

Conectividad en redes inalámbricas de área personal utilizando Arduino y componentes electrónicos

***Connectivity in Personal Area Wireless Networks Using Arduino and Electronic
Components***

***Conectividade em redes sem fio de área pessoal usando Arduino e componentes
eletrônicos***

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Resumen

En la carrera de Ingeniería en Sistemas Computacionales del Instituto Tecnológico Superior de Irapuato existen materias como Principios Eléctricos, Programación de Dispositivos Móviles y Fundamentos de Telecomunicaciones en las que la tecnología *bluetooth* tiene un papel trascendental, pues gracias a esta un profesionalista del área puede solventar diversos problemas de conectividad inalámbrica local a un precio accesible y de manera eficaz. En algunas ocasiones, sin embargo, el estudiante podía verse obligado a limitar sus habilidades cuando el temario avanzaba

y tenía que desarrollar prácticas de conectividad inalámbrica de mayor complejidad, por lo que recurría continuamente a fuentes de información en Internet que no garantizaban confiabilidad en la información expuesta, o bien evitaba investigar y desarrollar sus propios programas al descargar herramientas o aplicaciones genéricas de terceros en la Play Store, los cuales no eran los más adecuados o no se adaptaban a las necesidades técnicas de sus componentes.

En el contexto planteado, los aprendices no lograban dominar el fundamento técnico necesario al utilizar código y programación de páginas de Internet que eran aplicados a sensores y actuadores con los que no contaban, debido a la gran variedad que existe en el mercado, lo que repercutía en su rendimiento académico. Por lo que estudiantes y profesores desarrollaron una guía técnica para ayudar al alumno a realizar prototipos con transmisión de datos y reforzar aquellos conocimientos donde la tecnología *bluetooth* es un común denominador y así pueda aplicar las competencias específicas de las materias mencionadas.

Como resultado se ha logrado que los estudiantes trabajen en equipo fomentando el liderazgo, se han creado hábitos de estudio técnico-prácticos y elaborado prototipos sustentando la solución del algún problema citado. Además, se han generado *apps* de código abierto y fomentado la constante participación en eventos académicos, lo que ha traído la obtención de primeros lugares y algunas patentes, todo lo cual ha contribuido a mejorar su rendimiento académico.

Palabras clave: Android, Arduino, *bluetooth*, código abierto, dispositivo móvil, electrónica, HC05, programación, red inalámbrica local, rendimiento académico.

Abstract

In the Computer Systems Engineering career at the Higher Technological Institute of Irapuato there are subjects such as Electric Principles, Mobile Device Programming and Telecommunications Fundamentals, in which Bluetooth technology is of importance, since it is one of the technologies and electronic modules with which a professional in the area can solve various local wireless connectivity problems at an accessible and efficient price. Occasionally students could be forced to limit their skills when the scholar program progress and they had to develop more complex wireless connectivity practices, so they continually resorted to sources of information on the Internet that did not guarantee reliability in the exposed information as well as

they avoided researching and develop their own programs by downloading generic tools or applications from third parties in the Play Store, which were not the most appropriate or did not adapt to the technical needs of their components.

With the problems raised, the student could not master the technical foundation necessary to use code and programming of Internet pages that were applied to sensors and actuators that did not have, due to the wide variety that exists in the market, impacting on their academic performance. For this reason students and teachers have developed a technical guide in order to help them to make prototypes with data transmission to avoid this problem and reinforce the student's knowledge through the use of Bluetooth technology as a common denominator and means by which the student can apply the specific competences of the mentioned subjects.

As a result, students have been managed to work as a team, fostering leadership, technical-practical study habits have been created, prototypes have been developed, supporting the solution of aforementioned problem, the generation of open source mobile applications (apps), the constant participation in academic events with obtaining first places and some patents that have contributed to improve their academic performance.

Keywords: Android, Arduino, bluetooth, open source, mobile device, electronics, HC05, programming, local wireless network, academic performance.

Resumo

Na corrida de Sistemas de Computação Engenharia pelo Instituto Tecnológico Superior de Irapuato existem temas como Princípios Elétricos, Programação de dispositivos móveis e Fundamentos de Telecomunicações em tecnologia Bluetooth tem um papel vital, porque graças a este uma área profissional pode resolver vários Problemas de conectividade sem fio local a um preço acessível e de forma eficaz. Às vezes, porém, o aluno poderia ser forçado a limitar suas habilidades quando a agenda foi em movimento e teve que desenvolver a conectividade sem fio prática mais complexo, por isso continuamente recorreram a fontes de informação na Internet que não garantia informações confiabilidade expostos ou impedido de pesquisa e desenvolver seus próprios programas para download ferramentas ou aplicativos de terceiros genéricos na Play Store, que não foram adaptados ou não adaptados às necessidades técnicas dos seus componentes.

No presente contexto, os formandos foram capazes não dominar a base técnica necessária a utilização de código e programação de páginas da Internet que foram aplicadas para sensores e atuadores com que não contavam por causa da variedade que existe no mercado, que reverberou em seu desempenho acadêmico. Para que os alunos e professores desenvolveram um guia técnico para ajudar os alunos a fazer a transmissão de dados protótipos e reforçar essas habilidades onde a tecnologia Bluetooth é um denominador comum e, portanto, pode aplicar os poderes específicos dos materiais acima mencionados.

Como resultado, os alunos puderam trabalhar em equipe promovendo a liderança, criaram hábitos de estudo técnico-prático e desenvolveram protótipos que apóiam a solução de qualquer problema mencionado. Além disso, têm gerado aplicativos de código aberto e encorajou continuou participação em eventos acadêmicos, que trouxe a obtenção primeiros lugares e algumas patentes, todos os quais tem ajudado a melhorar seu desempenho acadêmico.

Palavras-chave: Android, Arduino, bluetooth, código aberto, dispositivo móvel, eletrônica, HC05, programação, rede sem fio local, desempenho acadêmico.

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Introduction

Some of the areas involved in the project for the generation of a technical guide are basic digital electronics, programming, mobile devices and telecommunications, which are part of integrative projects with which students and teachers have managed to collaborate and generate productivity . Likewise, when promoting collaborative work, research, comprehension and learning competences are applied, since "because it is a training research strategy it is not aimed at the generation of an objectively new knowledge but rather at the comprehensive appropriation of knowledge already developed but new for the student "(Hewitt, 2007, p 236).

Specifically, the programming was carried out with Arduino:

An open electronic platform, that is, it uses free hardware for the creation of prototypes based on flexible and easy-to-use software and hardware; its operation is based on a board with a microcontroller and a development environment (Llanga and Cano, 2014 , p79).

The foregoing is in addition to the fact that it is one of the most common tools with which middle and upper level students interact. Acquiring one of these plates is simple and at a low cost: qualities that contribute to students choosing to acquire one of them in order not only to carry out academic activities, but on their own initiative and to be able to investigate and inquire more about an area or topic that interests them. Undoubtedly this tool encourages and allows the student to obtain a research profile of science and technology.

Programming is one of the reasons for being an engineer in computer systems. In this regard, it is known that there are different languages, techniques, certifications and specializations, including the programming of mobile devices, which involves the use of object-oriented programming (OOP) and free-code tools such as Android, Arduino and others. Open access environments, for example the MIT App Inventor, so that, by implementing these types of activities, the student manages to work with different platforms and paradigms. In the case of the subject related to electronics (Electrical Principles and Digital Applications), the competence achieved involves solving problems in the computer field with the help of digital systems. And in this project, this competence has been achieved by involving bluetooth technology and various microcontrollers, with the help of applications that are generated in the field of Mobile Device Programming, in addition to applying the standards and communication protocols seen in the subject of Fundamentals of Telecommunications. All this was documented in a guide whose purpose is to identify the theoretical and technical aspects of the areas involved (electronics, programming, networks) in the first semesters of the student. In this way, the bases are acquired to undertake new projects and prototypes with greater impact in the Computer Systems Engineering (ISC) career of the Higher Technological Institute of Irapuato (ITESI).

The fact that a student can analyze, integrate and apply different areas of their career can reinforce their skills by acquiring new knowledge and making use of the skills indicated in table 1.

Tabla 1. Materias y competencias ligadas al proyecto

Materia	Competencia alcanzada
Fundamentos de Programación	Aplica algoritmos y lenguajes de programación para diseñar e implementar soluciones a problemáticas del entorno.
Programación Orientada a Objetos (POO)	Diseñar e implementar objetos de programación que permitan resolver situaciones reales y de ingeniería.
Principios Eléctricos y Aplicaciones Digitales	Comprende y aplica las herramientas básicas de análisis de los sistemas analógicos y digitales para resolver problemas del ámbito computacional.
Fundamentos de Telecomunicaciones	Analiza los componentes y la funcionalidad de diferentes sistemas de comunicación para evaluar las tecnologías utilizadas actualmente como parte de la solución de un proyecto de conectividad.

Fuente: Elaboración propia con información obtenida en los temarios de la retícula actual de la carrera de ISC del Itesi

The objective of this project was to obtain as a product a technical guide in which the students can consult the information, requirements and adequate requirements of the related subjects for the generation of prototypes of local wireless connectivity, and with it, solve the problematic raised. Likewise, the advantages and benefits that students have received from the use of the technical guide are the implementation of workshops or dissemination courses taught to students and teachers at the basic and higher levels, the generation of quality products, controlled prototypes via wireless, such as robotic automated arms, obstacle evaders, line followers and projects with a positive impact on the environment. To mention an example, in 2016 students of the degree obtained a third place at the graduate level in a contest of innovation and technological development of the National Association of Universities and Institutions of Higher Education (Anuies), also obtained the first place of the local phase of the National Student Event of Technological Innovation (ENEIT) held at the Itesi, and finally the first place in the category of technological development at the Meeting of Young Researchers. Another aspect to highlight is that as a result of the above three products have been registered in the National Copyright Institute (Indautor).

Methodology

To carry out the technical guide, three areas were analyzed in three fundamental stages of the ISC career carried out according to the chronological order and delivery in their grid. Next, the theoretical / technical references of each of them are specifically described, based on the fact that some concepts or terms are seen and exposed by the teacher during the first classes, so that only the information that the student describes is described. requires for the integration of these areas.

Stage 1: Digital Electronics

- Matter: Electrical Principles and Digital Applications.
- Semester: 4th.
- Topics involved:

Topic 1. Foundations of electrical circuits.

Topic 4. Converters.

- Competence achieved: Understands and applies the basic tools of analysis of analog and digital systems to solve problems in the computing environment.

Technical aspects

Two topics are analyzed in this stage: 1) Arduino as the base platform on which the student manages to promote their automation, robotics or home automation projects, and 2) the bluetooth module with which they will interact with their mobile device.

Knowledge of Arduino

The student must know that Arduino is declared as hardware and free software. Commonly the hardware is known as a board with a programmable microcontroller and of which there is a great variety of types (One, Mega, Nano, etc.) and the software with which it interacts is usually called Arduino IDE in reference to the interface or environment graphic on which the plate is programmed.

Why Arduino?

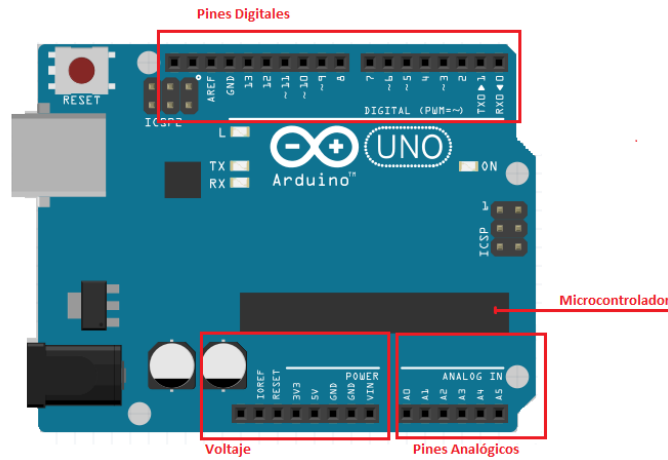
"Arduino simplifies the process of working with digital electronics, implies low acquisition costs, works with different operating systems so it is multiplatform and its software is open source" (Vega, Santamaria and Rivas, 2014, p 26). Arduino Uno and Arduino Mega are the two types of plates that are used in this guide since they are the most common, economical, accessible in the local market and because they are compatible with a vast universe of electronic components. Equally:

The platform allows the teaching of concepts included in the field of automation such as motor control, position and speed control, trajectory control, electronic knowledge reinforcement, wireless communications management, integration with Android systems in an applied way and without requiring advanced programming knowledge (Soriano et al., 2013).

How does Arduino work?

Arduino uses a programmable microcontroller whose integrated circuit has the three basic characteristics of a common processor of any computer: a central processing unit, which is in charge of executing the instruction block or program that is "loaded"; a limited but sufficient memory to store a block of instructions to perform infinitely the same operation until the electrical supply or voltage is wasted, and a means of communication with the input and output peripherals whose purpose is to interact with sensors and actuators.

Figura 1. Segmentación de pines en Arduino UNO



Fuente: Elaboración propia

The Arduino microcontroller (see figure 2) is the 8-bit ATMEGA328P-PU, which has a small RAM memory, a microprocessor, a digital analog converter, an oscillator for data transmission, digital inputs, analog inputs and busses. communication. Some of its main features are the following: 23 input / output pins, programmable 32 kB flash memory, SRAM with capacity for 2 kB and an EEPROM memory of 1 kB.

Figura 2. Microcontrolador ATMEGA328P-PU



Fuente: <https://www.microchip.com/wwwproducts/en/ATmega328P>

E / S signals and component compatibility

"The signals represent information, often the signals do not directly carry the necessary information and may not be free of disturbances, signal processing forms the basis to highlight, extract, store or transmit useful information" (Ambardar, 2002). For this reason, students must understand which of the electronics components they are using are able to send or receive this type

of digital or analog signals and subsequently perform some type of processing with the extracted data.

There is a list of materials and components that must be identified, such as sensors, which are all components and devices capable of detecting physical quantities to convert them into measurable electric quantities; instead, an actuator is all that component and device capable of transforming some type of energy into another, according to the objective of each of them, communicating by means of pins and a USB port with which the code programmed in Arduino IDE is stored . Next, in table 2, the sensors and actuators that are used in the matter of Electric Principles are listed and the type of component that is each of them is assigned.

Tabla 2. Sensores y actuadores utilizados por estudiantes de ISC

Sensores	Actuadores	Shields
Sensor de golpe	Servomotor Sg90	Motor drive Shield L2939d
Sensor de temperatura	Motor reductor de doble eje	Ethernet Shield W5100
Sensor ultrasónico	Mini bomba de agua	LCD Keypad Shield 6x2
Sensor óptico reflectivo		Sensor Shield v5
Sensor de humedad		Proto Shield
Sensor RFID		Shields puente H

Fuente: Elaboración propia

Arduino pins

Every Arduino board has three areas for three types of pins. There are voltage supply and supply pins that handle 3 V and 5 V levels, as well as ground (GND); an area with analog pins, which go from pin A0 to pin A5 and are characterized by reading different voltage levels ranging from 0 to 5 volts, and has another area for digital pins that go from pin 1 to 13 and its characteristic The main thing is that it can only read two signal levels: LOW for values close to 0 V and HIGH for values close to 5 V. The Serial 0 (RX) and 1 (TX) pins, for their part, have the objective of sending and receive data, while the AREF pin is in charge of assigning a specific value to the analog pins through the "analogReference" function. Figure 1 shows the location of these areas in the Arduino UNO.

Shields

"A Shield is nothing more than a printed circuit board that is placed on top of an Arduino board and connected to it by coupling its pins are need for cable" (Torrente, 2013, p.127). For the development of some more complex practices some extra components compatible with the Arduino boards are necessary to allow to expand their capacities and work with the same voltage levels as the board. These types of components are known as shields and there is a wide variety of them. Figure 3 shows some examples.

Figura 3. De base Arduino UNO, encima Shield Wifi, encima Shield Ethernet.



Fuente: <https://aprendiendoarduino.wordpress.com/2016/03/28/shields-arduino/>

The shields also manage to facilitate the coding of the devices to the programmer and reduce the lines of code necessary to make them work, as well as being able to include accessible and easy-to-install libraries.

Arduino IDE, general use

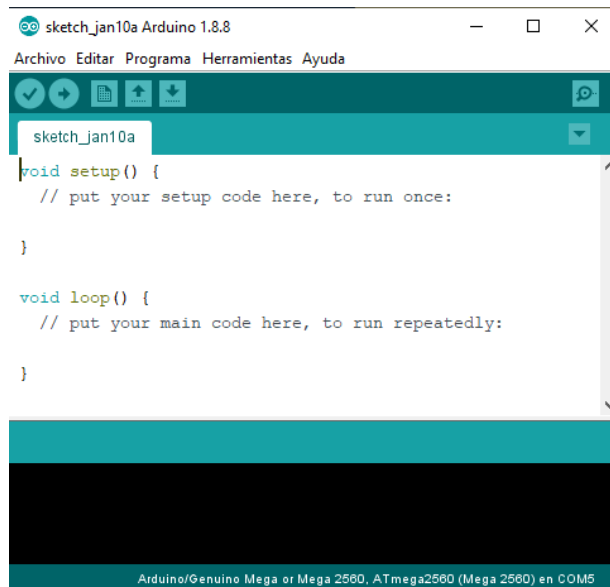
For the use of the development environment or software that interacts with the programmable board, the following points must be taken into account:

- 1) To compile a program it is first necessary to save it, later you can click on the blue icon on the left with a popcorn, at the bottom it will be notified if there is a problem with the syntax.
- 2) If the project that is being developed requires a component or shield with a library, it should be downloaded as a rar file, installed and declared at the beginning of the program.

- 3) Variables must be declared at the beginning of the program with the components and pins that will be working as inputs and outputs according to their use (INPUT / OUTPUT).
- 4) The main code is usually called sketch, which is divided into two parts: void setup and void loop. In the void setup, the declared variables are declared and assigned initial values, as well as inputs and outputs in the ports that will be interacting with the components of the prototype. In the void loop, the action or actions that the sensors or actuators are performing infinitely as a cycle are coded, according to the conditions and indications that are programmed.
- 5) Once the program is compiled without errors, it will be available to be "uploaded" or "loaded" on the Arduino board. To do this, select the plate and port indicated for each practice in the "Tools" menu.

Figure 4 shows the main characteristics of the Arduino IDE interface, such as the name of the program, the location of variables and the main code that will be executed.

Figura 4. Pantalla principal de Arduino IDE

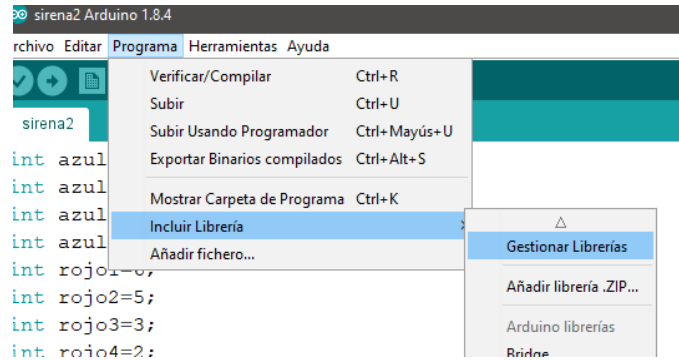


Fuente: Elaboración propia

Installation of libraries

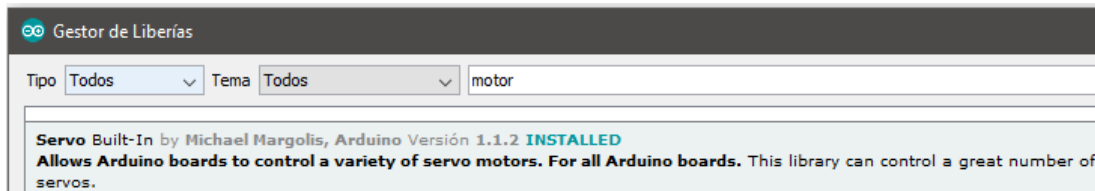
A library can be considered as a complement or extension that allows, for the case of Arduino, that two or more electronic components interact, or manage to transmit data between them. In the case of Arduino, the libraries are generated by third parties and, being free, any user can make modifications or adaptations. Arduino IDE account by default with a group of libraries ready to be used, it is enough that the programmer declares at the beginning of the sketch any of these to make use of it. In this regard, there are two ways to install a library to the Arduino IDE. The first is through the software assistant itself (see figures 5 and 6), following the "Program" menu, "Include Library" and then "Manage Bookstores". Next, a window with a text box will appear to perform specific searches with a description of the component or shield and an option to download it.

Figura 5. Menú para acceder al gestor de librerías



Fuente: Elaboración propia

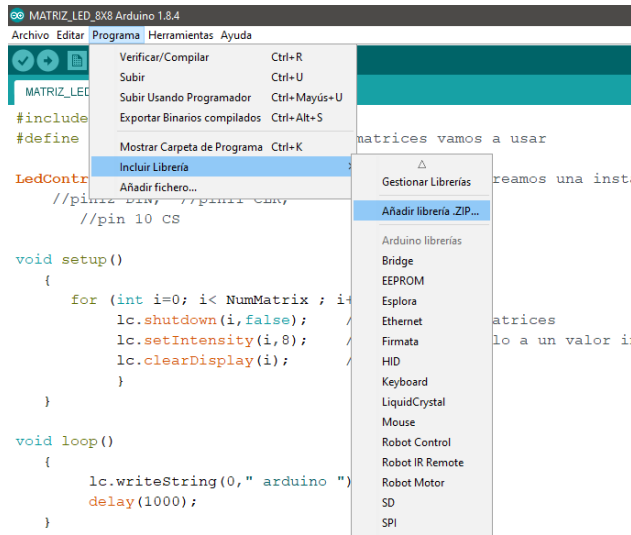
Figura 6. Ventana de búsqueda para librerías en Arduino IDE



Fuente: Elaboración propia

The second option allows you to manually install the library previously downloaded from an official website or from the manufacturer's website, depending on the component or shield to be used. To do this, click on the "Program" menu, "Include Library" and then on "Add .ZIP Library" (see figure 7). The dialog box will open to search the library in any location and click on accept. Arduino IDE will notify that the library was added in the lower part of compilation notifications and may be visible in the list of libraries of the "Program" menu.

Figura 7. Menú para agregar una librería en formato zip

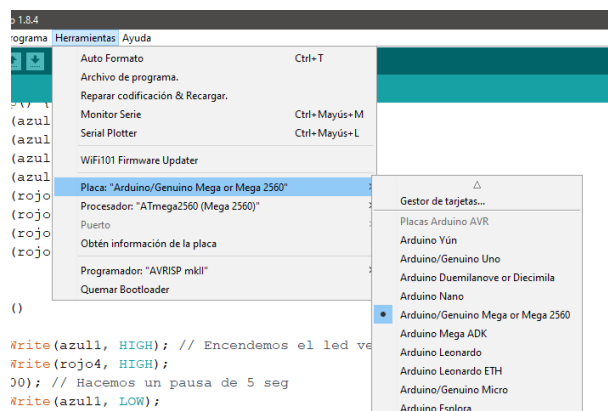


Fuente: Elaboración propia

Load program on Arduino board

Before loading the sketch on an Arduino board, you must have clearly identified the type of board with which it is counted and indicate this information to the software. It can be done in the "Tools" menu, then in "Plate" and click on the indicated name (see figure 8). Otherwise, the sketch will not load and a notification with the error is generated.

Figura 8. Lista de placas Arduino



Fuente: Elaboración propia

In addition, the USB port of the equipment to which the board is connected must be indicated, following the "Tools", "Port" menu and the enabled port is selected. It should be noted that the computer that detects the Arduino assigns a communication port (COM), which will be enabled

only when the board is detected and once the drivers necessary for its operation are downloaded once.

Stage 2: Telecommunications and bluetooth technology

- Subject: Fundamentals of Telecommunications.
- Semester: 5th.
- Topics involved:

Topic 1: Communication system.

Topic 2: Means of transmission.

Topic 5: Communication models and devices.

- Competence achieved: Analyzes the components and functionality of different communication systems to evaluate the technologies currently used as part of the solution to a connectivity project.

Bluetooth

It is one of the most common wireless transmission media available today. Widely used in portable computing equipment and mobile devices, it is considered as "a short-range technology designed for connections from peripherals to computers or devices, it is optimized for energy-efficient radio transceivers ideal for personal devices" (Raya, Raya and Martínez, 2008, p.101).

Bluetooth technology is a standard that combines various communication protocols, applied in low-cost devices that use Full-Duplex transmission with radio frequency connectivity to transmit voice and data in a wireless personal area network (WPAN), operating at a transfer speed of 720 kb / second in an optimum range of 10 meters and a frequency that can vary from 2.4 to 2.48 GHz. Analyzing this technology from the electronic point of view, the Bluetooth module HC-05 is currently one of the most efficient for the local wireless connection to have greater features and benefits than the HC-06, since, by making use of AT commands (pre-established code whose purpose is to interact by means of a terminal between the human being and the component), it can be operated in a slave or teacher: its main difference when students develop projects and applications that require this composes nte.

The bluetooth module HC-05 is the one that offers a better price and features ratio, since it is a master-slave module, that is, in addition to receiving connections from a computer or tablet, it is also capable of generating connections to others bluetooth devices. What allows to connect two bluetooth modules and form a point-to-point connection to transmit data between two microcontrollers or devices. Next, the function for each one of the pins in the module HC-05 is described (since it has two more pins than the HC-06, it is deduced that the latter will have the characteristics mentioned in the four pins with which it has):

- 1) Pin State: this pin determines the current state in which the module was configured / programmed (slave / master).
- 2) Pin RX: this pin receives the data that is processed on the Arduino board by means of the sketch with which it was programmed.
- 3) Pin TX: this pin transmits data read from the bluetooth module and returns them to the Arduino board to wait for some new indication of the sketch.
- 4) Pin GND: ground pin, necessary for module operation.
- 5) Pin VCC: voltage supply pin that can go to the 3.3 V or 5 V pin, according to the characteristics of each practice.
- 6) Pin KEY: this pin is the one that is required to indicate to the module that it will be working as a master by means of AT commands.

States of the HC-05 module

The bluetooth module can be presented in four possible states: disconnected, connected, AT1 mode and AT2 mode. Table 3 describes some characteristics.

Tabla 3. Estados del módulo *bluetooth* HC-05

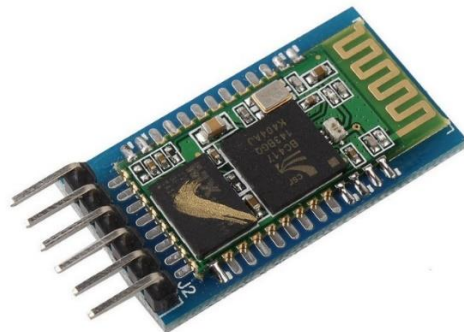
Estado	Características
Desconectado	<ul style="list-style-type: none"> - El módulo no establece comunicación con ningún otro dispositivo. - No puede interpretar ningún comando AT. - Su led, enciende y apaga rápidamente.
Conectado	<ul style="list-style-type: none"> - El módulo ha establecido comunicación con otro dispositivo. - Es capaz de enviar y recibir información por lo pines RX y TX. - Su led parpadea dos veces continuas y hace una espera.
Modo AT1	<ul style="list-style-type: none"> - El módulo es capaz de recibir comandos AT a la velocidad con la que fue programado. - Para entrar a este modo, se requiere presionar el botón del módulo.
Modo AT2	<ul style="list-style-type: none"> - El módulo puede recibir comandos AT a una velocidad preestablecida de 38 400 baudios. - Para entrar a este modo, se requiere dejar presionado el botón durante unos tres segundos.

Fuente: Elaboración propia

Basic program with Arduino and module HC-05

One of the first practices that can be done through the bluetooth component is to turn on a led by means of an application. This requires a breadboard, a led, resistance, power supply and a device (cell phone) on which the application will be installed. In figure 9 this component can be observed.

Figura 9. Módulo *bluetooth* maestro-esclavo



Fuente: <https://www.pccomponentes.com/modulo-hc-05-bluetooth-compatible-con-arduino>

Then, in figure 10, you can see the source code for the creation of a basic practice with bluetooth transmission, in which the goal is to turn on and off a led.

Figura 10. Programa para encender un led por conexión *bluetooth*

```
led_blue $
1 #include <SoftwareSerial.h>
2 SoftwareSerial BT(5,6); // TX= 5, RX=6
3 char opcion;
4
5
6 void setup()
7 {
8   pinMode(13, OUTPUT); //pin 13 al led
9   // Velocidad serial del Modulo BT
10  BT.begin(9600);
11 }
12
13
14 void loop() |
15 {
16   if (BT.available())
17   {
18     opcion=BT.read();
19     if (opcion=='e')
20     {
21       digitalWrite(13, HIGH);
22       BT.println("LED on");
23     }
24     if (opcion=='a')
25     {
26       digitalWrite(13, LOW);
27     }
28   }
29 }
```

Fuente: Elaboración propia

- Line 1: the library required for the use of the bluetooth module is included.
- Line 2: pin 5 connects to the TX port of the HC-05 module, pin 6 connects to the RX port of the HC-05 module.
- Line 3: the variable "opcion" is declared, which will receive the turn-on or turn-off instruction.
- Line 8: Pin 13 is declared as the connection port of the Arduino to the led.
- Line 10: standard speed of the bluetooth module.
- Line 16: if the external device (cell phone) is already connected to the HC-05.
- Line 19 and 24: conditions to turn on or off the led.

Finally, the bluetooth module HC-05 implies the application of the official communication and speed standards seen in the matter of Fundamentals of Telecommunications, as a component of Full-Duplex wireless transmission.

Stage 3: Programming

- Subject: Fundamentals of Programming (FP) / Object Oriented Programming (OOP).
- Semester: 1st / 2nd.
- Topics involved:
 - Topic 1: Algorithmic design (FP).
 - Topic 2: Introduction to programming (FP).
 - Topic 3: Flow control (FP).
 - Topic 2: Classes and Objects (OOP).
 - Topic 4: Polymorphism (OOP).
- Competence achieved: Applies algorithms and programming languages to design and implement solutions to environmental problems (FP).
- Competence achieved: Design and implement programming objects that allow solving real and engineering situations (POO).

As already mentioned, one of the most basic and indispensable areas that an engineer in computer systems must master is programming. To do this, the project aims for the student to master and enter new challenges in which he can acquire new knowledge and programming paradigms. "Many languages can be used to program a computer, the most basic is the machine language, although the most frequent is to use high-level languages" (Gottfried, 2005). In this sense, the students of the career are involved in the programming from the first semester, the competences of the subject matter are covered and they are linked to some more advanced semester subjects.

Technical aspects

From the subject of Fundamentals of Programming, the student acquires the necessary knowledge to carry out online programs of commands, or in an interface with some high level language such as .NET, so that the development of competences related to programming it is directly applied when configuring and programming various electronics modules and sensors in the Arduino IDE, according to the conditions and instructions determined by the objective to be met. This implies the analysis of algorithms, flowcharts and pseudo-code that must later be compiled and "uploaded" to the Arduino's programmable board.

In the case of programming apps with bluetooth technology, the student can opt for an open access tool such as the App Inventor, and thereby create new projects and link various areas and knowledge of the engineer in computer systems.

At present, there are various environments that continue to invite to "build" products derived from languages or environments somewhat simplified, but no less productive that are capable of producing important contributions, not only personal ones; but the beginning of future developments, some of these languages are: Scratch, Alice, Kodu, RoboMind, RoboLab and AppInventor (Diaz, 2015).

The student of computer systems is forced to make flow diagrams and other activities of the race to propose a possible solution to the problem that is being faced in computer terms, which is why the development of one or several algorithms is essential. "To understand an algorithm well, it must be done and executed (...). The term algorithm is used to describe a method of solving a problem that is suitable for its implementation as a computer program" (Sedgewick, 1995, p. 4).

App Inventor is a development environment created by Google and MIT that uses the Android operating system as a base and requires well-supported algorithms for the creation of mobile applications. Among its main advantages are those listed below:

- The development of block programming, which greatly facilitates the student that their algorithmic analysis or pseudo-codes can be implemented by pre-programmed blocks and ready to change parameters or structured sequentially as an algorithm for the execution of a specific objective.

- Accessible and secure: applications can be developed and stored online, an email account is required in the cloud and a password to access, the only requirement is to have internet service.
- Compatible Installer: means that once the application is finished, App Inventor gives the option to download the app with the .apk format and ready to be installed on Android devices, including being able to mount an image or photo as an icon.
- Compatible with a wide variety of sensors and components such as wifi, bluetooth, GPS and maps, among others.

Figure 11 shows the main screen of the website that hosts App Inventor, whose link is <http://appinventor.mit.edu>.

Figura 11. Ventana de acceso a la plataforma App Inventor

You are now logged out of MIT App Inventor

You are logged out. You can either close this window or use the button below to login to MIT App Inventor again.

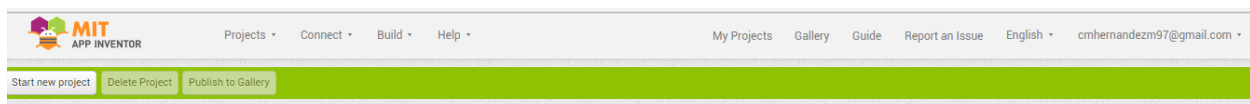
Login Again to MIT App Inventor



Fuente: <http://appinventor.mit.edu>

The use of App Inventor requires minimal programming knowledge, so for a student in the area it is extremely easy to use as a first step in creating apps on the device, as well as emulating in the computer equipment.

Figura 12. Menú principal de App Inventor

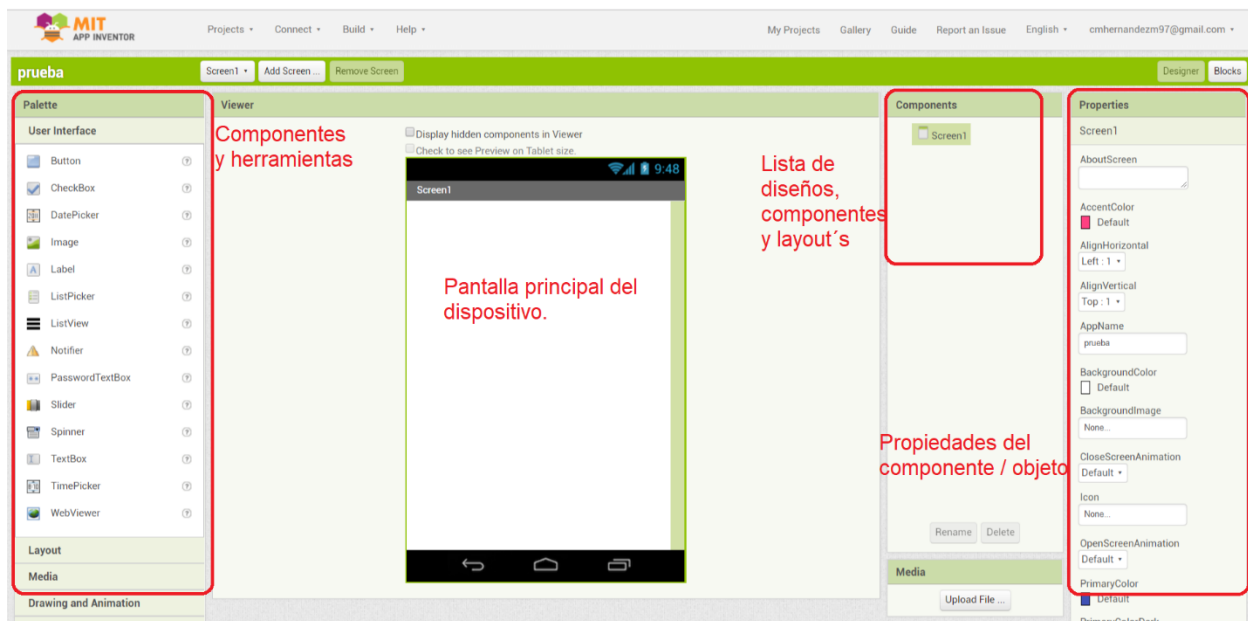


Fuente: <http://appinventor.mit.edu>

Once the user enters the system with their registration data, they can immediately create their first online application by clicking on the "Start new project" button (see figure 12).

Figure 13 shows the modules of the new project with which the student can interact, which are easy to identify and use.

Figura 13. Pantalla principal de un proyecto nuevo en App Inventor



Fuente: Elaboración propia

Components and tools

Like a high-level programming language, App Inventor has a list of objects and components that can be added to the interface, such as labels, text boxes, buttons, layouts, panels, among others. Simply select the component and drag it to the main screen.

List of components

In this section, all the components and objects involved in the application will appear, in order to change their name, rename it or delete it. It is useful in the case of selecting overlapped components.

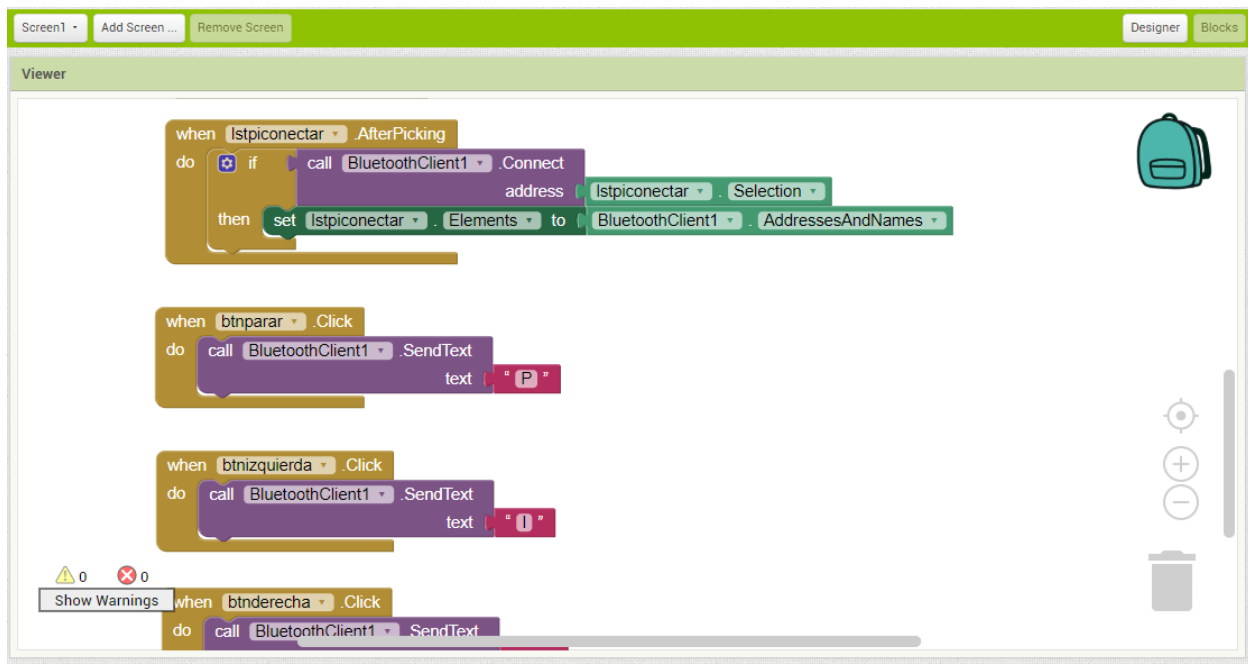
Properties of the object

As can be anticipated, in this section the user can modify the visual effect of the components used, as well as the size, style or alignment of the same.

Instruction blocks

Figure 14 shows the blocks of instructions used by App Inventor, which could pass as "source code" of the application as it is more a set of preprogrammed instructions for configuring and adapting parameters (it can also be considered pseudo-code), without However, it requires algorithmic analysis and the sequence of instructions that must be executed in relation to the Arduino IDE sketch. It is extremely important that the source code of the sketch be linked to the options programmed in App Inventor.

Figura 14. Código fuente de la sección bloques en App Inventor



Fuente: Elaboración propia

At the end of the application, the student can make a first test of the result obtained in his device, since it is common to find some technical flaws in the dimensions of some components. To create the application installer, click on the "Build" button and then choose the option of your

choice, since another of the qualities of this platform is that it allows you to download the application with a QR reader or through of a code, in addition to the traditional "save on the device".

Finally, the three areas mentioned in the project culminate with the development of a wireless transmission prototype, and as a result a sufficient technical guide is obtained so that students can undertake the development and undertaking of more complex projects.

Conclusion

The development of activities and practices related to this project foster in the student the interest to undertake new prototypes in which they can apply and increase their knowledge. In the area of telecommunications come to understand the standards and protocols applied in wireless transmission by bluetooth, including programming these modules in its two versions (master-slave), in addition to retransmit and link to more than two bluetooth devices. In the area of programming the student has access to free software platforms capable of creating mobile applications in a simple and effective way, so it is common for these students to present some semesters of advantage over their peers, which guarantees better performance and comprehension in the semesters dedicated to this platform. In the area of electronics, students can see the terms and concepts seen in their syllabuses when performing their practices.

The result of obtaining a technical guide for students of the first semesters is the rapid understanding of the three areas of the career involved, the integration with teams of more advanced students with whom they have to collaborate and practice a teaching practice among peers, the development of various skills and competences implicit in career agendas, leadership being an active member of a work group and delegating some activities, the initiative to generate new ideas in integrating projects, the continuous participation in contests and events of the nature and the generation of new knowledge.

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