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A CASE-STUDY VISION

Home automation control and monitoring through IoT

Control domótico y monitoreo por medio de IoT

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ABSTRACT

This article shows the process developed as a degree option with the design and implementation of a prototype of a Home automation Control system and monitoring through IoT for people with visual impairment using voice commands, which evidences the use of a second generation Intel Galileo card in which the programming corresponding to the home automation control was carried out by means of voice commands using the Arduino IDE, together with an inventor App in which the recognition of the commands sent to The Intel processing board through a cell phone with Android operating system, in the same way the monitoring of variables such as temperature and heart rate was performed through the IoT Ubidots platform through the use of an Arduino one, together with an Ethernet shield for to be able to visualize these variables, as well as generate an alert message to our mobile phone informing us that s e has produced an anomaly in the pre-established parameters previously in the platform, it is also necessary to mention some tests carried out against some of the potentials that Intel Galileo has as a test carried out in the python software when checking its connectivity and operation with the card output pins.

RESUMEN

En este documento se presenta el proceso desarrollado como opción de grado con el diseño e implementación de un prototipo de un sistema de Control Domótico y monitoreo por medio de IoT para personas en condición de discapacidad visual utilizando comandos de voz, en el cual se evidencia el uso de una Intel galileo de segunda generación tarjeta en la cual se realizó la programación correspondiente al control domótico por medio de comandos de voz haciendo uso del IDE de Arduino, junto con una App inventor en la cual se efectúa el reconocimiento de los comandos enviados a la placa de procesamiento de Intel mediante un celular con sistema operativo android, de igual forma se realizó el monitoreo de variables como temperatura y ritmo cardíaco por medio de la plataforma Ubidots de IoT mediante el uso de un Arduino uno, junto con un escudo Ethernet para poder así visualizar dichas variables, al igual que generar un mensaje de alerta a nuestro teléfono móvil informándonos que se ha producido una anomalía en los parámetros preestablecidos con anterioridad en la plataforma, también es necesario mencionar algunas pruebas realizadas frente a algunas de las potencialidades que posee la Intel galileo como una prueba realizada en el software python al comprobar su conectividad y el funcionamiento con los pines de salida de la tarjeta.

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1. Introduction

This article shows the elaboration and execution of the degree work entitled home automation control and monitoring through IoT for people with visual disabilities using voice commands, in which it is desired to facilitate the daily tasks of their homes such as irrigation of their gardens, the ignition of heaters, the opening and closing of doors, among others. In addition to providing a real-time monitoring and control system of different health variables (vital signs or similar) such as temperature and heart rate in this case, generating a report via messaging to our email. But how important is home automation and IoT with real-time monitoring for these populations? The internet of things has the power to change our world, the IoT will play an important role in the future from Industry 4.0 and it is estimated that there will be a large amount flowing through the market in the coming years. More than half of the new commercial processes and systems will incorporate elements of IoT. The essence of IoT is simply interconnecting devices that generate and exchange data from observations, facts, etc. although, the simple fact that something is connected to the Internet does not make it IoT. An IoT solution has a lot to do with how to better understand the world around us to offer an intelligent service to society. IoT solutions allow us to sensorize the world around us and learn from these observations. The sequence of events with some complexity lies in how to collect, store, process and present the data. While home automation control will allow us to automate each element or process in our home, in this case through programmed voice commands, people with disabilities will be able to have greater comfort and in a certain way autonomy from each of these processes which will provide energy management, security, well-being and communication services in their homes.

2. Justification

The project has great social relevance because it solves the problem that visually impaired people face every day in their homes. In the same way, it has an academic relevance since the internet of things is used, which is a tool that is currently under development as a line of research in the faculty, in addition to the contribution that the development of the project provides to it.

Finally, the project is pertinent and economically viable because it uses the Intel Galileo platform which was donated by the IEEE to the faculty as a tool for the

development of projects with the use of the IoT, because Intel specifically developed This unit for IoT solutions providing great advantages compared to carrying out projects related to 4.0 technology, in addition to the fact that the card is widely used in communication protocols and in the same way allows us to work with different programming environments such as platforms such as arduino and phyton

3. Theoretical foundation

3.1. History of home automation:

Home automation had its beginnings in the 70s, more precisely in 1975, where after many years of research, automation of buildings based on the X-10 technology, which is used today, resulted. This protocol was extended not only by the United States, but also in Europe, where the United Kingdom and Spain were the countries that most welcomed this standard. [1]

3.2. Origin of the IoT:

It was in 2009 that Kevin Ashton, a professor at MIT at the time, used the expression Internet of Things (IoT) publicly for the first time, and since then the growth and expectation around the term has been increasing exponentially. It was in the RFID journal that Ashton publicly coined the term. Although he himself has commented that the expression was in common use in internal investigation circles since 1999, although it was not made public in a conspicuous way until then. [2]

3.3. Advantages of home automation for people with disabilities:

As advances in technology are made constantly, advantages are generated for people with disabilities since the fact of being able to give them control of their actions is in some way the best way to optimally influence their mood, since that these types of advances allow these populations the control of turning off or turning on the lights from a mobile application, raising or lowering the blinds or programming the irrigation of the garden are utilities that become accessible thanks to home automation. Having an integrated home automation system in each home facilitates teleworking and online learning, therefore increasing the opportunities to develop a job with all the functional benefits to be able to carry it out in conditions of comfort and adaptability, it is an open door to the integration.

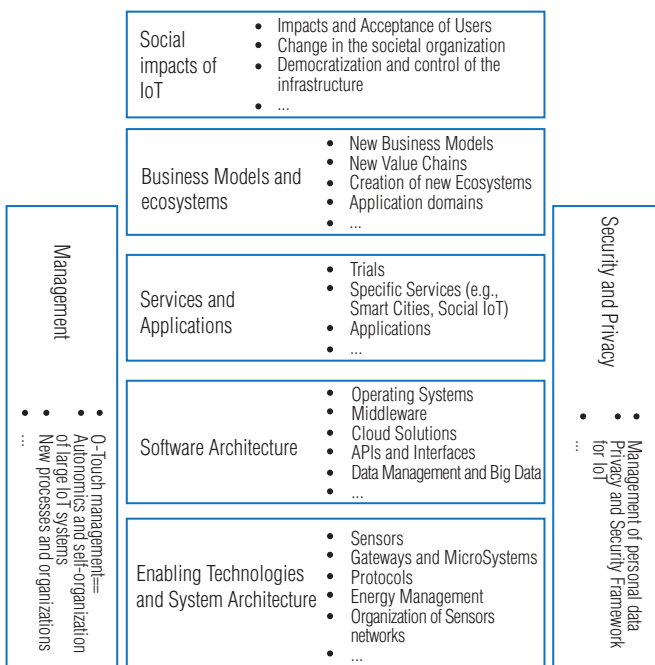
Figure 1. Advantages of home automation control IoT, [3].



3.4. The internet of things:

Internet of things IoT, is an application domain that integrates different technological and social fields. Despite the diversity of research on IoT, its definition remains fuzzy. Having a robust definition that addresses all the characteristics of IoT can facilitate a better understanding of the topic, lead to further research, and advance our understanding of this emerging concept. Broadly speaking, the IoT covers many areas ranging from enabling technologies and components to various mechanisms to effectively integrate low-level components. Software is then a discriminating factor for IoT systems.

Figure 2. Technological and social aspects related to the IoT, [3].



3.5. IoMT (internet of medical things) or IoT of health:

Internet of Medical Things (IoMT) is the collection of medical devices and applications that connect to healthcare IT systems through online computer networks. WiFi-equipped medical devices enable machine-to-machine communication, which is the foundation of IoMT. IoMT devices connect to cloud platforms such as Amazon Web Services, where the captured data can be stored and analyzed. IoMT is also known as Health IoT. [4]

3.6. Current state of home automation:

To analyze what the current state is, it is necessary to talk about the future of it, due to the way in which technology advances day by day. Currently, different spaces are being automated, such as the home, shopping centers, buildings, among others. This automation is due to the strong impact and boom that the implementation of these systems is having in the market so that in one way or another more comfort and convenience is created for people, which is what you really want to achieve. [5]

3.7. History of home automation for people with disabilities:

People with disabilities acquire benefits from the use of home automation since it allows them to have greater autonomy to carry out different tasks in their homes. However, at present it has not been possible to generate total satisfaction in the automation of their homes, since in many cases some companies do not fully comply with the demand or promises made to this population. That is why it is worth mentioning the beginnings of home automation in the early 70's, when the first automated devices for buildings appeared, as a pilot test, but it was really in the 80's when the Integrated systems were used commercially, to later be developed in the domestic aspect of housing in urban areas. [3]

3.8. Origin of the IoT:

It was in 2009 that Kevin Aston, a professor at MIT at the time, used the expression Internet of Things (IoT) publicly for the first time, and since then the growth and expectation around the term has increased exponentially. It was in the RFID journal that Aston publicly coined the term. Although he himself has commented that the expression was in common use in internal research circles since 1999, although it was not made public in a conspicuous way until then. [6]

3.9. *Mont-Blanc to IoT:*

The origin of connected objects is not something from a few decades ago, it actually dates back to the technological dawn of the 19th century, in what are considered the first telemetry experiments in history. The first on record was carried out in 1874 by French scientists. They installed meteorological and snow depth information devices on top of Mont Blanc. Through a short-wave radio link, the data was transmitted to Paris. [6]

3.9.1. *Smart Assist project with IoT for people with disabilities:*

Offering effective solutions through technology that facilitate the day-to-day life of people with disabilities, the elderly who require care or people with special needs and their caregivers is the objective of Smart Assist. Smart Assist is based on technologies such as the Internet of Things (IoT) and massive data analysis (Big Data Analytics) to develop intelligent solutions that allow personalization of care by creating an environment that integrates mobile and home telecare, favoring maximum safety and security, accessibility, while respecting and promoting the autonomy and privacy of people. [7]

3.9.2. *Intel Galileo vs. IoT:*

It is a new family of Arduino compatible boards that work under the Intel architecture. It is one of the first Intel products to enter the IoT market, it brings functions very similar to Raspberry Pi or Arduino. Galileo is a micro controller based on the IQuark SoC X1000 processor that works at 400MHZ, it is really a 32-bit CPU has an architecture similar to that of the old Pentiums.

It is the first board based on Intel architecture and whose design is designed to be compatible with Arduino. It brings compatibility with the Shields used by Arduino UNO rev3 and the Arduino IDE can be used. It is cross-platform so it can be used on Linux, Mac and Windows. [8]

3.9.3. *Ubidots Platform:*

Ubidots is an IoT platform that empowers innovators and industries to prototype and scale projects from IoT to production.

The Ubidots platform is used to send data to the cloud from any device with internet access. You can then

configure actions and alerts based on your real-time data and unlock the value of your data through visual tools. Ubidots offers a REST API that allows data to be read and written to available resources: data sources, variables, values, events, and information. The API supports HTTP and HTTPS and an API key is required. [9]

3.9.4. *MIT App Inventor:*

It is a software development environment created by Google Labs for the development of applications for the Android operating system. The user can, visually and from a set of basic tools, link a series of blocks to create the application. For the development of applications with App Inventor you only need a web browser and an Android phone or tablet. App Inventor is based on a web service that allows you to store your work and will also help you keep track of projects. [10]

3.9.5. *SSH protocol:*

It is a protocol that facilitates secure communications between two systems using a client / server architecture and that allows users to connect to a host remotely. Unlike other remote communication protocols such as FTP or Telnet, SSH encrypts the connection session, making it impossible for someone to obtain unencrypted passwords. [2]

3.9.6. *Arduino IDE:*

It is an open source electronics creation platform, which is based on free hardware and software, flexible and easy to use for creators and developers. This platform allows the creation of different types of single-board microcomputers that the community of creators can give different types of use. [11]

3.9.7. *Linux:*

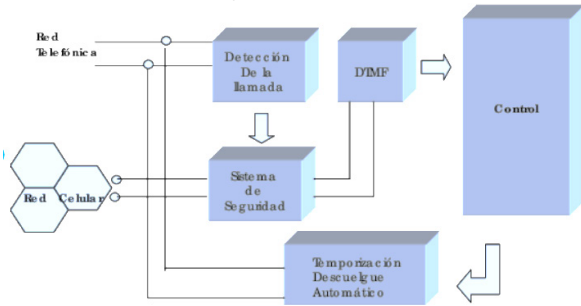
It is a free operating system like Unix POSIX; multi-platform, multi-user and multi-tasking. The system is the combination of several projects, among which GNU and the Linux kernel stand out. [12]

3.9.8. *GPIO (General purpose Input/Output):*

It is a generic pin on a chip, the behavior of which can be controlled by the user at runtime. The GPIO pins have no defined special purpose, and are not used by default. [13]

3.9.9. IoT (Internet of Things):

Figure 3. Functional blocks of a home automation system, [10].



It is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that have unique identifiers and the ability to transfer data over a network, without requiring human-to-human or human-to-computer interactions. [10]

4. Results

For the development of the prototype, the advantages offered by the second-generation Intel Galileo card were taken into account compared to programming platforms which are compatible with the image of the card's Linux operating system, within which are platforms as python and arduino, based on the above it was developed:

4.1. Elaboration of voice recognition on the card

In Figure 4 you can see the interface made in the MIT App inventor program in which there are the buttons to connect the bluetooth hc06 module with the mobile device and the talk button to execute the voice commands programmed for the home automation control of the prototype.

Figure 4. Interface of the program made in the MIT Inventor App for our mobile phone, [6].

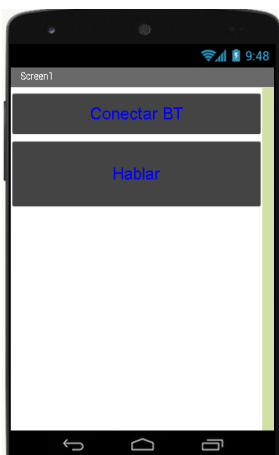
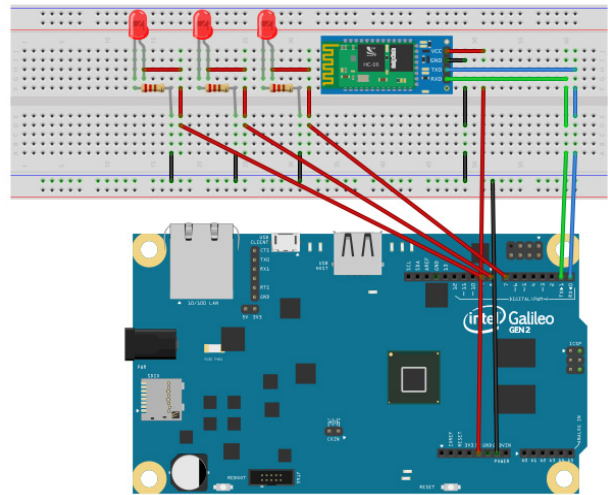
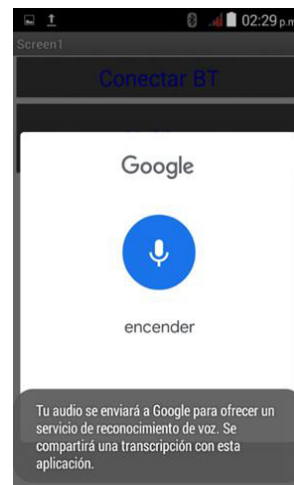


Figure 5. Test performed with LEDs next to the Intel Galileo Gen 2 board, [6].



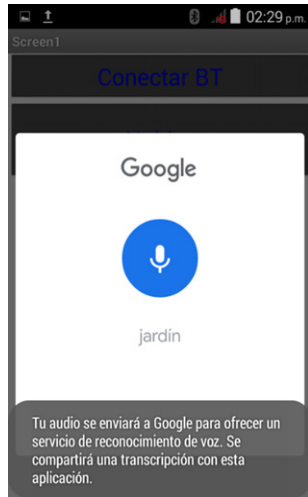
In Figure 5 you can see a test of the assembly of the home automation control carried out, for the prototype, in this case some LEDs were used which, according to the execution or commands given by means of an inventor App made, the different LEDs used are executed In the assembly, for this, 4 commands were used (light, garden, turn on and turn off), in addition to using a Bluetooth HC06 module which was previously paired to the Bluetooth of our mobile phone for voice recognition, it should be noted that it is not necessary The use of the internet to run the application, which offers great advantages when using it, since the application programmed in App inventor was installed on our cell phone.

Figure 6. Executing the turn on command through App inventor, [6].



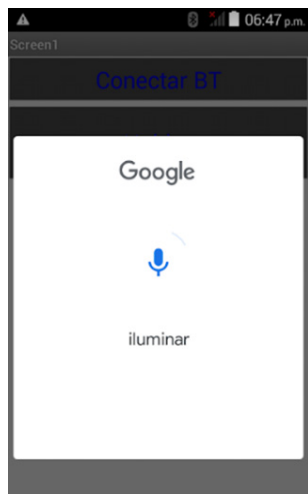
In Figure 6 you can see the execution of the turn on command through the program carried out in the inventor App used to carry out the project, in which the use of the Bluetooth provided by the mobile phone is essential along with access to the device’s microphone.

Figure 7. Executing the garden command in the App inventor, [6].



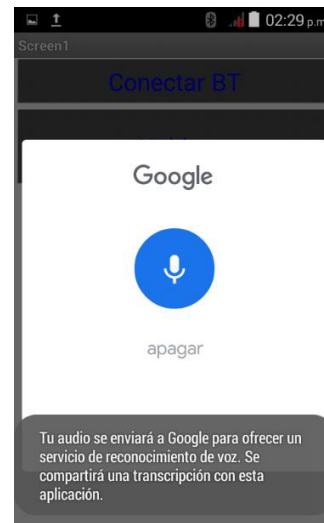
In Figure 7 you can see the execution of the garden command in the MIT App inventor for its subsequent activation in the Intel Galileo.

Figure 8. Running the illuminate command in the MIT Inventor App, [6].



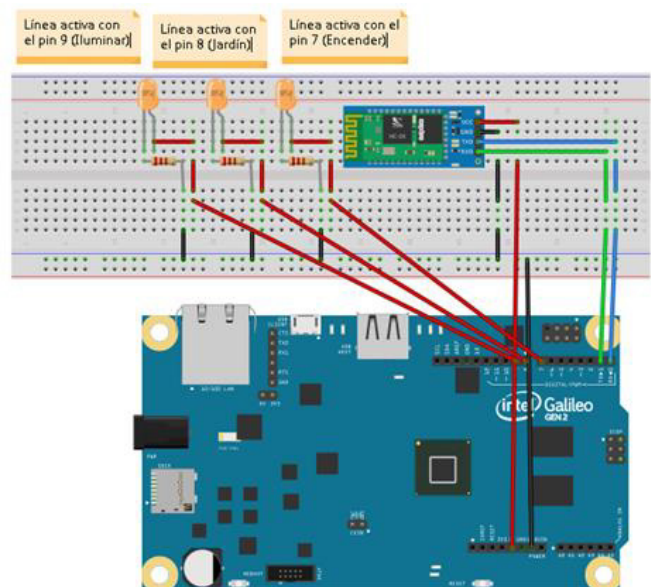
In Figure 8 you can see the execution of the illuminate command on the mobile phone using the program made in the MIT App inventor.

Figure 9. Running the shutdown command in the MIT Inventor App, [6].



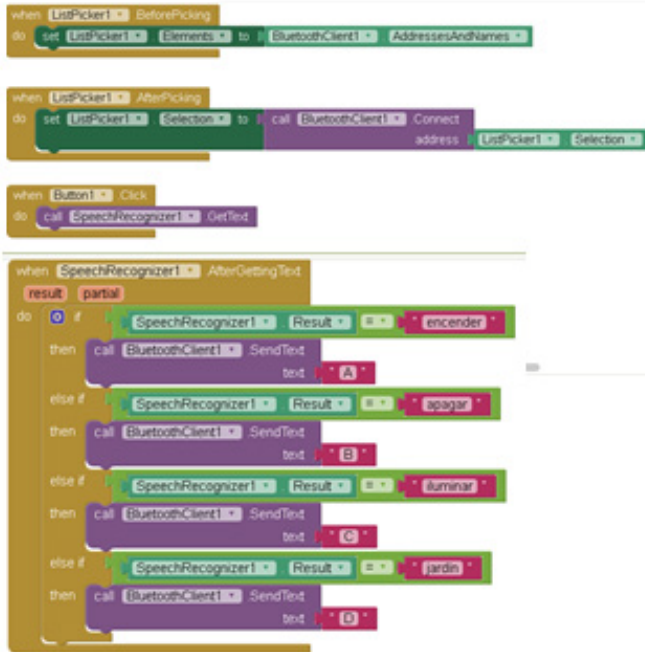
In Figure 9 you can see the execution of the shutdown command in the inventor App programmed and installed on our mobile phone.

Figure 10. Recognition of the commands given on the Intel Galileo generation 2 card, [6].



In Figure 10, you can see the recognition made of the commands given by the mobile phone which are executing each pin of the Intel processing card in which the different LEDs are activated according to the specified order of voice recognition.

Figure 11. Programming done in the MIT App inventor, [6].



In Figure 11 you can see the programming carried out in the MIT App inventor application in which the commands that will be recognized in the mobile device are defined, the Bluetooth client is called in the same way, characters are sent for subsequent serial communication Using the Bluetooth module HCo6 to arduino to execute the different pins of the Intel Galileo depending on the command obtained, the speech recognizer is called to make the respective recognition of the given voice commands.

Figure 12. Conditioning of the model made, [6].



In Figure 12, you can see the conditioning carried out for the model made for the respective verification of the prototype.

Figure 13. Garden command drive in the model, [6].



In Figure 13 you can see the activation of the garden command in the model in which three LEDs light up consecutively for this case.

Figure 14. Activation of the illuminate command on the model, [6].



In Figure 14 you can see the execution of the illuminate command in the model in which three LEDs light up simultaneously on the inside of it.

Figure 15. Executing the turn on command on the mockup, [6].



In Figure 15 you can see the execution of the turn on command in the model in which the three LEDs at the top turn on simultaneously.

4.2. Elaboration of the monitoring through the Ubidots platform

In Figure 16 you can see the circuit with the

temperature and heart rate sensor, together with an arduino uno with its respective Ethernet shield to connect to a router and send the data obtained to the Ubidots platform.

Figure 16. Circuit with the temperature and heart rate sensor connected to an Arduino uno, [6].

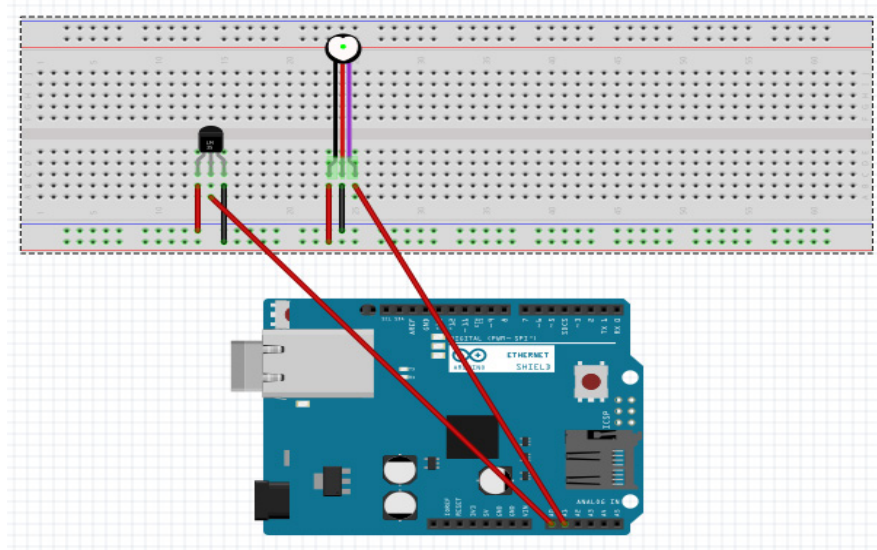
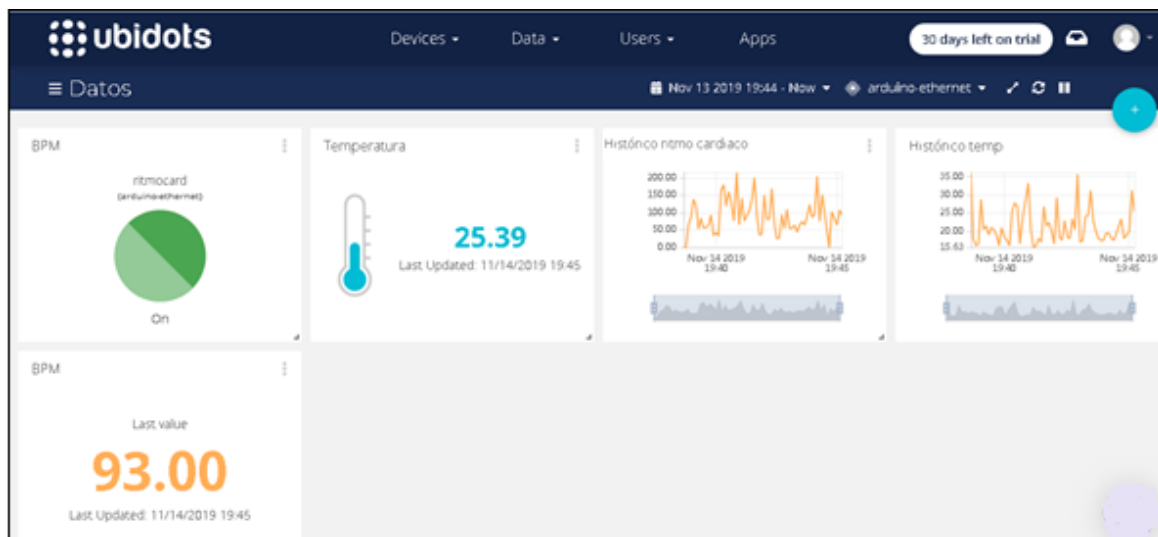


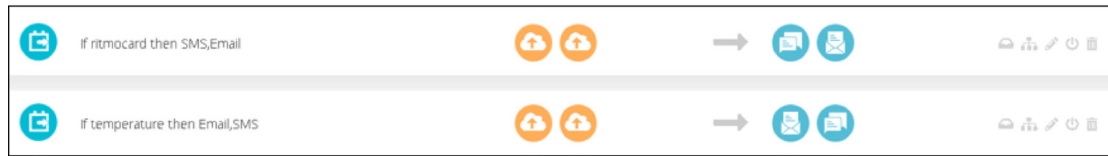
Figure 17. Temperature and heart rate monitoring, [6]:



In Figure 17, you can see the monitoring of the temperature in Celsius ($^{\circ}$ C) and the beats per minute (BPM) delivered by the sensors used in the project viewed through the Ubidots IoT platform, the monitoring consists of the value delivered by the sensors and the data history obtained by them, in

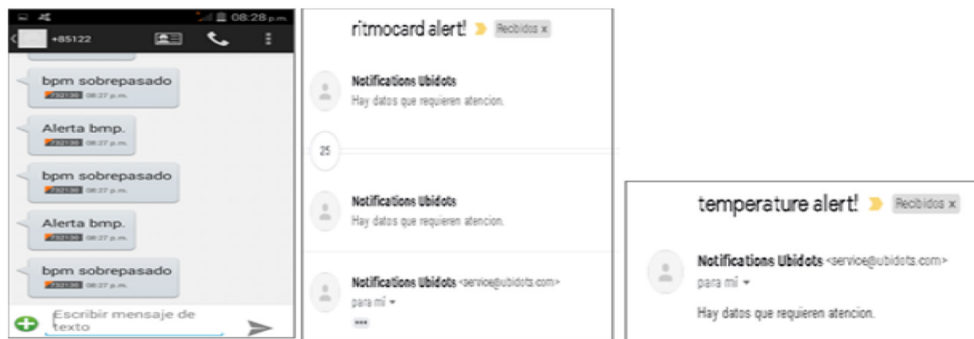
which the variations obtained in the data are observed every 10 minutes during which the patient is being monitored, observing a non-linear behavior in the graph of both temperature and heart rate in this way, a database corresponding to the result that the platform is updating is obtained.

Figure 18. Creation of reports via email and SMS, [6].



In Figure 18, you can see the creation of reports via SMS and email according to the parameters established in the platform for generating the alert.

Figure 19. Reports generated by the IoT Ubidots platform, [6].



In Figure 19 you can see the reports generated by exceeding the limits established in the Ubidots platform for measuring both heart rate and temperature via sms for the user's mobile phone and by email. [14]

5. Conclusions

The integration of the Arduino IDE, MIT App Inventor and Ubidots platforms together with the use of the Intel processing card and an Ethernet shield allowed successfully generating home automation control through voice commands, as well as the monitoring of vital signs, thus demonstrating the functionality of this prototype and its application to people with visual disabilities, with respect to the expected functions of this System, an optimal response is obtained from it on the execution of voice commands and their corresponding action on home automation control, also a correct visualization and sending of alerts to carry out the monitoring of vital signs through the IoT.

The realization of this prototype allows obtaining the solution to the problem that visually impaired populations face every day since it provides greater autonomy in daily tasks at home, it also increases the safety of the health of the person, given that constant monitoring can be exercised on biological signals from the human body.

The different subsystems of the project were integrated, such as the programming and control part through the Intel processing board, as well as the sending of data from the sensors used for monitoring temperature and heart rate through the Ethernet shield and It verified its correct operation by means of the respective tests carried out on the prototype.

Intel Galileo processing card has great potential for different electronics projects thanks to all the platforms with which it is compatible. In this case, platforms such as the arduino and python IDE were used for the elaboration of this project, thus demonstrating the importance and its usefulness, although a limitation of the card is that it does not allow the installation of libraries in its Linux image for the python platform, for which it was not possible to work with the speech recognition library, but efficient communication interfaces can be generated With cards that fulfill supplementary tasks such as the arduino IDE, thanks to this it was possible to recognize the voice commands for the operation of the project.

IoT technology was very useful when generating reports and monitoring in this case of temperature and heart rate, which makes possible a better quality of life for people with visual disabilities, in addition to health safety, contributes to offer a better reaction capacity when priority medical attention is required.

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