Child Accident Prevention Bracelet

Paulo Jorge Nascimento Rosário IST88123

***Abstract*— Information and communication technologies play an important role in the way we communicate and live in society, with the development and improvement of telecommunication technology structures and equipment, which have become more reliable, more accessible and with lower costs for the consumer, have made is an essential tool in our day-to-day life.**

Wireless technologies provide users with the ability to communicate without being fixed to a location, mobility, and the low cost of mobile communications equipment, making these services accessible to all users who have quickly popularized them.

Personal mobile telecommunications equipment and its entire structure including the network services provided by the operators, which we define as the set of technological resources that, used in an integrated way, provide the possibility through radio waves, to communicate by voice, to share images, videos and data in real time, and control other devices.

For the dissertation, a prototype of a child protection system with the capacity to create a low-cost, low-power wireless radio network generated by hardware devices was developed, which automatically communicates with each other without the need to create a physical infrastructure of network.

The system consists of Smartphones or tablets, which will communicate with the [PPAI] bracelet, a mobile application to interpret / analyze the received data [APP-PPAI] and a Web server application [WEB-PPAI], the developed prototype implements a monitoring network for the prevention of children's accidents through bluetooth communication devices a parent can create safety zones for their child, activate an automatic search system with security entities and the interaction of other parents registered in the system.

The great advantages in the system are the speed in search and rescue in case of accident, security, privacy, the PAI was thought and designed as a system dedicated to the safety and protection of the child, in the scope of privacy, there is no personal data, and the existing data are not available in CLOUD, although it is a system dedicated to the protection and safety of the child, the data is non-existent.

***Index Terms*— Child safety, beach safety, beach accidents, privacy of data, monitoring equipment.**

I. Introduction

The Portuguese coast is bathed by the Atlantic Ocean over 850 km, the climate is warm with coastal bathing waters and interiors qualified as beaches of sea and river baths [1], which invite families to join in and enjoy cozy moments of leisure offered during the bathing season, seasonal period that extends from June to September.

Children in this period are more exposed and vulnerable to existing dangers, the environment they are in, new places or annual visits that are different from everyday life, in many cases children lose or disappear, we will consider this the fact that a voluntary act does not appear as an accident or an act committed by a third party for a particular purpose and which in most cases calls into question the physical integrity of the child.

There are initiatives by public entities, such as the Public Security Police (PSP) "Programa Estou Aqui!" Program, which has been used by 163,000 children in the last 5 years, designed to increase parents' chances of reuniting with their parents. positioning itself as an effective and expeditious solution in case of disappearance, is constituted by a cloth bracelet, a unique alphanumeric code, personal and non-transferable and the emergency number 112.

For the dissertation a prototype was developed, which implements a monitoring network for the prevention of children's accidents, the system through radio wave communication devices with the ability to transmit, receive and interpret data locally in real time and show the results obtained to its user.

The communication network that is generated by the various hardware devices is classified as WPAN, which is used to exchange information between the various wireless devices, and requires very low energy consumption and has as a priority area to minimize the consequences of accidents children.

II. Problem

There are in the market a set of solutions for locating people, animals and objects, which are based on GPS / GSM / GPRS technologies.

These systems are supported by internet networks, which raises some apprehension in the protection of privacy that must be increased with regard to the best interest of the child.

One of the characteristics of the Internet as an open means of communication is to be accessible in any part of the world and by anyone, all the information that is placed in websites, database and other repositories, however safe it may be, there is always the possibility of being accessed, copied, altered and reproduced.

"If data relating to any natural person deserve legal protection, guaranteed at the constitutional level, it must be especially strengthened when it concerns children and young people.

The essential legal principle here is that of the best interests

Lisbon 31 may 2019

Paulo Rosário, Student of the Electrical Engineering in Instituto Superior Técnico.

of the child, enshrined in the UN Convention on the Rights of the Child (Article 3), Convention 192 of the Council of Europe3 (Article 6) and Charter of Fundamental Rights of the European Union (Article 24 (2)). "[12].

These systems have aroused the curiosity of many users, knowing where their child is, which way they usually go from home to school.

Localization devices have found some barriers, and the privacy of the children that has aroused more discussion, the economist António Osório of the institute of studies of the child, affirms that "it is the feeling of guilt that these technologies can create in the parents" [7].

In England, the Guardian newspaper highlighted the invention of the first GPS-enabled children's jacket, which cost £ 250 plus £ 10 per month for the use of GPS technology (October 2007). Professor Kevin Warwick of Reading University in 2009 created a microchip to be implanted in the body of a child, which provoked very negative reactions by psychologist Michele Elliott, founder and director of Kidscape, foundation for the protection of the child.

In Portugal, the coordinator of the SOS Children's Missing Line, Alexandra Simões, said that localization devices "may give parents a false sense of security and jeopardize the process of transition from minors to adulthood", it is necessary to protect the child, but protection with restrictions of freedom can be detrimental [7].

The systems presented do not have a specific objective, they can be used for various purposes, being the most common the location of a child and the accompaniment of a route, use GPS, 3G technologies and save personal and geographic data in CLOUD.

A. Child safety at beaches

In the scope of security, support, surveillance and assistance to bathers, ISN, the Competent Authorities, Life Guard, Concessionaires and Entities responsible for public swimming pools are included.

The spaces for bathers are provided by safety devices fitted with Life Guard, which in an integrated manner and in coordination with complementary means of rescue in the context of assistance to Life Guard ensure the necessary vigilance and rescue. [11].

B. Products for location

The monitoring systems aim to identify the position of a fixed or mobile target (persons or objects) in a coordinate grid, at this point a presentation is made of the monitoring systems on the market, and the technology used.

The GPS system offers several types of services, in this study we will use only the location services that determine the distance between the equipment of the receiver and the satellites. By calculating the distance separating the receiver equipment from three satellites it is possible to determine the relative position through the intersection of circles whose radii are the measured distances between the receiver and the satellites [19].

It was developed in the 1970s by the United States Department of Defense, initially for military purposes and later for civilian purposes.

Consisting of 32 GPS satellites, distributed in 6 orbital planes, positioned between 2,000 and 22,000 km of altitude.

The orbital period is 11 hours and 58 minutes, satellites are tilted 55 degrees to the equator to ensure that 4 to 6 satellites can send signals to GPS receivers.

There are other satellite navigation systems, GLONASS developed by the extinct Soviet Union in the year 1976 with a constellation of 12 satellites, BeiDou developed by China and Galileo a civil project, compatible with the other GPS systems, developed in partnership by the European Union and the European Space Agency (ESA), consisting of a constellation of thirty satellites, three orbital planes with 56 degrees of inclination to the equator at an altitude of 32,222 km away from the earth's surface.

The GSM system uses frequencies in the 900 MHz to 1800 MHz band for transmissions with the network, uses the FDMA that shares 124 channels with a width of 200 kHz with a transmission capacity of 270 Kbps, allocates these channels to each base station, which uses TDMA to divide them back into eight timeslots.

Transmission and signal reception stations use timeslots so that mobile equipment can not receive and transmit at the same time [22].

The GSM network covers the entire national territory and is available to all users who are customers of services provided by telecommunications operators.

These two GPS and GSM services are used the most commonly used in the development of monitoring systems and are usually accompanied by applications for smartphones that collect the data received and show the location of people, animals or objects on a map.

The data collected by these systems are stored in public or private servers that are managed by civil entities or by governmental entities, there is no guarantee that the data recorded in CLOUD can be made available or accessed by entities that do not belong to the system

C. Child Privacy

The context of the Internet as an open network accessible by anyone in any part of the world that allows the replication of published information in an infinite way, without being able to permanently erase, facilitates the collection, crossing and aggregation of personal data, access to search engines without control or consent of their owners and depending on the extent of the data collected, elaborate behavioral profiles and identify habits of life.

If the data relating to any natural person deserve legal protection, guaranteed at the constitutional level, the General Data Protection Regulation [21] expressly reinforced the protection of the personal data of children, establishing a more demanding legal regime for treatments that personal data, in particular in the Internet environment. Geolocation devices involve restrictions of fundamental rights whereby, in the case of a conflict of rights, restrictions should be limited to what is necessary to safeguard other fundamental rights or interests, for

the purpose of 'protection and safety of persons and goods'. [8]

D. Child Accident Statistics

According to the information provided by the General Directorate of the Maritime Authority, issued on September 12, 2107, in the last 5 years occurred in fluvial zones, (date taken from the SEGMAR information system, where all accidents and incidents occurring in AMN , 214% between 10 and 14 years of age, 22.4% between 5 and 9 years, 21.5% between 10 and 14 years of age, with a total of 689 drowning accidents in the aquatic environment, 34.4% of the children were aged between 0 and 4 years, years and 13.6% between 15 and 18 years, the remaining 9.1% do not exist information about age [3].

III. SOLUTION DESCRIPTION

The PPAI system consists of smartphones to receive and transmit information to the bracelet, the bracelet produces information and makes it available directly to the smartphone, the smartphone application that receives, analyzes and interprets the information of the bracelet and a web server to generate the accesses between users and send information to the PPAI system.

The PPAI introduces a new concept that combines well-identified and authoritative voluntary efforts, such as security agencies, other parents and other children, in a defined area where each user who is recognized by the system, and on his own initiative, share resources to generate a better result, crowdsoursing, with a very specific purpose, not to lose the child's sight, not to hinder their privacy and respect their freedom, without sharing data in CLOUD and without a physical network, another great innovation that the PPAI introduces in this type of systems is the creation of a P2P network between the existing and authorized equipment, when the bracelets leave the area of the scope of the equipment originally configured, notifications are generated for all the participating entities.

(1)

IV. THE ALGORITHM DEVELOPED

The algorithm developed and the variables involving the localization problem are presented, the objective is to locate the lost bracelet with the possible precision.

The Figure 1, showing the proposed localization algorithm is based on the estimation of the relative distance averages. Distance measurements are obtained by reading the RSSI signal sent by the bracelet and received to APP-PPAI installed on the smartphone of the parent who is monitoring it.

When the bracelet is no longer within the APP-PAI's safety radius, a warning is sent to the father to remove the bracelet. The parent, when he does not find the child, can send a notification with lost pulse alert to WEB-PPAI, the Life Guard, validates the notification and sends a notification with the Bluetooth Mac Address of the bracelet for all the smartphones have the APP -PPAI installed and are registered in WEB-PPAI. All APP-PPAI smartphones that are registered on the WEB-PPAI receive the Bluetooth Mac Address and begin to monitor the lost bracelet, this action is transparent to the parent receiving the lost child notification, APP-PPAI does all the process automatically if there is need for intervention by parts of your user. When the lost child passes the security radius of a smartphone with the APP-PPAI that is configured through the notification sent by WEB-PPAI or vise versa, the geographical position and estimated distance is sent automatically through the RSSI signal of the smartphone to the WEB-PPAI and notified the Life Guard. The WEB-PPAI server receives the geographic coordinates and estimated distance through the RSSI signal of the various devices that detected the wristbands and runs the location algorithm, measures distances in meters across the geographical coordinates received from smartphones to determine the geographic location of the lost child from the previously known position of smartphones through the intersection of three or more circles with radius equal to distance and center in the coordinates.

V. TRILATERATION

The figure 3 shows how to determines the location of the bracelet with reference to the known location of three smartphones, by intersecting circles with rays in the center of the reference smartphones. From the estimation of the distance (d) to the phone (A)(B) and (C), it is calculated that the bracelet must be located at any point in the circle of radius (d), the same is done for the other smartphones and the intersection of the circumferences gives us the point that matches the location of the bracelet.

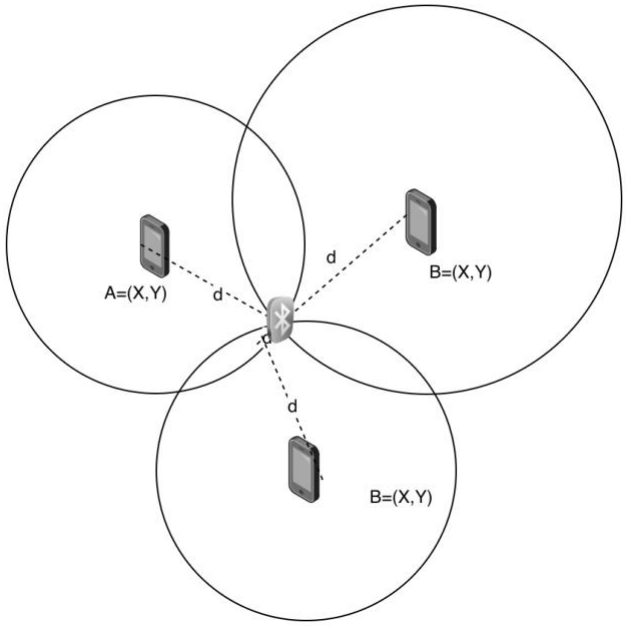

Fig. 3. Trilateration, the d are in meters and the x and y are GPS coordinates, Latitude and longitude. .

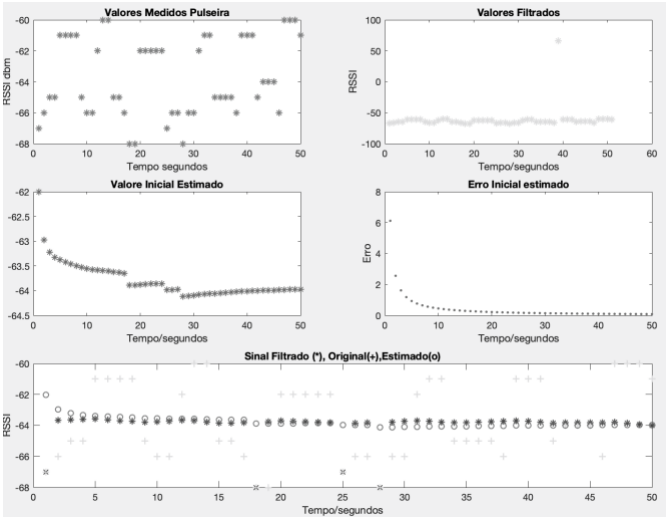

Fig. 1. Operation of the algorithm with values collected at 1 meter between bracelet and a smartphone.

VI. PROPOSED ARCHITECTURE

The proposed Architecture is represented by a set of diagrams with the main components for the process of information exchange, before entering in detail in the architectural models, the representation of the PPAI architecture is described The Figure 2, shows the architecture of the PPAI, the smartphone(9) communicates with the web server(14) via the REST protocol (1), uses the CLOUD(13) to send lost bracelet messages, receives the RSSI signal from the bracelet (12) by bluetooth (11) and converts the signal over distances, receives the GPS signal (21) from the satellite (10) to update the location, the tablet (8) / PC (5) communicates with the web server (14) through of the HTTPS protocol (3) for registering users, wristbands (12) and receiving messages, receives the RSSI / MAC ADDRESS (11) signal from the bracelet (12) via bluetooth (11), receives the data from the citizen's card through the (7) connected by USB cable (6) to register, the web server (14) sends messages by REST protocol (2) in json format to the smartphone (9), sends HTTPS messages (4) to the PC (5) and tablet (8), passes the firewall (15) to send data over HTTP (16) to the application server (17) that sends the data to be stored in the database (19) or requests to the database (20)

1) Web Service

The web server provides the resources for the mobile and web platforms, through HTTPS REQUEST / RESPONSE communications protocols and REST URI HTTPS REQUEST / RESPONSE, composed of several modules, the core consists of the internally used services that make up the system and do not are available abroad;

- CONTROLER are the SERVELTS generated by the developed JSPs, which provide the client with the data generated by the REQUESTS made to the server.
- VIEW, all JSPs that communicate with MODEL, which contains the business components, validate the requests and generate information that is available to the client.
- MODEL, composed of all classes and functions of the business model.
- REST SERVICES, provides information that is accessed through mobile devices (smartphone or tablet).

The application developed for the web server can be installed on Windows or Linux operating systems.

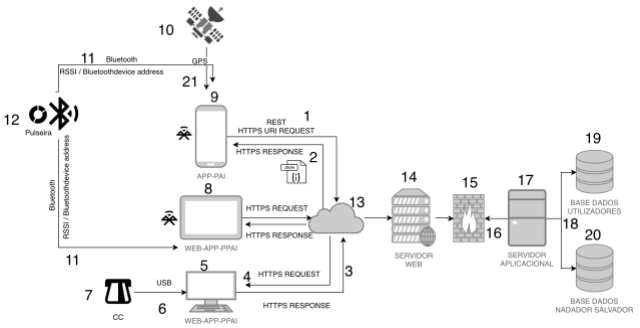

Fig. 2. The proposed architecture for the system PPAI.

2) Smartphone application

Was developed in Swift language with the program xcode, an application for the Apple iOS platform, which must be installed on the mobile device of the father, the application must have access to the location of the device, access to bluetooth communications, must have permissions to send notifications to the user.

3) Web application

The web application was implemented following the concept of client-server, and business logic

Developed in JAVA and JSP language, it is installed on the web server and allows the user to access the system through the browser or mobile device, using HTTPS over TCP / IP, implemented with SSL. The graphical interface (the user interface) adapts automatically to the width of the screens of the devices used, without limiting the functionality.

4) System data base

Regarding the Data Layer, it is based on the PostgreSQL DBMS to save the necessary information to the system operation, it is a free, reliable, easy to use and scalable database management system, it is installed on a server specific for the can be installed on a server with a Windows or Linux operating system.

VII. HOW THE SYSTEM WORKS

The PPAI system has two modes of operation, in PPAI-SON mode, the father attaches the bracelet to your phone to monitor the child.

In this mode the father visualizes the distance his son is and receives alarms when he moves away from the safety zone.

In PPAI-SON-OTHERS PPAIS mode, it is necessary for the father to make a face-to-face registration of the wristband on the Life Guard through the citizen's card, after successful registrations a QRCODE with a security code for data transmission between the PPAI APP - WEB APP - OTHER PPAIS that is read by the parent.

With the application open and registered, the parent has access to the features of searching for bracelets that are in their area of

security, registering bracelets, erasing bracelets, monitoring their safety area, sending lost child alerts to the rescuer Life Guard.

Lost child alerts are created by the parent who sends a notification to the rescuer who sends the lost brace's UUID to all other parents registered to the system.

The lost child's search is automatically performed when the smartphones of the other parents registered in the system receive the UUID the lost bracelet, if a lost bracelet enters the security area of a registered parent, the geographic position and the distance in meters are automatically sent. of the bracelet.

Finding the lost child, Life Guard sends the MAC ADDRESS of the lost bracelet to the other parents, the other parents when they find the bracelet automatically send a notification to the web server with the geographical position, latitude and longitude of their smartphone and RSSI signal of the lost bracelet.

VIII. RESULTS AND DISCUSSION

The objective of the RSSI data collection was to study the behavior of the signal and to minimize the errors obtained in the estimates in the calculation of the distances between the smartphones and the bracelet was made on the beach of Albarquel in Setúbal, with two mobile devices [IOS and Android] one personal computer to store the data and the MCU of the bracelet.

To find the coverage area of the bracelet MCU, image 41, 100 RSSI data were collected in four directions [N, S, E, O] at the same distance in 1-second intervals for a total of 400 samples, the data were discarded with RSSI = 0 values and RSSI = 127, with two smartphones [IOS, ANDROID] and the MCU of the bracelet, the smartphones at a height of 60 cm from the ground and the distance 15 meters from the MCU of the bracelet.

The results obtained in the experiments to estimate the distances with the algorithm developed with RSSI values between the [-61dbm and -100dBm] are obtained acceptable accuracy in the estimations obtaining errors between [1 meter and 3 meters], obtaining a good performance.

It is verified that when there is much interference in the received signal, values below -100 dBm, that the performance of the algorithm reduces by 20% to 40%, this is due to the fact that the RSSI = 0 and RSSI = 127 values do not are considered for the distance estimates, if these values are considered the performance of the algorithm reduces significantly to 60% to 80%.

IX. CONCLUSION

The positioning accuracies of the test areas are affected by the number of RSSI data obtained, for the the algorithm. In general the positioning accuracies are good, the error is about 1 to 3 meters, in this approach cost and effort are minimum, the user only needs to introduce small initial coordinates as the startup that search a child can visualized the children at that distance. In conclusion, the system introduced is simple and fast and have fairly accurate localization.

REFERENCES

[1] Decreto-lei n.º 159/2012, N.º 142 ed., vol. 1.ª série, Diário da Republica, 2012.
[2] Portaria n.º 173/2017, 102 ed., vol. 1.ª série, Diário da Republica, 2017.
[3] "AMN-Segurança Marítima 2015-2017," 2017.
[4] O. M. d. Saúde, "Guidelines for Safe Recreational-Water Environments," vol. 2, nº Swimming pools, spas and similar recreational-water environments, 2006.
[5] APSI, Afogamento de crianças e jovens até aos 18 anos, em Portugal, 2011.
[6] E. C. S. Alliance, The Water Wise facts Sheet – Child Water Safety, 2007.
[7] M. d. Saúde, Programa Nacional de Prevenção de Acidentes, 2016.
[8] CNPD, "Deliberação n.º 7680/ 2014," 2014.
[9] Convenção sobre as relações pessoais no que se refere às crianças, 192 ed., 2003.
[10] "Portugal. Localizador de crianças por GPS made in Portugal preocupa peritos," 6 abril 2006. [Online]. Available: publico.pt. [Acedido em 12 outubro 2017].
[11] AUTORIDADE MARÍTIMA NACIONAL, "Missão e Competências," [Online]. Available: www.amn.pt. [Acedido em 12 setembro 2017].
[12] Lei n.º 68/2014, Artigo 4º ed., 2014.
[13] Ahmed El-Rabbany, "Introduction to GPS," London.
[14] fórum GSM e 3G, "GSM," [Online]. Available: https://pt.wikipedia.org/wiki/GSM. [Acedido em 12 setembro 2017].
[15] Ministério da Justiça, Vigilância electrónica, 2011.
[16] Findster, Inc., "Findster Duo+: GPS pet tracker free of monthly fees for dogs and cat," 2017. [Online]. Available: https://getfindster.com. [Acedido em Janeiro 2018].
[17] Weenect, "Family first," [Online]. Available: https://www.weenect.com/pt/. [Acedido em 23 outubro 2017].
[18] Lapa, "Encontra e protege tudo o que importa," [Online]. Available: https://findlapa.com/pt/. [Acedido em 23 outubro 2017].
[19] Lapa Studio, "findlapa," [Online]. Available: https://findlapa.com/pt/. [Acedido em 23 outubro 2017].
[20] HergTech AG , "petpointer - Onde está meu pet?," [Online]. Available: https://www.petpointer.ch/pt/. [Acedido em 23 outubro 2017].
[21] C. N. d. P. d. Dados, "Rgpd," [Online]. Available: https://www.cnpd.pt/bin/rgpd/rgpd.htm. [Acedido em 27 maio 2018].
[22] pt.wikipedia.org, "https://pt.wikipedia.org/wiki/Onda_de_rádio," pt.wikipedia.org, [Online]. Available: https://pt.wikipedia.org. [Acedido em 20 2 2019].
[23] K. Yu, Positioning and Navigation in Complex Environments, 2018.
[24] Diário da República, Diário da República, 55 ed., vol. ANEXO A, 2015.
[25] ANACOM, "Missão, valores, atribuições e poderes," [Online]. Available: https://www.anacom.pt/render.jsp?categoryId=381611. [Acedido em 11 4 2019].
[26] ANACOM, "SERVIÇO MÓVEIS - Primeiro semestre de 2018," 2018.
[27] 2. B. SIG, "www.bluethoo.com," 14 12 2018. [Online]. [Acedido em 14 12 2018].
[28] I. N. d. C. d. M. e. a. MULTICERT, "www.kitcc.pt," INCM e da MULTICERT, 6 7 2009. [Online]. Available: https://www.kitcc.pt/ccidadao/documentos/manual_kit_cc.pdf. [Acedido em 2019 fevereiro 14].
[29] DGAM, Sistema de Informação de Segurança Maritima, 2008.
[30] National Instruments Corporation, "Tecnologia sem fios," [Online]. Available: http://www.ni.com/rf-academy/pt/. [Acedido em 10 setembro 2017].
[31] Joonyoung Jung, Dongoh Kang, Changseok Bae, Distance Estimation of Smart Device using Bluetooth, Deajeon: ICSNC, 2013.
[32] marktest, "Smartphone continua a crescer em Portugal," [Online]. Available: ttp://www.marktest.com/wap/a/n/id~2046.aspx. [Acedido em 16 novembro 2017].
[33] Texas Instruments Incorporated, TMS 1000 SERIES MOS/LSIONE-CHIP MICROCOMPUTERS, 1975.

[34] ANACOM, “O Sector das Comunicações 2016,” [Online]. Available: https://www.anacom.pt/render.jsp?contentId=1424786. [Acedido em 9 setembro 2017].
[35] pycom invented, “Development Boards,” [Online]. Available: https://pycom.com. [Acedido em 12 novembro 2017].
[36] Tecnomundo, “O que significa cada quadrado de um QR Code?,” 12 3 2013. [Online]. Available: https://www.tecmundo.com.br/qr-code/37372-o-que-significa-cada-quadrado-de-um-qr-code-.htm. [Acedido em 1 3 2019].
[37] ASPI, “ASPI,” [Online]. Available: https://www.apsi.org.pt/index.php/pt/apsi/quem-somos/quem-somos-home. [Acedido em 19 2 2019].
[38] pt.wikipedia.org, “ARM_Cortex-M,” pt.wikipedia.org, [Online]. Available: https://pt.wikipedia.org/wiki/ARM_Cortex-M. [Acedido em 12 Dez 2018].
[39] L. Shenzhen Radioland Technology CO., “NRF51822-Beacon Datasheet,” 2018. [Online]. Available: http://www.radioland-china.com.

Paulo Rosário (12484) Work on the Portuguese Navy, has a navy officer at 32 year in Department of technologies has Senior Developer, licensed in computer programming by Naval Scholl. Student of Electrical Engineering and computers in Instituto Superior Técnico.