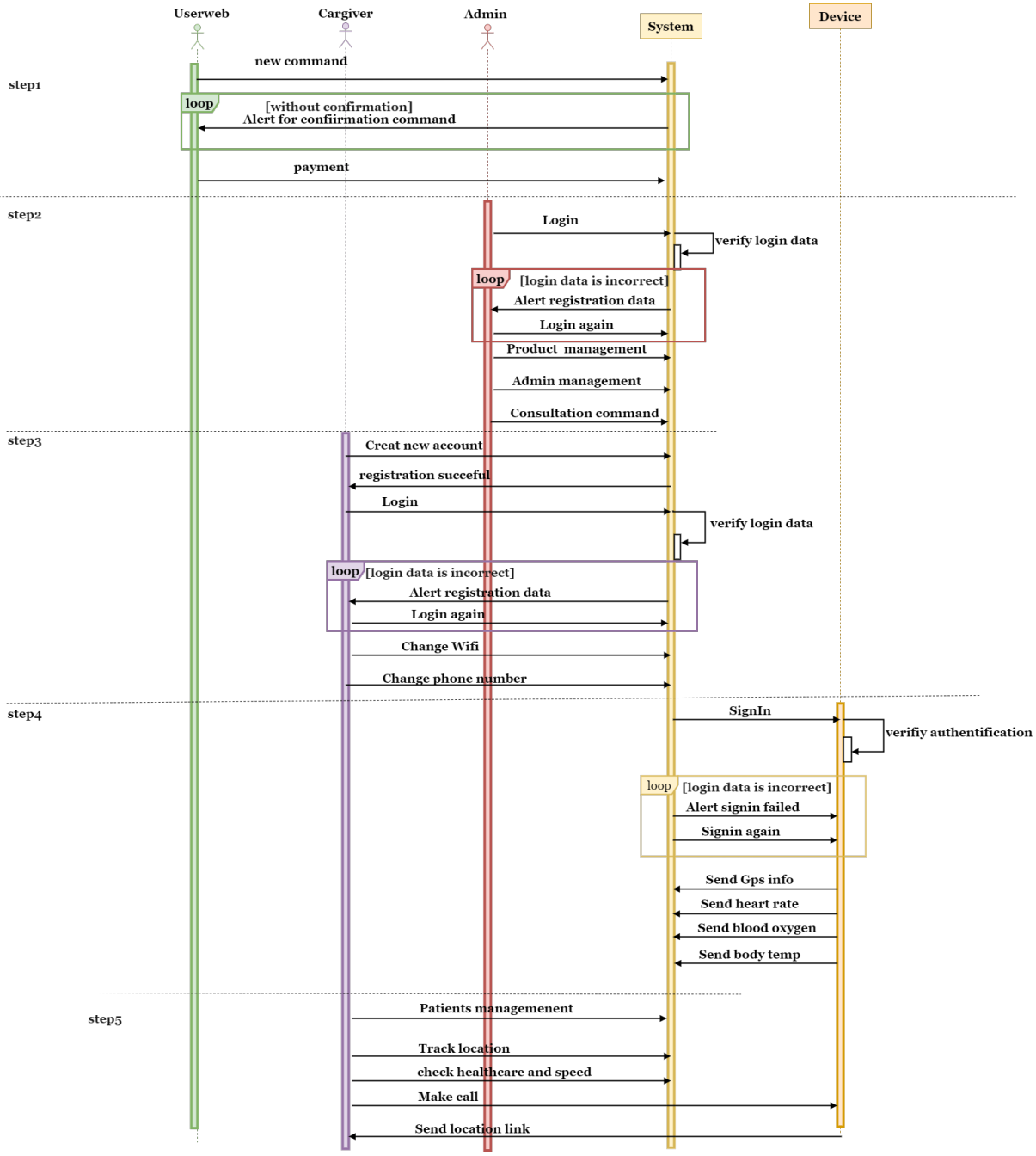


Figure 3.13: Sequence Diagram of The System.

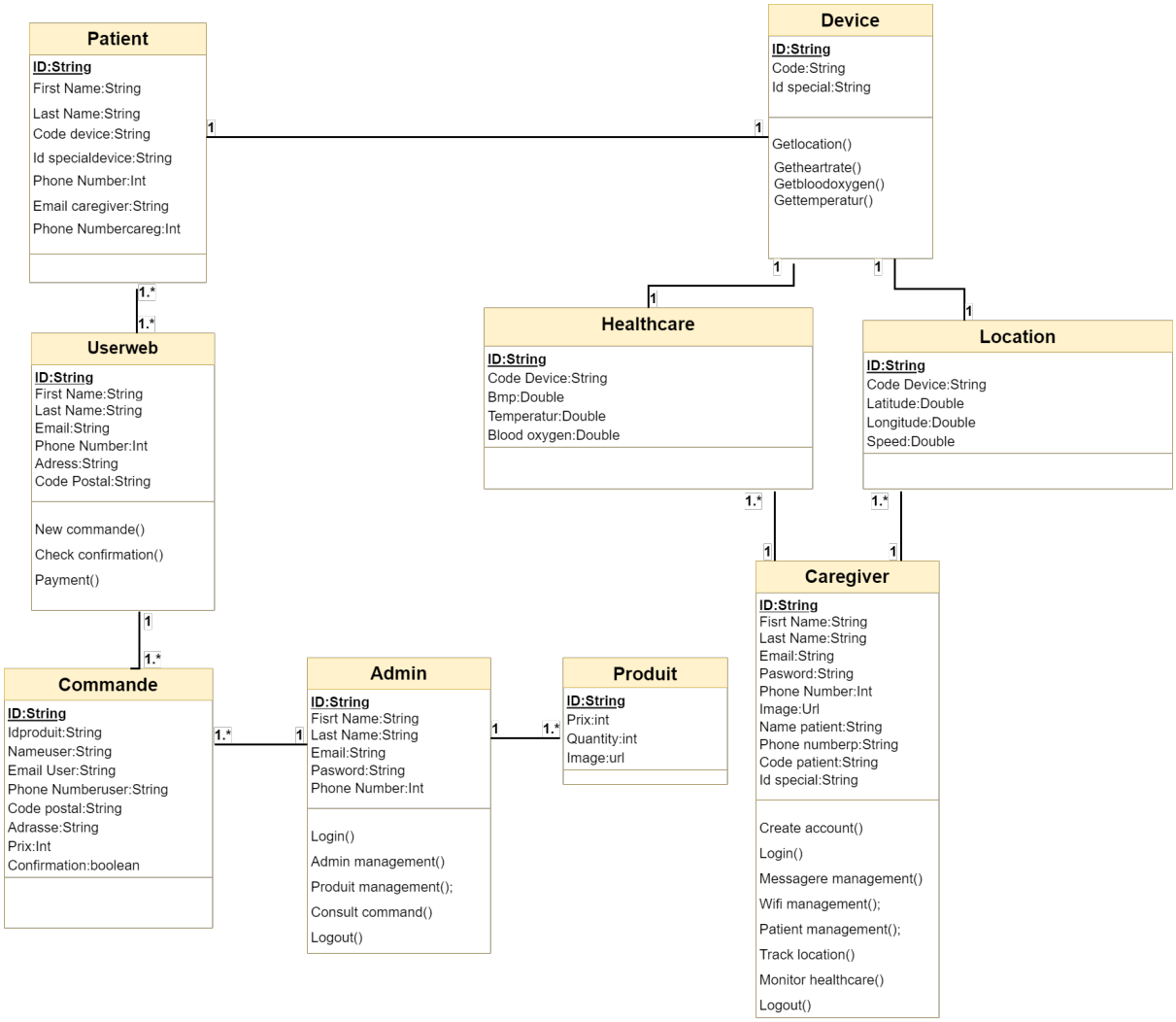


Figure 3.14: Diagram Class of the System.

3.7 Conclusion

In this chapter we introduced our solution and we described it in detail. At first we introduced our general architecture then we proceeded to our detailed architecture that show the actors of our system, we introduced each component and how it works and we added some used algorithms and flowcharts. After, we introduced its functionality in form of pseudo algorithms, then in form of use case, sequence diagrams.
In the next Chapter we are going represent the implementation of our system.

Chapter 4

Implementation

4.1 Introduction

In this chapter, our primary focus will be on the implementation and practical aspects of our project and the device we have developed. We will begin by introducing the tools we have utilized, including software, hardware, and applications.

4.2 Environment and Software Tools

4.2.1 Python

Is an object-oriented, interpreted, mid-level programming language that is simple to learn and use, and it is today regarded as one of the best programming languages to learn. Some of the reasons for its success include its free, open-source nature and large online community.[53] While the standard Python library provides a lot of capability, there are instances when we require modules and libraries that are not included in the standard library. That's where Anaconda comes in.

4.2.2 Anaconda

Is a free, open-source platform that allows you to develop and run programs written in the Python programming language. It was created by continuum.io, a Python programming business. When you install Anaconda, you can access many environments that allow you to develop in either Python or R. These environments, often known as integrated development environments(IDEs), are platforms or programs that make coding easier.[53]

4.2.3 Jupyter Notebook

Jupyter Notebook is a web-based IDE that runs in your browser. Each block of code may be executed independently, making it extremely versatile and simple to experiment with. This enables the use of several text kinds in the same Notebook. As a result, code outputs, visualizations, equations, and plain text may all be utilized in the same area.[53]

4.2.4 JSON

Is a human-readable, open, text-based data interchange format built from the JavaScript computer language. It is extremely lightweight, and despite its close relationship to JavaScript, it is language-independent, with parsers for practically any programming language accessible.[40]

4.2.5 Flutter

Flutter is a free and open-source mobile UI framework created by Google and released in May 2017. In a few words, it allows you to create a native mobile application with only one codebase. This means that you can use one programming language and one codebase to create two different apps (for iOS and Android)[15].

4.2.6 Firebase

Firebase is a Cloud-hosted, NoSQL database that uses a document-model. It can be horizontally scaled while letting you store and synchronize data in real-time among users.Firebase is built on the Google infrastructure and is built to scale automatically. In addition to standard NoSQL database functionality, Firebase includes analytics, authentication, performance monitoring, messaging, crash reporting and much more. Because it is a Google product, there is also integration into a lot of other products. This includes integration with Google Ads, AdMob, Google Marketing Platform, the Play Store, Data Studio, BigQuery, Slack, Jira, and more[7].

4.2.7 Arduino IDE

Arduino IDE is an open-source software, designed by Arduino. cc and mainly used for writing, compiling and uploading code to almost all Arduino Modules.It is an official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process[6].

4.3 Hardware Implementation

4.3.1 ESP32 DevkitC

This component was a 32-bit, low-cost, low-power SoC, which operates at 160 or 240 MHz, and had integrated IoT capabilities (Wi-Fi and dual-mode Bluetooth)[25].

4.3.2 GPS module Neo6m

GPS Neo 6m is featuring the high-performance u-blox 6 positioning engine. It offers various connectivity options in a miniature 16 x 12.2 x 2.4 mm package. Due to its low cost and power consumption, as well as small size, GPS Neo 6m is used in devices like smartphones where the amount of space and power available is less. GPS Neo 6m takes 27 seconds for a cold and warm start.and only 1 second for a hot start. A key feature is the presence of an EEPROM to save.settings and has a 25x25 ceramic antenna It is a 50-channel positioning system of u-blox 6, with more than 2 million effective correlators[38].

4.3.3 Sim800L

SIM800L is a miniature cellular module. It allows send and receiving SMS and making and receiving calls. The key feature of GSM Sim800L is that it is small footprint at low cost[38].

4.3.4 MAX30102 Pulse Oximetry

This component is an integrated SpO2 and HR monitor module for low-noise electronics with built-in ambient light rejection. MAX30102 functioning was fully validated and comprised of an optical module of 5.6 mm × 3.3 mm x 1.55 mm 14-pin with low-power HR monitor (¡1 mW) and an ultra-low shutdown current of 0.7 µA, as well as robust motion artifact resilience and 40 °C to +85 °C operating temperature range. It could be supplied with a single 1.8 V source, or a separate 3.3 V. [25]

4.3.5 LM35

The LM35 is a temperature sensor integrated circuit manufactured by National Semiconductor. It offers higher precision and a wider linear working range compared to other sensors. The output voltage of the LM35 is directly proportional to the temperature in Celsius. It provides a common precision of ±1/4°C at room temperature without requiring additional calibration or fine-tuning[41].

4.3.6 Schematic Diagram

As shown in Figure 4.1 the system elements those we described in the section before and how they are connected.

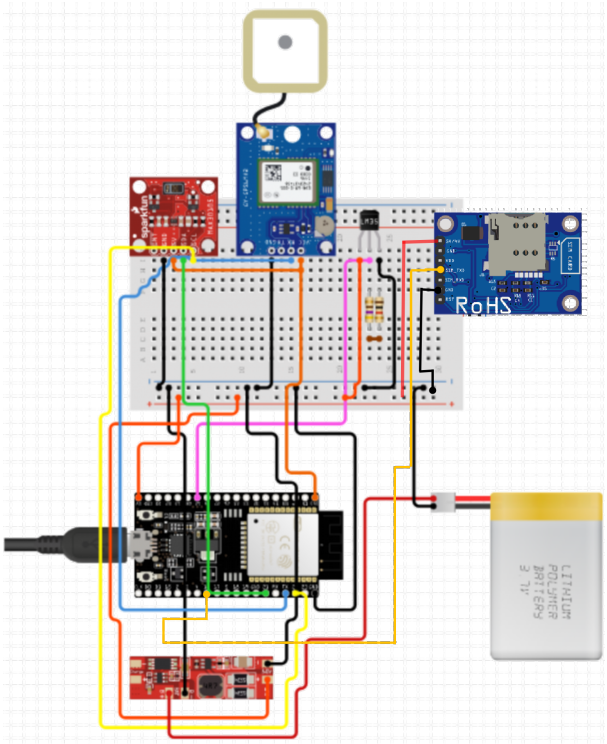


Figure 4.1: Schematic Diagram of Smart Bracelet

4.3.6.1 Connection of the Circuit Diagram

- 3.3V pin of ESP32 is connected to VCC pin of Gps Neo-6M.
- 3.3V pin of ESP32 is connected to VIN pin of MAX30102.
- 5V pin of ESP32 is connected to VCC pin of SIM800L.
- 5V pin of ESP32 is connected to VCC pin of LM35.
- GND pin of ESP32 is connected to GND pin of MAX30102.
- GND pin of ESP32 is connected to GND pin of Gps Neo-6M.

- GND pin of ESP32 is connected to GND pin of SIM800L.
- GND pin of ESP32 is connected to GND pin of LM35.
- GPIO 16 of ESP32 is connected to TX pin of Gps Neo-6M.
- GPIO 17 of ESP32 is connected to RX pin of Gps Neo-6M.
- GPIO 19 of ESP32 is connected to TX pin of SIM800L.
- GPIO 18 of ESP32 is connected to RX pin of SIM800L.
- GPIO 21 pin of ESP32 is connected to SDA pin of MAX30102.
- GPIO 22 pin of ESP32 is connected to SCL pin of MAX30102.
- GPIO 36 (ADC) pin of ESP32 is connected to VOUT pin of LM35.

4.4 Smart Bracelet Prototype

Our bracelet prototype as its shown in Figure 4.2.

Figure 4.2: Illustration Image of Prototype

4.5 Machine learning Models Implementation

This part explains the machine learning process to detect and predict the stress level. To do so, we have used the Anaconda platform that allows using Jupyter Notebook to implement the models. First, we imported the necessary packages depicted in Figure 4.3.

```
# read and preprocesisng
import numpy as np
import pandas as pd
from sklearn.preprocessing import MinMaxScaler
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import train_test_split
# visualization
import seaborn as sns
import matplotlib.pyplot as plt
# models
from sklearn.svm import SVC
from sklearn.ensemble import RandomForestClassifier
from sklearn.neighbors import KNeighborsClassifier
# evaluation
from sklearn.metrics import accuracy_score
from sklearn.metrics import classification_report
from sklearn.metrics import confusion_matrix
# warrings
import warnings
warnings.filterwarnings("ignore", category=UserWarning, message="X does not have valid feature names")
warnings.filterwarnings("ignore", message="Precision and F-score are ill-defined and being set to 0.0 in labels with no predi
```

Figure 4.3: Import packages

4.5.1 Dataset Import and Preparation

We have collected the dataset ”healthcare data for stress prediction” and modified it according to what we need. The dataset contains four columns (body temperature, blood oxygen, heart rate, and stress level ”5 levels”) and 630 lines with size 14Ko as shown Figure 4.4.

	body temperature	blood oxygen	heart rate	stress level
32	36.449	96.072	52.68	0
625	33.867	90.960	62.40	2
363	33.991	91.184	62.96	2
124	32.489	88.480	67.40	3
494	32.942	89.296	71.48	3
219	33.431	90.176	60.44	2
394	31.222	85.840	81.40	4
45	31.467	86.368	82.28	4
205	35.662	95.128	50.32	0
396	37.129	96.888	54.72	0

Figure 4.4: Our Dataset

To use this dataset, the first step is to import it as shown in Figure 4.5.

```
df=pd.read_csv(r'C:\Users\AIB\Downloads\health-Copie2.csv')
```

Figure 4.5: Import Our Dataset

Then to prepare the dataset we split it into Features/Target as shown in Figure 4.6. After, we resized the

distribution of features values so that the mean of the observed values is 0 and the standard deviation is 1 with StandardScaler and split the dataset into training sets 80% and testing sets 20% which we chose as the best splitting, with convert the data frame to a NumPy array. as shown in Figure 4.7

```
x=df.drop('stress level',axis=1)
y=df['stress level']
```

Figure 4.6: Dataset Split Code

```
# Scale the input data using StandardScaler
scaler = StandardScaler()
x_normalized = scaler.fit_transform(x)
```

```
# Split the dataset into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(x_normalized, y, test_size=0.2, random_state=42)
```

```
# convert data frame to numpay array
X_train=np.array(X_train)
X_test=np.array(X_test)
y_train=np.array(y_train)
y_test=np.array(y_test)
```

Figure 4.7: Dataset Preparation

To understand the correlation between the four Features (heart rate, Oxygen saturation, Body temperature, and stress level). We used the confusion matrix, and the output is shown in Figure 4.11

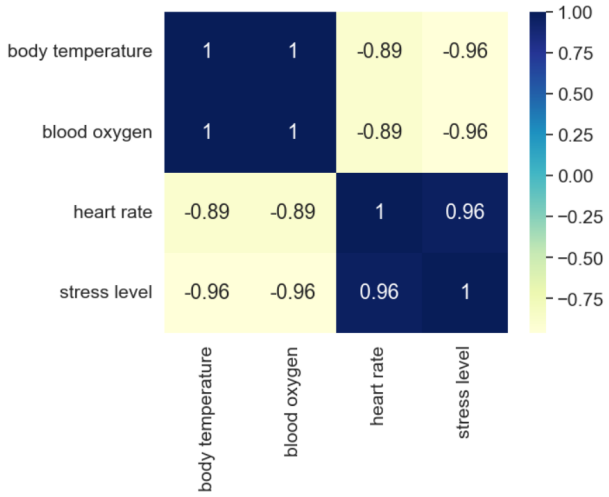


Figure 4.8: Correlation between the Three Features

The result is a table with the coefficients. Yellow represents negative numbers, and blue is used for positive ones. We can see that we have a diagonal line of the values of 1. This is because these values represent the correlation between a column and itself.

The correlation between all features is strong cose the coefficient value is closer to 1 (or -1), and this is the relationship between the features:

- **Body temperature** & **stress level**: -0.96 demonstrates that the relationship is negative. That is, as body temperature increases, the stress level will decrease.
- **Heart rate** & **stress level**: 0.96 demonstrates that the relationship is positive. That is, as the heart rate increases, so does the stress level.

- **Blood oxygen** & **stress level**: -0.96 demonstrates that the relationship is negative.
- **Body temperature** & **blood oxygen**: 1 demonstrates that the relationship is positive.
- **Body temperature** & **heart rate**: -0.89 demonstrates that the relationship is negative.
- **Blood oxygen** & **heart rate**: -0.89 demonstrates that the relationship is negative.

4.5.2 Training the ML Models

Three machine learning algorithms (Support Vector Machine, k-Nearest Neighbor, and Random Forest) were used to detect and predict patient's stress state based on their healthcare data. The input parameters for each algorithm are:

- SVM (C=10, kernel='poly', degree=50)
- KNN (k = number of neighbors = 200)
- RFc (n estimators=100, random state=42)

4.5.2.1 Comparison between Algorithms

The three ML classification algorithm's performances were calculated and compared with 4 evaluation metrics (accuracy, precision, recall, and F-score) as shown in Table 4.1. We used the classification of five-class (0 = normal, 1 = low medium, 2 = medium, 3 = high medium, and 4 = high).

Classification Algorithm	Category	Precision	recall	F1-score	Support	Accuracy
SVM	0	1.00	1.00	1.00	23	0.57
	1	0.31	1.00	0.47	24	
	2	0.00	0.00	0.00	28	
	3	0.00	0.00	0.00	26	
	4	1.00	1.00	1.00	25	
KNN	0	1.00	1.00	1.00	23	0.94
	1	0.86	1.00	0.92	24	
	2	1.00	0.86	0.92	28	
	3	0.87	1.00	0.93	26	
	4	1.00	0.84	0.91	25	
RF	0	0.96	1.00	0.98	23	0.98
	1	1.00	0.92	0.96	24	
	2	0.93	1.00	0.97	28	
	3	1.00	0.96	0.98	26	
	4	1.00	1.00	1.00	25	

Table 4.1: Comparison between Support vector classifier (SVM), K Neighbors Classifier (KNN) and Random Forest Classifier (RF)

When all the classifiers mentioned above are employed and their performance is compared, it becomes apparent that the RF classifier reached the highest classification accuracy 98% of accuracy, as well as for other

evaluation measures as shown in the Table 4.1.

We used also the Confusion Matrices to see how well our models perform in each class. We plot the Confusion Matrices and got the following results:

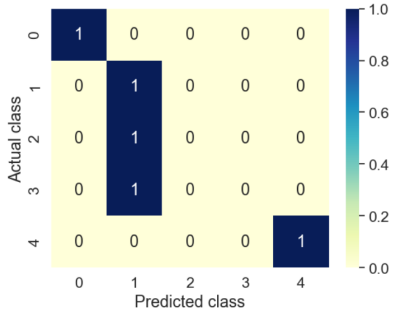


Figure 4.9: Confusion Matrix of SVM

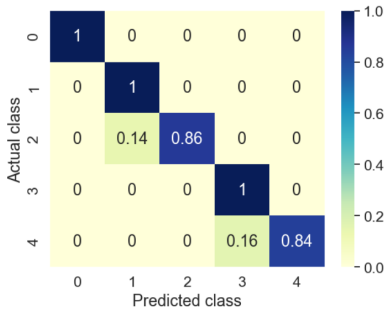


Figure 4.10: Confusion Matrix of KNN

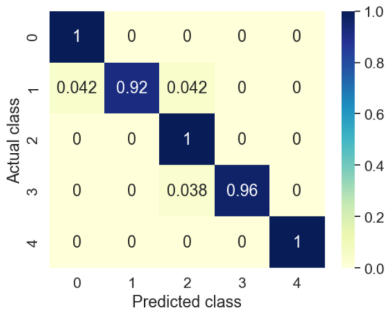


Figure 4.11: Confusion Matrix of RF

The confusion matrix reveals that the RF model is the best at classifying stress level prediction. As he classed three classes 100% correct, one 96% and the other 92%, and this is an excellent result.

4.5.3 Testing the RF Model

We chose to use Random Forest Classifier (RF) to train our model, which provided us with better accuracy compared to other machine learning algorithms: K Neighbors Classifier (KNN) and Support vector classifier (SVM), the following Figure 4.12 shows the testing code of RF model.

```
def test_sample(sample):
    classes=["normal","low medium","medium","high medium","high"]
    input_sample=np.array(sample)
    normalized_input=scaler.transform(input_sample.reshape(1, -1))
    result=rfc.predict(normalized_input)
    return classes[result[0]]
```

```
body_temperature=35
blood_oxygen=83
heart_rate=71
print(test_sample([body_temperature,blood_oxygen,heart_rate]))
```

```
high medium
```

Figure 4.12: Testing Code of RF Model

4.5.4 Save the RF Model

The RF model will be saved to a JSON file with the SkLite pip installed. To connect it with the Flutter app.

```
from sklite import LazyExport
lazy = LazyExport(rfc)
lazy.save('model.json')
```

Figure 4.13: Saving Code of RF Model

4.6 Software Implementation

4.6.1 Web Site Interfaces

4.6.1.1 Home

Figure 4.14 describe our web site home interface where :

1. **About us:** Description About us and our Start-up.
2. **Contact :** State our contact info as it shown in 4.16.
3. **Services :** It explain more about our given services.

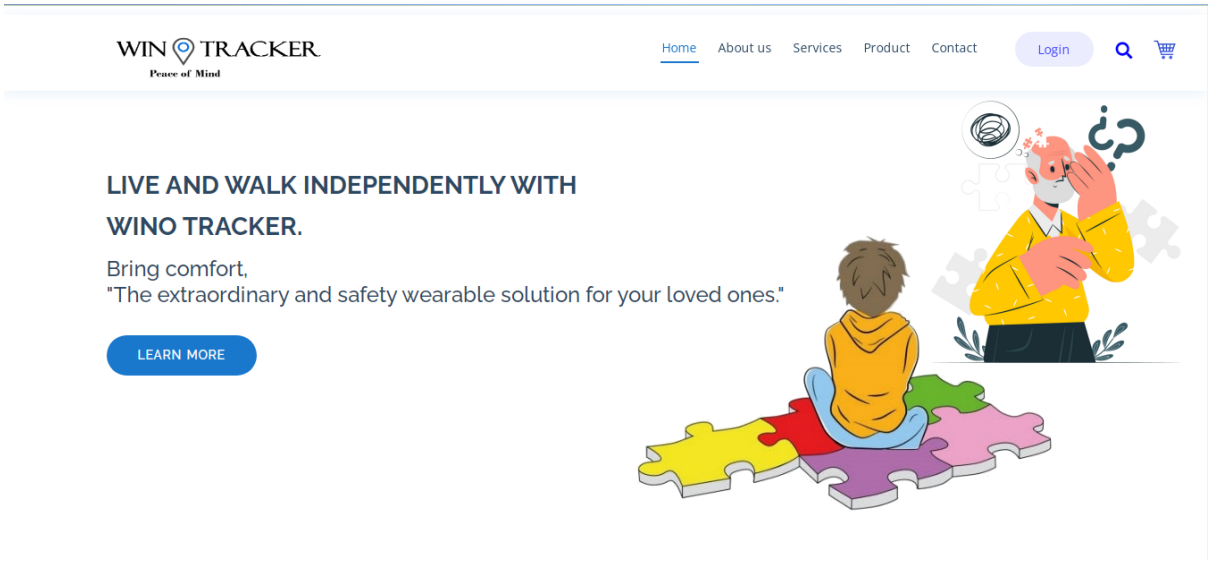


Figure 4.14: Web Site Interface

4.6.1.2 User

Figure 4.15 describe one of the most privileged could user do on the website, new command interface.

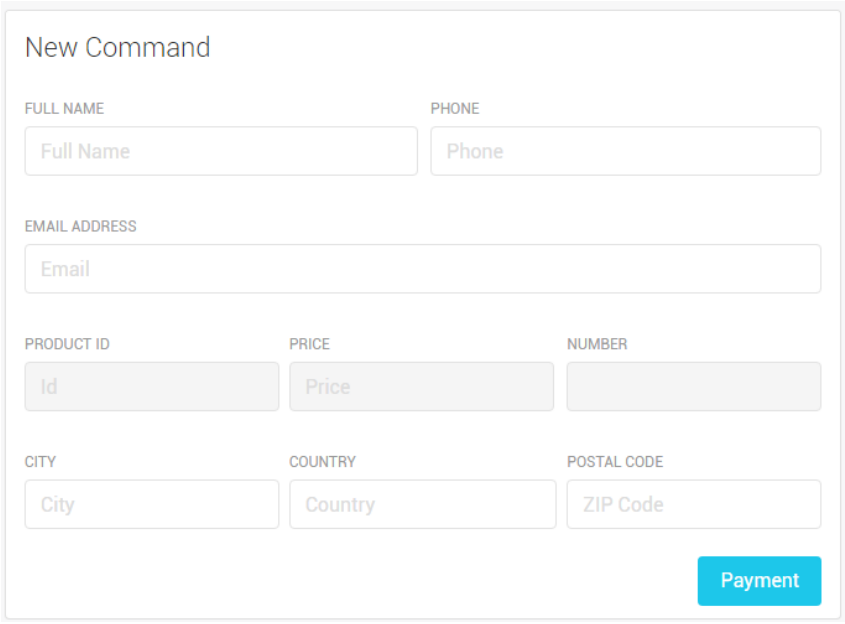


Figure 4.15: Command Interface

4.6.1.3 Support

Figure 4.16 describe our team support contact info interface.

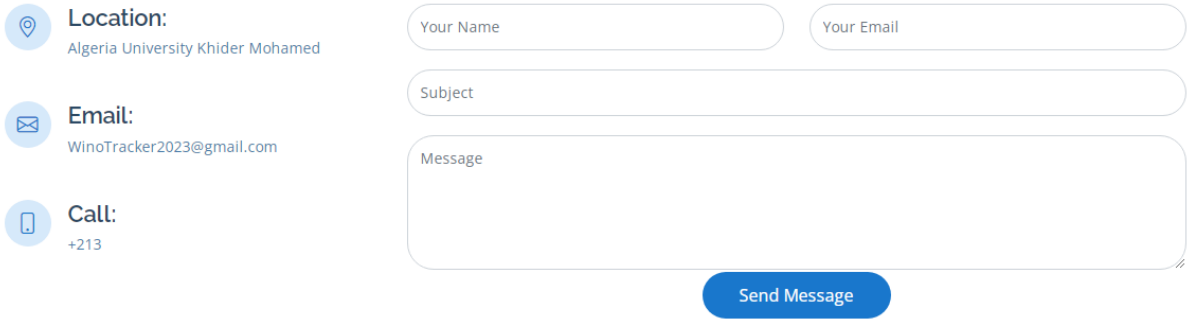


Figure 4.16: Team Support Interface

4.6.1.4 Admin Dashboard

Figure 4.17 represent Admin Dashboard interface and their components where :

1. **User Profile :** It describes process that admin of site web can do Figure 4.18 to update his profile information.
2. **Management :** Through Database admin can manage all functionality from add, update, delete, check operation of pieces or confirmation of payment, availability of stock. Moreover, search in database, and that all depend on admin privilege in the website.
3. **Maps :** It shows the location of all the pieces that have been sold and are in operation.
4. **Notification :** It states all messages received on the web page from customers can be problems, questions or services.

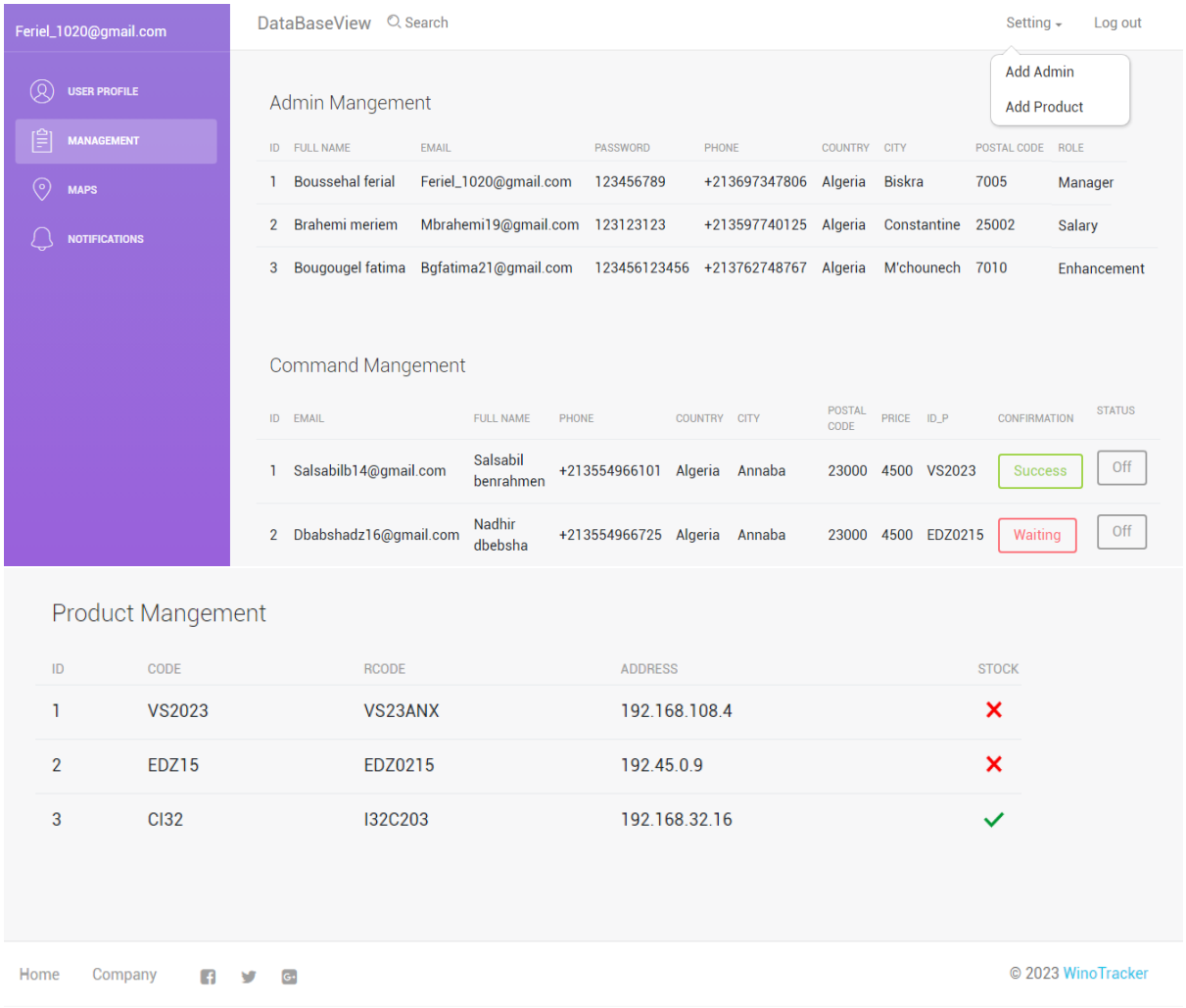


Figure 4.17: Admin Interface

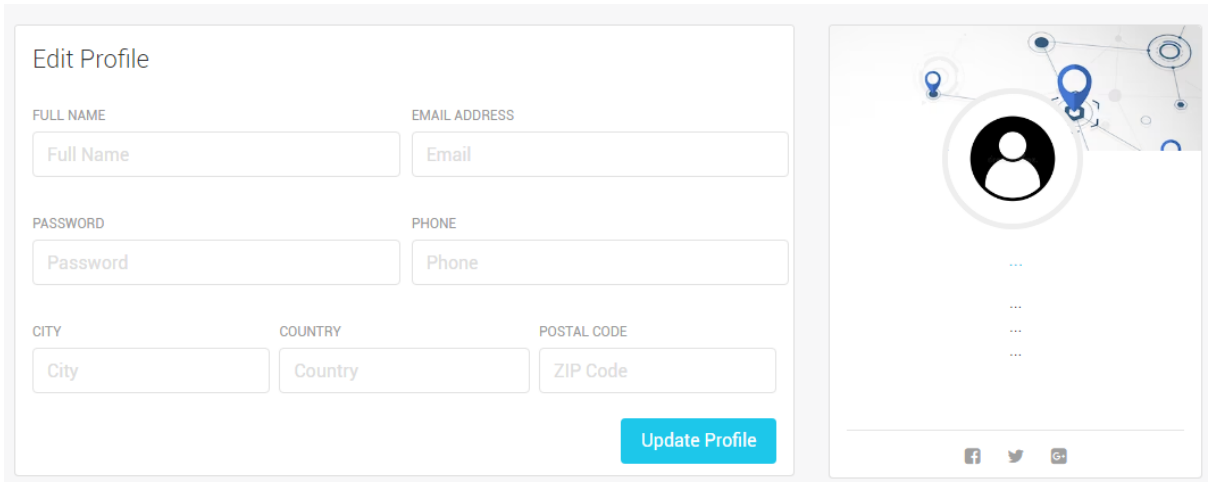


Figure 4.18: Profile Interface

4.6.2 Mobile Application Interfaces

4.6.2.1 Home Interface

Figure 4.19 describe our application mobile interface.

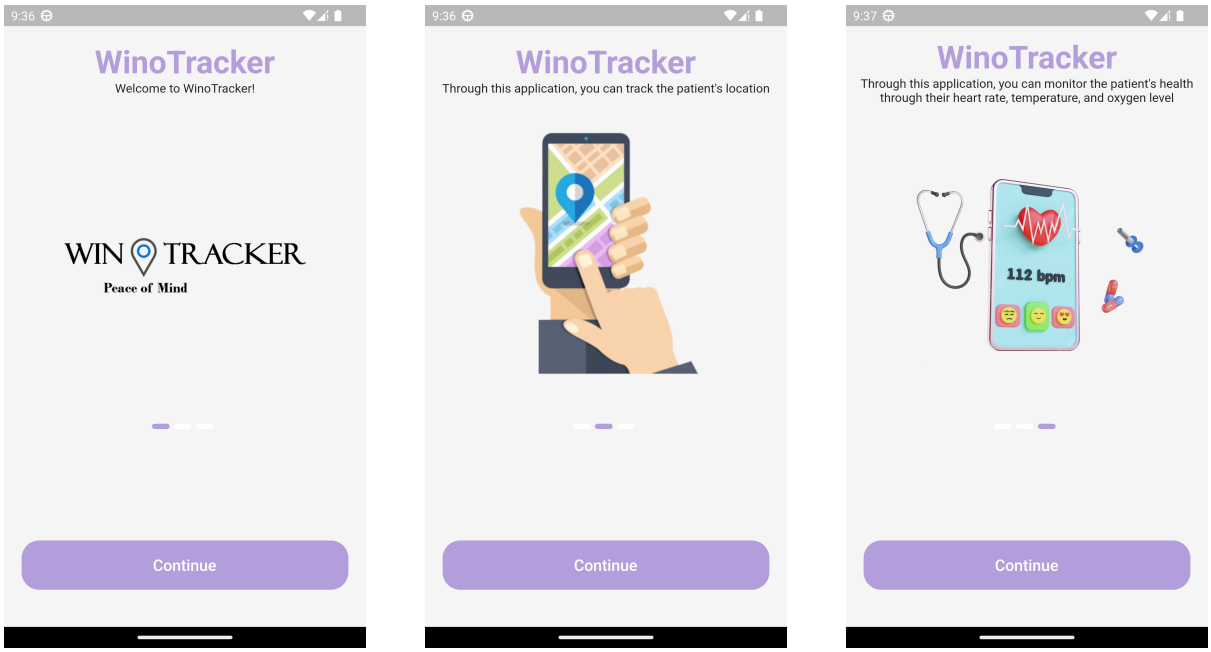


Figure 4.19: Home Interface.

4.6.2.2 Registration Interface

Figure4.20 allows the caregiver to register for the first time, it allows entering the username and requires email and password, and information of patient such as first name, bracelet code (patient special ID), where he gets it at the time of purchase.

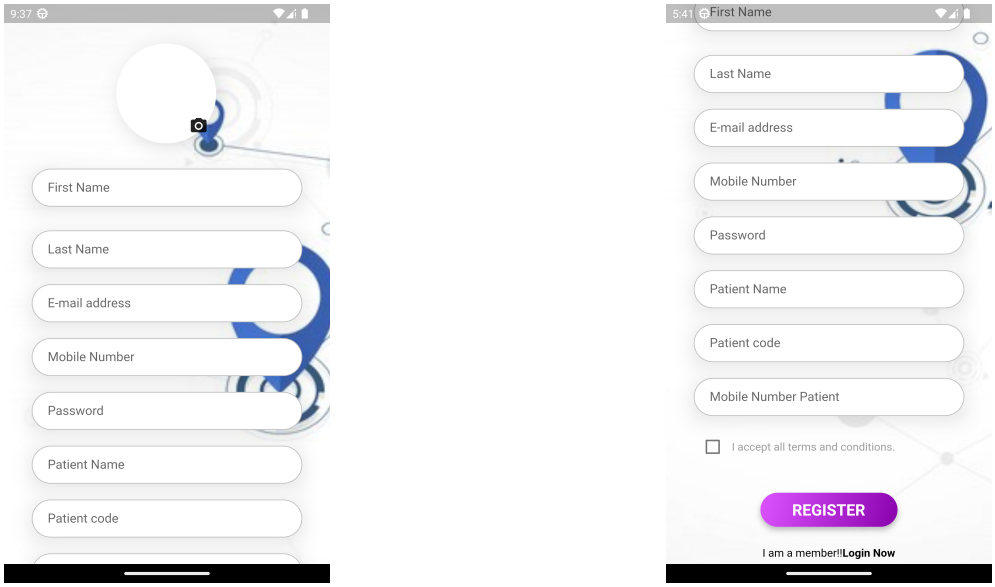


Figure 4.20: Registration Interface.

4.6.2.3 login Interface

In the interface, caregiver will find two input fields labeled ”Email” and ”Password.” The ”Email” field is where users enter their registered email address, and the ”Password” field is where they enter their chosen password associated with the account. Below these input fields, there will be a ”Sign In” or ”Log In” button. Once users have entered their email and password, they can click this button to initiate the login process. As shown in the following figure :

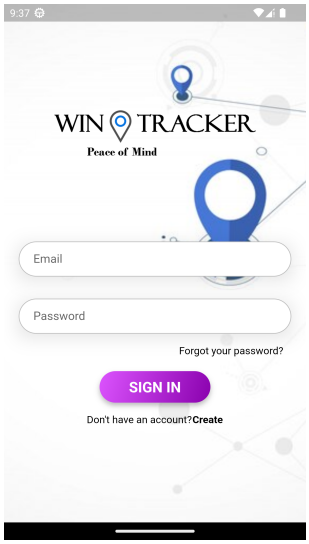


Figure 4.21: Login Interface.

4.6.2.4 Profile Caregiver Interface

This interface allows caregiver view and manage their personal information and settings. It provides caregivers with an overview of their profile and allows them to make updates or changes as needed.

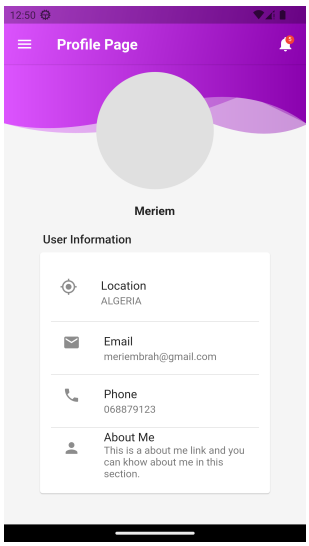


Figure 4.22: Profile Caregiver.

4.6.2.5 Menu Interface

The menu interface typically consists of five main components as follows and show in figure 4.23:

1. **Live Track:** This interface allows caregiver view the real-time positions of patients on a map as show in figure 4.24.
   Additionally, Figure 4.29 displays the complete trajectory or route taken by the patient.
2. **Healthcare:** This interface provides caregivers with real-time access to the health status of patients, including their current health statistics and stress levels, as show in figure 4.25.
   Additionally, the interface incorporates an alert system that notifies caregivers of any warning signs or critical conditions that require immediate attention figure 4.26.
3. **New Patient:** This interface enables caregivers to add new patients by entering their information, including their name, code, and other relevant details, as show in figure 4.27.
4. **Profile Patient:** This interface enables caregivers to view a comprehensive list of all the patients under their care, as show in figure 4.28.
5. **Setting:** Explained more in section 4.30

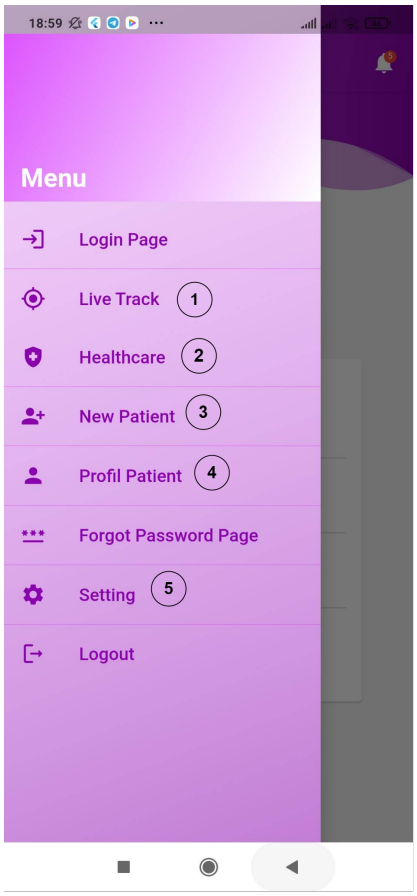


Figure 4.23: Menu Page .

Figure 4.24: Track Page.

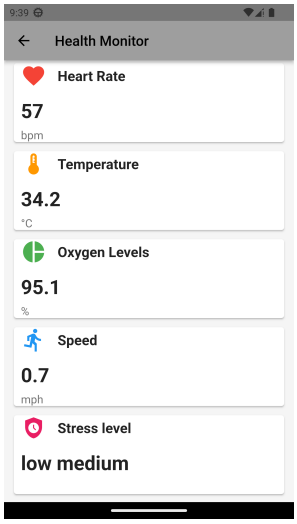


Figure 4.25: Healthcare Page.

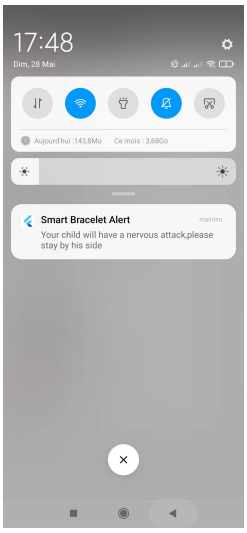


Figure 4.26: Alert.

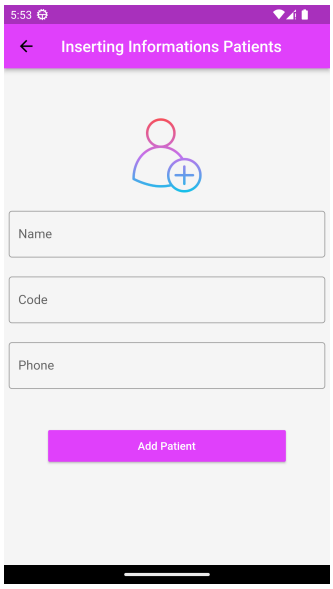


Figure 4.27: Add patient Interface.

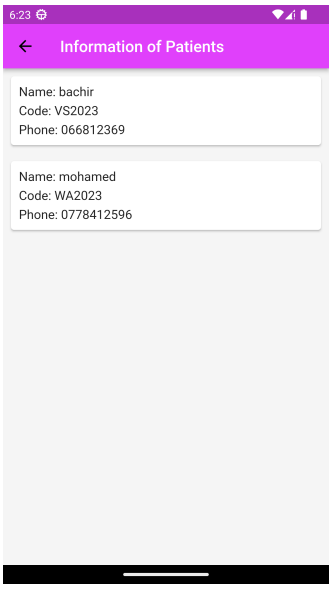


Figure 4.28: Information Patients.

Figure 4.29: Path Historical

4.6.2.6 Setting Interface

The setting interface typically consists of three main components as follows and show in figure 4.30:

1. **Geofencing:** This interface presents a map view.The map display the caregiver's current location and patient's location, and allows caregivers choose distance from list. Additionally, the interface incorporates an alert system that notifies caregivers, as show in figure 4.31.

2. **Wifi Management:** Caregiver can access this interface to change the **ssid** and **password** of WiFi network of the smart bracelet is connected to. However, prior to accessing this page, caregiver need to connect to the access point of the smart bracelet, as show in figure 4.32.

3. **Message Management:** This interface allows caregiver to enter three phone numbers for receiving messages with a link of the location of patients. However, prior to accessing this page, caregiver need to connect to the access point of the smart bracelet, as show in figure 4.31.

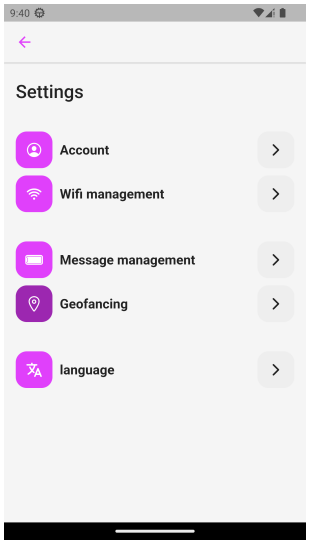


Figure 4.30: Setting Interface.

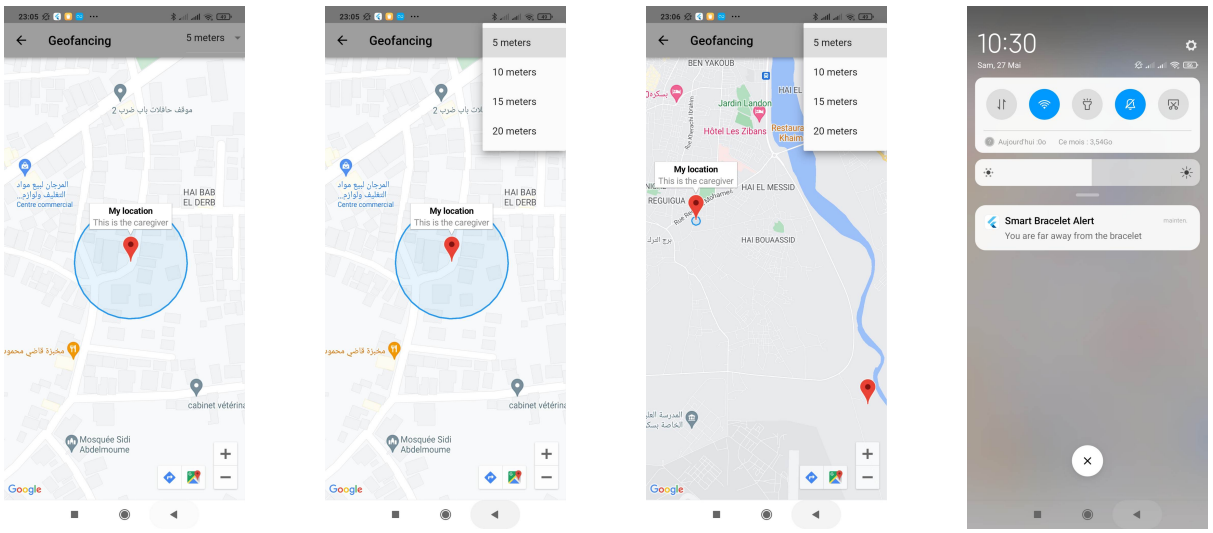


Figure 4.31: Geofencing.

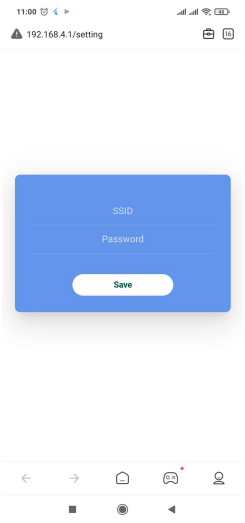


Figure 4.32: Wifi Setting Interface

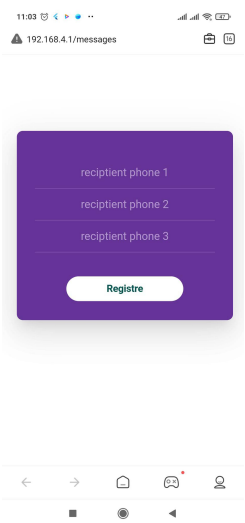


Figure 4.33: Recipients Interface

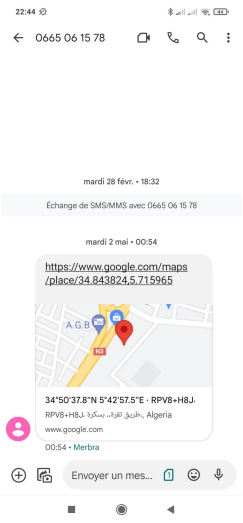


Figure 4.34: Link Location by Message

4.6.3 Firebase Interface

This interface presents the Firebase Real time Database used as an intermediate storage for the data received from the smart bracelet before transferring it to a mobile application.

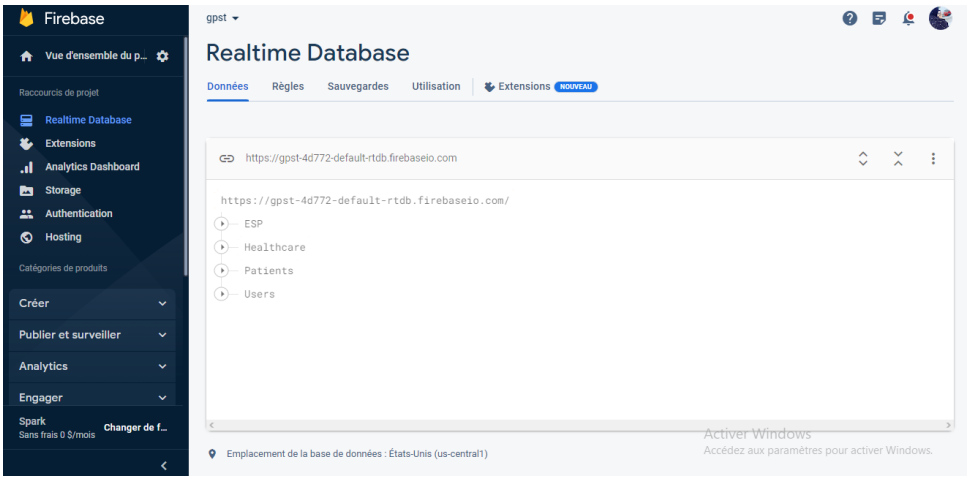


Figure 4.35: Firebase Real time Database Interface

Figure4.36 displays full database information on caregivers.

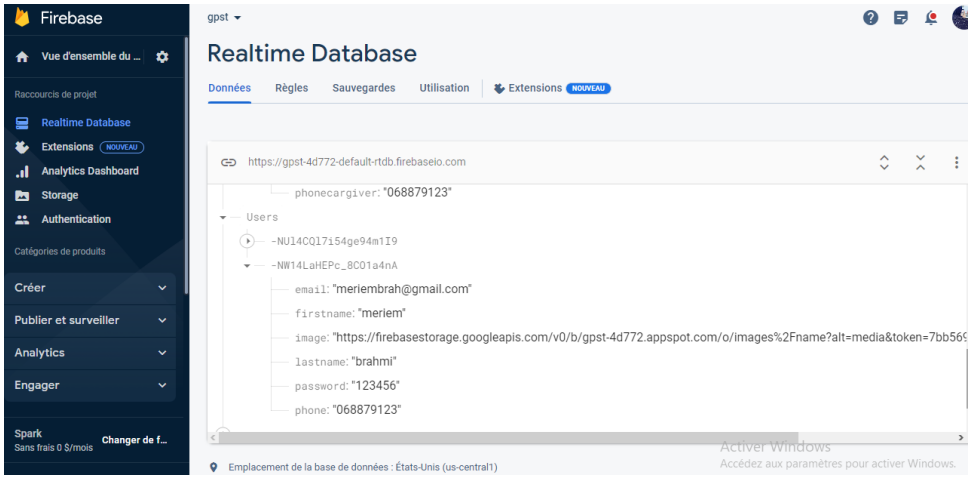


Figure 4.36: Firebase Real time Database Users

Figure4.37 present showcases an database record of patients, encompassing their codes, id special, first name, and phone number. Furthermore, it includes the caregiver's email address along with their phone number.

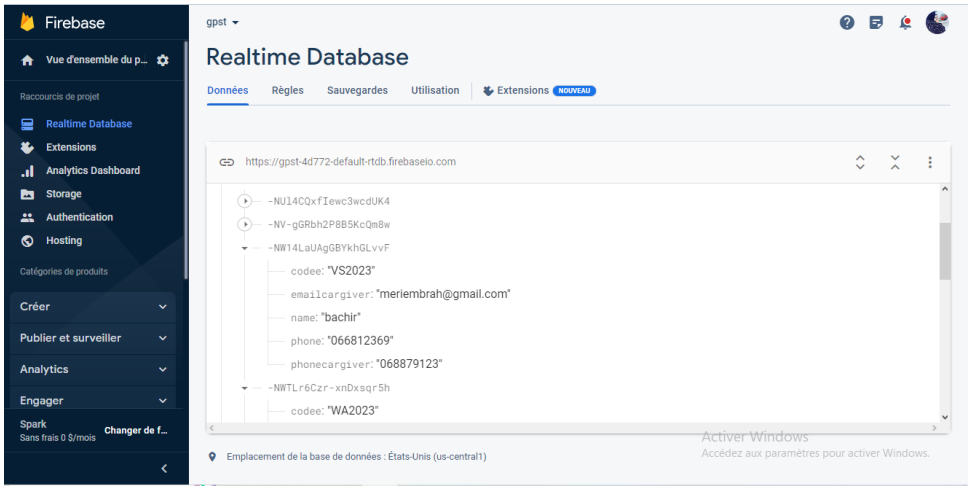


Figure 4.37: Firebase Real time Database Patients

The figure4.38 illustrates the database records containing the latitude and longitude positions of patients, along with their respective speed measurements.

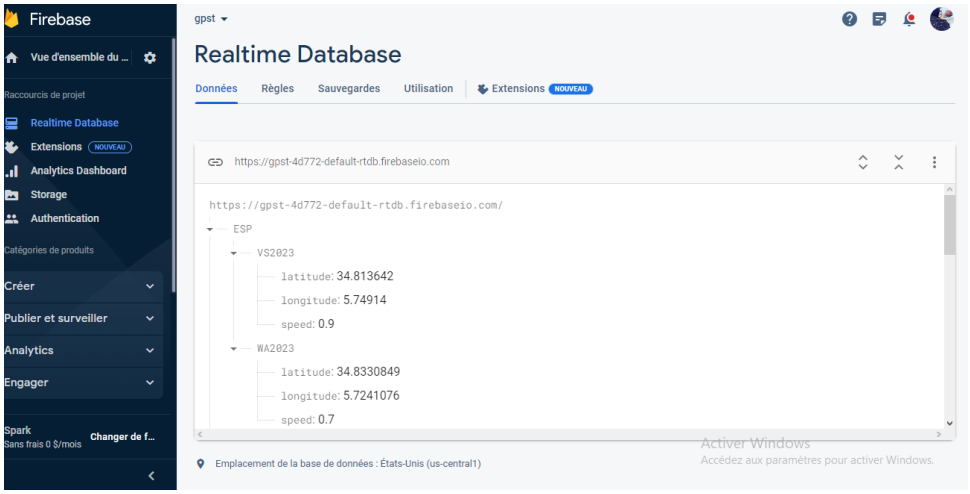


Figure 4.38: Firebase Real time Database Position

The figure4.39 presents the database information on patients heart rate, blood oxygen saturation, and body temperature.

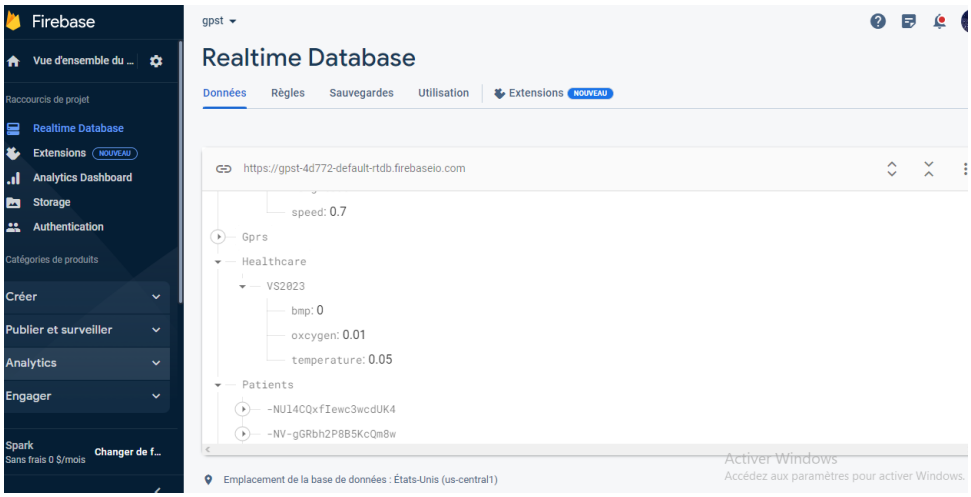


Figure 4.39: Firebase Realtime Database Healthcare

4.7 Conclusion

In this chapter, first we started by introducing the used hardware tools, after that we described the smart bracelet prototype and results of applicating our prediction system, lastly we presented our mains interfaces of site web and phone application.

General conclusion

The development of a smart bracelet connected to a mobile application provides a promising solution to address the challenges faced by parents of children with autism in Algeria. The fear of losing their children during moments of impulsiveness or confusion is a significant concern for parents, and the smart locator offers a means to track and monitor the real-time location of individuals who require special attention and care. By leveraging advanced geolocation technologies such as GPS and IoT, We proposed a system for tracking and monitoring a child with autism. Where we developed and designed a smart bracelet prototype based on IoT with a geolocation sensor and healthcare sensors that record physiological data. Also, we developed a site web and mobile application. The site web allows caregivers to purchase smart bracelets, and the mobile app we developed allows caregivers to access real-time data such as the child's location, heart rate, body temperature, and blood oxygen saturation level. This information can be extremely helpful in understanding the child's current state and addressing any potential concerns promptly. Not only that, but we added a stress and anxiety prediction alert for autism using a machine-learning algorithm to estimate the child's stress level based on the collected data. We chose the algorithm "Random Forest Classifier", which reached the highest classification accuracy with a value of 98%, to estimate the child's stress level, which is beneficial for caregivers and healthcare professionals in managing their care effectively.

Future Works

As future works, for the stress prediction, we plan to extract more features from the physiological signals and increase the size of the dataset by collecting more or even using the data already built to increase efficiency, and we plan also to implement Deep Learning models such as Convolution Neural Networks (CNN) and Recurrent Neural Networks (RNN).

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Appendix A

Questionnaire and Result

A.1 Survey

إستبيان حول مرضى التوحد

بضع أسئلة تخص طفل التوحد.

1. هل أنت .... مريض التوحد *

- عائلة
- طبيب
- مقدم رعاية

2. هل تجد صعوبة في مراقبة طفلك ؟ *

- نعم
- لا

3. هل سبق وضاع الطفل ؟ *

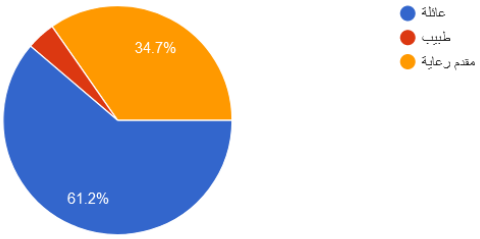
- نعم
- لا

Figure A.1: Autism Survey

A.2 Results

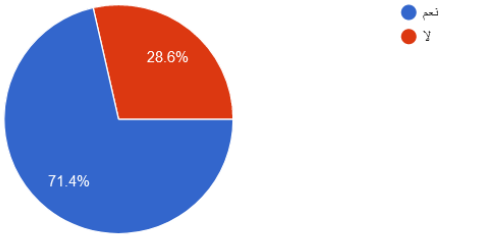
هل انت ..... مريض التوحد

49 ردًا



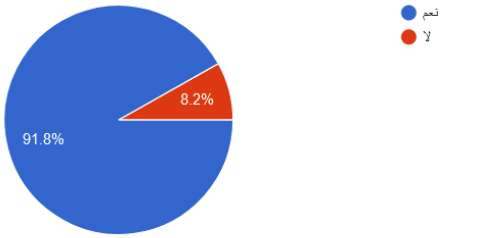
هل صادف و ضاع الطفل ؟

49 ردًا



هل تجد صعوبة في مراقبة طفل التوحد ؟

49 ردًا



هل يعاني مريض التوحد من نوبات توتر و قلق ؟

49 ردًا

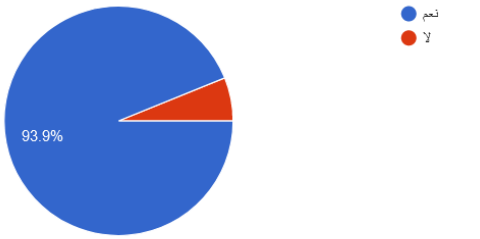


Figure A.2: Results

Appendix B

Start-Up

الجمهورية الجزائرية الديمقراطية الشعبية

وزارة التعليم العالي و البحث العلمي

جامعة محمد خيضر بسكرة

التجاري الاسم

WinoTracker

صورة التجارية العلامة

WIN TRACKER

Peace of Mind

السنة الجامعية

2022 _ 2023

عنوان المشروع:

Smart Device for Peace of Mind

مشروع لنيل شهادة مؤسسة ناشئة بشـــي إطار القرار الوزاري 1275

بطاقة معلومات:

حول فريق الاشراف وفريق العمل

1- فريق الاشراف:

فريق الاشراف	
المشرف الرئيسي : صهيب اياد	التخصص : اعلام الي

2- فريق العمل:

فريق المشروع	التخصص	الكلية
براهمي مريم	اعلام الي	علوم الدقيقة و الطبيعة و الحياة
بوسهل فريال	اعلام آلي	علوم الدقيقة و الطبيعة و الحياة
بوغقال فطيمة الزهرة	اعلام الي	علوم الدقيقة و الطبيعة و الحياة

فهرس المحتويات

المحور الأول: تقديم المشروع

المحور الثاني: الجوانب الابتكارية

المحور الثالث: التحليل الاستراتيجي للسوق

المحور الرابع: خطة الإنتاج والتنظيم

المحور **الخامس: الخطة** المالية

المحور السادس: النموذج الاولي التجريبي

مقدمة

في الجزائر، يعاني أولياء الأمور الذين يقدمون الرعاية لأطفال التوحد من تحديات كبيرة وصعوبات متعددة. يعتبر التوحد اضطرابًا عصبيًا طيفيًا يؤثر على التواصل والتفاعل الاجتماعي والسلوك لدى الأطفال المصابين به. تحتاج هذه الأطفال إلى دعم واهتمام خاصين لتحسين جودة حياتهم وتعزيز قدراتهم.

تواجه الأسر المعنية العديد من التحديات في رعاية أطفالهم المصابين بالتوحد. أحد أبرز هذه التحديات هو خوف الأهل من ضياع أطفالهم في حالات الاندفاع أو الارتباك الشديد. قد يكون لدى بعض الأطفال التوحد رغبة قوية في الهروب أو الفرار من المواقف المجهدة أو المرهقة، مما يزيد من قلق أولياء الأمور بشأن سلامة أطفالهم. يتطلب الأمر منهم أن يكونوا في حالة يقظة دائمة ويتبعوا إجراءات أمان صارمة للتأكد من سلامة أطفالهم في كل الأوقات.

بالإضافة إلى ذلك، يواجه الأهل صعوبات في التعامل مع الأزمات العصبية التي يمكن أن تنشأ لدى الأطفال التوحد. قد يعاني هؤلاء الأطفال من ضغوط وتوترات داخلية تؤدي إلى تفاعلات عصبية غير منضبطة وصعوبات في التحكم بالانفعالات. يمكن أن تتسبب هذه الأزمات في صعوبات في التواصل والتفاعل مع الأطفال، مما يزيد من الضغط على العائلة ويزيد من حاجتها إلى دعم خاص.

يبلغ عدد المصابين بالتوحد في الجزائر أكثر من 450 ألف شخص، بحسب آخر تقرير لمديرية السكان بوزارة الصحة بهذا الشأن عام 2021.

من خلال البيانات والدراسة التي قمنا بها وبينما شرعنا في معالجة استبيان التوحد الخاص بنا لاكتشاف بعض المعلومات السريعة عن الطفل المصاب بالتوحد. كانت النتائج مختلفة لكل ممثل، اعتمادا على ما إذا كان طبيًبا أو عائلة أو مقدم رعاية للأطفال المصابين بالتوحد، حيث أوضح جميع المستجيبين بنسبة 91.8% منهم يعانون من صعوبة في رعاية أطفالهم طوال الوقت، و71.4% ممن عانوا من فقدانهم بشكل متكرر، بينما 29.7 % قالوا لا. كما أكد 93.8% أن حالة أطفالهم المصابين بالتوحد تظهر نوبات القلق والتوتر التي تهيمن على سلوكهم معظم الوقت، وهذا غالبا ما يكون من الصعب التعامل معه أو التنبؤ به.

هذا يسلط الضوء على غلبة وانتشار نوبات الأطفال المصابين بالتوحد في المجتمع. بالإضافة إلى ذلك، أظهرت النتائج استجابة كبيرة ورغبة 95.5% في محاولة شراء جهاز مراقبة وجهاز رعاية صحية للأطفال المصابين بالتوحد.

المحور الأول: تقديم المشروع

1. فكرة المشروع (الحل المقترح)

لقد تم تطوير جهاز ذكي للتعقب ومراقبة الرعاية الصحية بشكل سوار يحتوي على مستشعرات لتحديد الموقع باستخدام تقنية GPS وقياس السرعة والحالة الصحية. يتم ربط هذا السوار بتطبيق على الهاتف المحمول يمكن من تعقب الأفراد ذوي الاحتياجات الخاصة التوحد بشكل فوري عن طريق تحديد المواقع باستخدام GPS ومراقبة البيانات الفسيولوجية مثل درجة الحرارة ونبضات القلب ومستوى الأكسجين في الدم. يتميز التطبيق أيضًا بقدرات تنبؤية تهدف إلى رصد نوبات التوتر والقلق لدى أطفال التوحد بهدف تعزيز الرعاية والسلامة للأفراد. بالإضافة إلى ذلك، يوفر السوار إمكانية الوصول إلى موقع المريض حتى في حالة عدم توافر اتصال بالإنترنت. يتيح لأولياء أطفال التوحد الاطمئنان إلى أحبائهم في الوقت الفعلي وفي أي مكان، مما يوفر لهم الأمان والراحة.

2. القيم المقترحة

منتجنا كجهاز تعقب ذكي صنع جزائري يتميز بالعديد من القيم المضافة. فهو يوفر أمانًا عاليًا للمستخدم من خلال عرض حالة الصحية للمريض وموقعه في الوقت الفعلي، مما يقلل الوقت والجهد الذي يتطلبه مقدمو الرعاية مثل أفراد الأسرة وإدارة المدارس الخاصة ومرافقي مرضى التوحد. بفضل التنبؤ بنوبات التوتر والقلق، يمكن اتخاذ التدخلات المناسبة بسرعة لإدارة وتخفيف ضغوط الأطفال المصابين بالتوحد. هذا يسمح ببدء التدخل في أسرع وقت ممكن لتوفير الدعم اللازم للأطفال. بالإضافة إلى ذلك، يمتاز جهازنا بكونه منتجاً محلياً صُنع في الجزائر، مما يساهم في تعزيز الصناعة المحلية وتوفير فرص عمل محلية.

3. أهداف المشروع

- توسيع النطاق السوقي: نرغب في زيادة تواجدنا وتغطية سوق بسكرة في فترة زمنية قصيرة، من خلال تعزيز الوعي بالتطبيق وجذب المزيد من المستخدمين.
- توفير خدمات إضافية: بعد عام من انتشار التطبيق واستخدامه، نهدف إلى توسيع نطاق الخدمات التي نقدمها. نرغب في تلبية احتياجات المستخدمين وتقديم خدمات جديدة تجذبهم وتعزز تجربتهم مع التطبيق.
- توسيع الفئات المستهدفة: نسعى لاستهداف فئات جديدة مثل مرضى الخرف والزهايمر. نهدف إلى تطوير خدمات مخصصة تلبي احتياجات هذه الفئة وتساعدهم في حياتهم اليومية.
- توسيع النطاق الجغرافي: نرغب في زيادة تواجدنا وتغطية أكبر نسبة ممكنة في الجزائر. نهدف إلى توفير التطبيق والخدمات الخاصة به في مناطق أخرى والوصول إلى مستخدمين جدد.
- الوصول إلى جهاز منافس عالميًا: في المستقبل البعيد، نهدف إلى أن يكون لدينا جهاز ينافس بقوة على المستوى العالمي. نرغب في تصدير وتوريد المنتج إلى عدة بلدان عبر طلبات من الموقع الإلكتروني.

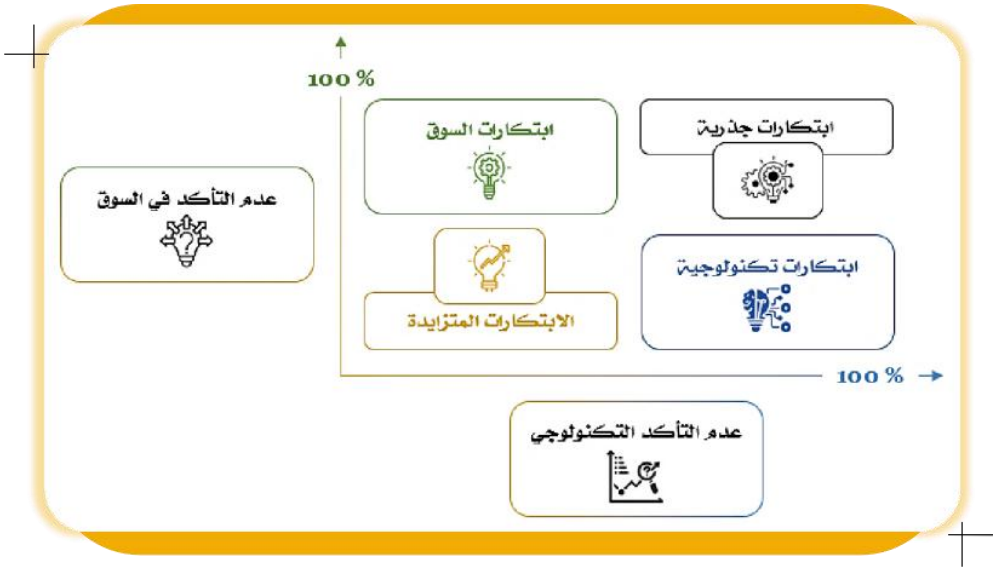
4. جدول زمني لتحقيق للمشروع:

المهمة	مدة الانجاز
شراء المواد الأولية(مستشعرات وسلع الكترونية)	5 ايام
تركيب دارة المستشعر	يوم
برمجة كل مستشعر	اسبوعان
جمع المستشعرات و البرمجة	اسبوعان
تركيب البطارية	اسبوع
برمجة التطبيق	شهر
تصميم السوار ثلاثي الأبعاد 3D	اسبوع

المحور الثاني: الجوانب الابتكارية

1. طبيعة الابتكار

طبيعة ابتكارنا تتمثل في تقديم منتج أو خدمة غير متوفرة في السوق الجزائرية والتي تستفيد من التكنولوجيا المتاحة لكن بطريقة تلبي احتياجات خاصة وتقدم خدمات مختلفة. هذا النوع من الابتكار يعتبر **"ابتكار السوق"** لسوق التي لم تشهد هذا النوع من الحلول من قبل. بمعنى آخر، منتج أو خدمة فريدة تلبي احتياجات محددة وتقدم مزايا لا تتوفر في المنتجات الموجودة حاليًا في السوق الجزائرية. على الرغم من أن التكنولوجيا متوفرة خارج الجزائر، إلا أننا نقوم بتكييفها وتطويرها لتناسب احتياجات السوق الجزائرية وتقديم خدمات فريدة تميز ابتكارنا عن المنافسين الآخرين.



2. الجوانب الابتكارية

- أول مشروع في الجزائر يهدف إلى استخدام تقنية التنبؤ بنوبات التوتر والقلق في تطبيق هاتف محمول للعناية بأطفال التوحد.
- يتم من خلال مراقبة وتتبع الحالة الفسيولوجية لأطفال التوحد في أي وقت وأي مكان .
- يتم استهداف فئات جديدة من المستهلكين مثل مرضى التوحد.
- يمكن استخدام قاعدة بيانات المرضى واستغلالها في دراسات أخرى وفي المستشفيات الكبرى .
- استغلال تقنية التتبع وتوفيرها في كلتا الحالتين، سواء كان هناك اتصال بالأنترنت أو لا.

المحور الثالث: التحليل الاستراتيجي للسوق

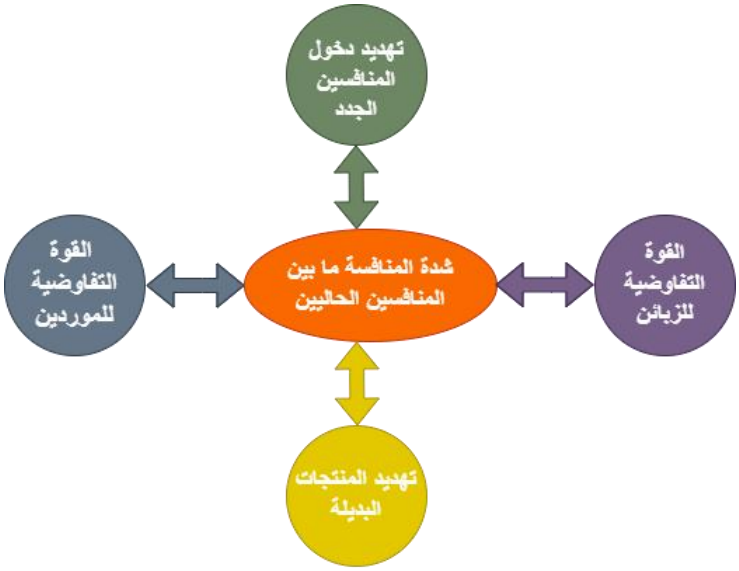
1. تحليل المتغيرات الكلية (PESTEL)

هي أداة تستخدم من طرق المؤسسات لتحليل ومراقبة العوامل البيئية التسويقية الخارجية التي تؤثر على هذه المؤسسات.

المتغير	التحليل	نوع التأثير
P سياسي	• قوانين وتشريعات جديدة مشجعة على انشاء مؤسسة ناشئة • قرارات رئيس الجمهورية بشأن فتح وغلق الاستيراد • قرار وزير التعليم العالي بتمويل المؤسسات الناشئة التي تدخل في قرار 1275 • الاستقرار الحكومي	• إيجابي (+) • سلبي (+) • إيجابي (+) • إيجابي (+)
E إقتصادي	• التسهيلات التي منحتها الدولة للمؤسسات الناشئة • الإعفاء الكلي من الضريبة الجزافية • سهولة الحصول على القروض من وكالات الدعم (LANAD) • قيود الاستيراد • توفير صناديق تمويل خاصة بالمؤسسات الناشئة	• إيجابي (+) • إيجابي(+) • إيجابي (+) • سلبي (+) • إيجابي (+)
S إجتماعي	• مستوى وعي الأفراد والمؤسسات • المستوى المعيشي للمستهلك • حجم السكان في الجزائر (46 مليون نسمة منهم 1% مصاب بالتوحد) • الوعي الصحي	• إيجابي (+) • إيجابي (+) / سل • إيجابي (+) • إيجابي (+)
T تكنلوجي	• إستراد بعض المعدات الإلكترونية • توفر شبكة الأنترنت • توفر أنظمة البرمجة (سهولة الوصول اليها) • التعود على التكنلوجيا	• سلبي (+) • إيجابي (+) • إيجابي (+) • إيجابي (+)
E بيئي	/	/
L قانوني	• قانون حماية الملكية الفكرية • قوانين مشجعة على انشاء مؤسسة ناشئة	• إيجابي (+) • إيجابي (+)

2. تحليل القوى التنافسية (PORTER)

تحليل القوى الخمس لبورتر هو إطار عمل يساعد في تحليل مستوى المنافسة داخل صناعة معينة. إنه مفيد بشكل خاص عند بدء عمل تجاري جديد أو عند دخول قطاع صناعي جديد.



التحليل:

1- **شدة المنافسة:**

بالنسبة لمشروع صناعة السوار الذكي للتعقب والرعاية الصحية مع تطبيق الهاتف المحمول، يمكننا القول إنه يوجد تركيز الصناعة كبير في هذا المجال في الجزائر، حيث لم يتم تطبيق مشروع مماثل حتى الآن ولا يوجد مصنع جزائري يقوم بإنتاج هذا السوار. وبالتالي، لا يوجد منافسون مباشرين لهذا المشروع في الجزائر. يتواجد فقط مستوردين، ولكن هناك اختلاف في الخدمات المقدمة. لذا، يمكن القول إن شدة المنافسة في هذا المجال ضعيفة جدًا نظرًا لعدم وجود منتج محلي في هذا القطاع.

2- **قوة التفاوضية للزبائن:**

تعتبر قوة التفاوض للعملاء ضعيفة لأن المنتج غير متوفر محليًا وهو منتج فريد لا يوجد له مثيل شـــي السوق المحلية، ولا يوجد منافس مباشر. عندما يكون هناك مصنع محلي يوفر المنتج بجودة عالية وأسعار أقل، فإن قدرة العميل على المفاوضة ستكون محدودة.

3- **القوة التفاوضية للموردين:**

ضعف القدرة التفاوضية للموردين بشكل كبير بسبب وفرة السلع الإلكترونية وفرص العمل المتاحة. ويتجلى ذلك من خلال معدل البطالة المرتفع وندرة الوظائف العامة. ونتيجة لذلك، تستفيد المؤسسة من هذا الوضع، مما يساهم بشكل أكبر في النفوذ المحدود للموردين في المفاوضات.

4- **تهديد المنتجات البديلة:**

حالياً، هناك منتجات مستوردة تشبه السوار الذكي شـــي التعقب والمراقبة الصحية، ولكنها تقدم خدمات أقل بعض الشيء. يتميز السوار الذكي بمجموعة من الميزات التي تجعله فريدًا، ولا يوجد منتج محلي ينتج هذا النوع من الأساور حاليًا، مما يجعل المنافسة ضعيفة جدًا. وبالتالي، فإن التهديد الناشئ من المنتجات البديلة ضعيف جدًا، حيث أن المنتج الحالي يتمتع بمزايا كثيرة ولا يوجد بديل مباشر محلي له.

ومع ذلك، إذا دخل منافس مباشر ينتج السوار محليًا، فإن التهديد قد يصبح كبيرًا لأن الخصائص ستكون مشابهة أو يمكن أن يتوفر المنافس الجديد على فروع أكثر وخدمات أحسن بسعر اقل.

5- **تهديد دخول منافسين جدد:**

تدخل منافس جديد إلى سوق السوار الذكي والمراقبة الصحية مع تطبيق الهاتف المحمول وخاصية التنبؤ ليست مهمة سهلة ولا صعبة تمامًا. هناك عدة تحديات كبيرة يجب التغلب عليها. على سبيل المثال، هناك قيود قانونية تحمي فكرة المشروع من خلال الحصول على براءة اختراع على المستوى الوطني. وبالتالي، لا يمكن لأي شخص آخر تطبيق نفس الفكرة بناءًا على البراءة التي ستحصل عليها المؤسسة، وبالتالي فإن احتمالية دخول منافس جديد تكاد تكون معدومة.

بالنسبة لصناعة السوار الذكي والمراقبة الصحية، لا يوجد حاجز دخول قوي يمنع المنافسين الآخرين من دخول السوق وتطبيق المشروع. ومع ذلك، فإنه يتطلب خبرة تقنية وتطوير برمجي وتصنيع إلكتروني. وقد يكون هذا التحدي صعبًا إذا كان لدى المنافسين الجدد موارد محدودة أو معرفة محدودة شـــي هذه المجالات، سوق الأجهزة القابلة للارتداء مستمر شـــي التطور والتحسين، ويتطلب الابتكار المستمر والتحديثات المنتظمة للتكنولوجيا والبرمجيات. لذا،

S STRENGTHS نقاط القوة	W WEAKNESS نقاط الضعف	O OPPORTUNITIES الفرص	T THREATS التهديدات
• أول جهاز تعقب صنع جزائري • صاحب المشروع في الميدان • تطبيق مجاني مفتوح المصدر • تطبيق سهل الاستخدام وواضح • يحل مشكلة متعلقة بحياة الأفراد	• الاعتماد على الواردات • ارتفاع سعر المواد الأولية في الجزائر	• التسهيلات للمؤسسات الناشئة ودعمها • قرار تمويل المؤسسات الناشئة التي تدخل في قرار 1275 • ضعف فاعلية الأجهزة المتاحة حاليا في الجزائر • زيادة وعي الأفراد لهذه الأجهزة • ارتفاع نسبة المصابين بالتوحد	• تهديد غلق الحدود (مواد أولية من خارج البلد) • العديد من أجهزة التتبع خارج البلد التي يمكن استيرادها • التهديد من دخول منافسين جدد

يجب على المنافس الجديد أن يكون لديه رؤية طويلة الأمد وقدرة على الابتكار المستمر للبقاء شـــي المنافسة. وبالتالي، احتمالية دخول منافس جديد تكون متوسطة إلى مرتفعة.

3. تحليل(SWOT)

وهي طريقة للتحليل الاستراتيجي تساعد على تحليل البيئة الداخلية لمؤسستنا والمتمثلة بنقاط قوتها ونقاط ضعفها من جانب، وما يقابلها من تحليل للبيئة الخارجية المتمثلة بالفرص المتاحة والتهديدات التي قد تواجهها، وقد سميت هذه المصفوفة بتحليلSWOT اختصاراً للحرف الأول من كل عنصر من عناصرها كما هو موضح في الجدول التالي:

1. تحليل السوق

- **نطاق السوق:** يتعلق التحليل السوقي بسوق جهاز التعقب والرعاية الصحية في الجزائر، مع التركيز الأولي على ولاية بسكرة.
- **السوق المحتمل:** كل فرد أو مؤسسة تحتاج إلى جهاز تعقب ورعاية صحية يختصر الوقت و لجهد و يقدم الأمان.
- **السوق المستهدف(الزبائن):** نسعى إلى استهداف المراكز المتخصصة في رعاية الأشخاص ذوي التوحد، العائلات ذات مرضى التوحد والأطفال، مراكز بيع المعدات شبه الصيدلية (Parapharm)، والمدارس الخاص.

خصائص الشريحة المستهدفة (في بسكرة):

الشريحة	العدد	طبيعة الطلب	حجم الطلب
مراكز التوحد	4	مرة واحدة	منخفض
العائلات	120	شهرية	مرتفع
Parapharm	9	ثلاثية	متوسط
المدارس الخاصة	7	مرة واحدة	متوسط

✓ تم اختيار هذه الشرائح لأنها أكثر اهتمام بهذا الجهاز وتواجه مشاكل في مراقبة الفئة المسؤولة عليها، حيث أن الجهاز سيسهل عملية المراقبة ويوفر خدمات صحية وتنبؤ بنوبات القلق.

- **تحديد المنافسين:**

المنافس المباشر: بعد القيام ببعض الدراسات الحقيقية للسوق الوطنية والاستفسار من طرف التجار والمستوردين لأجهزة تعقب الأطفال حول إمكانية وجود مصنع لإنتاج أجهزة تشابه جهازنا تبين أنه لا يوجد لحد الآن من قام بالدخول لمثل هذا النوع من الصناعات في الجزائر وهذا بالتأكيد تقودنا للقول إنه لا يوجد منافسين مباشرين في السوق الوطنية.

المنافس الغير مباشر:

لكن بالنسبة للمنافس الغير مباشر فيوجد فقط من يقوم باستيراد أجهزة التعقب (Smart 2030, Nabi, GF-07) التي تشبه جهازنا لكن لا تتوفر على جميع خصائص وخدمات جهازنا ولا تستهدف فئاتنا، يُعتبر المستوردون المنافسين الرئيسيين في هذا السوق والمتمثلين في صفحات التواصل الاجتماعي ومراكز البيع بالتجزئة.

✓ **نقاط قوتهم:**

✘ **نقاط ضعفهم:**

غير متوفرة بشكل مستمر

كميات محدودة

تغطية جغرافية ضيقة

- **تحديد الموردين:**

تتعامل المؤسسة مع مجموعة من الموردين من أجل تزويدها باحتياجاتها للمشروع سواء من آلات، مكاتب ... ومن مستلزمات إلكترونية. حيث يمكن تحديد الموردين الذين نتعامل معهم كما يلي:

الإسم	مكان التواجد	المادة الأولية	معيار المفاضلة	طبيعة التوريد
Ali express	الصين	البطارية، المقاومات، الاسلاك، Esp32، LM35، MAX30102، GPIO Pin M، GPS Neo-6m، Breadboard، TP4056، Cable FM/FF، Sim800l	لا يوجد انتاج محلي السعر المنخفض تسليم سريع	دائم
	بسكرة	اداة تلحيم	قرب المسافة السعر المناسب	مؤقت
OSM Meuble Biskra	بسكرة	مكتب، كراسي	قرب المسافة السعر المناسب	مؤقت
Horizon Biskra Informatique	بسكرة	طابعة ورق، طابعة وصل	قرب المسافة السعر المناسب	مؤقت
websoog	الجزائر	طابعة ثلاثية الأبعاد حلقات بلاستيك	توفير التوصيل سعر مناسب	مؤقت

2. *الاستراتيجيات التسويقية*

نعتمد في تسويق منتجاتنا على عدة استراتيجيات والتي تتمثل في:

- **استراتيجية الانطلاق:** بما أن المؤسسة ستكون مؤسسة جديدة ومبتكرة في سوق موجود من قبل يتميز بتنوع جودة

المنتجات المستوردة بين المتوسطة والجيدة فإن المؤسسة ستحاول الاعتماد على **استراتيجية التميز والتركيز** نظرا لرغبتنا في:

- ← تقديم منتوج ذو جودة عالية وخصائص متميزة.
- ← تقديم منتوج مبتكر مع خدمات تطبيق مبتكرة.
- ← التركيز وخدمة فئة معينة وأساسية وهي مرضى التوحد والأطفال.

- **استراتيجية التوسع:** بعد اكتساب حصة سوقية وسمعة جيدة وزيادة الطلبات سنحاول توسيع الشريحة المستهدفة والالتفات إلى فئة المصابين بالخرف والزهايمر وأيضا المسنين في العمرة والحج حيث سنقوم بتوفير خدمات أخرى تساعد وتحل مشاكل هاته الفئة.

✓ بالإضافة إلى اعتمادنا على موقع إلكتروني لإدارة الطلبيات وتوزيع المنتجات وكما تعتبر شركتنا أن زبائنها هي الأساس حيث تتيح لهم التعبير عن آرائهم ومشاكلهم ... عبر الموقع الإلكتروني ومواقع التواصل الاجتماعي (Facebook، Instagram،...) ونقوم بمعالجتها في أقرب وقت ممكن.

3. المزيج التسويقي

- **المنتج:** يركز مشروعنا على جانبين هما إنتاج "جهاز التعقب والمراقبة الصحية "و تطوير "تطبيق الهاتف و الموقع الإلكتروني"

المؤشر	جهاز التعقب	تطبيق الهاتف و الويب
الخصائص	• تحديد الموقع الجغرافي وتتبع المسار و ارساله لمقدم الرعاية عبر SMS او تطبيق الهاتف • قياس معدل نبضات القلب • قياس نسبة الأكسجين في الدم • قياس درجة حرارة الجسم • ارسال رسائل نصية SMS الى الارقام المسجلة • ارسال الموقع و المعلومات الصحية عبر الانترنت لتطبيق الهاتف • لكل جهاز شريحة هاتف نستخدمها في حين انقطاع الانترنت	• التحكم في عدة مرضى بحساب واحد • التتبع في وجود الانترنت و بدونها (حيث يصل الموقع لتطبيق الهاتف و كرسالة SMS) • التتبع في الوقت الحقيقي لعدة مرضى معا • التنبيه لخروج المريض من المنزل او المحيط الجغرافي الآمن • اظهار مستوى دقات القلب و الاكسجين و درجة الحرارة • التنبؤ لحدوث نوبة توتر للطفل المتوحد • طلب المنتج من الموقع الالكتروني
التشكيلة و التصميم	• مريح و سهل • قابل للارتداء • قابل للتصغير و التكبير • متعدد الوظائف • لكل جهاز رمز خاص • لكل جهاز شريحة هاتف	• سهل الاستخدام و واضح • الوان مريحة للعين
العلامة WIN TRACKER Peace of Mind	• يتم طبع العلامة التجارية في جهازنا عند طبعه • يتم طبعها في علب التغليف	• تظهر العلامة التجارية في الواجهة الرئيسية لتطبيق الهاتف والموقع الإلكتروني

الإسم التجاري	WINO TRACKER	
التغليف	• يتم تغليف الجهاز بغلاف شفاف وغلقه ثم وضعه بعلبة كرتونية سميكة لحماية الجهاز من أي ضرر • يتم وضع: العلامة التجارية، رقم الهاتف، البريد الالكتروني، مواقع التواصل الاجتماعي، عنوان المقر و QR code تطبيق الهاتف ... في العلبة الكرتونية • يتم ارفاق الجهاز بكتاب التعليمات داخل العلبة	/
الضمان	• ضمان المؤسسة هو ان تصل المنتجات للزبون بسلامة	• ضمان حماية المعلومات الشخصية داخل التطبيق
خدمات ما بعد البيع	• صيانة الجهاز • كتاب تعليمات عن كيفية استخدام الجهاز	• تعليمات عن استخدام التطبيق

- **السعر:** بما أن المنتج موجود من قبل ومعروف لدى الزبائن عن طريق الإستيراد فإن هذا يعني وجود أسعار متداولة في السوق وعند الأخذ بعين الاعتبار الخدمات التي نوفرها والجديدة يمكن القول أن المؤسسة سوف تعتمد على استراتيجية القيمة الى جانب السيطرة على التكاليف والأخذ بعين الاعتبار المنافس.

سعر المنتج = (التكلفة المتغيرة للوحدة) + (نصيب الوحدة من التكاليف الثابتة) + (هامش الربح)

ومنه سوف تعتمد المؤسسة على سعر **6500** دج لتقدير رقم أعمالها

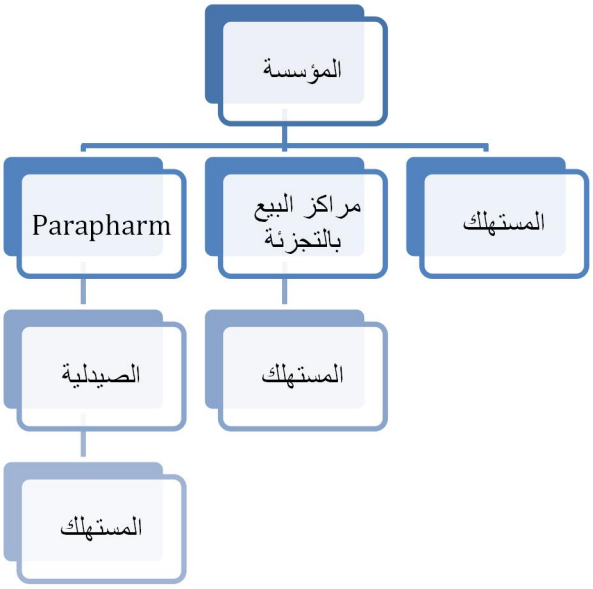
- **الترويج:** من أجل أن يصل المنتج لأكبر عدد ممكن من الشرائح المستهدفة يحتاج جهود ترويجية مكثفة من المؤسسة والتي ستكون عبر:

الوسيلة الترويجية	التفاصيل	العدد	التكلفة	المجموع
الإعلان عبر مواقع التواصل الاجتماعي	Facebook, Instagram, YouTube, ... نشر منشورات و فيديوهات في المجموعات التي تتواجد فيها الشريحة المستهدفة و إرسال إيما يلات لهم	/	مجاني	/
بطاقة العمل (الزيارة)	يتم تصميم بطاقة عمل و توزيعها على الأشخاص و المراكز المهتمين بالمنتج	500	10 دج	5000 دج
الترويج عبر موقعنا الإلكتروني	تسهيل عملية الطلب و معرفة التفاصيل	/	مجاني	/
المؤتمرات و الأحداث	الترويج و الإشهار عن المشروع في المؤتمرات و الأحداث المهمة و في الجمعيات المتعلقين	/	مجاني	/

	بالفئة المستهدفة			
	المجموع			5000 دج

- **التوزيع (قنوات التوزيع):**

غير مباشرة:



مباشرة: عن طريق الموقع الإلكتروني

← **وسائل النقل:** لا توفر الشركة خدمة النقل والتوصيل للعملاء حيث تقوم بعقد مع شركة توصيل.

← **نقاط البيع:** لا تملك الشركة نقاط بيع خاصة بها

4. تحليل العرض و الطلب

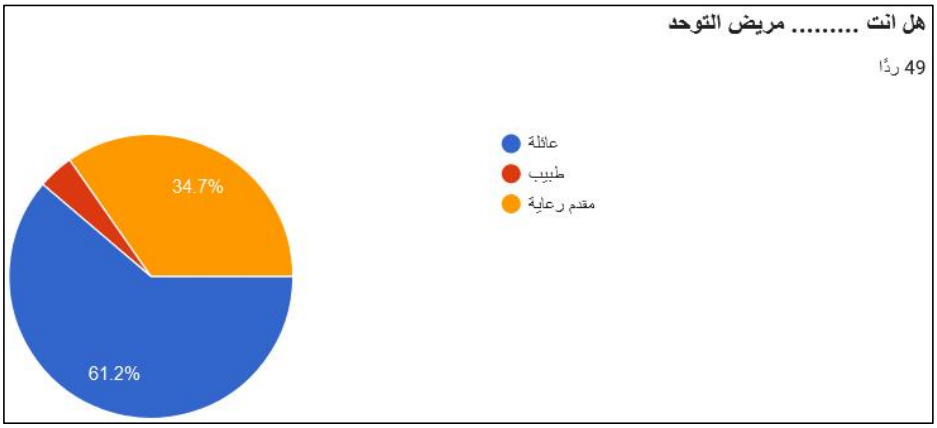
1. دراسة السوق على مستوى الطلب :

بعد تجزئة السوق و تحديد الزبائن المستهدفين الذين سنوجه لهم منتجنا و خدماتنا، تم اعداد إستبيان إلكتروني وزع عليهم، بحيث يتضمن مجموعة من الأسئلة التي تتعلق بتوصيف و تحليل الزبائن المستهدفين من حيث سلوك مريض التوحد و الصعوبات التي يواجهونها في الإعتناء و مراقبة هذه الفئة، حيث تساءلنا عن ضياعهم و صعوبة مراقبتهم، عن نوبات التوتر و القلق التي يتعرضون لها و عن جهاز رعاية و مراقبة مرضى

التوحد. هذا في الأخير من أجل تحديد الطلب على منتجنا و خدماتنا لإستكمال بقية الدراسة، حيث تم أخذ عينة تتكون من 49 فرد من طبيب، مقدمي رعاية و عائلات مرضى التوحد. كانت النتائج كما يلي:

1) العينة المأخوذة :

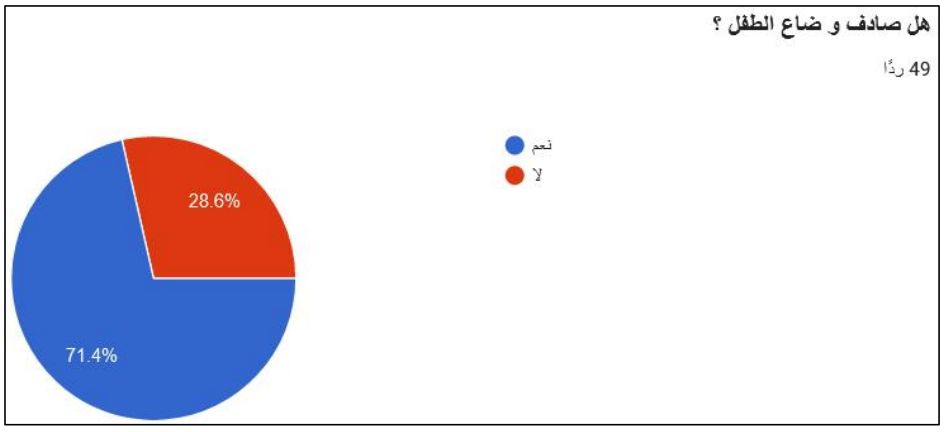
تم توزيع الإستبيان الإلكتروني في بسكرة على عائلات مرضى التوحد مقدمي الرعاية في مراكز التوحد – بسكرة و طبيب.



عائلة	طبيب	مقدم رعاية
30	2	17

2) تحليل نسبة ضياع مريض التوحد :

نلاحظ من خلال الشكل أن نسبة ضياع مرضى التوحد أكبر حيث ان 71.4 % صادف و ضاع لهم المريض أما 28.6 % لم تصادفهم حالو ضياع للمريض و هذا يبين أنه رغم الإهتمام الكبير بهذه الفئة إلا أن نسب ضياعهم كبيرة مما يعني أنهم بحاجة إلى مراقبة أكثر من قبل العائلة و مقدمي الرعاية.

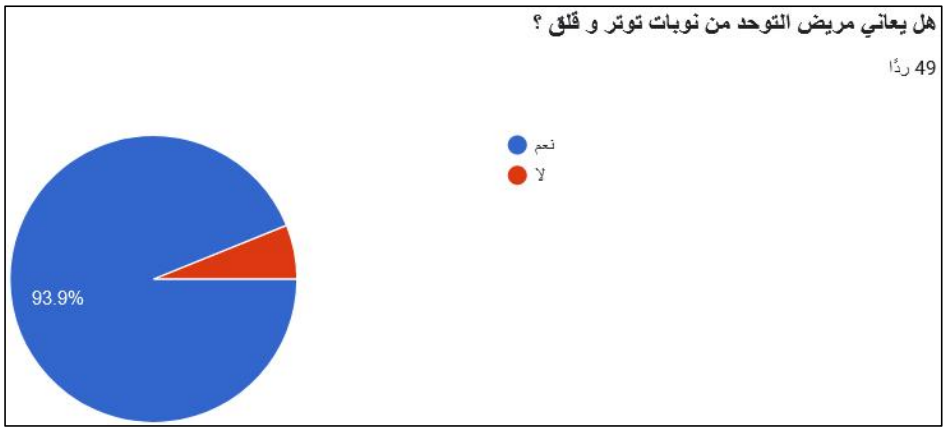


3) تحليل مدى صعوبة مراقبة مريض التوحد :

من خلال الشكل نلاحظ مدى صعوبة مراقبة الطفل المتوحد حيث أن 91.8 % من الأشخاص يجدون صعوبة كبيرة في مراقبة مرضى التوحد، و 8.2 % فقط من لا يجدون صعوبة أي أنها نسبة صغيرة جدا و يحتاج العديد من الأولياء إلى مساعدة و حل للتخفيف من التعب في مراقبة اطفالهم.

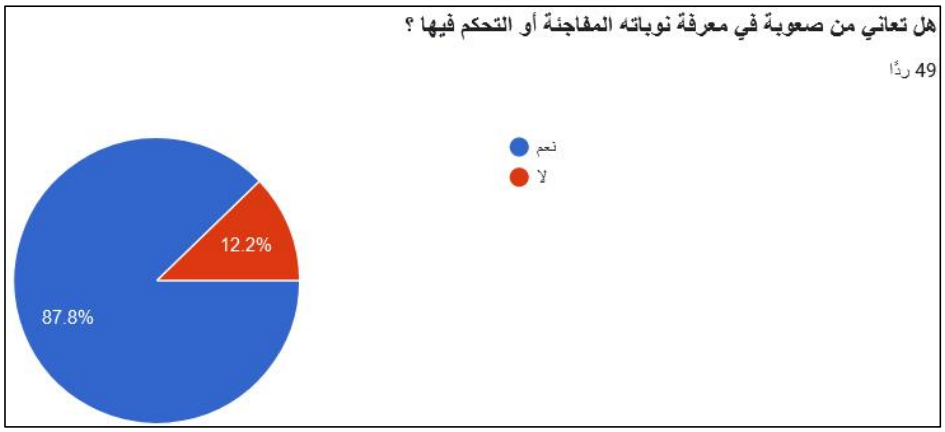
4) تحليل نوبات القلق و التوتر لمريض التوحد و مدى صعوبة التحكم بها:

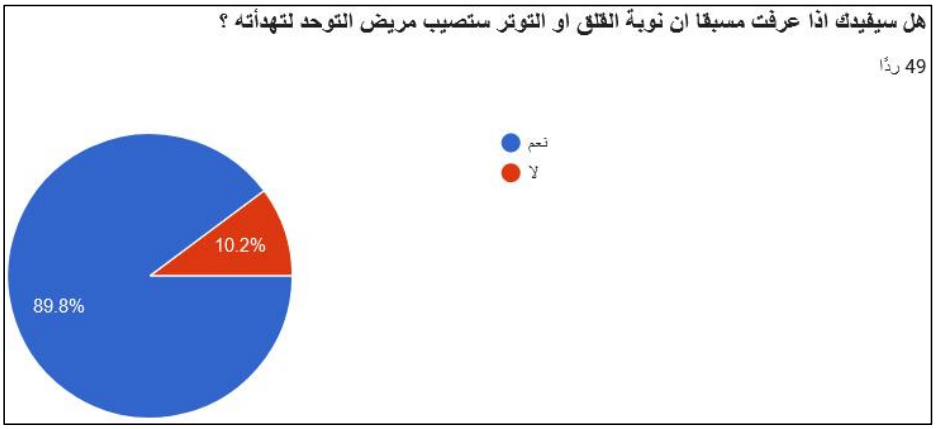
نلاحظ من خلال الشكل مدى انتشار نوبات التوتر بين أطفال التوحد حيث ان 93.9% من الاجابات نعم اي ان الطفل يعاني من نوبات التوتر و هذا يعد مشكل يؤثر عليه و على عائلته بشكل كبير، ما دعانا الى الاهتمام بوضع حلول لهذه النوبات.



5) تحليل أهمية معرفة النوبات قبل حدوثها :

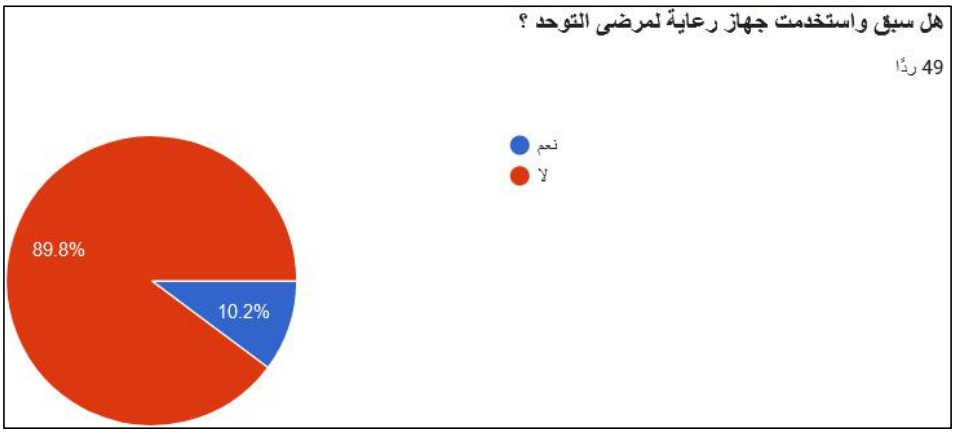
يوضح الشكلان او نتيجة الإستبيان صعوبة و اهمية معرفة نوبات التوتر لدى اطفال التوحد قبل حدوثها للتحكم بها و تهدئتها، حيث وصلت نسبة الافراد الذين يعانون من هذه النوبات لدى اطفالهم الى 87.8% ونسبة المهتمين بالتنبؤ بالنوبات الى 89.8%. وهذا ما جعلنا ندخل في مجال الذكاء الاصتناعي للتنبؤ بهذه النوبات لحماية المريض و مساعدة مقدم الرعاية.

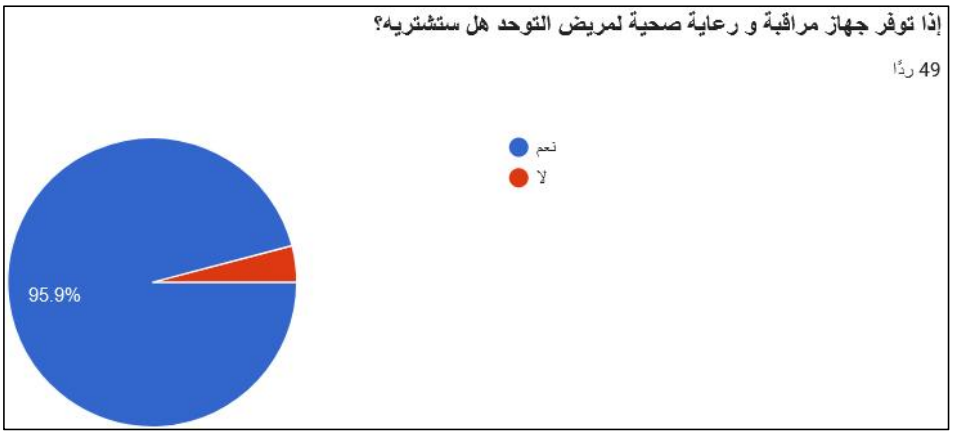




6) مدى تقبل و إحتياج الشريحة لجهاز التعقب و الرعاية الصحية :

ان نتائج الشكلين ادناه تدل ان تقبل الزبون لجهاز التعقب و الرعاية الصحية كبير جدا يصل الى نسبة 95.9% من الاجابات و هذا ما تم تأكيده حول المناقشة وجها لوجه مع بعض العائلات.





تقدير والتنبؤ بالطلب:

بالاعتماد على المعلومات المجمعة من الشريحة المستهدفة قدرنا الطلب على المنتج كما يلي:

1) تقدير حجم الطلب المتوقع لسنة 2024 (عدد الأجهزة)

الأشهر	حالة الذروة	الحالة العادية	حالة الركود
جانفي	12	10	8
فيفري	14	12	10
مارس	17	15	13
أفريل	19	17	14
ماي	18	16	13
جوان	17	15	12
جويليا	19	17	14
أوت	21	18	15
سبتمبر	22	20	16
أكتوبر	24	22	17
نوفمبر	20	18	14
ديسمبر	20	18	14
حجم الطلب فب السنة	223	198	160

2) تقدير حجم الطلب المتوقع لسنة 2024 (الثمن)

الأشهر	حالة الذروة (دج)	الحالة العادية (دج)	حالة الركود (دج)
جانفي	78000	65000	52000
فيفري	91000	78000	65000
مارس	110500	97500	84500
أفريل	123500	110500	91000

ماي	117000	104000	84500
جوان	110500	97500	78000
جويليا	123500	110500	91000
أوت	136500	117000	97500
سبتمبر	143000	130000	104000
أكتوبر	156000	143000	110500
نوفمبر	130000	117000	91000
ديسمبر	130000	117000	91000
حجم الطلب فب السنة	1449500	1287000	1040000

- من خلال الجداول التالية يتبين ان الطلب على جهاززنا (جهاز التعقب والرعاية الصحية) يرتفع خلال الأشهر الدراسية و أشهر العطل و السفر، حيث أن الأولياء يعملون و الأطفال يدرسون أو يذهبون الى مراكز الرعاية، فيحتاج الولي أو مقدم الرعاية أكثر الى جهاز المراقبة.

2. دراسة السوق على مستوى العرض (تحليل نوعي) :

بالنسبة لمشروع انتاج أجهزة التعقب و الرعاية صحية مع تطبيق هاتف لأطفال التوحد فلا يوجد اي عرض محلي للمنتج وبالتالي فان العرض الحالي يقدر ب 0 تبقى فقط كون المنتج المشابه لمنتجنا موجود في السوق الوطنية عن طريق الإستراد إلا أنه لا يتوفر بشكل مستمر.

3. الفجوة التسويقية :

الفجوة التسويقية = الطلب - العرض

من أجل تقريب الفجوة التسويقية للواقع الإقتصادي أكثر سيتم الأخذ في عين الإعتبار المنتج الشبيه لمنتجنا المستورد بنسبة 1% من الطلب في السوق أي بثمن 12870 دج

الفجوة التسويقية للمشروع = 1287000 – 12870 = 1274130 (دج)

5. تقدير حجم المبيعات

يمكن تقدير الطاقة الإنتاجية للمنتج بحوالي 20 وحدة في الشهر و نظرا لكون السوق الوطنية هي سوق واعدة ولا يوجد أي عرض مباشر للمنتج، فإن المؤسسة لديها المساحة الواسعة لتلبية احتياجات الزبائن. من خلال تحليل العرض و الطلب و تحليل الفجوة التسويقية لمشروعنا فيمكننا بطاقتنا الإنتاجية تغطية الفجوة التسويقية و تلبية احتياجات الزبائن.

المحور الرابع: خطة الإنتاج والتنظيم

أولا-خطة الإنتاج:

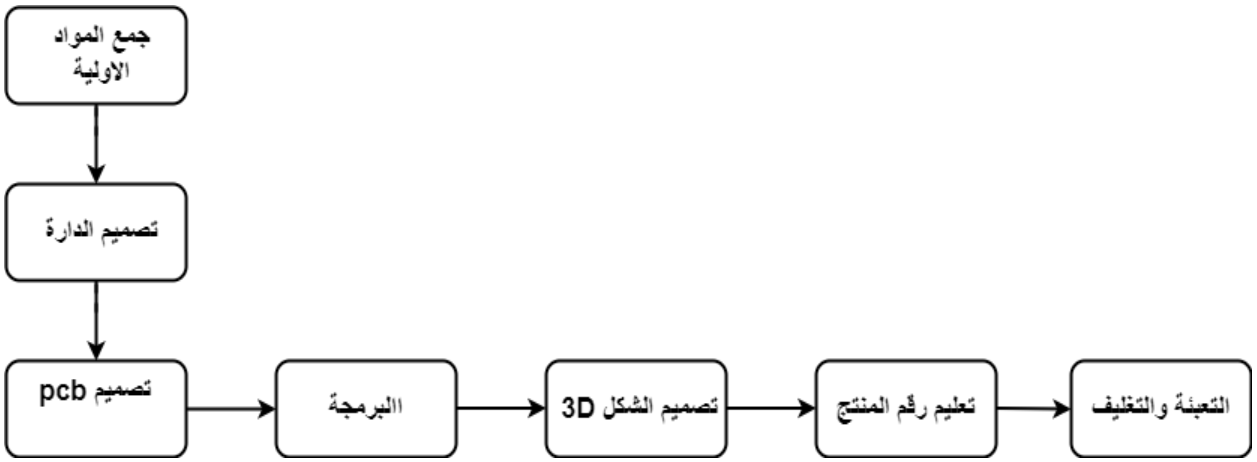
يمثل المخطط الإنتاجي الأخذ بعين الاعتبار الطلب المستقبلي على سلعة معينة، وعلى هذا الأساس يتم تعبئة الطاقات الإنتاجية اللازمة لمواجهة الطلب، إن هذا النشاط يتطلب التوقع بالمبيعات المستقبلية، وترجمة هذا التوقع في مختلف المتطلبات الإنتاجية والعمل للحصول على هذه المتطلبات، وتتمثل خطوات اعداد المخطط الإنتاجي فيما يلي:

المطلب الأول: موقع المشروع

عمليات بيع المنتج ستتم عبر الانترنت، ومنه تم تحديد موقع المشروع بمساحة تقدر بـ 50 متر مربع تقريبًا، وهي رقعة جغرافية ملك تستخدم كمكتب صغير لإدارة وتنظيم العمليات الداخلية للمشروع. حيث ان من فوائد تحديد موقع المشروع بمساحة صغيرة:

- ✓ **تكاليف منخفضة:** يكون تأجير أو شراء مساحة صغيرة أرخص بكثير من المساحات الكبيرة، مما يساعد في خفض التكاليف العامة للمشروع..
- ✓ **إدارة سهلة:** تحديد مساحة صغيرة يجعل إدارة العمليات الداخلية أكثر سهولة وفعالية، حيث يمكن التحكم بالعمليات بشكل مباشر وسريع.
- ✓ **مرونة وتكيف:** في حالة نمو المشروع، يمكن بسهولة توسيع أو تغيير المساحة بناءً على احتياجات العمل والطلب.

المطلب الثاني: طبيعة الإنتاج



المطلب الثالث: الطاقة الإنتاجية

يتأثر مستوى الطاقة الإنتاجية بعدة عوامل، وفقًا للمعلومات المذكورة:

1. **المعدات والتجهيزات:** يتطلب توفير المعدات والتجهيزات اللازمة لعملية الإنتاج ثلاثة أيام بعد طلبها. هذا يعني أنه يجب توفير المعدات والتجهيزات اللازمة قبل أن يتمكن المشروع من البدء في عملية الإنتاج.
2. **تخطيط الإنتاج:** يستغرق تصميم وتغليف المنتج يومان على الأقل. بينما يستغرق عملية التجميع والبرمجة وقتًا قليلاً.

بناءً على المعلومات المذكورة، يمكن تقدير الطاقة الإنتاجية للمنتج بحوالي 20 وحدة في الشهر. وهذا يعني أنه يمكن إنتاج حوالي 20 وحدة من المنتج في كل شهر، مع ذلك، يجب أن تأخذ في الاعتبار أن الطاقة الإنتاجية المحددة قد تختلف وفقًا للعديد من العوامل الأخرى مثل الطلب السوقي.

المطلب الرابع: احتياجات الإنتاج (المشروع)

1- المواد الأولية

المواد الأولية	الوحدة	تكلفة الوحدة	التكلفة الكلية	الفترة الزمنية بين طلبها و الحصول عليها
ESP32	1	600	**600**	ثلاثة ايام
GPS Neo-6M	1	**700**	**700**	ثلاثة ايام
SIM800L	1	1100	**1100**	ثلاثة ايام
MAX30102	1	**150**	**150**	ثلاثة ايام
LM35	1	**120**	**120**	ثلاثة ايام
C.F.F	10	**10**	**100**	ثلاثة ايام
C.F.M	10	**10**	**100**	ثلاثة ايام
بطارية	1	**500**	**500**	نفس اليوم
مقاومات	2	**10**	**20**	نفس اليوم
USB 2.0/3.0	1	**900**	**900**	نفس اليوم
TP4056 Chargeur	1	**400**	**400**	نفس اليوم

GPIO Pin Male	1	70	70	نفس اليوم
			المجموع	4760

2- الآلات والمعدات اللازمة لتنفيذ المشروع

الآلات و المعدات	الوحدة	تكلفة الوحدة (دج)	التكلفة الكلية (دج)
طابعة3D	1	5 3200	5 3200
حلقات البلاستيك	2	4900	9800
أداة التلحيم	1	2000	2000
Breadboard	1	500	500
		المجموع	65500

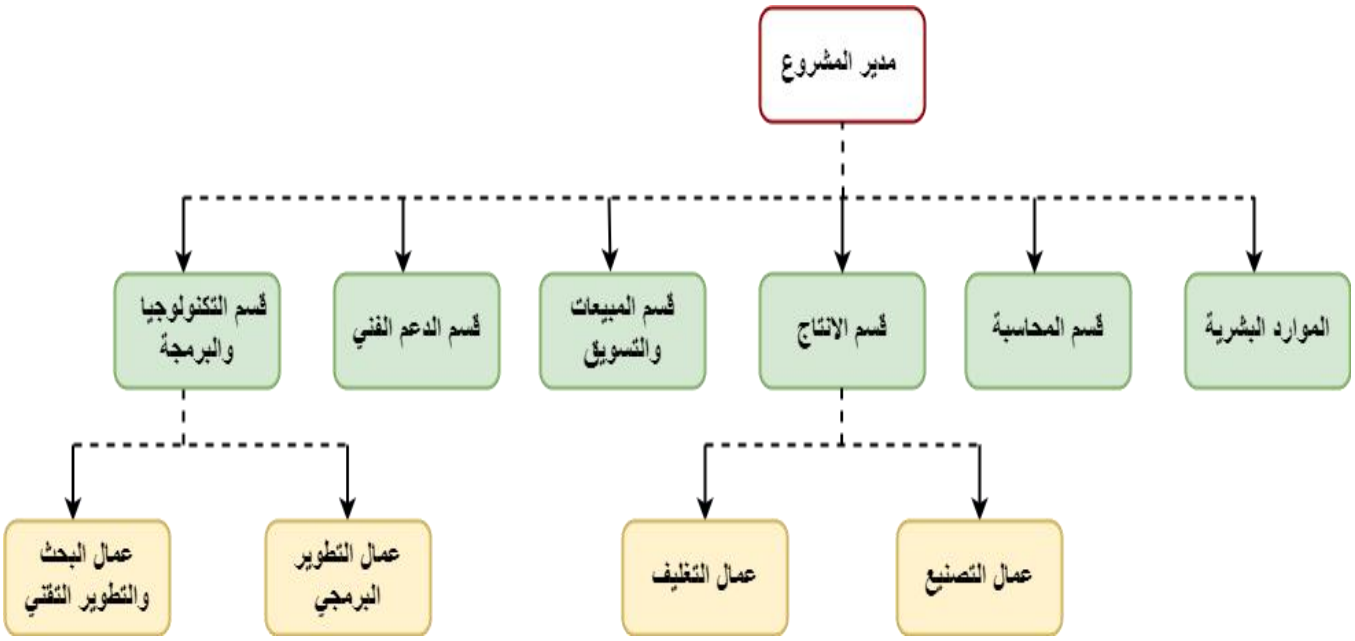
3- الموارد البشرية اللازمة لتنفيذ المشروع

العمال	الوحدة	تكلفة الوحدة	التكلفة الكلية
مهندس إلكترونيات	1	15000	15000
مطور تطبيقات	1	25000	25000
مطور واب	1	20000	20000

4- الأثاث ووسائل النقل

الأثاث و المعدات	الوحدة	تكلفة الوحدة	التكلفة الكلية
مكتب	3	12 000	36 000
طابعة ورق	2	24 900	49 800
طابعة وصل	1	3500	3500
كراسي	3	2000	6000
وسائل النقل السلع	1	1000	1000
		المجموع	95300

ثانيا-المخطط التنظيمي:



المحور الخامس: الخطة المالية (PLAN FINANCIER)

أولا- تكاليف المشروع واهتلاك الاستثمار

تكاليف المشروع: تتمثل التكاليف الاجمالية للمشروع في التكاليف الاستثمارية والتكاليف التشغيلية:

التكاليف الاستثمارية:

الأصول	التكلفة (دج)
المباني	00
الآلات والمعدات	65500
الأثاث	**95300**
رأس المال العامل	18260
المجموع	**179060**

التكاليف التشغيلية:

الأصول	التكلفة (دج)
مواد أولية	**4760**
الإيجار	00
الهاتف والانترنت	2000
الكهرباء والماء	4500
الترويج	5000
التعبئة و التغليف	2000
المجموع	**18260**

1- **الهيكل التمويلي:** يتم تمويل المشروع بعدة طرق إما بالاعتماد الكلي على الأموال الخاصة لصاحب المشروع وهذا ما يسمى بالتمويل الذاتي، أو الاستعانة بأحد المؤسسات المالية وذلك عن طريق التمويل

الثنائي او الثلاثي، أما بالنسبة لمشروعنا (جهاز تعقب و رعاية صحية) سيكون بالتمويل كما هو موضح في الجدول التالي:

البيان	النسبة (%)	القيمة (دج)
أموال خاصة	20%	**35812**
القروض	80%	**143248**
المجموع	100%	**179060**

	PREVISION
Produit A destiné Client	**N**
Quantité produit A	**198**
Ventes produit A	**6500 DA**
CHIFFRE D'AFFAIRES GLOBAL	**1287000 DA**

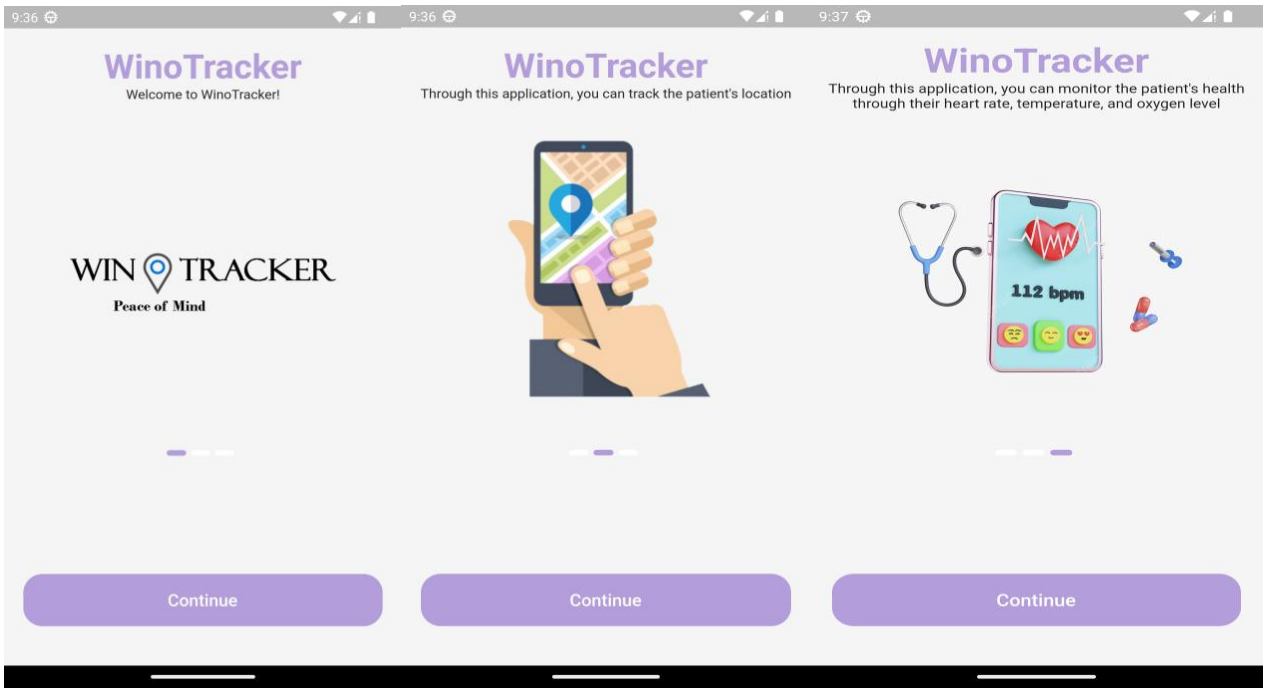
المحور السادس: النموذج الاولي التجريبي

1- السوار الذكي

نموذج اولي لسوار الذكي ي مزود بمستشعرات متعددة. يحتوي السوار على مستشعر لتحديد المواقع العالمية GPS، ومستشعر لقياس دقات القلب ودرجة الحرارة، وكذلك مستشعر لقياس نسبة الأكسجين في الدم .تعمل هذه المستشعرات على تجميع البيانات الحيوية الهامة وإرسالها إلى التطبيق المخصص الذي تم تطويره لمقدم الرعاية. يتيح التطبيق لمقدم الرعاية الوصول إلى هذه البيانات ومراقبتها بشكل فوري.

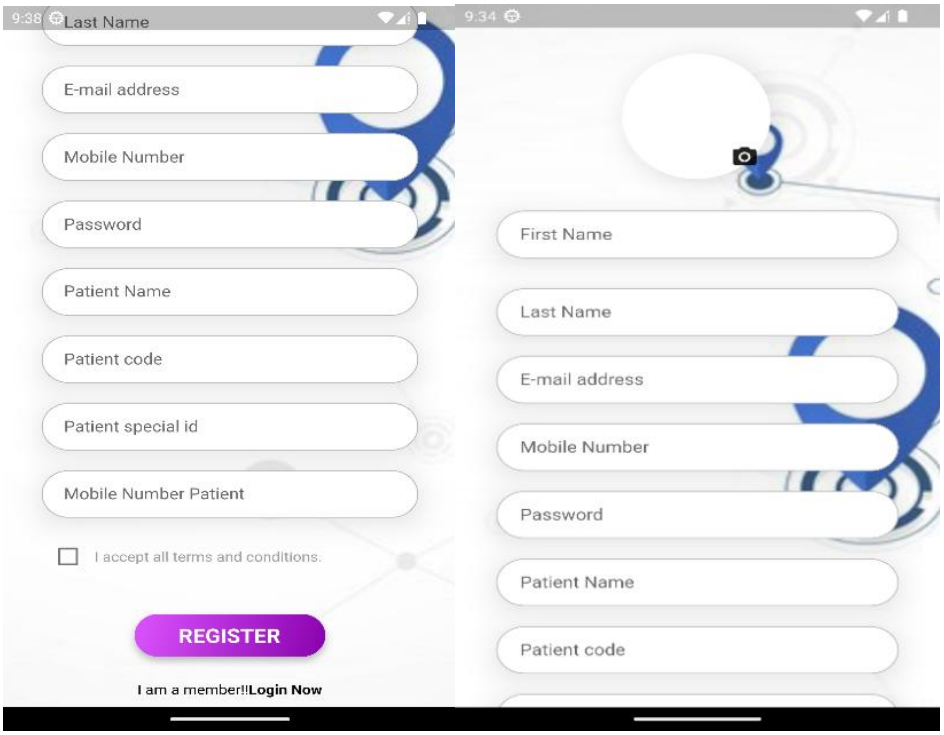
2- تطبيق الهاتف المحمول

الواجهة الأولى: توفر هذه الواجهة نبذة موجزة حول تطبيق الهاتف.



واجهة تسجيل حساب:

من خلال هذه الواجهة، يمكن لمقدم الرعاية إنشاء حساب جديد بسهولة. يتطلب إكمال عملية التسجيل إدخال معلومات شخصية لمقدم الرعاية، بما في ذلك الاسم، والبريد الإلكتروني، وكلمة المرور. بعد ذلك، يجب على مقدم الرعاية إدخال معلومات المريض المرتبط به، مثل اسم المريض. عندما يقوم مقدم الرعاية بشراء السوار الذكي المتوافق مع التطبيق، سيتم تخصيص رقم فريد لهذا السوار ويتم تعيين رمز (كود) خاص به. ستتم مشاركة هذه المعلومات مع مقدم الرعاية ليتمكن من ربط السوار بالمريض المعني. يتيح هذا الربط إرسال البيانات والإشعارات المتعلقة بالصحة من السوار إلى تطبيق الهاتف المرتبط بحساب المقدم لتوفير الرعاية اللازمة للمريض.



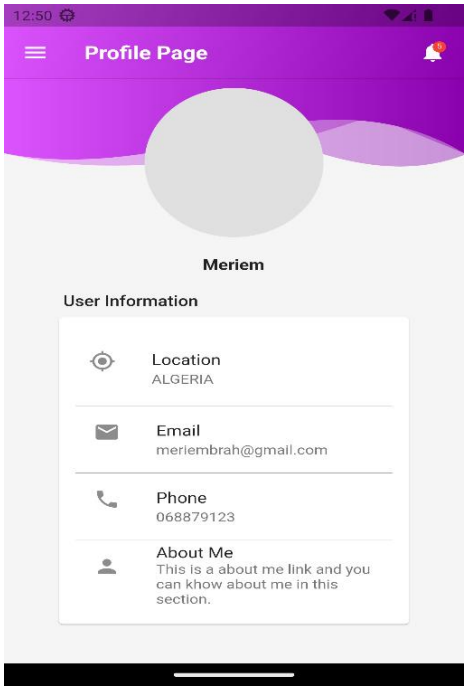
واجهة تسجيل الدخول:

بعد إكمال عملية تسجيل الحساب بنجاح، يمكن للمقدم الرعاية استخدام واجهة تسجيل الدخول للوصول إلى حسابه. يجب عليه إدخال معلومات اعتماد الدخول التي قام بإنشائها أثناء التسجيل، وتشمل ذلك عنوان البريد الإلكتروني وكلمة المرور المرتبطة بالحساب.

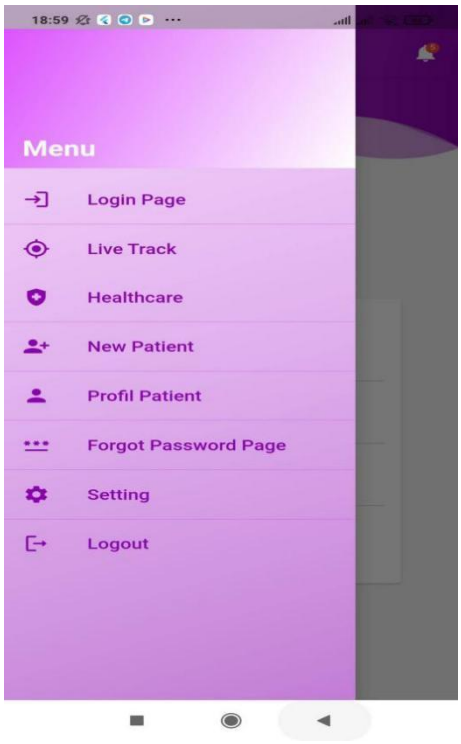
بعد إدخال المعلومات الصحيحة والنقر على زر "تسجيل الدخول"، ستتم مطابقة المعلومات المدخلة مع البيانات المسجلة في قاعدة البيانات. إذا تم التحقق بنجاح، سيتم توجيه المقدم الرعاية إلى واجهة الصفحة الرئيسية. في حالة عدم تطابق المعلومات أو إدخال معلومات غير صحيحة، سيتم عرض رسالة خطأ تطلب من المستخدم إعادة إدخال المعلومات الصحيحة.

الواجهة الرئيسية:

توفر الواجهة الرئيسية صفحة ملخصة لمقدم الرعاية، حيث يتم عرض حساب تعريفي له. تهدف هذه الواجهة إلى توفير معلومات أساسية وملخصة عن المقدم الرعاية بالإضافة إلى ذلك، تتضمن الواجهة الرئيسية زر للانتقال إلى الخدمات الأخرى.



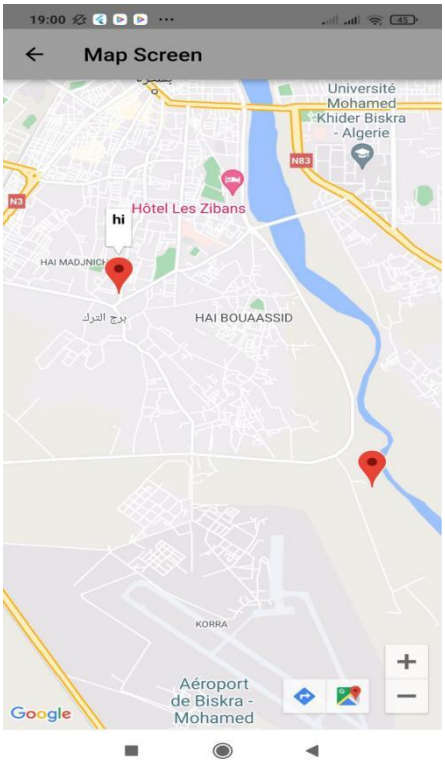
واجهة الخدمات: هنا يتم عرض الخدمات المتاحة لمقدم الرعاية.



واجهة التعقب(live track) :

توفر واجهة التعقب (Live Track) خريطة تفاعلية على موقع التطبيق لمقدم الرعاية، تسمح له بتتبع موقع مرضى التوحد المرتبطين به. يتم عرض جميع المرضى المرتبطين بمقدم الرعاية على الخريطة، مما يتيح للمقدم الرعاية الحصول على نظرة شاملة عن مواقعهم الحالية.

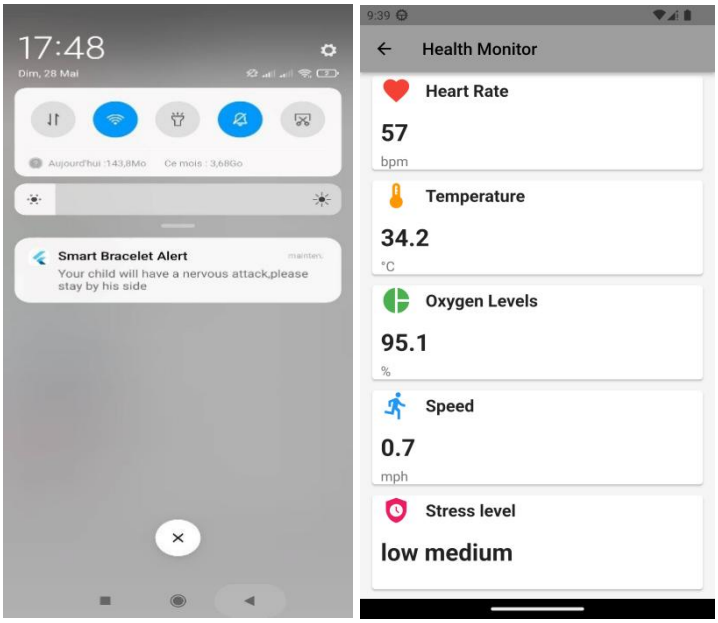
يتيح لمقدم الرعاية مشاهدة مواقع المرضى بشكل مباشر وفي الوقت الحقيقي، مما يساعده على مراقبة وتتبع حركتهم ومكانهم. قد يكون ذلك مفيدًا في حالات الطوارئ أو لتحديد موقع المريض في حالة ضياعه أو تعرضه لموقف خطر.



واجهة الرعاية الصحية (Healthcare) :

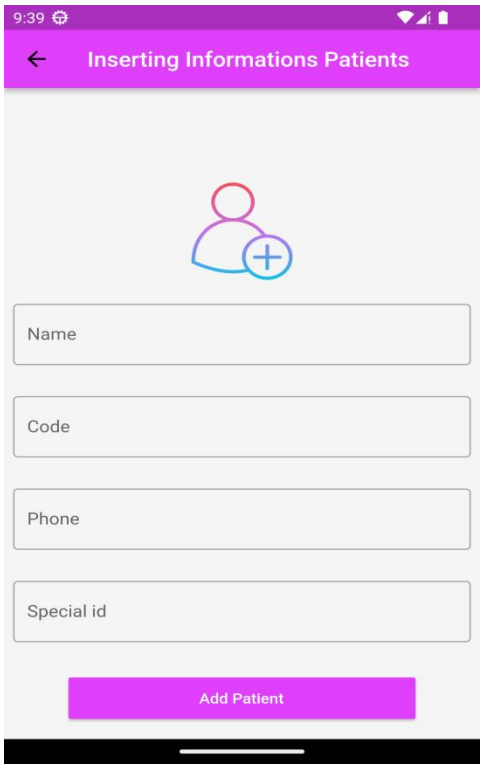
توفر هذه الواجهة لمقدم الرعاية معلومات مهمة حول حالة صحة المريض التوحد المرتبط به. يتم عرض مقاييس مهمة مثل درجة الحرارة، نسبة الأكسجين في الدم، دقات القلب، والسرعة. يتم قياس هذه المعلومات باستخدام أجهزة الاستشعار المتوافقة مع التطبيق.

بفضل تجميع البيانات الصحية من المريض، يمكن للذكاء الاصطناعي المدمج في التطبيق تحليل البيانات وتقديم تقديرات لنسبة التوتر والقلق للمريض. يعتمد هذا التحليل على نماذج سابقة وتجارب سابقة لتوقع النوبات المحتملة للتوتر. عندما يتم الكشف عن زيادة في مستويات التوتر وفقًا للتنبؤات، يتم إصدار تنبيهات لمقدم الرعاية لاتخاذ تدابير سريعة ومناسبة لمساعدة المريض.



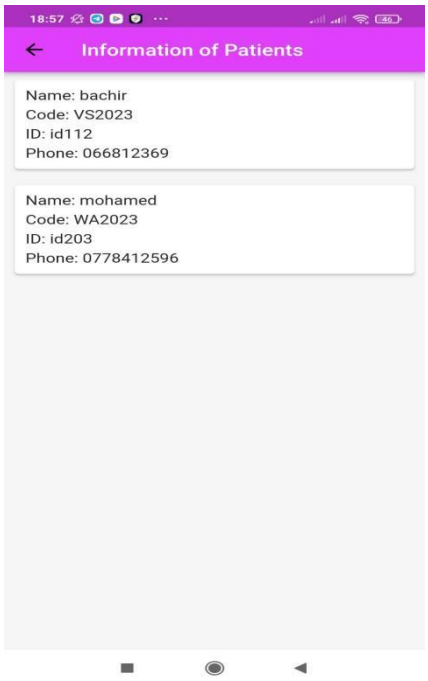
واجهة (New Patient):

تسمح هذه الصفحة لمقدم الرعاية بإضافة مريض جديد إلى قائمة المرضى المرتبطين به. يتم توفير واجهة سهلة الاستخدام تتيح لمقدم الرعاية إدخال معلومات المريض الجديد وتفاصيله الشخصية. بعد إدخال معلومات المريض الجديد وتأكيد الإضافة، ستتم إضافة مريض جديد إلى قائمة المرضى المرتبطين بمقدم الرعاية.



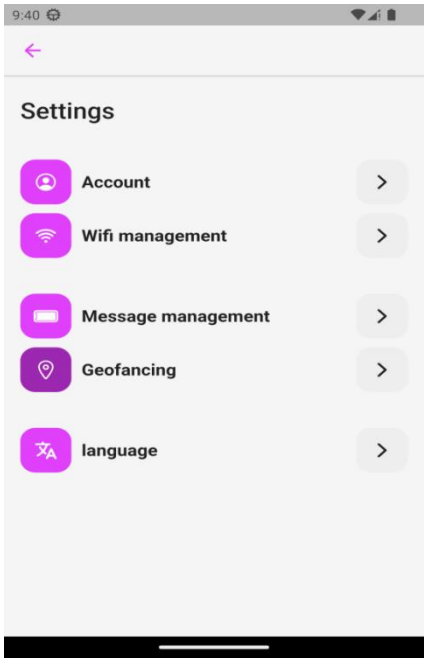
واجهة (Profile Patient):

توفر هذه الواجهة لمقدمي الرعاية عرضًا شاملاً لقائمة جميع المرضى الذين يتم رعايتهم ومتابعتهم. تتيح لمقدم الرعاية الوصول السريع إلى معلومات المرضى وتفاصيلهم من خلال قائمة سهلة القراءة والاستخدام.



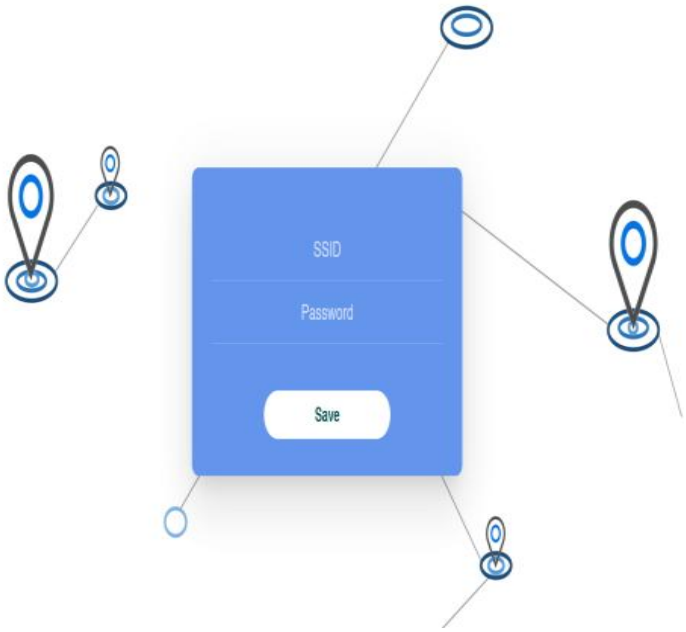
واجهة الاعدادات (Setting):

توفر هذه الواجهة لمقدم الرعاية إمكانية إجراء التعديلات اللازمة وإدارة الإعدادات المختلفة في التطبيق. تتيح له الوصول إلى مجموعة متنوعة من الخيارات والإعدادات.



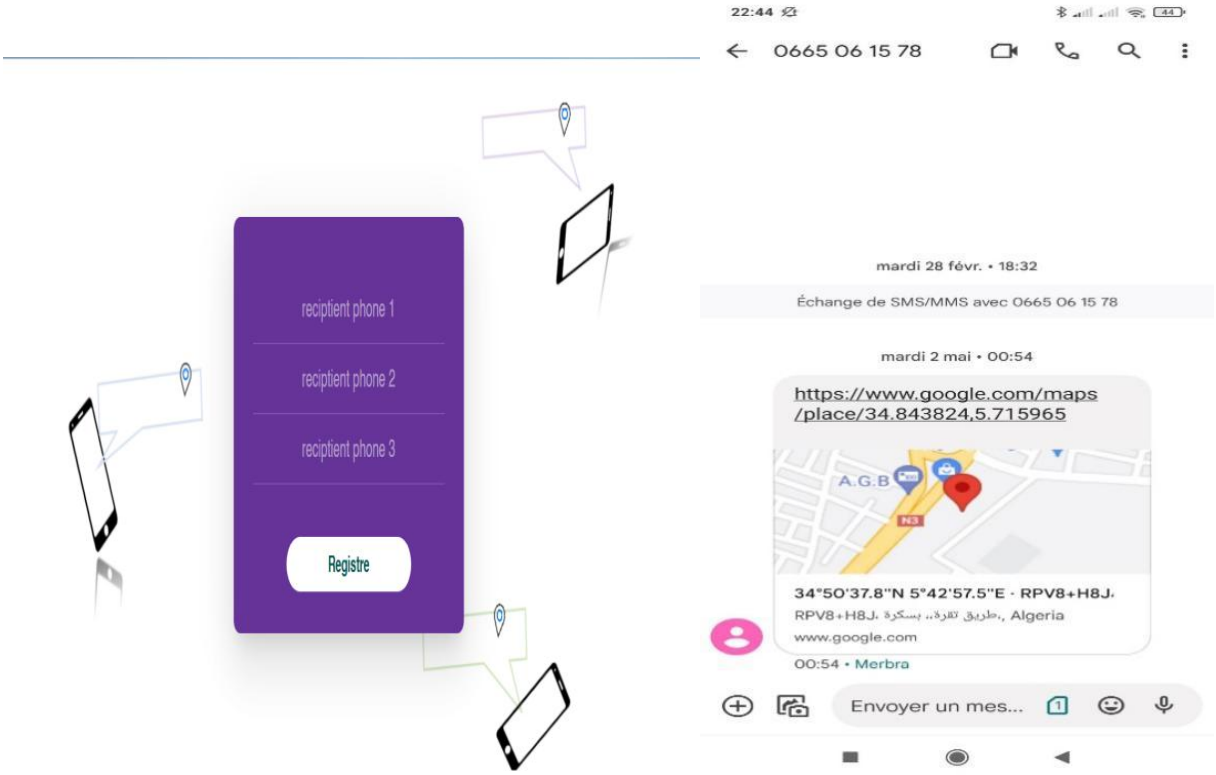
واجهة (Wifi Management):

تسمح هذه الواجهة لمقدمي الرعاية بتغيير إعداد WiFi لسوار ذكي. من خلال الوصول إلى هذه الواجهة ، يمكن لمقدمي الرعاية تعديل شبكة WiFi التي يتصل بها السوار الذكي و ذلك لبعث البيانات من السوار الى التطبيق.



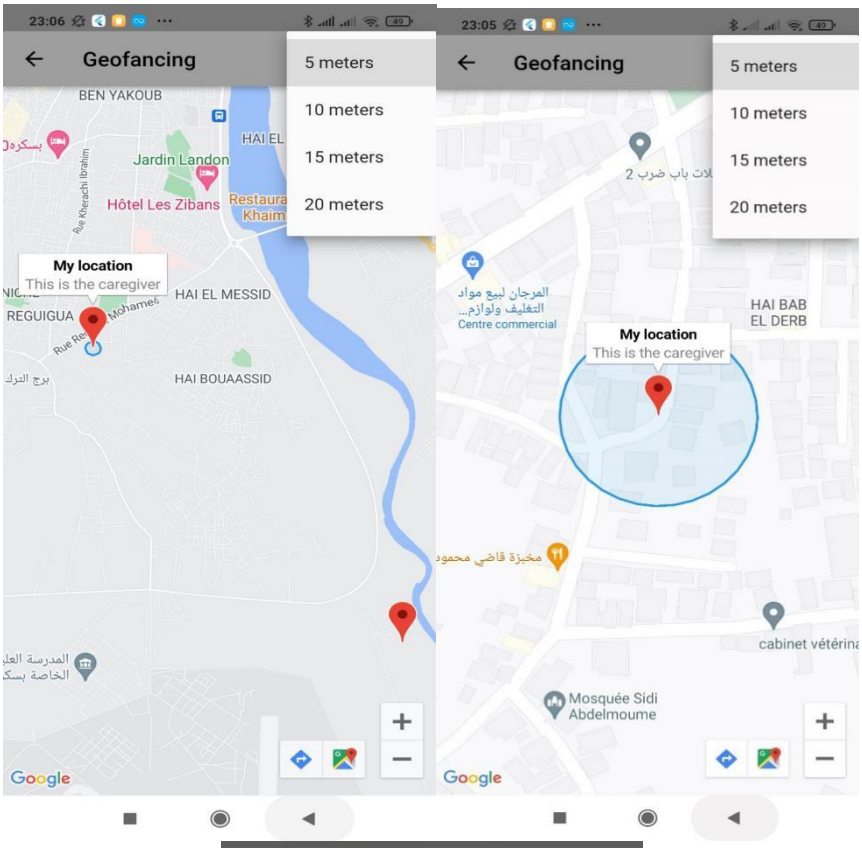
واجهة (Message Management):

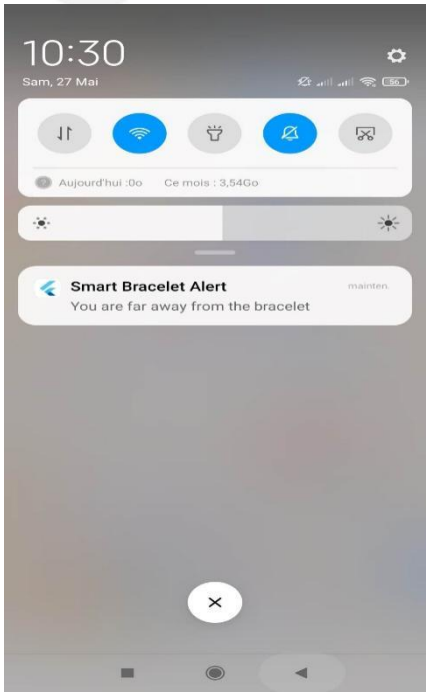
تتيح هذه الواجهة لمقدمي الرعاية إدخال ثلاثة أرقام هواتف لتلقي رابط لموقع المرضى. يتم توفير هذه الواجهة لضمان التواصل الفعال والسريع مع مقدمي الرعاية في حالة عدم الاتصال بالأنترنت.



واجهة (Geofancing):

تقدم هذه الواجهة عرضًا للخريطة، وقد تعرض الخريطة الموقع الحالي لمقدم الرعاية وموقع المريض، يمكن لمقدمي الرعاية اختيار المسافة المطلوبة من قائمة متاحة، مثل مسافة 10 كيلومتر، 5 كيلومترات. باستخدام نظام التنبيهات، سيتلقى مقدمو الرعاية إشعارًا عندما يتجاوز المريض المسافة المحددة ولتنبيه المقدمين بأن المريض قد ابتعد عن المنطقة المحددة وقد يكون بحاجة إلى متابعة إضافية.





نموذج العمل التجاري

BMC

الجمهور المستهدف	العلاقة بالعملاء	القيمة المضافة	الأنشطة الرئيسية	الشركاء الرئيسيون
المستهدف: • مريض التوحد • الأطفال **الزبون (العميل):** • مراكز مرضى التوحد • مركز بيع المعدات الشبه صيدلية parapharm • المدارس الخاصة • العائلات (ذات مرضى التوحد و الاطفال)	• موقع الكتروني (علاقة غير مباشرة) • المحتوى المساعد (آراء الزبائن عن التطبيق "google app") • المجتمعات (صفحات فيسبوك، انستغرام...) • الخدمة الآلية (تعاريف و ارشادات داخل التطبيق) **قنوات التواصل** • قنوات التواصل الإجتماعي (صفحات فيسبوك، انستغرام...) • مقابلة شخصية (مع مراكز مرضى التوحد، المدارس الخاصة، مركز بيع المعدات الشبه صيدلية) • حضور ملتقيات مرضى التوحد • الموقع الإلكتروني • شركات التوصيل	• صناعة جهاز ذكي للتعقب و الرعاية الصحية (صنع جزائري) • تقديم أمان عالي للمستهلك • عرض الحالة الصحية و الموقع للفئة المستهدفة في الوقت الفعلي • تقليل الوقت و الجهد لمقدم الرعاية (افراد الاسرة، مرافقي مرضى التوحد، ادارة المدارس الخاصة) • التنبؤ و التنبيه بنوبات القلق و التوتر للتدخل و تهدئة المتوحد	• التجميع (تجميع القطع الإلكترونية) • تطوير تطبيق الهاتف و الموقع الإلكتروني • البيع و التسويق **الموارد الرئيسية** **مادية:** • القطع الالكترونية (أسلاك, بطارية ,GPS , Max30102, ESP32 SIM800L, LM35,...) • طابعة 3D **بشرية:** • مصمم برامج و مطور تطبيقات • مهندس إلكتروني **فكرية:** • ملكية فكرية (براءة إختراع)	• شركات بيع القطع الإلكترونية • شركة التوصيل • شركة mobilis • جمعية اليد في اليد

مصادر الإرادات	هيكل التكاليف
• خدمة Fremium (التسجيل في التطبيق و المنصة مجانا) • بيع الجهاز • رسوم استخدام رعاية صحية خاصة • الاعلانات عبر التطبيق	• المواد الأولية (القطع الإلكترونية) • عقود شركات التوصيل و mobilis • أجور العمال • براءة إختراع • إستضافة الموقع