Design of a System Access Control for Classrooms Faculty of Applied Sciences Engineering and Electronic Devices Using Wireless Network Technology in a WPAN.

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Summary. - The objective of this project is to design an access control system for the doors of the Faculty of Engineering of Applied Science providing safety, comfort and flexibility to students and teachers. Initially a study of electronic devices for the creation of an electronic board as well as the creation of a database in SQL Server and design software in Microsoft Visual Studio C # which are the main basis for the design is done.

I. INTRODUCTION

Electronics is the part of science and technology studies the behavior and performance of electronic devices. Initially, it was based on the use of pipes and valves, but today the situation is very different, since in almost all of the elements used in any electronic system are constructed from materials called semiconductors.

The advancement of technology has made it very likely to come across hundreds of electronic components in very small spaces (phones, laptops, etc.)

II. ELECTRONIC COMPONENTS

Electronic components are known devices that are part of an electronic circuit. Generally they encapsulated, usually in a ceramic, metal or plastic, and finish in two or more terminals or metal pins. They are designed to be connected together, usually by welding, to a printed circuit, to form said circuit.
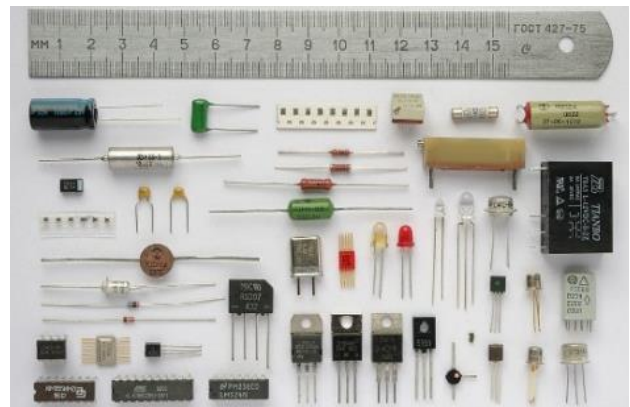

Fig. 1 Electronic components.

A. Classification of Electronic Components.

According to the criteria you choose can get different classifications. Then more detailed commonly accepted.

1) *According to its physical structure.*

- Discrete: Those that are encapsulated one by one, such as resistors, capacitors, diodes, transistors, etc.

- Integrated: Forman more complex assemblies, such as an operational amplifier a logic gate or which may contain from a few discrete components to millions. They are called integrated circuits.

2) *According to the manufacturing base material.*

- Semiconductors.
- No semiconductors.

3) *According operation.*

- Assets: provide electrical excitation, gain or control.

- Liabilities: Ensure the transmission of electrical signals or changing your level.

4) *The energy type.*
   - Electromagnetic: Those who take advantage of the electromagnetic properties of materials (mainly transformers and inductors). Electroacoustic: They transform the acoustic energy into electrical and vice versa (microphones, speakers, speakers, headphones). Optoelectronic: They transform light energy into electrical and vice versa (LED diodes, photocells, etc.).

One of the most important for this design electronics is the microcontroller and wireless modules which three alternatives are studied, as currently there are different types and trademarks that are dedicated to the distribution of these elements, each with different characteristics.

III. MICROCONTROLLERS

A microcontroller is basically integrated semiconductor circuit comprising (transistors) interconnected to facilitate the functioning of a particular process that is desired sequentially and automatically.

A. *Microcontroller Manufacturers.*

In the world of electronics there are various brands of microcontrollers, each with its respective feature, but its basic structure is the same in all the different families of each. Among the most renowned manufacturers mentioned:

- Microchip
- Intel
- Motorola
- Atmel, etc.

B. *Common Resources Microcontrollers.*

A microcontroller to be integrated on a chip, its basic structure and its basic characteristics are very similar, however each manufacturer seeks to emphasize the most efficient resources for different applications are used. In Fig. 2 the internal structure of a microcontroller indicated.
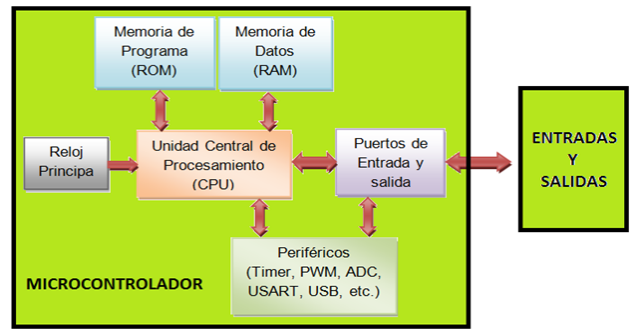

Fig. 2 Internal structure of a microcontroller.

C. *Special Resources Microcontrollers.*

They are modules incorporated in a given microcontroller, microcontroller known as fuses that support for better control of peripherals which are mentioned below.

- "Timers".
- "Watchdog".
- Power up timer.
- Protection against power failure or "brownout".
- State of rest or low consumption.

D. *Microcontroller architecture and Types of Processors.*

According to the internal architecture of the memory of a microcontroller you can be classified considering as the CPU accesses data and, in 2 types instructions:

1) *Von Neumann Architecture.*

It was developed by John Von Neumann, it is characterized by having a single main memory where instructions and data are stored interchangeably. The CPU is connected through a system bus (address, data and control). This architecture is limited when speed is claimed.

Fig. 3 Von Neumann Architecture.

2) *Harvard Architecture.*

It was developed at Harvard, Howard Aiken, this architecture is characterized by two independent memories one containing only instructions and another that contains only data. Both have their respective bus systems for access and it is possible to access operations simultaneously in both memories.
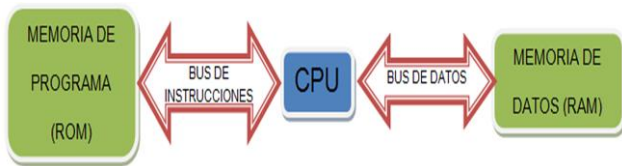
Fig. 4 Harvard Architecture.

3) *Pipelined processor.*

Simultaneously performs two processes:

- The instruction execution and
- The search for the code of the next instruction.

In this way, you can execute an instruction in a single machine cycle. This system is accompanied by a Harvard structure, which allows instructions to be executed in one machine cycle except the program jump, as indicated in Fig. 5.
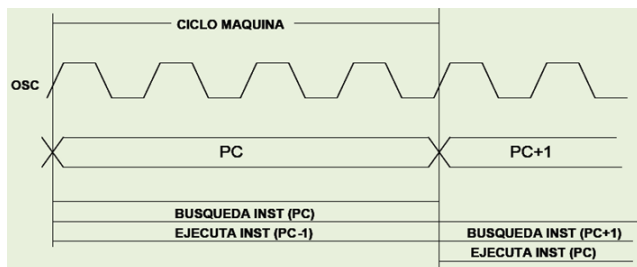

Fig. 5 Pipelined processor.

4) *Processor according to the number of instructions.*

CPUs depending on the type of instructions that can be classified mainly used in:

- CISC (Complex Instruction Set Computer) processors are a set of complex instructions. Its instruction set is high and some of them are very sophisticated and powerful. Their problem is that they require many clock cycles to execute the instructions.
- RISC (Reduced Instruction Set Computer) microcontrollers are a repertoire of reduced instruction. The instructions are very simple and usually run on a single machine cycle. RISC processors usually have a Pipe Line structure and run almost all directions at the same time.
- SISC (Specific Instruction Set Computer): These processors have a set of specific instructions for each application. They are intended for very short applications.

E. *Comparison of Different Microcontrollers Manufacturers.*

Microcontroller manufacturers listed above are the most globally recognized for what has been decided to study a microcontroller, the most representative or "popular" on a commercial level, of each of them. We must take into account that each manufacturer classifies microcontrollers "microcontroller families" as each "family" has similar characteristics, varying in some parameters to each other.

TABLE I

COMPARISON OF MICROCONTROLLERS

Parameters		PIC18 F4550	ATmega 164P	Intel 8051
Architecture		**RISC**	RISC	CISC
Data processing		**8 bits**	8 bits	8 bits
Word Width		**8 bits**	8 bits	16 bits
Memory	RAM	**2048 bytes**	4000 bytes	128 bytes
	FLASH	**32000 bytes**	44000 bytes	4000 bytes
	EEPROM	**256 bytes**	2000 bytes	-
Feeding tension	Max	**5.5 V**	5.5 V	21.5 V
	Min	**2.0 V**	4.5 V	-0.5 V
Ports Input / Output (Pines)		**5 (40 Pines)**	4 (40 pines)	4 (40 pines)
Communication	USART	**Yes**	Yes	Yes
	USB	**Yes**	No	No
Programming language		**Easy**	Easy	Complex
Size		**Medium**	Medium	Medium
Cost		**8,00**	10,50	8,50

IV. WIRELESS MODULES

The wireless modules are devices that allow you to add connectivity without the need for wiring to network and expand it. These modules are designed by different manufacturers, as well as microcontrollers, but each belonging to a different wireless standard that specify certain characteristics thereof.

These standards are referenced in the IEEE 802.x, where x specifies the technology with which communication is handled.

In 1978 the US-NSPAC (National Advisory Committee on Standards Policy) defined "standard" as: "A prescribed set of rules, conditions, or requirements concerning definitions of terms; classification of components; specification of materials, performance or operations; delimiting procedures; or measures the quantity and quality in describing materials, products, systems, services or practices.

The standards are used to ensure safety, quality, and consistency in teams. A team that follows a specific standard implies the possibility of interoperability with other products and not be "tied" to a single vendor.

Three different technologies use different standards emphasizing the main features of each are analyzed.

A. IEEE 802.15.4 (ZIGBEE).

Zigbee is a wireless communication protocol based on standard IEEE 802.15.4 wireless communications networks. Created by Zigbee Alliance, an organization theoretically non-profit, more than 200 large companies (include Mitsubishi, Honeywell, Philips, Motorola, among others), many semiconductor manufacturers.

1) 802.15.4 Features.

- Double physical layer (2.4 GHz and 868/915 MHz).
- Data Rate 250 Kbps (2.4 GHz), 40 Kbps (915 MHz) and 20 Kbps (868 MHz).
- Energy optimization.
- The channel access method is CSMA / CA.
- Low battery use, it can take several months or years.
- Multiple topologies (mesh, point-to-point, star).
- You can create a network with devices connected together 65535.
- It has a range of 10-75 m. Depending on the work environment and the equipment used. There are devices that can reach up to 1 km away.

2) Network Topology 802.15.4.

Depending on the degree of functionality of the device, the standard defines:

- The FFD (Full Function Device-), which are devices that implement a comprehensive communications model, which allows you to communicate with any other device on the network.
- The RFD (Reduced Function Device-), which are devices with limited benefits for communication, which only allow you to communicate with FFD.

The networks can be formed host three types of nodes:

- Coordinator. It is a FFD device that is responsible for creating the network of nodes and manage their communication. In each network there is a single coordinator.
- Router. It is a FFD device that is responsible for routing information between nodes that are far apart on the network.
- End device. RFD is a device that can transmit or receive information, but it cannot perform routing tasks. Necessarily it must be connected to a coordinator or a router.

Each Zigbee network has a unique network identifier, which allows multiple Zigbee networks can share a single communications channel, and can be configured according to different topologies: star, tree or mesh. In all there is a Coordinator and one or more devices Routers and / or Finals.
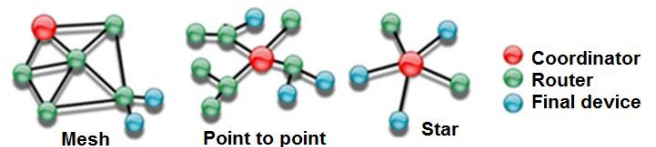

Fig. 6 Network topology 802.15.4 standard.

These topologies allow communication between two devices that are outside of its transmission range, as long as they are connected by intermediate nodes. The most interesting topology is the mesh topology. This allows that if, at a given moment, a road node fails and is unable to transmit or receive information, can continue communication between all other nodes because all the roads are re-enacted. The administration of the roads is up to the coordinator.

3) Advantages and Disadvantages of 802.15.4.

Zigbee like all communication technologies has its positive side and their drawbacks:

Advantage.

- Ideal for point-to-point and point to multipoint
- Designed for addressing information and network refresh.
- Opera in the free band ISM 2.4 GHz for wireless connections.
- Optimal for networks of low data transfer rate.
- Reduce waiting times in sending and receiving packets.
- Energy Detection (ED).
- Low duty cycle - Provides long battery life.
- Support for multiple network topologies: Static, dynamic, star and mesh.
- Up to 65,535 nodes on a network.

- 128-bit AES encryption - Provides secure connections between devices.
- They are cheaper and simpler construction.
- Zigbee have low radiation and therefore can be used in the medical sector.
- Range 10 m to 75m.

Disadvantages.

- The transfer rate is very low.
- Only small text handling compared to other technologies.
- Zigbee works so that may not be compatible with Bluetooth in all its aspects because they fail to have the same transfer rates, or the same ability to support nodes.
- Have less coverage because it belongs to type WPAN wireless networks.

B. IEEE 802.11 (WI-FI).

The IEEE 802.11 (ISO / IEC 8802-11) is an international standard specification that defines the characteristics of a wireless local area network (WLAN). Wi-Fi (which stands for "wireless fidelity") is the name of the certification by the Wi-Fi Alliance, formerly WECA (Wireless Ethernet Compatibility Alliance), a group which ensures compatibility between devices using the 802.11 standard.

1) Features of 802.11.

The 802.11a, 802.11b and 802.11g standards, called "physical standards" are amendments to the 802.11 standard and operate in different ways, allowing them to achieve different speeds in data transfer according to their ranks.

TABLE II

BANDS OF WI-FI.

Standard	Frequency	Speed	Rank
802.11a	5 GHz	54 Mbps	10 m
802.11b	2,4 GHz	11 Mbps	100 m
802.11g	2,4 GHz	54 Mbps	100 m

The standard defines two transmission techniques:

- The first spread spectrum signal by direct sequence (DSSS).
- The second with expanded frequency hopping (FHSS), which defined the operation and interoperability between wireless networks spectrum.

The media access method is by monitoring, but no collision detection, CSMA / CA (Carrier Sense Multiple Access with Collision Avoidance).

Modulations used are:

- DBPSK (Differential Binary Phase Shift Keying) and
- DQPSK (Differential Quadrature Phase Shift Keying) for transmission rates of 1 and 2 Mbps respectively.

Only three non-interfering channels allows spaced 25MHz in the 2.4GHz band, although the standard 14 channels of operation are defined in that band. In current commercial products, the nominal transmit power is 100mW.
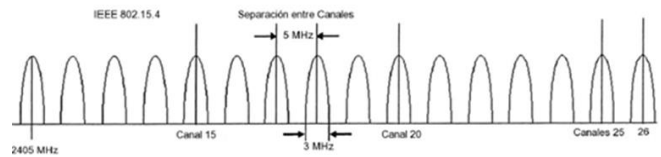

Fig. 7 IEEE 802.15.4 channels.

2) 802.11 network topology.

The IEEE 802.11 standard defines Basic Service Set (BSS Basic Service Set) consisting of two or more wireless nodes or stations recognize each other and can transmit information between them. A BSS can exchange information in two different ways:

- Each node communicates with the other directly and without any coordination form. Also called Ad-Hoc or IBSS (Independent Basic Service Set). This mode only allows transmission between wireless nodes and does not solve the problem of extending a wired LAN.
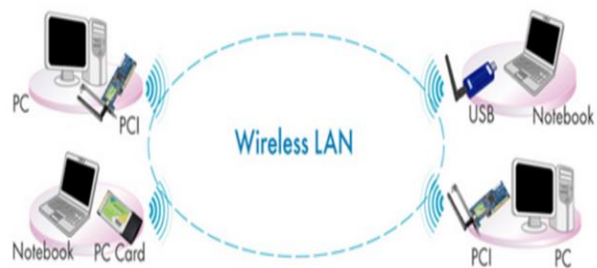

Fig. 8 Network topology Ad-Hoc or IBSS.

- There is an element commonly called AP (Access Point) that coordinates transmission between wireless nodes. This mode is called Infrastructure mode, and allows wireless network link with the wired network as the AP acts as a bridge between

the two networks. The existence of multiple APs connected to a DS (Distribution System) which can be a wired LAN is what is called EBSS (Extended Basic Service Set). 802.11 technologies allow roaming between different AP.
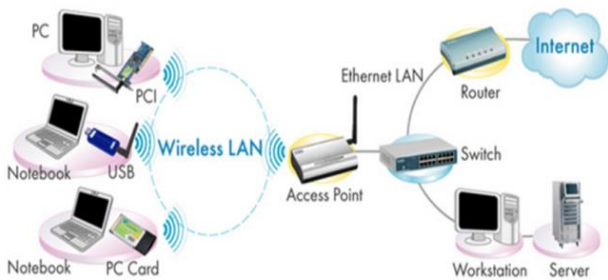

Fig. 9 BSS Infrastructure topology or network.

3) Advantages and Disadvantages of Wi-Fi.

Wi-Fi as well as all communication technologies has its positive side and disadvantages.

Advantage.

- Wireless connectivity, which eliminates wiring and give mobility to a team without losing communication in a certain range.
- Opera in the free band ISM 2.4 GHz for wireless connections.
- Compatibility with any team in the Wi-Fi Alliance.
- Enlarge the network so your network topology can be varied.
- It has different types of security such as: AES, WEP, and WAP2. etc.
- Have greater coverage belonging to WLANs.

Disadvantages.

- Faulty connection.
- High energy consumption.
- Not compatible with other technologies.
- High cost of equipment..

C. IEEE 802.15.1 (BLUETOOTH).

Bluetooth technology is a wireless personal area network (WPAN), defined as a global standard for wireless communication, also known as IEEE 802.15.1 standard, which is used to connect devices to each other without a cable connection. Unlike the IrDa technology, Bluetooth devices do not need a hotline to communicate display. This makes their use more flexible and allows communication between rooms in small spaces, making it a short-range technology.

1) 802.15.1 Network Topology.

The structure that handles this technology consists, in its most basic form, which is called a Piconet and a slightly more complex structure which is called a scatternet..

- Piconet: Two or more Bluetooth devices sharing the same channel form a Piconet connection. This is established through links point - multipoint, where one of the devices plays the role of master while the others are slaves. A piconet can have up to seven active slaves. If a computer is within the radius of coverage of another, they can establish connection between them, as shown in Fig. 10.
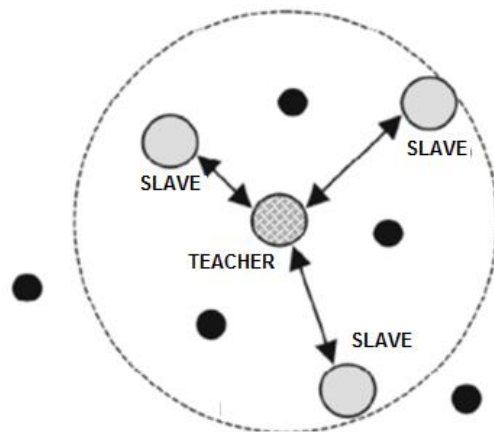

Fig. 10Piconet topology of a Bluetooth network..

However, only those units that really want to share information share the same channel creating the piconet. This allows multiple piconet are created in areas of overlapping coverage.

- Scatternet: A group of piconets is called a scatternet. You can see the formation of a scatternet in which piconet A and B are involved, as shown in the following Fig. 11.
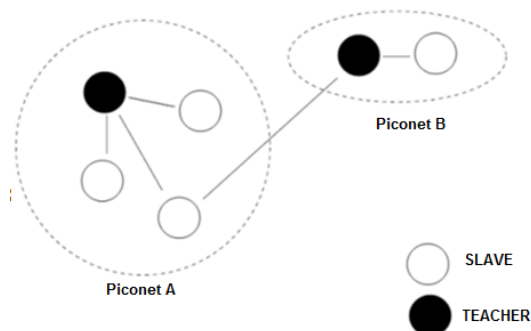

Fig. 11 Scatternet topology of a Bluetooth network.

The more piconets are added to the scatternet, system performance of frequency hopping decreases gradually, and there is a reduction on average of 10%, and on the other

hand a Bluetooth device can only act as master in one piconet, because a piconet is determined by the Bluetooth clock synchronization with the master device. Instead, the device itself can play the role of slave in several piconets.

2) Advantages and Disadvantages of 802.15.1.

Bluetooth like all communication technologies has its positive side and their drawbacks:

Advantage.

- Opera in the free band ISM 2.4 GHz for wireless connections.
- Bluetooth is used for applications in mobile phones and home computers.
- Allows the transmission of data, images and videos between devices.

Disadvantages.

- Durability of very short battery.
- Very slow speeds transmission and data loss in case of disconnect or desynchronization.
- Has short range which does not allow the mobilization of the user.
- Only few devices can connect to each other.

D. Selecting Wireless Technology Fair.

As he mentioned above, a different wireless technology to those used today for wireless communications WPAN, in which were analyzed its main characteristics, same that are necessary for this project was selected. Importantly, one or the other technology is a little difficult to compare because it differs in the use and services delivered. Some observations are discussed; therefore the comparison made in the following table only includes measurable fields.

TABLE III

WIRELESS TECHNOLOGIES COMPARING

Tecnología	Zigbee	Wi-Fi	Bluetooth
Transition speed	250 Kbps	11 Mbps	1 Mbps
		54 Mbps	
Frequency	868 - 868,8 MHz	2.4 MHz	2.4 MHz
	902 – 928 MHz		
	2.4 - 2.483 MHz	5MHz	
	5 MHz		
Modulation	BPSK - OQPSK	DBPSK - DQPSK	GFSK
Transmission techniques	DSSS	DSSS y FHSS	FHSS
Channels	16	3	1

Need line of sight	No	No	No
Maximum range	75 m	100m	10m
Power	1mW	100mW	100mW
Battery duration	Years	Continuous power	Months
Device Number	65535	256	7
Network Topology	Several	Several	Several
Security	AES	AES, WEP, WAP, WAP2	-
Size	Small	Big	Small
Cost	40 $	35 $	25$

V. ELECTRICAL DESIGN FOR CONTROL OF ACCESS TO CLASSROOMS

The electrical interface for controlling access to the classrooms of the Faculty of Engineering of Applied Science (FICA) is based on the study of the logical and physical structure it will have for proper operation; both the part of the wireless communication, and power consumption of the various electrical elements contained therein.

The system consists of three key pairs:

- The graphical interface.
- The transmitter circuit.
- The receiver circuit.

1) Graphical Interface: It is an application that will be used by the teacher to proceed to use a particular classroom.

2) Transmitter Circuit: This will allow for communication between the GUI and the receiver circuit. At the transmitter circuit have the following functions:

- Acquire information through the graphical interface designed.
- Process the information through the XBEE wireless module.
- Transmit and receive the processed information to and from the receiver circuit respectively.

3) Receiver circuit: This will allow for communication between the microcontroller (implemented in this circuit) and the transmitter circuit. In the receiver circuit have the following functions:

- Receive information sent by the transmitter circuit
- Processing the information in the microcontroller.
- Perform the necessary functions opening door.
- To transmit the results to the transmitter circuit.

A. Block Diagram

A block diagram is a general graphical representation of a process or a system internal operation. Then in Fig. 12 and 13 a general diagram of the components and function of each of the circuits that are used for this design are shown.

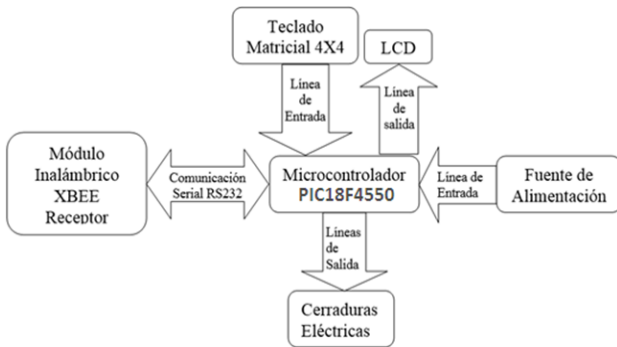Fig. 12 Block diagram of the transmitter circuit.

Fig. 13 Block diagram of the receiver circuit.

B. Network Topology

According to the Zigbee standard that allows multiple configurations in a network topology, for the case of this project, a type star topology by the geographical situation of the faculty and because the modules used with this type of technology does not require line it is used of view, ie work properly indoors and have a range of about thirty meters to communicate with each other, the design of the wireless network is performed as follows.

Each door has a "final device" (receiver module), which communicates with the "router" (router module) installed on each floor, to then send the data transmitted and received to the "coordinator" (transmitter module) installed on the computer, with software application designed for this project.

It should be noted that the physical position of the "coordinator" devices and "routers" are located in a strategic position to achieve full convergence of the wireless network.
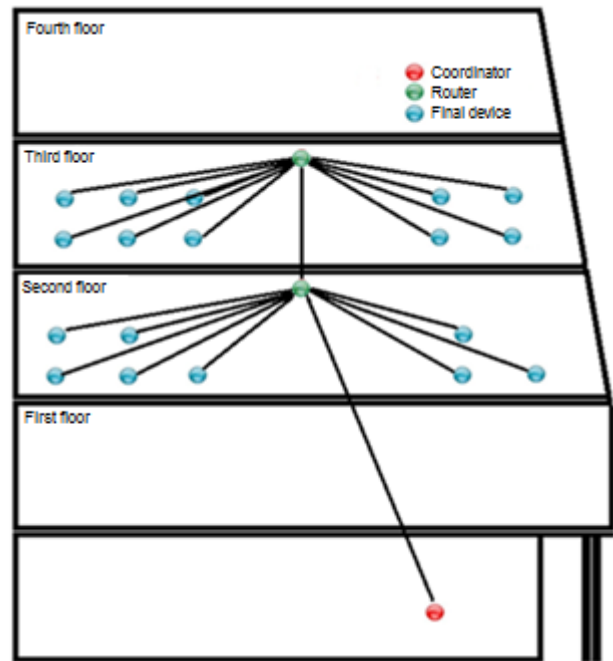

Fig. 14 Network topology using XBEE devices.

C. Send and Receive frames.

The readings of each electronic system are sent in plain text and information contained in the frame that is transmitted and received by each electronic system has the following format:
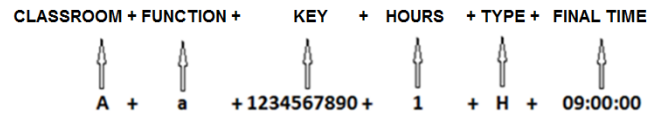

Fig. 15 General format of the frames.

Where:

- CLASSROOM: It belongs to the class corresponding plot.
- FUNCTION: has the following characters:
    - a: Indicates That the classroom will be opened by the owners teacher.
    - c: Indicates the end of class time by the teacher.
    - d: Check the teacher login to use esta classroom.
    - e: Inform the teacher That Remain 5 minutes to the end of class time in the classroom.
    - k: Identifies a confirmation of data sent.
    - v: Indicates That the key teaching is correct.
    - f: Indicates That the key teaching is incorrect.

- KEY: it contains 10 digits will be entered by keyboard corresponding to the characters to enter the classroom, should be typed correctly the classroom will be open, otherwise the system crashes.
- HOURS: Indicates the number of hours that teachers remain in the classroom.
- TYPE: Identifies whether the classroom will be used by:
  - H: The schedule for that academic year on that day.
  - A: If the classroom is used by a reservation made in advance by the teacher.
  - L: If the classroom is used by a janitor to clean the classroom.
- FINAL TIME: Identifies the time that the teacher will be in the classroom.
- SIGN (+): The "+" sign identifies a separation of each of the data to send and receive.

D. Power System Operation.

At this point the electrical parameters and physical configurations that are used in the receiver circuit, as this is the most work is done are analyzed, it will be analyzed separately depending on the operation to perform each electronic element.

1) Reception and transmission of data

When transmitting data should be taken into account that the voltage provided by the microcontroller and XBee module is not the same, we must be careful when integrating these two elements, which is why we should make an extra configuration on pins microcontroller transmission (Tx) and reception XBEE module (Rx), in order to regulate the voltage to the maximum value as specified.

Data:

$$Vm_{Tx} = 5V$$

$$Im_{Tx} = 0.17mA$$

$$V_0 = 3.3V$$

$$R_1, R_2 = ?$$

Where:

- Vm_{Tx} = Voltage pin microcontroller transmitter
- Im_{Tx} = Microcontroller current transmitter pin
- V_0 = Output voltage required for the module XBEE
- R_1, R_2 = Resistance to calculate

$$V_{R1} = Vm_{Tx} - V_0$$

$$V_{R1} = 5V - 3.3V$$

$$V_{R1} = 1.7V$$

$$R_1 = \frac{V_{R1}}{Im_{Tx}} = \frac{1.7V}{0.17mA} = 10K\Omega$$

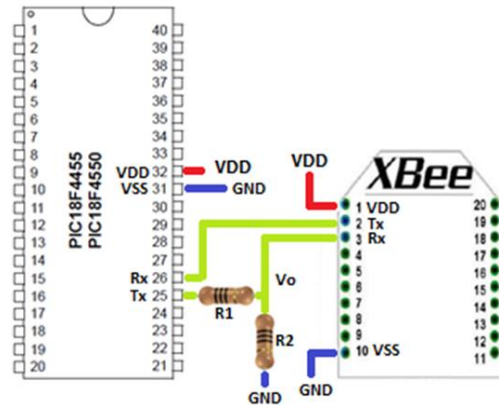$$R_2 = \frac{V_0}{Im_{Tx}} = \frac{3.3V}{0.17mA} = 19{,}411K\Omega \cong 20K\Omega$$

Fig. 16 Diagram of physical connection between the microcontroller and the module XBEE Pro.

2) Viewing Data

The parameters required for configuring the LCD are using a potentiometer, which will simply adjust the contrast of the characters displayed on the LCD, this element can be 5kW, because if it is not used, the characters may not be visible. Finally a resistance in feeding the LCD is placed, this may be 10Ω, and this latter parameter may be optional.
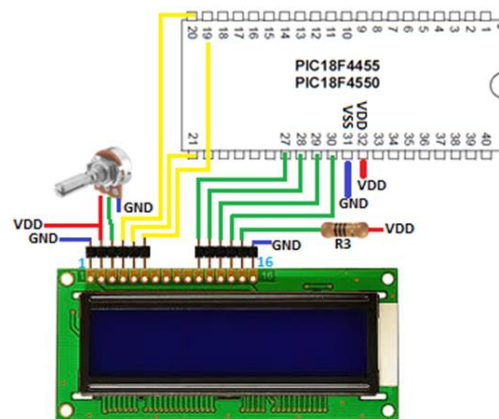

Fig. 17 Diagram of physical connection between the microcontroller and the LCD.

3) Mechanism Opening the Door.

To achieve open the classroom door an electrical mechanism with a relay and a BJT transistor in common emitter configuration is used, this transistor is 2N3904

because it allows work with voltages up to 40V and 200mA, for it is necessary to obtain the values of the resistance placed between the microcontroller and the transistor, this calculation is explained below.

Data:

$$I_{Bmax} = 50mA$$

$$h_{FE} = 30$$

$$Vm = 5V$$

$$V_{BE} = 0.7V$$

$$R_4 = ?$$

Where:

- I_{Bmax} = Maximum current transmitter in the base.
- h_{FE} = Gain transistor
- Vm = Voltage microcontroller
- V_{BE} = Voltage base - transmitter
- R_4 = Resistance to calcúlate.

$$I_B = \frac{I_{Bmax}}{h_{FE}} = \frac{50mA}{30} = 1.67mA$$

$$Vm = I_B * R_4 + V_{BE}$$

$$I_B * R_4 = Vm - V_{BE} = 5V - 0.7V$$

$$I_B * R_4 = 4.3V$$

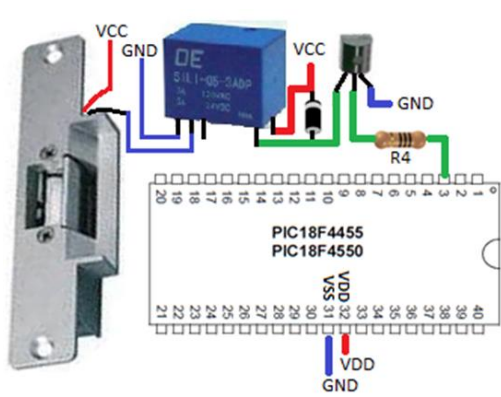$$R_4 = \frac{4.3V}{I_B} = \frac{4.3V}{1.67mA} = 2.57K\Omega \cong 2.7K\Omega$$

Fig. 18 Diagram of physical connection between the microcontroller and the lock relay.

4) Classroom Security (Authentication)

The use matrix keyboard on the receiver circuit helps provide security to the classroom, the connection diagram of this method is very simple, as when configuring the microcontroller in a special way, allows only the connection

of the rows is necessary and keyboard columns, these being the following:

The rows are numbered from 1 to 4 to differentiate the columns that are abbreviated with the letters A, B, C and D.
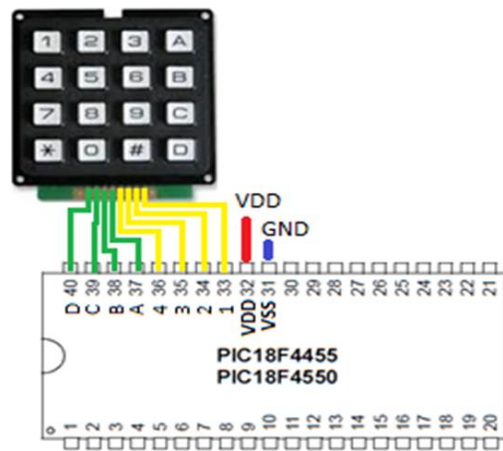

Fig. 19 Diagram of physical connection between the microcontroller and the keyboard.

5) Information remaining time in the classroom (Alarm)

This circuit is used to inform through a sound, the teacher that their time is about to end. This time parameters are pre-configured in the microcontroller, thus giving a better way of using the classroom. The physical configuration of this is similar to the door opening as the same elements and configurations are used therefore you need not be calculated resistance values again.
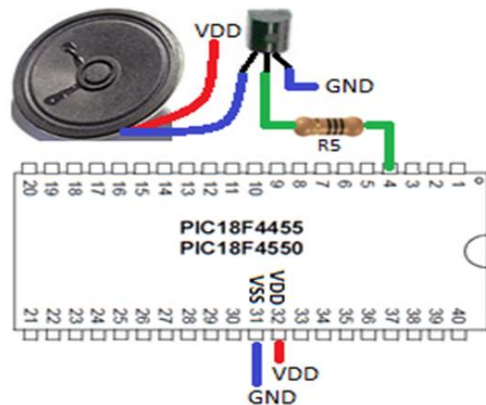

Fig. 20 Diagram of physical connection between the microcontroller and speaker.

6) Interruption of class time and Classroom Use by a Concierge (Pushbutton)

This module allows you to use a classroom without registering in the system before hand this method will be used only by the janitors that perform different functions

teachers of the faculty, and interrupt school hours of a teacher if warranted it so.

Data:

$$V_{in} = 5 \text{ V}$$

$$I_{mic} = 25 \text{ mA}$$

$$R_6 = ?$$

Where:

- V_{in} = Input voltage..
- I_{mic} = Maximum current microcontroller.
- R_6 = Resistance to calculate.

$$Si, I_R \ll I_{mic}$$

$$I_R = \frac{I_{mic}}{50} = \frac{25 \text{ mA}}{50}$$

$$I_R = 0{,}5 \text{ mA}$$

$$I_R = \frac{V_{in} - 0}{R_6} = \frac{5}{R_6}$$

$$R_6 = \frac{5}{I_R} = \frac{5}{0{,}5 \text{ mA}}$$

$$R_6 = 10 \text{ K}\Omega$$

The higher the value of resistor R6, the greater the current flow in the microcontroller pin, ie when using a resistance value greater this prevents the passage of current to the common terminal, allowing it to flow very intensive the microcontroller pin, so that a typical value is 10 k, which is among the calculations with the case C. in this connection Fig.21 module indicated in the circuit is placed.
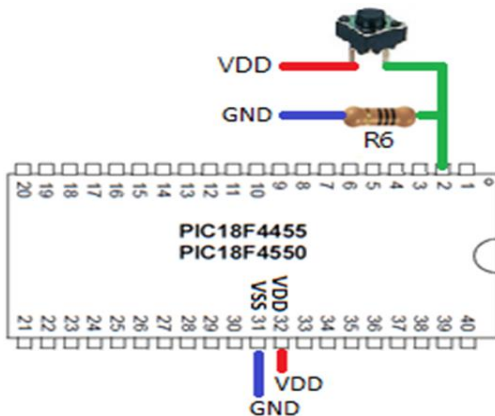

Fig. 21 Diagram of physical connection between the microcontroller and the button.

7) Circuit Status Indicators

This module displays the current state of the circuit, is used to verify if the classroom is being used or not physically by a teacher in a particular classroom.

Then the value of the resistance that will be needed to light a LED diode is calculated, taking into account that each of the LEDs has different characteristics, because depending on the color used it supports different voltage and amperage, so both take a general range of these elements being this 20mA and 10 to 2.2 V 1.5 as specified in the datasheet.

Data:

$$Id_{max} = 20 \text{ mA}$$

$$Vd_{max} = 2.2 \text{ V}$$

$$Vm = 5 \text{ V}$$

$$R_7 = ?$$

Where:

- Id_{max} = Maximum current through the diode led.
- Vd_{max} = Maximum voltage flowing through the diode led.
- Vm = Voltage microcontroller.
- R_7 = Resistance to calculate.

$$Vm = Vd_{max} + V_{R6}$$

$$Vm = Vd_{max} + R_7 * Id_{max}$$

$$R_7 = \frac{Vm - Vd_{max}}{Id_{max}}$$

$$R_7 = \frac{5 \text{ V} - 2.2 \text{ V}}{20 \text{ mA}}$$

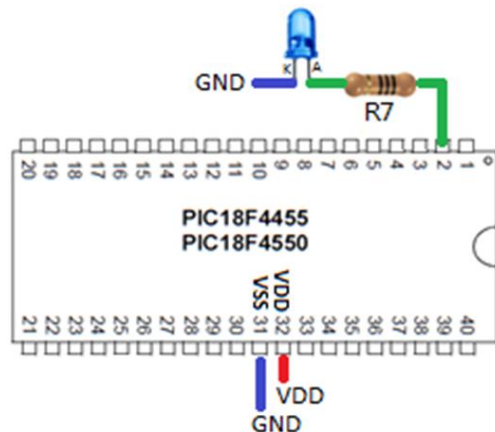$$R_7 = 0.14 \text{K}\Omega = 140 \text{ } \Omega \cong 220\Omega$$

Fig. 22 Diagram of physical connection between the microcontroller and the LED indicator.

Each of these configurations is necessary for the receiver of each of the doors circuit malfunction. Food in certain modules is different, for it is taken into account that the names: VDD, VCC and GND represent this power where: VDD voltage 5V DC voltage of 12V and GND respective grounding circuit, because as it could be seen in several functions are performed.

E. Circuit design Transmitter and Receiver

For the transmitter circuit are connected directly between the two modules and a diode and its respective resistance increases, to verify if the module is being fed properly or not, depending on the state of the module.
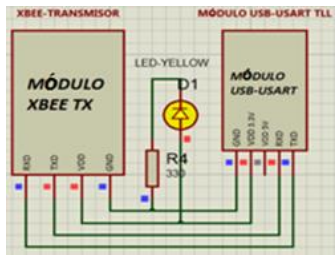

Fig. 23 Transmitter circuit design.

In the receiver circuit, all the electronic elements studied above, wherein the operation process is to receive the data via the XBee module, the same that will be received by the microcontroller, it processes the data using different programming methods are connected later display on the LCD entering data on the keyboard to open the door additionally buttons are incorporated in order to have access to classrooms, without using the graphical interface, this parameter will be used only by the janitors faculty since they do not need to register beforehand, but reports are generated revenue.
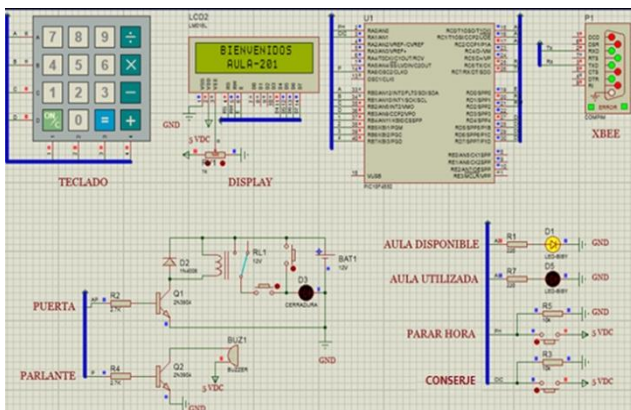
Fig. 24 Receiving circuit design.

F. Design Plate Transmitter and Receiver Circuits Eagle

The design of the tracks of each circuit was held at the Eagle program, which allows electronic design diagrams of a project, later mounted on Bakelite devices it contains. We decided to use this software for this design because it has a free license.
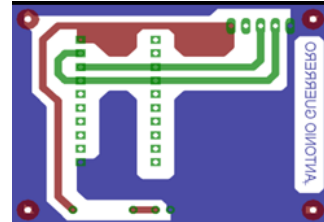
Fig. 25 Transmitter circuit track.
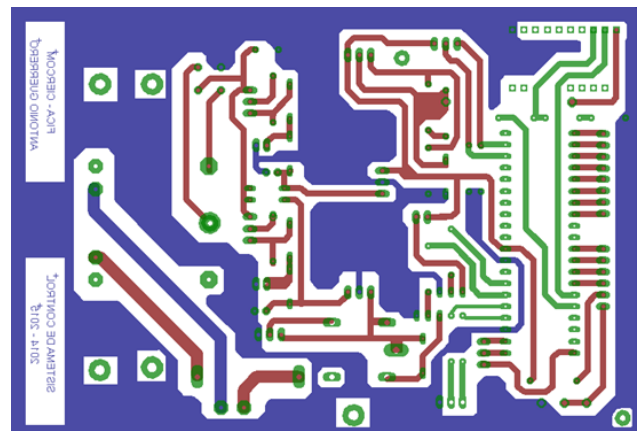
Fig. 26 Receiver circuit track.

G. Transmitter and Receiver circuits

At this point the images of the work or project end hardware indicated to proceed with the software (GUI), which will operate these circuits, said circuits boards are as follows.

Fig. 27 Transmitter circuit.

Fig. 28 Receiver circuit.

Fig. 29 Graphic interface.

VI.   DESIGN DATABASE ENTRY SYSTEM CLASSROOM

To design a database should take into account certain important parameters such as:

- The conceptual design
- The choice of System Manager Database (DBMS)
- The Logical design
- Physical design

VII.   GRAPHIC DESIGN SYSTEM INTERFACE ENTERING THE CLASSROOM

The design of the GUI of this project is based depending on the use to be given to the different classrooms, for it is has different ways of income which are called them:
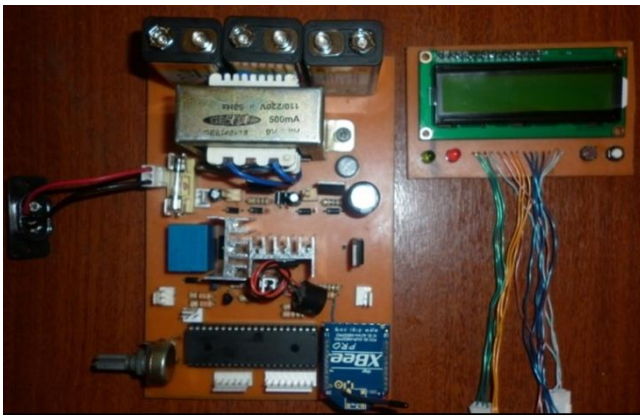
- Administrator
- User
- Eventual

1) Administrator: Is responsible for managing the application and the database as needed, which will allow for actions like delete, create, modify, whether the data of a teacher as data from classrooms and materials, allowing you to change different parameters.

2) User: Is one that will have certain permissions in the application, that is to say, it is only allowed to modify and verify own data and see the classrooms that are available at that time and use a classroom available should you need it out your normal schedule.

3) Eventual: It is one who can see different classrooms that are available and occupied in a given period.

A.   Priorities entry modes Control System

The priorities of each entry modes are assigned depending on the work that each teacher makes, which are:

- Enter a new teacher or officer.
- Search, modify and delete data from a teacher or official.
- Login or modify parameters of the different classrooms and subjects taught in the different races of the faculty.
- Create class schedules based on the parameters of distribution of classrooms taught in college.
- Modify personal data of teachers according to their registration.
- Use a classroom assigned for the designated time or previously reserved.
- Book a classroom available at a given time.
- View a map of classrooms available or used.
- Check reports of each teacher admitted to different classrooms.

VIII.   ECONOMIC ANALYSIS AND FEASIBILITY

We must stress that this project does not generate any revenue for the institution, for this reason an analysis of performance indicators will be made - performance that will determine the feasibility of the implementation of this project.

A.   Costs

Cost is the equivalent cash value or a need to manufacture a product or provide a service resource. The cost it is classified as follows:

- Direct Prima Material.
- Direct Labor.
- Indirect Costs Manufacturing.

1) Raw material: Are the elements on which a work is exercised in order to transform it into the finished product analyzed, the raw material is quantifiable and measurable as a unit. Then each material to be used in the manufacture of electrical circuits is presented.

TABLE IV

COST OF CIRCUIT TRANSMITTER.

CIRCUIT TRANSMITTER			
DESCRIPTION	CANT.	V. UNIT.	V. TOTAL
XBEE module S1 Pro	1	35,20	35,20
USB a UART 5-Pin CP2102	1	17,60	17,60
Led diode	1	0,09	0,09
Resistance	1	0,04	0,04
Plastic box 5x5 cm	1	0,88	0,88
Construction of the circuit (Bakelite, acid, etc.)	1	0,44	0,44
SUB TOTAL			54,24
12 % IVA			6,51
TOTAL			60,75

TABLE V

COST OF CIRCUIT RECEIVER.

CIRCUIT RECEIVER			
DESCRIPTION	CANT.	V. UNIT.	V. TOTAL
Transformer 9V a 500mA	1	3,52	3,52
Full wave rectifier	1	0,44	0,44
Led diode	2	0,09	0,18
Electrolytic diode 1000uF/25 V	1	0,35	0,35
Diode 1N4007	7	0,08	0,55
Diode Zenner 3.3V	1	0,13	0,13
Resistance	15	0,04	0,53
Rechargeable batteries	3	7,48	22,44
Regulator LM317T	3	0,53	1,58
Regulator LM7805	1	0,44	0,44
Regulator LM7812	1	0,53	0,53
Heatsinks	3	0,44	1,32
XBEE module S1 Pro	1	35,20	35,20
Microcontroller PIC18F4550	1	8,80	8,80
Matrix keyboard 4x4	1	4,40	4,40
LCD Liquid 2x16	1	7,92	7,92
Potentiometer 10K	1	0,35	0,35

Fuse	1	0,44	0,44
Construction of the circuit (Bakelite, acid, etc.)	1	0,44	0,44
Small buttons	2	0,09	0,18
Socket 20x2	1	0,35	0,35
Socket 10x2	1	0,18	0,18
Relay 5V	1	0,79	0,79
Speaker (Buzzer)	1	0,22	0,22
Transistor 3904	2	0,09	0,18
Plastic box 10x15 cm	1	4,40	4,40
SUB TOTAL			95,86
12 % IVA			11,50
TOTAL			107,36

TABLE VI

COST OF MECHANICAL PART RECEIVER CIRCUIT.

MECHANIC RECEIVER CIRCUIT			
DESCRIPTION	CANT.	V. UNIT.	V. TOTAL
Small buttons	2	0,09	0,18
Electronic lock	1	28,89	28,89
UTP cable	3	0,35	1,05
Canaleta	2	1,50	3,00
SUB TOTAL			33,12
12 % IVA			3,97
TOTAL			37,09

TABLE VII

CIRCUIT COST ROUTER.

CIRCUITO ROUTER			
DESCRIPTION	CANT.	V. UNIT.	V. TOTAL
Rechargeable batteries	1	9,73	9,73
XBEE module S1 Pro	1	35,20	35,20
Construction of the circuit (Bakelite, acid, etc.)	1	0,44	0,44
Diode Led	1	0,09	0,09
Resistance	1	0,04	0,04
Plastic box 5x5 cm	1	4,40	4,40
SUB TOTAL			49,90
12 % IVA			5,99
TOTAL			55,89

As shown in the above tables, the total value of each a single circuit relates, therefore, taking into consideration the

project requirements and the network topology, the total number of circuits in terms of raw material it refers, shown in table VIII.

TABLE VIII

INVESTMENT OF ELECTRONIC EQUIPMENT.

INVESTMENT OF ELECTRONIC EQUIPMENT			
DESCRIPTION	CANT.	V. UNIT.	V. TOTAL
Transmitter circuit	1	60,75	60,75
Receiver circuit	18	107,36	1932,48
Receiver circuit Mechanic	18	37,09	667,62
Router circuit	2	55,89	111,78
TOTAL RAW MATERIAL			2772,63

It should be emphasized that this research project has additional costs detailed below:

2) Direct Labor: It is the labor consumed in areas that are directly related to production or the provision of a service.

TABLE IX

COST OF DIRECT LABOR

DETAIL	CANT.	C. UNIT.	C. TOTAL	OBSERVATIONS
Installing the transmitter circuit	1	$ 10,00	$10,00	
Installing the receiver circuit	18	$ 20,00	$ 360,00	Installation is performed only for an operator
Installation of mechanical receiver circuit	18	$ 40,00	$ 720,00	
Installing the router circuit	2	$ 10,00	$ 20,00	
TOTAL WORKFORCE			$ 1110,00	

3) Indirect Costs Manufacturing (CIF): They are all costs involved indirectly in the manufacture of goods or products.

TABLE X

INDIRECT COST MANUFACTURING.

DETAIL	Cost $	OBSERVATIONS
Electric power	$360,00	This course is designed to a year.
Maintenance	$500,00	Maintaining circuits will be held once a year
Software/	$0,00	The software is donated
Microsoft Visual Studio 2010		by the institution, since this project is for use.
Software/ Microsoft SQL Server 2008	$0,00	The software is donated by the institution, since this project is for use.
TOTAL CIF	$860,00	

B. State of Production Costs

Then the state projected cost for one year is.

TABLE XI

STATE OF PRODUCTION COSTS.

	Initial Inventory Raw materials and supplies	$ -	
(+)	Raw Material Purchasing and Materials	$ 2772,63	
(=)	Available Raw Materials and Materials	$ 2772,63	
(-)	Final Inventory Raw Materials and Materials	$ -	
(=)	Real Cost Raw Materials and Materials	$ 2772,63	
	Workforce	$ 1110,00	
(=)	Cost of direct labor	$ 1110,00	
	Indirect Costs Manufacturing		
(+)	Electric power	$ 360,00	
(+)	Maintenance and Repair	$ 500,00	
(=)	Indirect Costs Manufacturing	$ 860,00	
=)	PRODUCTION COST		$ 4.742,63

As can be seen ascending the cost to this project it is four thousand seven hundred forty-two American dollars and sixty three cents ($4.742,63).

C. Investment

The investment is all disbursement of financial resources to purchase durable goods or specific instruments of production, called capital goods, and that the company will use for several years to fulfill its corporate purpose.

D. Feasibility

The following performance indicators are presented to measure the feasibility of this project, in order that it will be executed by the Engineering Faculty of Applied Sciences, to improve and meet the needs of teachers and students.

1) Indicators of performance: They are management tools that provide a baseline, from which you can make a

comparison between the goals set and the performance achieved.

- Effectiveness Indicator: This indicator measures planned and obtained, as well as the extent to which the institution is meeting its objectives.
- Efficiency Indicator: Measures the relative costs of benefits received as the level of activity and resources used.
- Economic Indicator: The ability of a project or program to generate and mobilize adequate financial resources.

Below is detail the following indicators:

TABLE XII

INDICATORS OF PERFORMANCE

PRODUCTO ESTRATÉGICO AL QUE SE VINCULA	Indicador	Fórmula de Cálculo	Fórmula	%
Servicios Asistenciales Implementación de un circuito eléctrico en las puertas de la FICA	Eficacia / Resultado	N° de docentes, alumnos y empleados de la FICA que sienten comodidad y seguridad con el nuevo circuito eléctrico / N° de docentes, alumnos y empleados de la FICA	=(1500/1560) *100	96,15%
Servicios Asistenciales Implementación de un circuito eléctrico en las puertas de la FICA	Efectividad/Resultado	N° de personal encargado del manejo del sistema a implementarse / N° de personal encargado del manejo del Sistema actual	=(2/5)*100	40,00%
Servicios Asistenciales Implementación de un circuito eléctrico en las puertas de la FICA	Efectividad/Resultado	N° de personas beneficiadas / Población objetivo	=(1560/1560) *100	100%
Servicios Asistenciales Implementación de un circuito eléctrico en las puertas de la FICA	Eficiencia/Resultados	N° de instalaciones de circuitos eléctricos/Horas hombre trabajadas	=(18/32) *100	56%
Servicios Asistenciales Implementación de un circuito eléctrico en las puertas de la FICA	Eficiencia/Resultados	Minutos de espera para ingresar al aula de clases con el circuito eléctrico/ Minutos de espera para ingresar al aula de clases sistema actual	=(2/10)*100	20%
Servicios Asistenciales Implementación de un circuito eléctrico en las puertas de la FICA	Economía/Resultados	Costos de Materiales / Costo Total	=(2772,63 /4.742,63) *100	58,46%

With the above it can be seen that the percentages in rates of effectiveness, efficiency, effectiveness and economy are quite favorable to execute this work, for the implementation of the control system access in every classroom is very beneficial for the Faculty of Applied engineering Technical University of North Sciences; because in this way facilitate the internal organization of the faculty and resources will be minimized: the time lost when entering the classroom, the use of leaves by monitoring teacher attendance, loss of property in college.

IX. CONCLUSIONS

In this project it was possible to design a system access control for classrooms of the Faculty of Engineering of Applied Science at the Technical University of the North, which is able to automate the entry to the classroom by teachers, taking data transmission and reception in a WPAN network topology, such system operates through a graphical interface also designed in the Microsoft Visual Studio 2010 C # software.

The implementation of a new control system for classrooms in the faculty is important because, as demonstrated in this project, the system is able to optimize the process of entering the same shortening income, it is safer that the use of traditional locks, allowing remove bars found in the building so we can keep an accurate record of people who use the classroom.

The design of the wireless network is structured in such a way that allows for future expansion by including new computers on the network, thus achieving extend the area of coverage and the amount of electronic circuits that perform the work of opening the doors .

Electronic circuits were designed to provide a reliable and easy to handle for both students, teachers and staff working in the power interface.

The graphical interface has manuals for each input mode, which facilitates use of the system, making it easier to handle. This system was designed taking into account the requirements needed studied in previous chapters.

Today electronic systems access control are replacing traditional manipulated locks manually by keys, it is for this reason that the project was developed for these systems, besides having optimum characteristics for deployment anywhere in which you want to control access to a specific area.

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