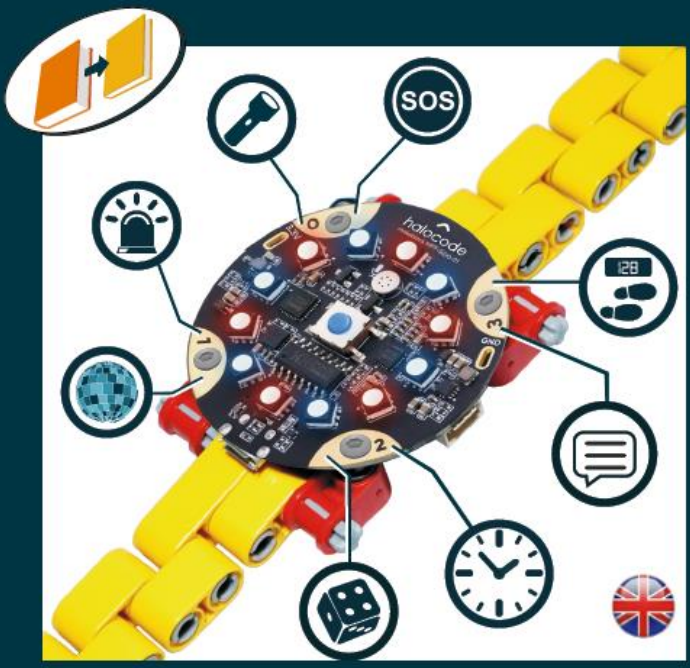
Educational Robotics with halocode®

by makeblock

- Summarised Edition -



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Educational Robotics with Halocode

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makeblock

Summarised Edition

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Summarised Edition

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PROLOGUE

Again, Makeblock surprised us pleasantly with a quality product with very interesting features that clearly differentiate it from other similar options.

Halocode is a programmable board with multitude of sensors, which can be used for both “training in robotics”, from basic to the most advanced levels, as well as for “training with robotics”, by allowing the youngest members to use it as a didactic resource for all kinds of activities, including, of course, the introduction to robotics.

Although other similar proposals already exist in market, the new Halocode is notable for its ability to carry out extremely easily projects related to voice recognition, for example, controlling lights remotely, just like domestic assistants do, so much in vogue now, or send voice messages translated to text from a Halocode to anywhere in the world.

This functionality also allows to carry out activities for, for example, learning English numbers. Its circular structure and the ring LEDS arrangement, invites us to carry out IoT projects, as the watch from book cover, that we are sure will shake up the wareable lovers.

Finally, I want to express my gratitude to all the people who have helped me in this work and, as usual, I apologize for the possible mistakes that might have been made. The only way to avoid them would have been leaving blank paper and that, as my readers know well, it is never an option.

The author.

Table of Contents

1.- Introduction

The purpose of this book is to provide theoretical and practical knowledge of robotics to readers, using Halocode as the working platform. It serves both for self-training and for educational support material.

1.3.- What is Makeblock?

Founded in 2012, Makeblock is an Educational Robotics Manufacturer that offers STEAM products. The website of the company is www.makeblock.com.

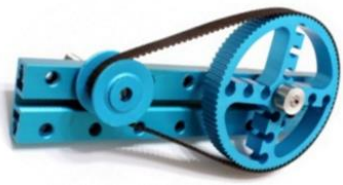
1.3.1.- Maker line

Makeblock Maker line it's composed of different robots with metallic structure, like mBot or Ranger. It consists of different mechanical parts and electronic modules, such as control boards, sensors, actuators, wheels, axes, beams, cables, etc.

Its undoubted qualities have allowed it to reach more than 140 countries in a very short time, making Makeblock one of the actually educational robotics leading manufacturers.

Its structural parts, made of reinforced aluminum, are designed so that they can be assembled easily, providing stability, which allows to build all kinds of robots, 3D printers, CNC machines, etc.

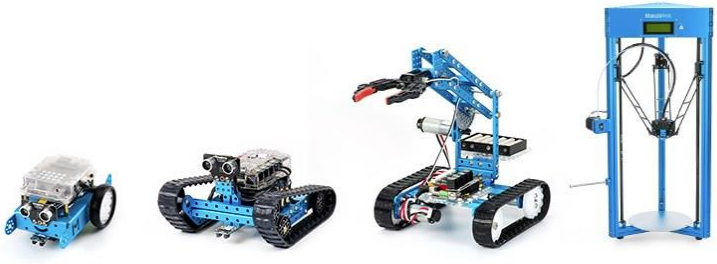
The easy and solid union of the pieces makes assemblies very simple and adapts to practically any project you can imagine.



These robots are based on the popular Arduino platform, so it can be programmed and controlled from a PC, either through a USB or Bluetooth connection.

Since current electronics are not simple (connections and circuit design are the main barrier), Makeblock has designed its own electronic modules called "Me", with a very simple way of interconnecting them through RJ25 connectors, marked with codes of colors, so make any robot become a simple "plug and play", focusing on robotics.

Makeblock has a wide range of Me sensors and actuators: bluetooth, potentiometer, infrared receiver with remote control, proximity sensors, motors, lights, smoke sensors, LED strips, etc.



In the following sections we describe the main Makeblock maker line features.

1.3.1.1.- Open source

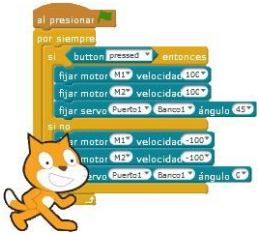
As the manufacturer states, Makeblock will be Open Source Hardware for ever with CC-BY-SA3.0 licence, so that the diagrams, plans and firmware will always be public.

1.3.1.2.- Simple and flexible assemblies

Connecting parts together is really simple and fast: its threaded beams allow to screw any other part along from the beam without need from using nuts.

1.3.1.3.- Programmable with Scratch, mBlock5 and Bitbloq

The Makeblock electronics are compatible with Scratch, a widespread graphic environment with which you can learn to program easily. mBlock5 is the Scratch 3 version developed by Makeblock for this product line.



Since May 2017 some Makeblock products can also be programmed with Bitbloq, an environment that, in our opinion, is much more powerful, but also somewhat more complex.

1.3.1.4.- Lego compatible

Due the holes distance in the structural parts of Makeblock and LEGO is the same, structural and robotic elements can be combined with both platforms, that we think fits perfectly with the robotics concept. In fact, in our books focused on the Maker line (mBot and Ranger) we take advantage of this feature to carry out some of the projects.

1.3.1.5.- Easy connections

All of the Maker line products connections are "plug and play" by means of RJ25 connectors, similar to those of LEGO, and with colour codes, so that it is not necessary to solder cables or use prototyping boards, which allows focused on robotics.

1.3.1.6.- Arduino compatible

Makeblock ME sensors and actuators are Arduino open source compatibles.

1.3.1.7.- Other books by the same author

For “maker” line we offer these Spanish books by the same author:

- Educational Robotics with mBot and Arduino (ISBN 978-8469749326)
- Educational Robotics with Ranger and Arduino (ISBN 978-8469771709)
- Domotics easy with Makeblock (ISBN 978-8409023752)

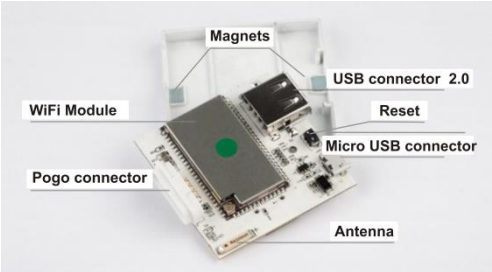
1.3.2.- Neuron

Neuron is an educational robotics platform based on interconnectable blocks, with more than 30 different functionalities, that allows to carry out in a very easy way all kinds of STEAM projects.

Precisely that simplicity makes it very suitable to introducing youngsters in electronics and robotics, but its power and versatility allows it to be used for all ages and levels.

1.3.2.1.- Neuron blocks

Each Neuron component is assembled by a compact design closed block that provides security and durability.



1.3.2.2.- Pogo connectors

The connections between the Neuron components are made through Pogo connectors, a connector type designed specifically by the company Everett Charles Technologies (ECT) to establish temporary but safe connections between electronic components.

1.3.2.3.- Neuron Kits

Neuron is available in kits (Inventor, Explorer, Artist and Creative), although you can also buy single components. The updated prices of the available components can be found on the Makeblock website:

https://store.makeblock.com/index.php?route=product/search&search=neuron

1.3.2.4.- Other books by the same author

For more information the reader has the Spanish book "Educational Robotics with NEURON" by the same author (ISBN 978-8409046966).

1.3.3.- Codey Rocky

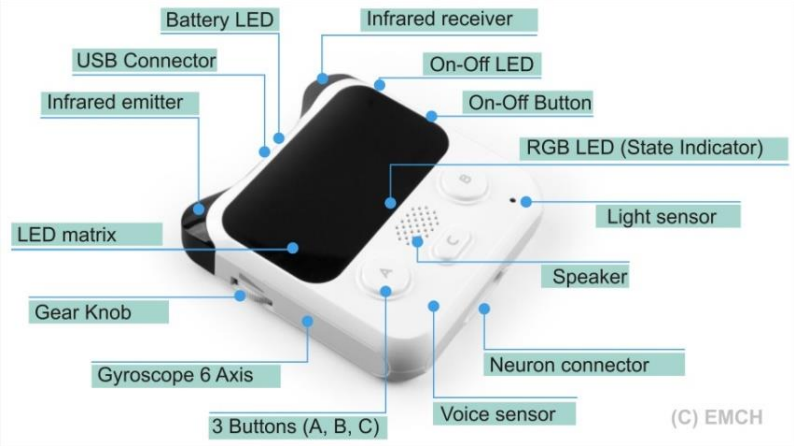
Codey Rocky is a programmable robot specifically designed to introduce in the educational robotics and STEAM projects to children from six years of age. For this, it combines a simple and attractive robotic hardware with two very simple and intuitive graphical programming environments, one for tablets and smartphones and the other one, more powerful, for computers.

As its name suggests, it is composed from two elements. One is Codey and other one is Rocky.

Characteristics of Codey Rocky	
Dimensions	102 x 95.4 x 103 mm (Codey and Rocky assembled)
Weight	290.5 grams (Codey and Rocky assembled)

1.3.3.1.- Codey

Codey is the brain of the robot that, in addition to the processor, integrates more than 10 electronic modules that can be controlled by program.



The processor, an ESP32, is a SoC (System on Chip) designed by the Chinese company Espressif and manufactured by TSMC. Integrates a Tensilica Xtensa dual-core 32bits at 160Mhz processor, WiFi and Bluetooth connectivity in a single chip.

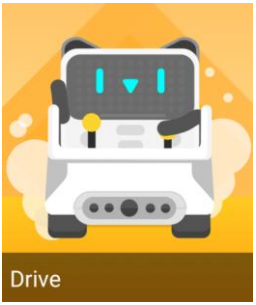
Since it has a processor, it allows the load of a program in its memory to work autonomously. The loading of the program can be done either from the Makeblock App or from mBlock5.

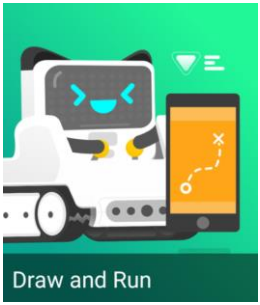
1.3.3.2.- Rocky

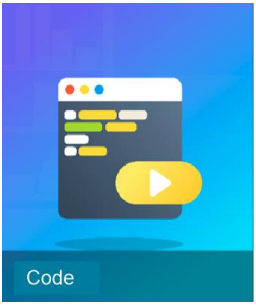
Rocky is the vehicle that gives Codey mobility. It has integrated, in addition to the motors that move its tracks, other sensors and a connector for Neuron modules, which further expands its possibilities.

1.3.3.3.- Makeblock App

The easiest way to use Codey Rocky is with the "Makeblock App", available for both Android and Apple, which allows three modes.







1.3.3.3.1.- Drive

In this mode the tablet or smartphone acts as a remote control from Codey. In addition to moving it in different directions and at different speeds, user can draw in its LEDS matrix or apply different combinations of sounds, expressions and movements.

It is therefore a way for the younger to have fun with Codey.

1.3.3.3.2.- Draw and Run

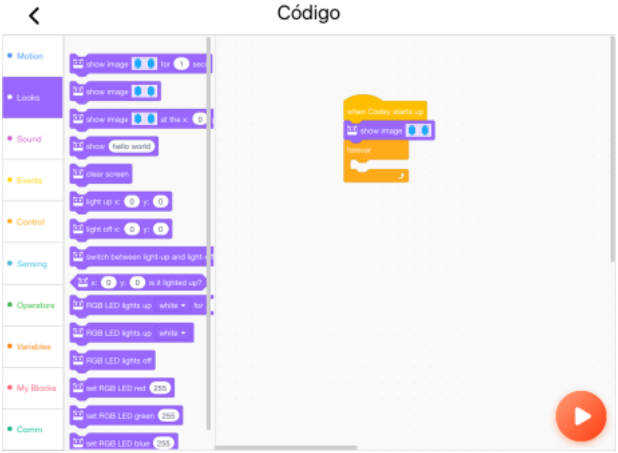
In this mode the user draws a path on which sounds and colors can be included.

Pressing "Play", Codey Rocky will follow the path by executing the instructions that he finds to emit sounds or turn on lights.

It is a conceptual way to introduce the younger in the programming.

1.3.3.3.3.- Code

This mode allows Codey Rocky programming using a block graphical environment very similar to mBlock5.



1.3.3.4.- Programing Codey Rocky

Codey has its own processor, so we can load programs into its memory so that it executes them autonomously. As usual in Arduino, the board can only contain a program that is executed when starting the robot. It can be programmed with the Makeblock App or with mBlock5.

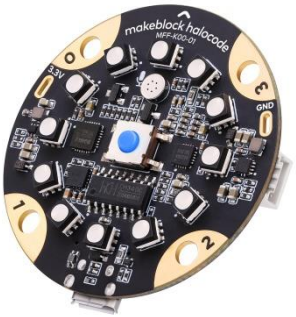
1.3.3.5.- Other books by the same author

For more information the reader has the Spanish book “Educational Robotics with Codey Rocky” by the same author (ISBN 978-8409067527).

1.3.4.- Halocode

HaloCode is a programmable small board that integrates some components:

- Button
- 4 Contact sensors
- Microphone
- 12 RGB LEDS
- WiFi module



In section 2 the Halocode is full detailed.

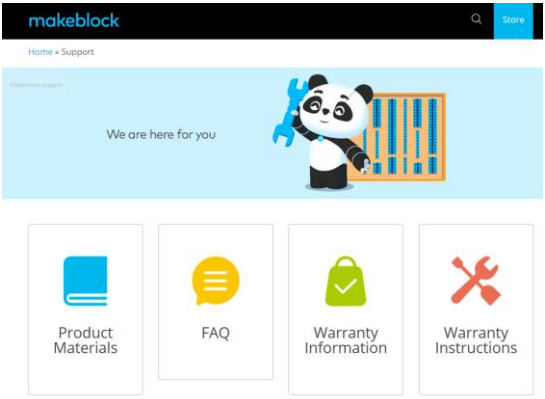
Halocode can be programmed from a computer (PC or Mac) with mBlock5, a graphical programming environment based on Scratch 3.

In section 3 of this book mBlock5 environment is detailed explained.

1.4.- On line suppport

Makeblock offers a website where users can find all kinds of resources and didactic material for their products:

https://www.makeblock.com/support



1.5.- Focus of the book

The content of this book is structured as follows:

- Explanation of Halocode sensors and actuators
- Explanation of the mBlock5 programming environment
- STEAM robotic projects using mBlock5

Many of the projects allow activities to promote "training in robotics", taking advantage of the possibilities of Halocode, along with its graphical programming environment, to bring the reader to robotics world and use the completed projects to achieve the following objectives:

- Access curricular contents from a different way.
- Overcome daily challenges putting into practice concepts and cognitive skills related to different curricular areas.
- Improve in the programming languages in a natural and playful way.
- Develop learning by research. Learning by trial and error.
- Consider the educational robotics as another learning resource.
- Enlist interest in the world of robotics and home automation.

1.5.1.- STEAM Philosophy

STEM, without the A, is the acronym of the names of four academic disciplines: Science, Technology, Engineering and Mathematics

Educational initiatives or projects oriented towards the STEM philosophy aim to combine these four subjects to develop an interdisciplinary approach to the teaching and learning process, also incorporating contexts and situations of daily life, and using the necessary technological tools.

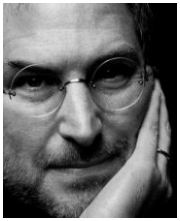
The European Commission bet decidedly by this methodology, as evidenced by the more than 13 million euros that it planned to devote in the period 2014-2020 to subsidize initiatives aimed to increasing the attractiveness of scientific studies and the interest of young people in the STEM philosophy.

However, despite the projection of this philosophy, the reality is that since the beginning of the 2000s there has been a considerable decline in the proportion of students in STEM disciplines, something that contrasts with the growing demand for this type of profiles in the labor market.

More recently, there has been a change in trend in STEM actions, possibly due to the rise of the maker philosophy and do-it-yourself (DIY) movements, as well as the inclusion in the educational field of promotion of creative thinking and work based on more competent and productive activities.

On the other hand, it is evident that the combination of STEM disciplines when carrying out projects, requires incorporating an original, attractive and efficient design, as reflected in the rise of the "maker", DIY (do-it-yourself) and DIWO (Do it with others) philosophies, that have shown that only when artistic and creative skills are combined with STEM education, aspects such as innovation and design, the development of curiosity and imagination are valued, the search for diverse solutions to a single problem.

All of which has led to the natural incorporation of the A of "Arts" to the acronym STEM, giving rise to STEAM: Science, Technology, Engineering, Mathematics & Arts, a methodology that, without having assigned a name or an acronym, many technological teachers already used for a long time.



In 2003, matching up with the third generation of the iPod presentation, the New York Times include in an article the following sentence from Steve Jobs:

Design is not just what it looks like and feels like. Design is how it works.

1.5.2.- Teaching in Robotics

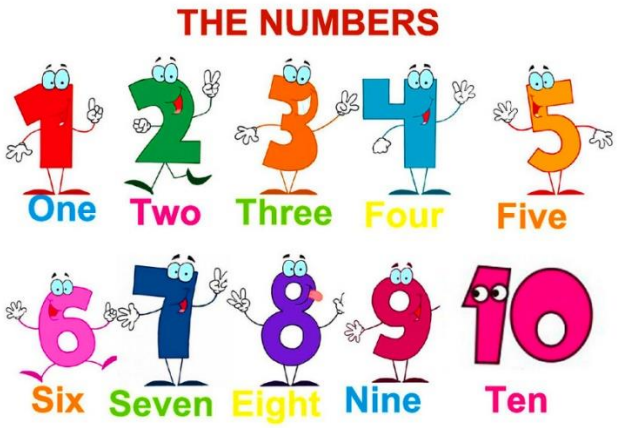
"Teaching in robotics" focuses on learning of robotics itself:

- Specific robotics components
- Programming (algorithm, program)

1.5.3.- Teaching with robotics

"Teaching with robotics" focuses on any subject, whether technological or not, using robotics as an educational technological resource. In this case, robotics, instead the aim, it is the medium.

In this book we will see projects made with Halocode that can then be used to carry out educational activities. An example of this would be the project "4.2.3.- Control the lit LEDS number " that allows to use Halocode as a didactic resource for learning numbers in English.



2.- Halocode components

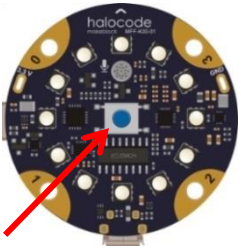
In the same way that the brain of living beings receives information through the senses and coordinates and moves the limbs, robots can interact in different ways with the environment, depending on the sensors and actuators used.

2.1.- Integrated sensors in Halocode

Sensors are the elements that give the robot "senses", such as touch, sight, hearing, balance, etc. In the following sections we will see the sensors that will be used in this book, starting with those that incorporate the Halocode board.

2.1.1.- Button

Halocode has a single blue button, located in the center of the board.



A button is a sensor which returns a logical value based on its state:

- True (logical 1) if pressed
- False (logical 0) if not pressed

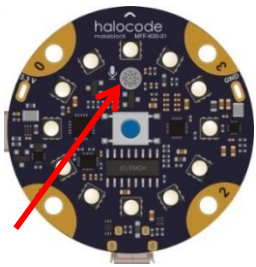
When the button is used to select options or toggle states (such as turning an LED on or off) it is convenient to include a waiting time of about 0.3 seconds since, being the processor much faster than user, as long as the user believes that performs a single press, the processor may have checked the status of the button tens or hundreds of times. Another, more efficient option is to wait for the button to be released.

2.1.2.- Touch sensor

The four golden colored connection Halocode pins are also touch sensors.

Conceptually this type of sensor, also known as a capacitive sensor, is very similar to a push button but, unlike this one, it does not need to be pressed, since it is enough to touch it to activate it.

2.1.3.- Sound and voice sensor



Halocode integrates a sound sensor and voice sensor.

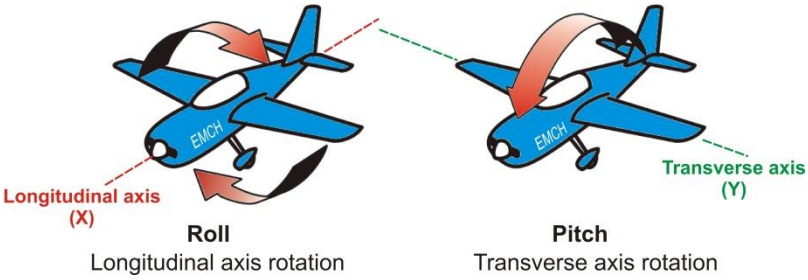
This sensor gives Halocode a sense similar to the sense of hearing capable, not only of measuring the intensity of sound, but also of interpreting it, which allows interesting applications, such as for example that the user can turn on or off the LEDS with the voice.

By means of this type of sensor it is possible to carry out a multitude of devices such as a sound level meter (instrument that measures the ambient sound), sonic alarms or a fun light noise for the classroom.

2.1.4.- Gyroscopic and accelerometer sensor

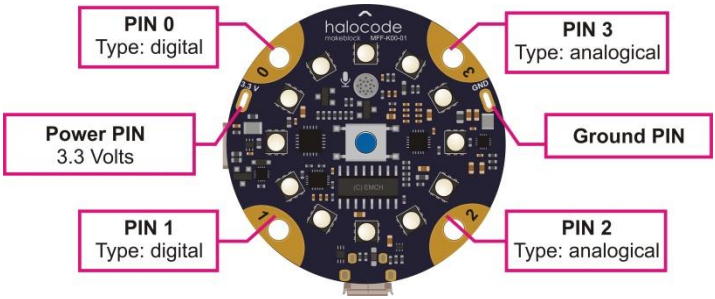
Halocode has a gyroscopic sensor and accelerometer, which allow to measure the angular movement and acceleration in the 3 axes. The gyroscope range is + -180° on the X axis and + -90° on the Y axis, while the accelerometer range is + -8g.

With this component we can detect board rotation and accelerations as well as its position in its 3 axes.



2.1.5.- Connection pins

Halocode board has 6 connection pins identifiable by its golden color:

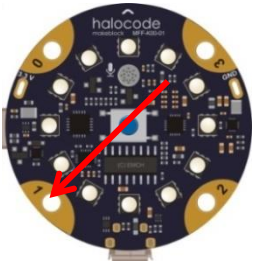


WIDE PINS	**GND**	Ground. Never connect directly to the power pin.
	3 V	Input or output 3 volt power. If the board is powered either through the USB connection or the battery, this pin works as output power. Otherwise, it can be used for power input. Never connect directly to the "GND" pin.
	0, 1, 2 and 3	Input or output signal, both analog and digital.

2.1.5.1.- Input and output pins

The four large pins allow the connection of components through cables equipped with crocodile clips.

Although crocodile clips hold the cable tightly, they can easily rotate, making contact with adjacent pins, which could damage the board. The structure proposed in section 2.9.2 reduces the risk of causing a short circuit by clamping the clamp on a metal screw fixed to each pin.



The 4 pins can be used for **digital** (ie: binary) **inputs and** outputs and for **analog outputs** (ie: values between 0 and 1023).

On the contrary for **analog inputs** (values between 0 and 1023) only pins 2 and 3 can be used.

2.1.5.2.- Power pin

The pin labeled "3.3 V" provides power to the additional sensors or actuators connected to the Halocode board.

If crocodile clips are used, it must be avoided that these makes contact with other components or pins of the board, since this could be damaged.

2.1.5.3.- Ground pin

The pin labeled "GND" is the ground connector for the additional sensors or actuators that we connected to the Halocode board.

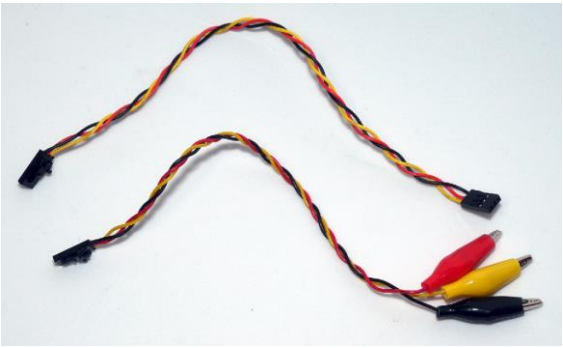
If crocodile clips are used, it must be avoided that these makes contact with other components or pins of the board, since this could be damaged.

2.2.- Additional sensors

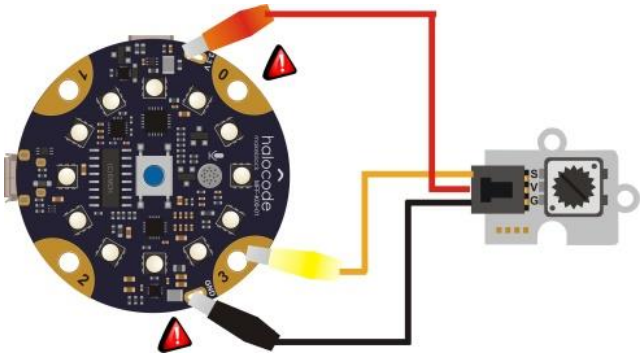
The Halocode board has connector pins for additional Arduino sensors and actuators. You can connect to Halocode without the need for protoboards or resistors, which makes mounts much easier and allows to focus in robotics.

The connection of the free protoboard components to the Halocode board is very easy.

Simply slightly modify the supplied wire, changing the connectors from the board side by three crocodile clips, for which welding is not required.



Once this change is made, the component can be directly connected to the Halocode board (G with GND, V with 3V and S with 0, 1, 2 or 3), as shown in the image.

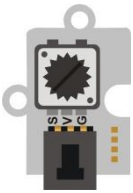


It is important to keep in mind that the crocodile clips do not make contact with each other or with other components of the board since; otherwise, it could be damaged.

Although mBlock5 programming environment does not have a specific block to manage these components, generic blocks are available for reading and writing, both analog and digital values, on the board pins.

In the following sections we discuss the sensors and actuators of other manufacturers that are used in the projects in this book.

2.2.1.- Potentiometer

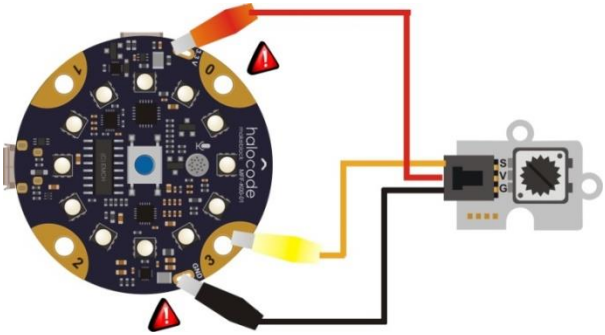


A potentiometer is a variable resistor. That is, an electronic component that makes it possible to regulate the intensity of the current (the amount of electricity) circulating in a circuit. A clear example are the controls that allow adjusting the volume in the music equipment.

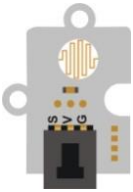
It is a very useful robotic sensor since it serves to select values, regulate speeds, light intensities, etc.

In the following diagram we show how to connect it to the Halocode board:

- **Signal wire (yellow)**: pin 3 (could also connect on pin 2)
- **Power wire (red)**: pin 3.3 Volts
- **Ground wire (black):** Ground pin (GND)



2.2.2.- Light sensor

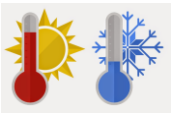


The light sensor allows Halocode to measure the intensity of light, which gives it a certain capacity for monochrome vision, not to see images as a whole, but rather the level of ambient light.

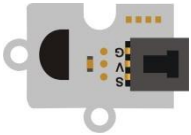
This functionality opens the door to the development of projects such as photometers, twilight switches, etc.

It is an analog digital component, so it must be connected in one of the analog digital pins (2 or 3) in a similar way as described in section 2.2.1.

2.2.3.- Temperature sensor



The temperature is a magnitude referred to the common notions of hot, warm or cold that people can perceive through thermo receptors, located in the skin, of cold and heat, called Krause corpuscles and Ruffini corpuscles respectively.



We can determine the numerical value of this magnitude by means of the analog temperature sensor TMP36 of Elecfreaks, capable of measuring temperatures in a range between -55 and 125 degrees centigrade with an accuracy of +/- 0.5.

It is an analog digital component, so it must be connected in one of the analog digital pins (2 or 3) in a similar way as described in section 2.2.1.

2.2.4.- Soil moisture sensor

This sensor determines the soil moisture by measuring the conductivity between the two probes and returning an analog value between 0 and 1023. Since water is a good conductor of electricity, the higher the humidity, the greater the measured current.

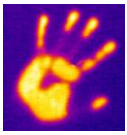
With this type of sensor you can, for example, control the humidity of a plant or, even, proceed to its irrigation when necessary.

The mBlock5 programming environment does not have a specific block to manage it, so we will use the direct reading block of the pin to which it is connected.

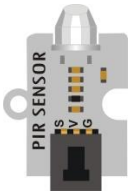
It is an analog digital component, so it must be connected in one of the analog digital pins (2 or 3) in a similar way as described in section 2.2.1

2.2.5.- PIR sensor

The acronym PIR corresponds to "Passive InfRared", a type of sensor that measures the infrared (IR) light emitted by the objects that are in its vision field. One of the most common applications of this type of sensors is motion detectors, either in alarm systems or in automatic lighting systems.



The term passive refers to the fact that PIR devices do not generate or radiate energy to achieve detection, but operate exclusively on the basis of the energy emitted by the objects.



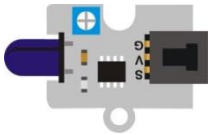
On the other hand, it is important to keep in mind that PIR sensors do not detect or measure "heat", but the infrared radiation emitted by an object, although this is usually proportional to the temperature of the object. For this reason, detectors based on PIR sensors can also be activated by the movement of hot objects.

It can be used for the detection of people and animals, within a range of action of about 5 meters and a beam of 90° opening. If something hot moves within that range the sensor activates the digital output to 1. Once activated it takes a few seconds to return to 0.

It is a binary digital component so it can be connected to any of the pins on the Halocode board, similar as described in section 2.2.1.

2.2.6.- Flame sensor

The flame sensor is based on an infrared light receiver that is extremely sensitive to the specific wavelength that flames emit (around 760nm), although they can give false positives with certain lights.



Although it is intended to detect flames, it must be taken into account that it only supports temperatures of up to 85 degrees Celsius, so it must be kept at an adequate distance from the flame.

It is a binary digital component so it can be connected to any of the pins on the Halocode board, similar as described in section 2.2.1

2.3.- Actuators integrated in Halocode

An actuator is a device capable of transforming hydraulic, pneumatic or electric energy in the activation of a process with the purpose of generating an effect on an automated process.

The actuator receives the order of a regulator or controller and accordingly generates the order to activate a final control element, such as a valve.

2.3.1.- RGB LED

Halocode has integrated 12 RGB LEDS forming a ring. Each RGB LED is made up of three monochrome LEDS, one of each primary color: red, green and blue.

The acronym RGB stands for red, green and blue colors. By combining these three primary colors you can get any colour from the spectrum.

In mBlock5 LED RGB it is controlled with several specific blocks that allow to indicate a colour name or the value of each component colour (red, green and blue).

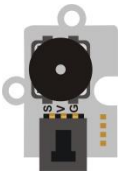
2.4.- Additional actuators

As we saw in section 2.1.5, the Halocode board has pins in which additional sensors and actuators can be connected.

The additional actuators that we will use in this book will be, like the sensors, compatible with Arduino and prototyping board free.

2.4.1.- Buzzer

A buzzer is a passive electro acoustic transducer (there are also active transducers) that produces a mono tonal continuous sound (usually sharp). It serves as a signaling or warning mechanism and is used in multiple systems, such as household appliances, vehicles, etc.



The quality and power are what you can expect from this type of device, much lower than a speaker. Even so they are apt for infinity of applications, even musical, for which it is relevant to know the relation between the notes and their frequencies.

It is a binary digital actuator so it can be only connected on Halocode board pins 0 or 1, in similar way as described in section 2.2.1

mBlock5 current version does not have any specific block to manage this type of component, so you have to use the direct write blocks to the digital pins.

To make a buzzer sound, it is necessary to quickly change its status between "on" (1) and "off" (0). The faster the state changes, the higher the frequency.

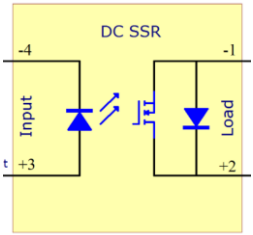
2.4.2.- Relay

A relay is a device similar to a switch but, instead of manually-operated, it is operated by a digital signal to turn it on or off.

In this way, with a low voltage signal, you can control the operation of equipment that works at 220 volts.

It is therefore the key element to use robotics in home automation projects (domotic).

Presently they are solid type, known as "SSR" (solid state relay), and the element that makes the switch is an optotransistor formed by an LED that when the control signal is set to 1 emits light that, when received by a photoresist, allows electrical courrent passes through the controlled circuit.

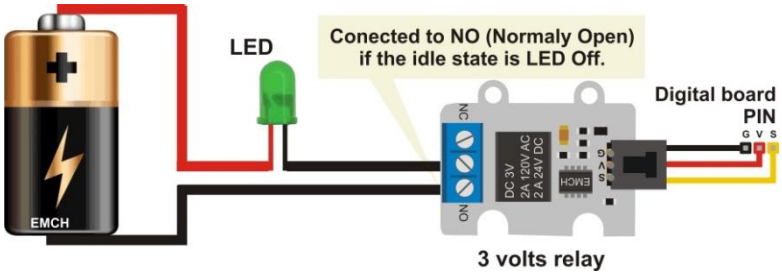


A relay completely isolates the control circuit (robotics) from the power circuit (controlled equipment), thus protecting the board and control elements.

The relays can have one or several channels. Each channel is used to control the operation of a device. In this book we use single-channel relays.

Each channel has 3 terminals to connect the circuit you want to control. One of the cables is connected to the central terminal, which is common to the other two, and the other cable will be connected to the NO (Normally Open) or NC (Normally Close) terminal depending on whether you want the idle state to be open (disconnected) or closed (connected) . The most common is to connect it to the NO (Normally Open) so the normal state of the controlled equipment is turned off.

The pins associated to each channel of the relay are connected directly to a digital pin of the Arduino board (we use only free prototyping boards) and the terminals to the positive and negative cables of the electrical circuit that we want to control. By writing a 1 (high value) on the digital pin to which we have connected the relay, it will be activated, closing the circuit and, in this example, turning on the light LED. Writing a 0 (low value) the relay will deactivate and open the circuit, turning off the LED.



In section 4.5 of the full book a domotic project is carried out using safe currents of maximum 25 volts.

2.4.3.- Fluid pump

It is a 3V vertical submersible pump that can be used for all types of projects.

Optionally you can use the Makeblock pump, with similar characteristics (see project 4.4.5 of the full book), although it is not submersible.

Both are controlled indirectly through a relay (see previous section).

2.5.- Comunication

Halocode has several components for communication, both wired and wireless.

2.5.1.- USB connector

Halocode has a mini USB connector that serves both to load the programs in your memory and to power it.

2.5.2.- WiFi module

The WiFi module allows Halocode to connect to a network to use, for example, the IoT functions or to communicate several boards with each other.

2.5.3.- Bluetooth module

The Bluetooth module is used to connect Halocode to a tablet, smartphone or PC. In the case of the PC it is advisable to use the Makeblock Bluetooth dongle. In section 3.2.2 we explain how to connect the Halocode board via Bluetooth.

2.6.- Processor

The processor is the brain of the robots. It is usually located on the "control board" which, in addition to the processor, usually includes memory, input and output ports, USB connection to the computer, a reset button, the on / off switch and, optionally, some additional elements as sensors, actuators and Bluetooth connection.

2.6.1.- Firmware update

The firmware is the non-volatile software (it is not erased when the Halocode is turned off) that controls the basic functions of an integrated circuit (chip). Sometimes the firmware has to be updated, either to solve operating problems or to add new functionalities.

2.6.1.1.- Halocode firmware update

By connecting a Halocode board to the computer and accessing the mBlock5 programming environment, it automatically checks if a firmware update is available, in which case it offers the user the possibility to update it.

Once the update process is started, it must be avoided that it can be interrupted.

2.7.- Program

A computer program is a set of instructions for a processor to perform a series of specific tasks. Without programs, computers are not capable of any action. The general set of programs is called software.

When talking about programs differentiation should be made between the source and the executable code.

It is called source program or source code to the written by the programmer in a particular programming language, more or less close to human language.

Halocode has its own graphical programming environment for PC and Mac called mBlock5, very friendly and intuitive.

As soon as the program load is finished, its execution begins. Since, just like the Arduino boards, Halocode can only contain one program in its memory, when it is loaded, it replaces the one that had previously.

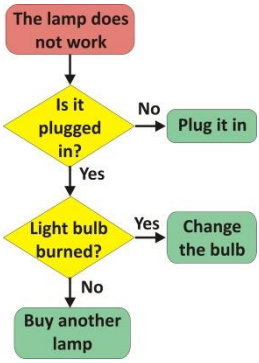
2.7.1.- Algorithm

An algorithm is a set of well-defined, ordered and finite instructions or rules that allows to carry out an activity following the steps indicated. They must be complete and should not generate doubts about the purpose of each of these steps, regardless of whether the reader may not know how to put it into practice.

In daily life, algorithms are used constantly, most of the time unconsciously, to solve problems or execute actions.

A typical example is to solve a problem with a light bulb.

It is highly recommended to be clear about the algorithm before starting to create the program.



2.7.2.- Pseudocode

The pseudocode is an informal, although accurate, high-level description of an algorithm, which essentially uses natural language together with some syntactic conventions of programming languages, such as assignments, cycles and conditional, although it is not governed by any standard.

It is used to describe algorithms and as an intermediate element during development, with the great advantage that it requires little extension.

The pseudocode is designed to make it easier for people to understand an algorithm, and therefore can omit irrelevant details that, nevertheless, are necessary in the later development of the program.

The main characteristics of this language are:

- It is a simple form of representation to use and understand.
- It facilitates the passage of the program to the programming language.
- It is independent of the programming language that will be used.

- Facilitates the further development of the program.

A typical example of commonly used pseudocode is a food recipe, but it can be applied in any activity or process.

This would be the pseudocode for the subsequent development of a program that is able to calculate the area of any rectangle:

```
While not pressing the X key
        Ask the user the base length
        Ask the user the height length
        Rectangle area = Base length x length height
        Display Rectangle area
        Ask the user to press any key to continue
        or X to end
```

All the projects in this book include the pseudocode of the algorithm that is then programmed in mBlock5 although the pseudocode could be used to develop the program in any other platform.

2.7.3.- Programming

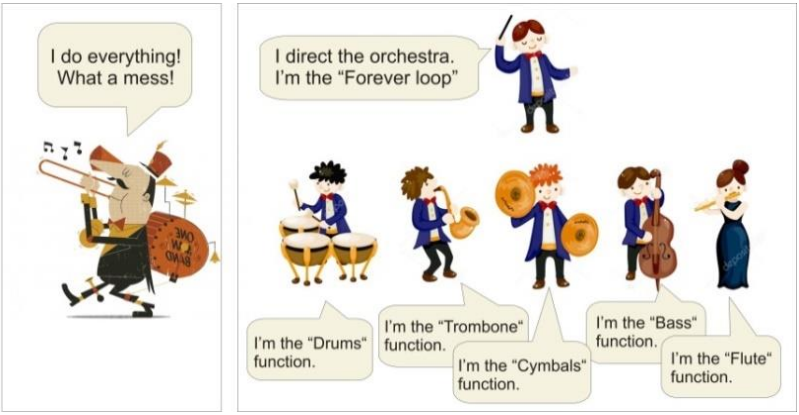
Finally, it remains to write the program from the pseudocode, for which the programmer must know the specific programming language to be used.

In section 3 the programming resources available in mBlock5 are described.

2.7.4.- Programming by functions

When solving a problem, it is always better to divide it into smaller problems, which will be easier to solve.

In programming, the same thing happens, so regardless of the programming environment or language used, it is always better (if possible) to split the program into functions that perform simple and specific tasks. We will touch on this question later.



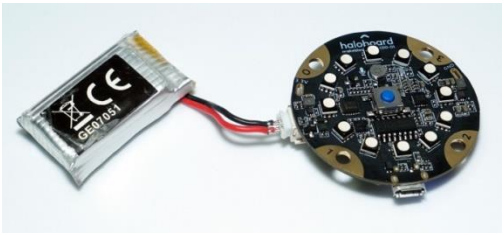
2.8.- Power supply

To operate, the Halocode board needs power, either through the USB connector or the side connector.

In the case of the USB connector, the power supply can be the computer to which we have connected it or an external battery equipped with this type of connector:

If batteries are used, they should be between 3 and 5 volts. In the market there are batteries of all sizes and capacities. For certain projects, such as

the watch, the ideal thing is to feed the Halocode board with a small battery that we can fix to its back side by means of velcro:



Halocode board powered by 3.7 volt LIPO batteries

Just after receiving power, the Halocode board will start and run the program that has loaded in its memory.

2.9.- Structural parts

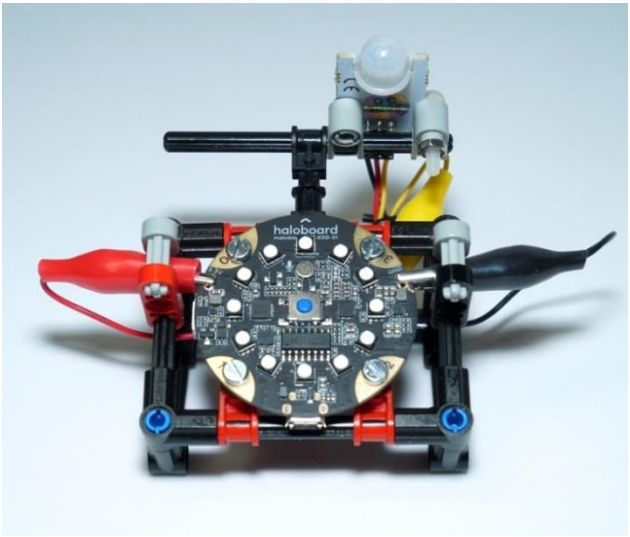
At the moment the Halocode board does not have additional structural components. However, as we will see it is very easy to combine it with LEGO pieces.

2.9.1.- Modding Pc

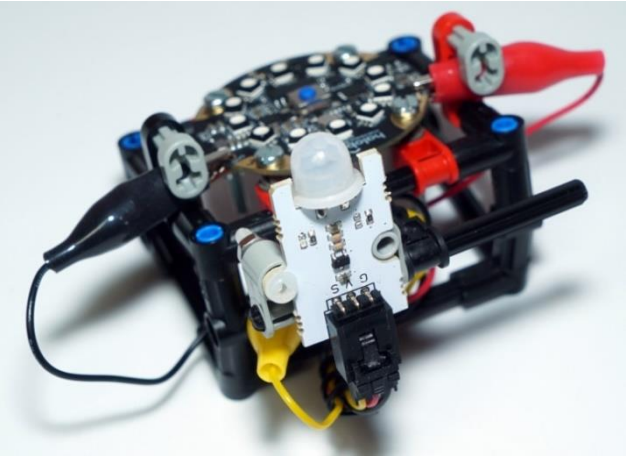
As usual in the books of this author, a faithful follower of the STEAM philosophy, the A (Arts) will be taken into account, which, in this occasion, will be oriented towards the so-called "Modding Pc", a design style that takes into account the strength, originality and functionality, that when applied to the PCs, and in this case the Halocode board will derive in models that leave the components exposed.

2.9.2.- LEGO Technic parts

As in other literary works by this author, we have chosen to use LEGO pieces from the Technic series to quickly and easily create very modding designs.



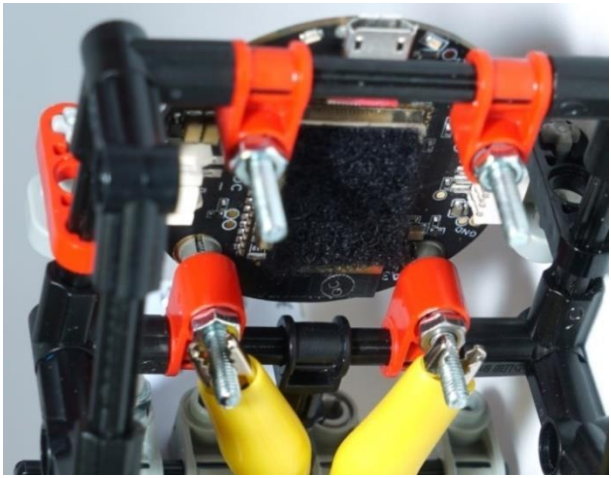
Frontal view



Back view

The result considers that, besides being functional, it contributes the artistic component required in the STEAM projects, offering absolute freedom to the user to quickly adapt the structures to their liking and to

fix additional components, such as the PIR sensor that appears in the image.



On the other hand this structure offers an adequate grip of the crocodile clips of power and ground, preventing them from making contact with other pins or components of the board, which could cause a short circuit and damage it.

Likewise, the metal screws with which the board is fixed to the structure also serve to fasten the crocodile clips of the signal cables simply and safely.

To fix the components we propose this simple and practical solution that also prevents it from moving or turning. As you can see, we use nylon 3 metric screws to avoid false contacts.

2.9.3.- Wareable technology

The term **wareable** refers to the set of devices and electronic devices that are incorporated in any part of the body or clothing, interacting continuously with the user and with other devices in order to perform a specific function.

Examples of wearable technology are smart watches, sneakers with built-in GPS, or wristbands that control our state of health, all of them increasingly present in our lives.

In that sense we also make use of a proposal that we consider fits both the design and the concept of the Halocode, a wristwatch entirely made with LEGO pieces:

2.9.4.- Metallic metric 3 screws

To fix the Halocode board to the structure we propose to pass through the holes of the contact sensors metric 3 metal screws which, in addition, will serve to securely and securely grip the crocodile clips of the signal cables.

2.9.5.- Nylon metric 3 screws

On the contrary, in the additional sensors it is advisable to use nylon screws to avoid false contacts.

On the other hand, nylon fasteners are more suitable for fixing components to LEGO plastic parts without damaging them.

3.- Programming with mBlock5

Halocode can be programmed with mBlock5, available for PC and Mac, a tool developed by Makeblock.

It is based on Scratch3, so it uses blocks that fit together, as if it were a puzzle, to build programs.

This helps to make programming accessible to children, because they do not have to worry about syntax (they do not need to learn how to write code in a literal programming language such as Processing, C ++ or Java).

Being a product developed by Makeblock, it is constantly updated and allows to use the full range of sensors and actuators of the brand.

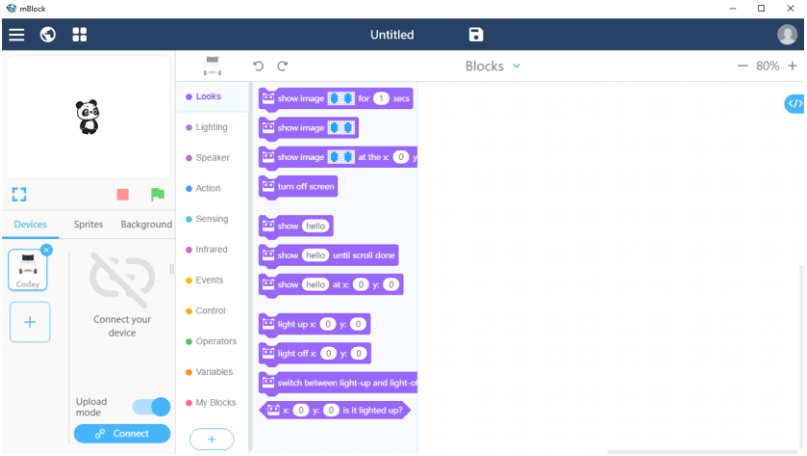
At the time of writing this book (February 2019) version 5.0.1 of mBlock5 had just been released, both for Windows and for Mac, which can be downloaded for free from the URL:

https://www.makeblock.com/software

The Web version is also available, which makes it possible to use mBlock5 from any site and with any device through a browser (provisionally at https://ide.makeblock.com/#/)

3.1.- Initial screen of mBlock5

When launching mBlock5, the following screen appears:



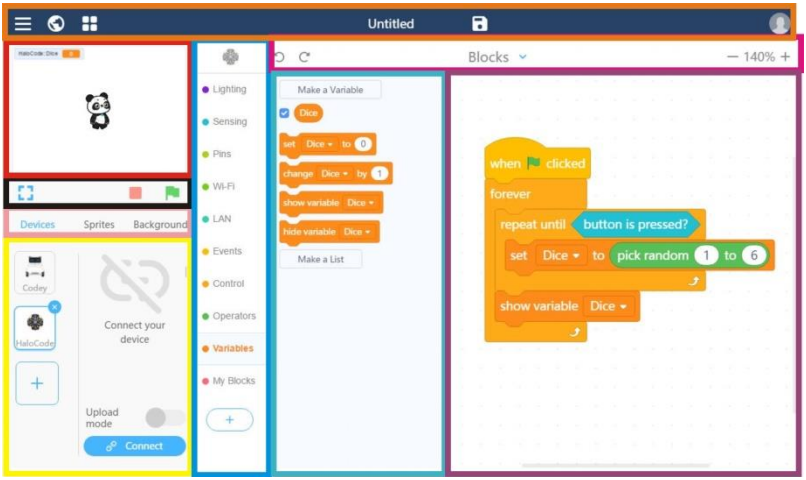
Option	Description		
	**Option menu:**		
	My Projects	Shows the user's projects. From this screen you can manage existing projects (open, share, rename, copy, save to the computer, delete) or open it.	
	New Project	Start a new project	
	Open from your computer	Open a project from the local computer.	
	Example programs	(See same section of )	
	Help	Help	User manual
			Check for updates
			Send comments to Makeblock
			About mBlock5
	Exit	Exit mBlock5	
	Language	Language selection Update translation	

	My Projects	Shows the user's projects. From this screen you can manage existing projects (open, share, rename, copy, save to the computer, delete) or open it.	
		New Project	Start a new project
		Search	Search projects
		Recent	Open recently worked projects.
	Sample programs	Codey Rocky	Codey Rocky projects samples
		Stage	Stage samples
		AI	AI Samples
		IoT	IoT samples
Proyecto1	Project name	To change Project name	
	Save	Save	Save in the same place and with the same name
		Save as	Save with other name
		Save to computer	Save to computer with other name
	Identify	Log in mBlock5 community. Once identified, the projects are saved in the cloud. You can also use the IoT functionalities and see data in the cloud.	

Selecting a specific language translates the entire environment, including the programming blocks.

Sometimes, especially for those who have experience programming, it is better to use the English language, since in this way the functionality of each programming block is better identified.

When you open an existing project or start a new one, you access the graphical programming environment, made up of different areas that we have marked with different colors.



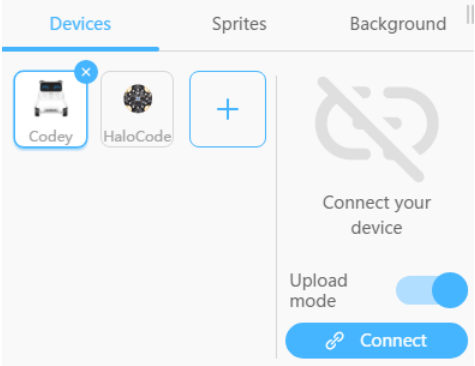
Area	Description
	Top menu
	Stage
	Execution menu
	Submenu
	Board selection and connection
	Edition comands
	Programming command groups
	Programming commands of the selected group
	Programming area

The following sections describe the different areas of the graphic environment mBlock5, although we will start with the selection and connection of the board since the environment is adjusted to the selected plate.

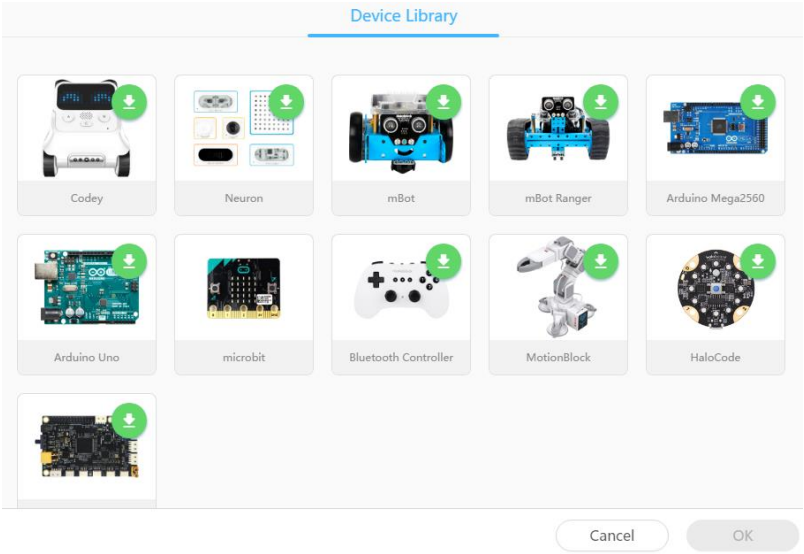
3.2.- Board selection and connection

In the lower left corner of the mBlock5 environment appears a box with three options (Devices, Objects and Background).

By clicking on Devices, the selected ones are shown:



By default Codey is marked, but if you wish you can work with other Makeblock robots, such as mBot, Ranger or Halocode, or even with other manufacturers' boards such as micro:bit. By clicking on the box that contains the plus sign, a new screen appears with the available robots and boards:



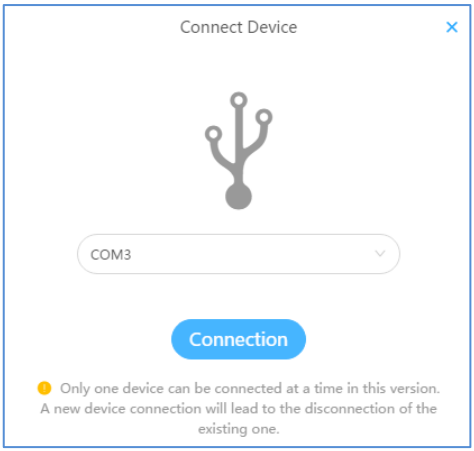
In this case, click on the Halocode icon to select this device.

Next, in order to load a program, Halocode must be connected to the PC, either through the USB port or the Bluetooth module.

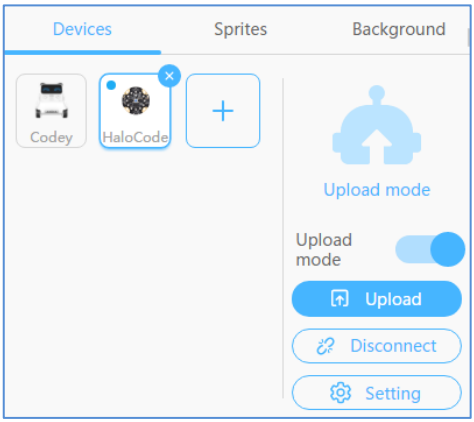
3.2.1.- USB connection

Halocode can be connected to a PC through the mini USB connector on top.

After connecting the USB cable, click on mBlock5 in "Connect", opening a window to select the port.



Just select the COM port to which the Halocode board has been connected and click on "Connection". As indicated, there can not be more than one device connected simultaneously, so when a new device is connected, the one that was previously connected is disconnected.



Once the connection is successful, this window closes and in the Devices section the option to load the program appears (upload).

The USB connection itself provides power to Halocode.

3.2.2.- Bluetooth connection

To connect the PC with Halocode via Bluetooth (BT4.0), the following steps must be followed:

- Concect the Makeblock Bluetooth dongle to a PC USB port.
- Switch on Halocode.
- Press the button on the Bluetooth dongle. Once the pairing is achieved, the blue light of both components will remain fixed.
- In mBlock5 connect Halocode following the same process as described for USB port connection.

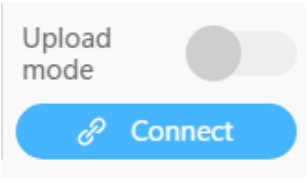
3.3.- Stage

In the upper left mBlock5 environment, appears the stage window.

In this book it is used only to visualize the values of the different variables, which is very useful to check the operation of the program and debug possible errors, especially if we take into account that Halocode does not have a screen that allows us to show the values of the variables.

To display the value from a variable in the stage, simply check the box next to its name in the variable section.

To be able to show the values of the variables (in the sample image is “Dice”); you must work with the board in peripheral mode, that is, with the "upload mode" disabled.



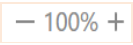
3.4.- Execution options menu

Below the stage window appears the execution options menu:

Execution options menu	
	Expand the stage
	Stops program execution
	Start program execution (in peripheral mode that is, with "up mode" disconnected)

3.5.- MBlock5 program edition options menu

This menu includes the edition options.

Edition menu			
	Undo the last action		Recover the undo
	It allows selecting the programming language available for the platform: by blocks, Python,...		
	Zoom ("-" to reduce, "+" to increase)		

3.6.- Programming block menu

In the programming environment, each resource is a block. These blocks are grouped by type of functionality.

3.6.1.- Lighting

This group includes the blocks used to manage the RGB LEDS ring that Halocode has on its front.

3.6.1.1.- Play LED animation with different effects

This block shows a certain pattern of lights in the RGB LEDS ring.

The block itself allows access to a drop-down menu to select one of the available patterns:

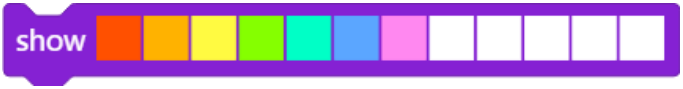
Rainbow	All the LEDs light up and a transition of the colors of the rainbow occurs.
Spindrift	All LEDs turn blue and then a group of white LEDs rotates until the circle is completed.
Meteor	Similar to the previous one but at a higher speed and two rounds are completed.
Firefly	At random, the LEDs are switched on and off progressively.

The execution of the program stops until the pattern is completed.

Since it is a very specific Halocode block, **we do not use it in the projects in this book**. Instead we use more usual programming blocks.

3.6.1.2.- Shows a pattern of colors

With this block a colour pattern will be permanently displayed.



Each position of the block corresponds to one of the 12 LEDS.

Since it is a very specific Halocode block, **we do not use it in the projects in this book**. Instead we use more usual programming blocks.

3.6.1.3.- Show a colour pattern from a position

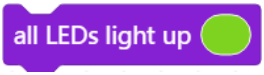
With this block a colour pattern will be permanently displayed from the LED indicated in the parameter.

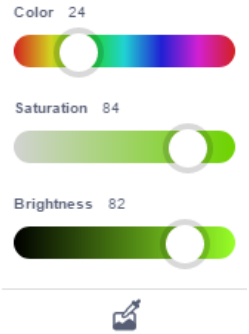
Each position of the block corresponds to one of the 12 LEDS.

Since it is a very specific Halocode block, **we do not use it in the projects in this book**. Instead we use more usual programming blocks.

3.6.1.4.- Turn on all LEDs with a certain colour

This block allows you to turn on all the LEDS by specifying a certain color, saturation and brightness.





Clicking on the colour opens a drop-down that allows selecting each parameter.

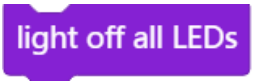
It also has a tool in the lower part to take the colour sample from the mBlock5 stage.

3.6.1.5.- Turn on all LEDs (brightness parameter)

This block allows you to turn on all the LEDs by specifying a certain color, saturation and brightness, but you can also set the brightness, either with a constant value or with a variable.

3.6.1.6.- Turn off all LEDS

This block allows you to turn off all RGB LEDS.



3.6.1.7.- Turn on all LEDs by specifying RGB values

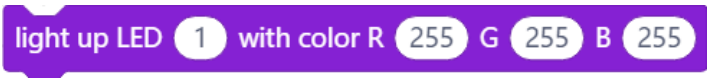
This block allows you to turn on all the LEDs by specifying the value of each of the three component colors (red, green or blue). Indicating the values 0 the LEDS turn off.

Instead of the values, variables can be used.

In the projects of this book it is usual to use this block in the following way:

3.6.1.8.- Turn on a specific LED specifying RGB values

This block allows you to turn on a specific LED by specifying the value of each of the three component colors (red, green or blue). Indicating the values 0 the LEDS turn off.

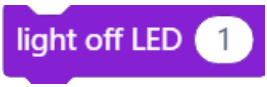


Instead of the values, variables can be used.

In the projects of this book it is usual to use this block in the following way:

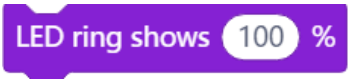
3.6.1.9.- Turn off a specific LED

This block allows you to turn off a certain RGB LED. A variable can be used instead of the LED number.



3.6.1.10.- LED ring shows a percentage value

This block allows you to use the Halocode LEDS ring as if it were an analog indicator to show percentage values.



It allows to indicate a fixed value or, what is more useful, a variable. A value of 50 lights turn on half of the LEDS, while a value of 100 lights all of them. On the other hand the LEDS are going on in a scale of colors.

3.6.2.- Sensing

This group includes the blocks used to manage the sensors integrated in the Halocode board.

3.6.2.1.- Check the button status

This block is used to check if the button is pressed. It is usually used to condition actions.

3.6.2.2.- Get the volume value of the ambient sound

This block is used to obtain the value of the sound sensor. It is usually used to assign this value to a variable or to condition actions.

3.6.2.3.- Check the contact sensor status

This block is used to check the status of one of the 4 Halocode contact sensors.

It is usually used to condition actions.

3.6.2.4.- Get the value of a contact sensor

This block is used to obtain the value of the specified contact sensor. It is usually used to assign this value to a variable or condition actions.

3.6.2.5.- Check the position of Halocode

This block is used to check the position of Halocode.

It is usually used to condition actions.

The possible positions that can be checked are:

- Left-tilted (Roll left)
- Right-tilted (Roll right)
- Arrow up (Tilted up)
- Arrow down (Tilted down)
- Face up (LEDS rind up)
- Face down (LEDS ring down)

3.6.2.6.- Check if Halocode is shaken

This block is used to know if the Halocode gyro sensor detects that it is being shaken.

It is usually used to condition actions.

3.6.2.7.- Get the value of the shaking strength

This block allows you to obtain the value with which Halocode is shaking.

It is usually used to assign it to variables or condition actions.

3.6.2.8.- Obtain the acceleration from an axis (X, Y, Z)

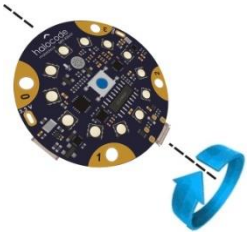
This block allows obtaining the acceleration with respect to one of the axes, X, Y or Z, in m / sec2. This value allows, for example, determining precisely the degree of inclination of Halocode with respect to any of the axes.

When Halocode is fully leveled in the horizontal plane, the acceleration values on the X and Y axes will be 0. When perfectly vertical, the acceleration value of the Z axis will be 0.

3.6.2.9.- Obtain the angle of lateral inclination (roll)

This block allows to obtain the lateral rotation angle of Halocode.

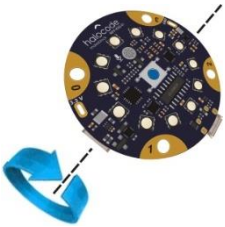
Returns values between 0 and 90 degrees, negative to the left and positive to the right. It is usually used to assign it to variables or condition actions.



3.6.2.10.- Obtain the elevation angle (pitch)

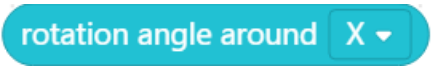
This block allows to obtain the inclination angle of Halocode.

Returns values between 0 and 180, negative forward and positive backward. It is usually used to assign it to variables or condition actions.



3.6.2.11.- Obtain the rotation angle with respect to the X axis

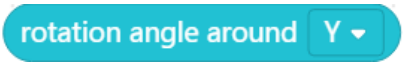
This block allows to obtain the rotation angle of the Halocode internal gyroscope with respect to the X axis, which corresponds to the angle of inclination of the board forward or backward. It is usually used to assign it to variables or condition actions.



The gyroscopes sensors are suitable for determining instantaneous and small magnitude turning angles, but they are not suitable for determining angles of rotation over time or of great magnitude.

3.6.2.12.- Obtain the rotation angle with respect to the Y axis

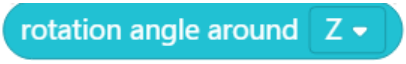
This block allows to obtain the rotation angle of the internal gyroscope of Halocode with respect to the Y axis, which corresponds to the angle of inclination of the board to the left or right. It is usually used to assign it to variables or condition actions.



The gyroscopes sensors are suitable for determining instantaneous and small magnitude turning angles, but they are not suitable for determining angles of rotation over time or of great magnitude.

3.6.2.13.- Obtain the rotation angle with respect to the Z axis

This block allows obtaining the rotation angle of the Halocode internal gyroscope with respect to the Z axis, which corresponds to the rotation angle of the board on itself. Towards the left the values grow, while to the right they decrease. It is usually used to assign it to variables or condition actions.

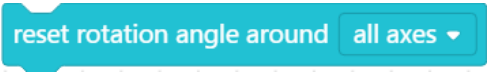


The gyroscopes sensors are suitable for determining instantaneous and small magnitude turning angles, but they are not suitable for determining angles of rotation over time or of great magnitude.

3.6.2.14.- Reset the rotation angle of an axis

This block allows you to reset the rotation angle of the internal Halocode gyroscope with respect to an axis or all of them.

The Halocode gyroscopic sensor presents the errors of this type of sensors. With this block the value of the angle of rotation is reset to zero, although this does not mean that Halocode recovers its initial orientation.



3.6.2.15.- Read the value of the internal timer

All the processors have an internal timer with which it synchronizes all the components and the operations that are carried out. When starting Halocode, the timer is reset to zero.

This block allows you to read the value of the internal timer, either to assign it to variables or to condition actions.

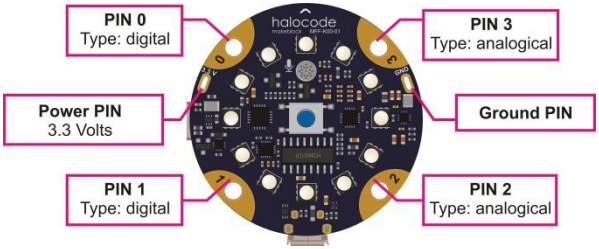
As we will see, in programs you can use the value of this stopwatch to control precisely the passage of time.

3.6.2.16.- Restart the timer

This block allows you to reset the internal Halocode timer.

3.6.3.- Pins

This group includes the blocks used to manage the four connection pins (0, 1, 2 and 3) of the Halocode board.



3.6.3.1.- Check the value of a pin in digital mode

This block allows you to check the digital (binary) value of any of the 4 pins. It is usually used to condition actions.

Pins 0 and 1 are identified as digital (D), while pins 2 and 3 are identified as analog (A). However, all analog pin can be read as digital, since values

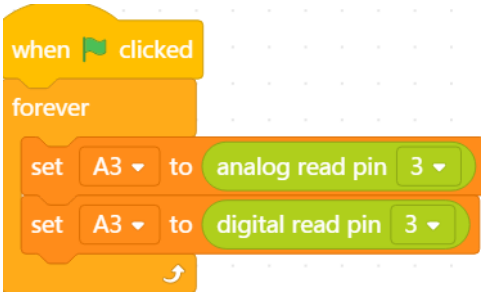
higher than 512 will be identified as 1 and lower values as 0, as shown in the example in the next section.

3.6.3.2.- Read the value of a pin in digital mode

This block allows you to check the digital (binary) value of any of the 4 pins. It is usually used to assign this value to a variable.

Pins 0 and 1 are identified as digital (D), while pins 2 and 3 are identified as analog (A).

However, all analog pin can be read as digital, since values higher than 512 will be identified as 1 and lower ones as 0, as shown in the example executed in "no upload" mode to display the values of the variables.



If, for example, we connect a button on pin 3 (which in principle is an analog pin), when we press it D3 will be 1 and, otherwise, it will be 0.

3.6.3.3.- Read the value of a pin in analog mode

This block allows you to check the analog value of any of the 2 analog pins (2 and 3). It is usually used to assign this value to a variable.

3.6.3.4.- Write a binary value in a pin

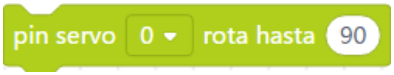
This block allows you to write a binary value (0, 1) in any of the 4 Halocode pins. Writing a binary 1 is equivalent to writing the value 1023 in analog mode.

3.6.3.5.- Write an analog value in a pin

This block allows you to write an analog value (between 0 and 1023) in any of the 4 Halocode pins. Writing the analog 1023 value is equivalent to writing the value 1 in binary mode.

3.6.3.6.- Move a servo

This block allows to move a servo, connected to the pin indicated in the block, to a certain position, indicating an angle between 0 and 180.



3.6.4.- Wi-Fi

This group includes blocks destined to manage WiFi communication, either to make use of voice recognition or to communicate two or more Halocode boards. These blocks can only be used in "Up load On" mode.

Voice recognition is based on Microsoft Cognitive Services, that is, the Halocode board records the voice message and sends it to the Microsoft server so that it translates the voice file into text.

Therefore, it will only be possible to use voice recognition if Halocode is first connected to a WiFi access point that also has an Internet connection, **and the user has logged in to his makeblock.com account**.

The communication between boards is done at the level of "user code", that is, any board with Internet access connected in the same user account can exchange messages with each other, regardless of their physical location.

3.6.4.1.- Connect Halocode to a WiFi hotspot

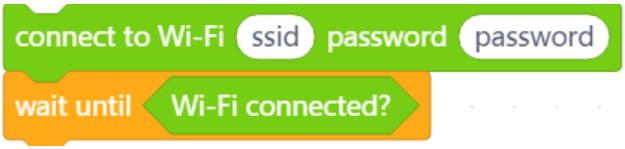
This block allows to connect the Halocode board to a WiFi access point, indicating the name (SSID) and the access key WPA / PSK of the access point.

Once the connection is established, the rest of the mBlock5 blocks related to WiFi communication can be used.

3.6.4.2.- Check WiFi connection

This block allows you to check if the WiFi connection between Halocode and the WiFi access point has been established.

Normally this block usually follows the one seen in the previous section, so that the execution of the program will wait until the connection has been established:

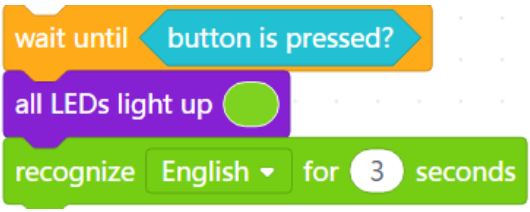


3.6.4.3.- Text recognition

This block performs the following actions:

- Record a voice file during the indicated seconds.
- Send the voice file to the Microsoft server so that it is translated into text based on the selected language (currently only Chinese and English are available).
- Wait to receive the text.

The normal thing is that the voice recognition is executed based on a user action, such as pressing the button:

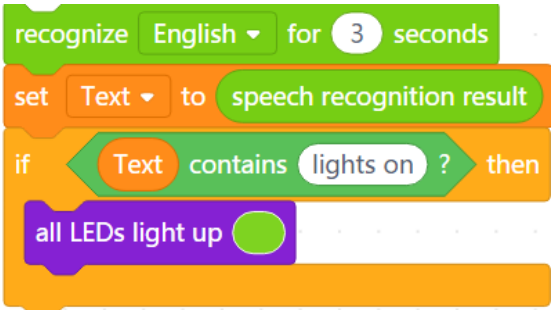


3.6.4.4.- Use the voice recognition text result

This block allows you to use the result of speech recognition to, for example, assign it to a variable:

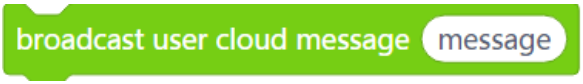
It is important to keep in mind that voice recognition is able to translate any word or phrase into a text, either in Chinese or English, correctly pronounced. The returned text always ends with a period.

Later this data can be used to condition actions, such as turning on the LEDs if "lights on" has been said:



3.6.4.5.- Send a message to the user's cloud

This block allows you to send a message to the user's cloud. This message will be received by all Halocode boards connected to the same user account, regardless of their location.

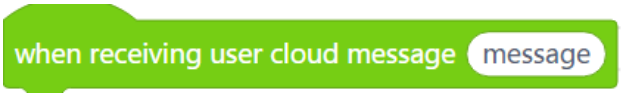


3.6.4.6.- Send a message with a value to the user's cloud

This block allows sending a message with a value to the user's cloud. This message, along with its value, will be received by all the Halocode boards connected to the same cloud.

3.6.4.7.- Event receive message from the user's cloud (WiFi)

This block allows grouping a set of actions to be performed when a message is received from the user's cloud.



3.6.4.8.- Use the value associated with a message

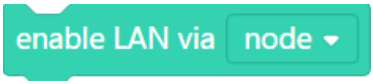
This block allows you to use the value associated with a message, as if it were a variable:

3.6.5.- LAN

This group includes the blocks destined to manage a WiFi wireless **local network** between Halocode boards to exchange messages and data between them.

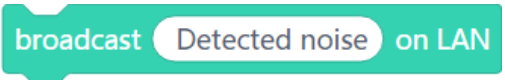
3.6.5.1.- Activate the local network

The first step to be able to use a local network is to activate it, either as root (master) or node (slave). In a local network there can only be one root board, while there is no limit in terms of node boards.



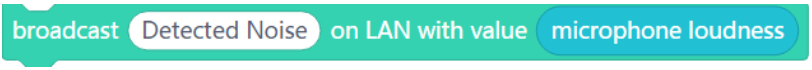
3.6.5.2.- Send a message to the local network

This block allows you to send a message to the local network. For example, the message "Detected noise" can be sent when the root board detects a high volume:



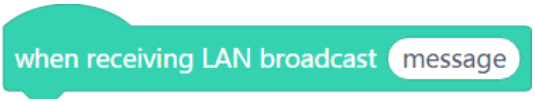
3.6.5.3.- Send a message with a value to the local network

This block allows sending a message with a value to the local network. For example you can send the message "Detected Noise", along with the volume, when the root board detects a high volume:



3.6.5.4.- Event receive message from the user's cloud (LAN)

This block allows grouping a set of actions to be performed when a message is received from the user's cloud.



3.6.5.5.- Use the value associated with a message

This block allows you to use the value associated with a message, as if it were a variable.

3.6.6.- Events

This group includes blocks associated with events.

3.6.6.1.- When pressing the green flag

This block is placed at the beginning of the main loop of the program in NO UPLOAD mode. Pressing the green flag starts the execution of said loop.

If you put more than one block of this type, all will run in parallel when you start up Halocode.

Since Halocode does not have a screen, we recommend working in "no upload" mode to check the values of the variables and to debug the programs, since in this way we can visualize the variables in mBlock5 stage.

3.6.6.2.- When Halocode turning on

This block is placed at the beginning of the main loop of the program. When Halocode is started, the execution of said loop begins.

If you put more than one block of this type, all will run in parallel when you start up Halocode.

3.6.6.3.- When button is pressed

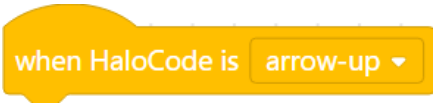
Pressing the button starts the execution of the block.

3.6.6.4.- When Halocode is shaking

When shaking Halocode starts the execution of the block.

3.6.6.5.- When Halocode is tilted

When Halocode is tilted to the indicated side starts the execution of this block.

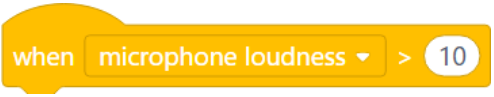


3.6.6.6.- When the timer exceeds a value

This block will be executed when the internal timer exceeds the indicated value.

3.6.6.7.- When microphone loudness greater than a value

This block will be executed when the intensity sound detected will greater than the indicated value.



3.6.6.8.- When receiving a message

This block will be executed when receiving a message.

3.6.6.9.- Send a message

This block allows you to send a message or a "new message".

3.6.7.- Control

This group includes all the blocks that allow controlling the execution flow of the program.

3.6.7.1.- Waits for a time

This block allows waiting times to be included in the program, whether fixed or variable.

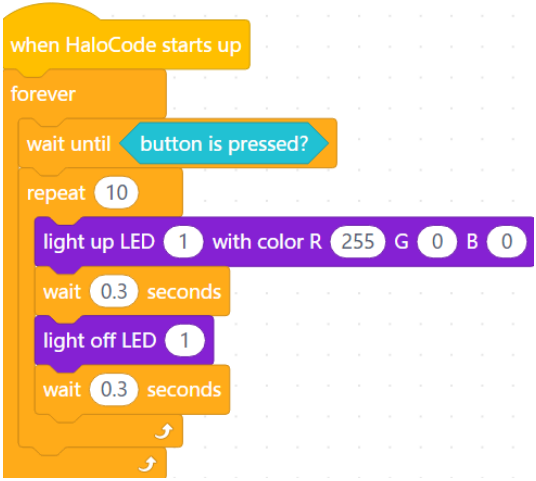
Wait 1 second

Wait for the second contents in the variable Time

3.6.7.2.- Repeat a certain number of times

With this block we can make a set of instructions run repeatedly a certain number of times.

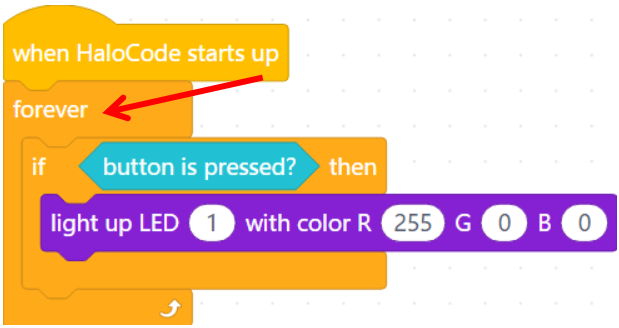
In the following example the LED will flash 10 times in red.



3.6.7.3.- Forever loop

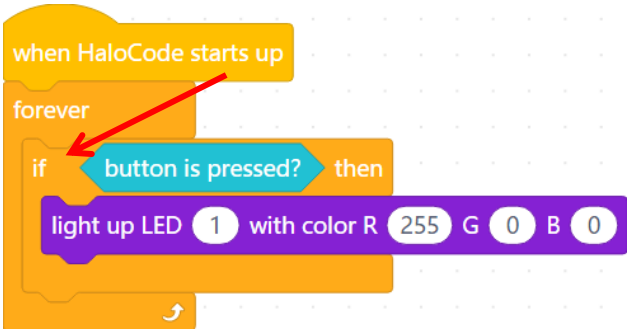
With this block we can make a set of instructions run indefinitely.

Normally it is only used in the main program loop.

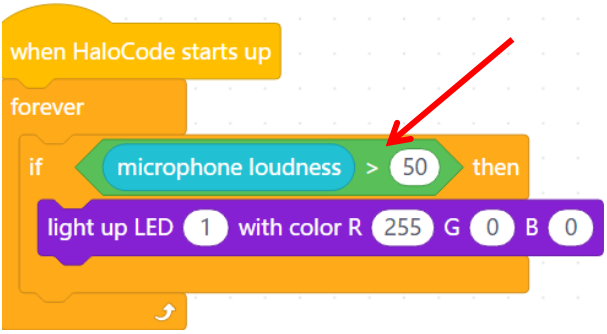


3.6.7.4.- Condition actions (If)

This block allows to condition the execution of a group of instructions. Precisely in the previous section we saw an example that included a conditional block "If".



The condition can be the state of a sensor, such as a button. You can also combine operators to check if the value returned by a sensor is equal, less or greater than a certain value. In the next program, when the volume measured by the microphone is greater than 50, LED 1 will light red.

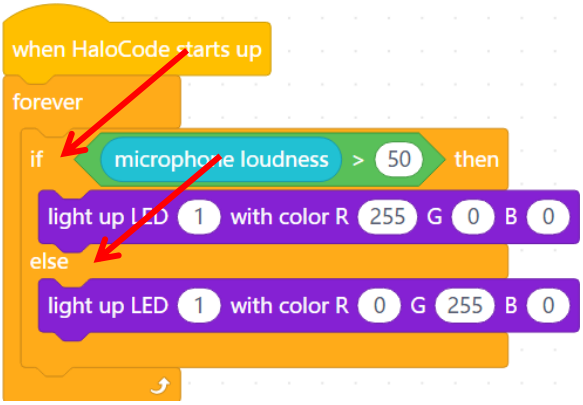


In section 3.6.8 (Operators), all the operators that can be used to determine the condition are detailed.

3.6.7.5.- Condition actions to a condition and to the opposite

This block allows to condition the execution of a group of instructions to a condition (If) and a second block of instructions to the opposite condition (Else).

The condition can be the state of a sensor, such as a button. In the following program, if the volume measured by the microphone is greater than 50, LED 1 will light red and, else, green.

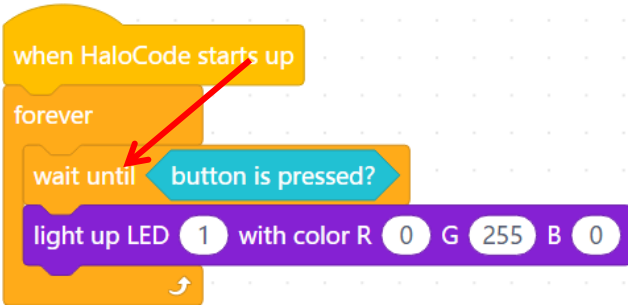


In section 3.6.8 (Operators), all the operators that can be used to determine the condition are detailed.

3.6.7.6.- Wait until a condition is met

With this block the execution of the program stops until the expected event occurs.

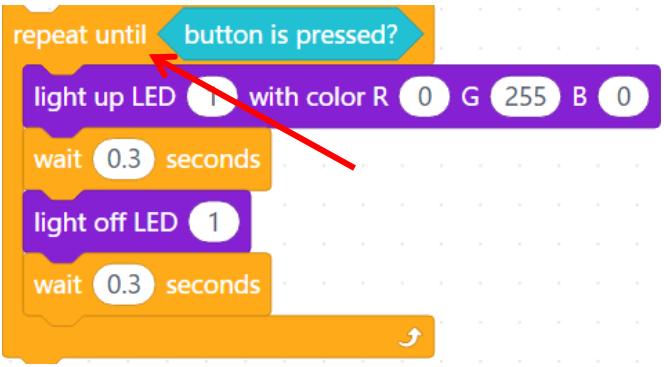
In the following example, the program waits for the button to be pressed, after which LED 1 will light up in green:



3.6.7.7.- Repeat until a condition is met

This block repeats the execution of a group of instructions until a condition is met.

In the following example LED 1 will flash green until the button is pressed:



3.6.8.- Operators

This group includes all the blocks that allow to perform mathematical operations, logical operations, comparisons, arithmetic functions, etc.

3.6.8.1.- Arithmetic operations

These four blocks allow performing arithmetic operations (addition, subtraction, multiplication and division) between variables and constants.

Addition | Subtraction | Multiplication | Division

Blocks can be combined:

Equivalent to
Average = (A + B) / 2

3.6.8.2.- Random number

A random number is a number chosen randomly. They are used mostly in games to make it look like an unpredictable operation of the program. In the case of robots, it allows to give him apparently random behavior.

The random numbers generated by the computer can not really be considered random since they follow a sequence determined from an initial number called “random seed”.

3.6.8.3.- Comparison

These three blocks allow you to compare two variables of the same type. If the comparison is true, the result is true. Otherwise it is false.

Assuming that the variables to be compared are A and B, the possible comparisons are:

Logical Operation		What does	Equivalent to
A = B		Check if A value equals the B value	A is **equal** to B?
A > B		Check if A vaule is greater than B value	A is **greater** than B?
A < B		Check if A vaule is lower than B value	A is **lower** than B?

This block can be combined, for example, with the "No" block, which allows to increase the variants:

Logical Op.		What does	Equivalent to
Not (A = B)		Check if it is not true that the value of A is equal to the value of B	A **not equal** to B?

Normally the comparison block is usually used in combination with control blocks:

3.6.8.4.- Logical operators AND, OR

With these two blocks you can perform logical operations AND and OR.

In logical operations, 1 equals "true", while 0 equals "false".

The operator AND allows combining two conditions. For the overall result to be true, both conditions must also be true.

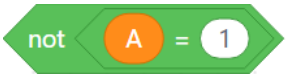
The operator OR allows combining two conditions but, unlike the operator AND, it is enough that one of them is true so that the global is true.

Logical operation AND	Result
1 AND 1 = 1	1
1 AND 0 = 0	0
0 AND 1 = 0	0
0 AND 0 = 0	0

Logical operation OR	Result
1 OR 1 = 1	1
1 OR 0 = 1	1
0 OR 1 = 1	1
0 OR 0 = 0	0

3.6.8.5.- Contrary (Not)

This block allows you to invert the resulting value of a condition. It corresponds to the "Not" operation of the Boolean algebra.



Not(1) = 0	Not(0) = 1

3.6.8.6.- Join texts

This block concatenates texts. In the example, the result would be "Hello world!"

3.6.8.7.- Extract a character from a text (Letter)

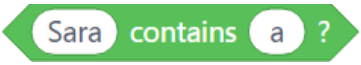
This block extracts a character from a text. In the example, the result would be "u".

3.6.8.8.- Length of a text

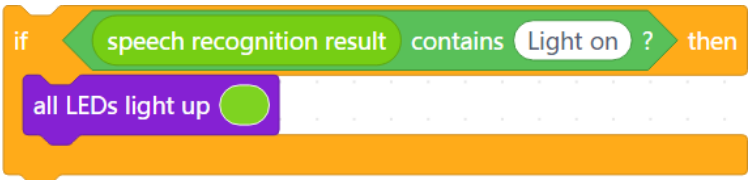
This block returns the length of a text. In the example, the result would be 4.

3.6.8.9.- Check if a text contains a string

This block allows you to check if a text contains a string of characters. In the example, the result is 1 (True).



This block will be used together with the result of speech recognition to condition instructions:



3.6.8.10.- Get the remainder of a division (modulo)

Modulo operation finds the remainder after division of one number by another (sometimes called modulus).

In the example, the value of A would be 1.

3.6.8.11.- Round

This block rounds a value. In the example, the value of A would be 2.

3.6.8.12.- Diverse functions

This block allows to perform different functions.

Function		Sample
ABS	Returns the absolute value of a number, that is, without the sign.	ABS(-1) = 1
Floor	Round down	FLOOR(1,8)=1
Ceiling	Round up	CEILING(1,2)=2
SQRT	Square root	SQRT(4)=2
SIN	Trigonometric function sine	SIN(90º)=1
COS	Cosine trigonometric function	COS(90º)=0
TAN	Trigonometric tangent function	TAN(45º)=1
ARC SIN	Arcsine = Inverse function of sine	ASIN(1)=90°
ARC COS	Arccosine = Inverse function of cosine	ACOS(0)=90°
ARC TAN	Arctangent = Inverse function of tangent	ATAN(1)=45°
Ln	Naperian logarithm function	Ln 2.71828 = 1
LOG	Logarithm to base 10 function	Log 10 = 1
e^	Exponentiation function	e^1 = 2.71828
10^	Powers of ten	10^2 = 100

3.6.9.- Variables

This group contains the programming blocks that allow creating and managing variables.

A variable is a container to which we give a name to identify it and in which we can store a data. There are different types of containers to store different types of data:

- Integer numbers
- Decimal numbers
- Text
- Logical vaules (true or false)

In the mBlock5 environment, the types of variables are not differentiated, so a variable can contain any type of data, be it numeric, literal or logical.

The group "Variables" has the option "Make a variable", which is used to create a new variable.

In the stage area appear the variables created, as well as their value, which is very useful to check and debug programs.

3.6.9.1.- Make a variable

This option is used to create variables. Once created, they can be assigned a numerical, literal or logical value. Variable names can contain any character except these: (& <> ")

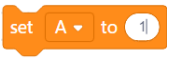
Here you can select if the variable is only for the current project or for all the projects.

3.6.9.2.- Show a variable on the stage

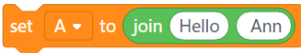
For a variable to be displayed in the stage, simply check the box next to its name in the variable section.

3.6.9.3.- Assign a value to a variable (Set)

Once a variable is created, it can be assigned a numerical, text or logical value.



Assign a numeric value



Assign a text

Assign a logical value

3.6.9.4.- Increase the value of a variable (Change)

This instruction allows you to increase the value of a variable. In the image the increment is 1 unit.

It is equivalent to writing A = A + 1. Since it is much easier to understand this second form, it is the only one that we use in all of our books.

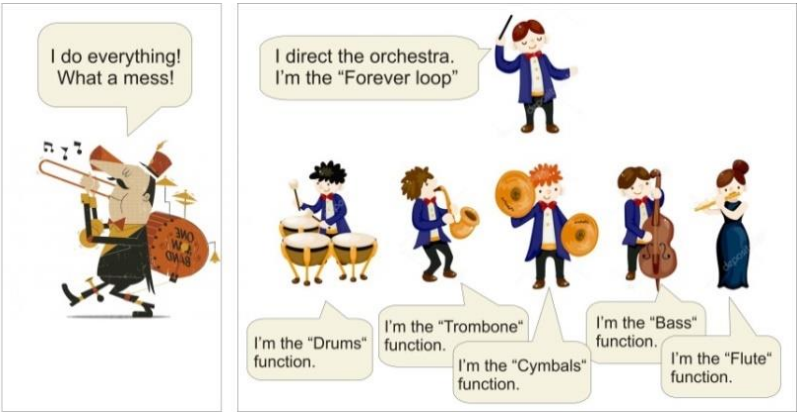
3.6.11.- My blocks

This group contains the programming blocks that allow creating and managing the blocks created by the user. It is the equivalent of the functions that we can find in other programming environments. The use of blocks (functions) allows to structure the programs better.

A function is a set of instructions that perform a specific task, usually returning a result. They are, therefore, small programs within programs. They serve to avoid having to repeat the same instructions throughout the program.

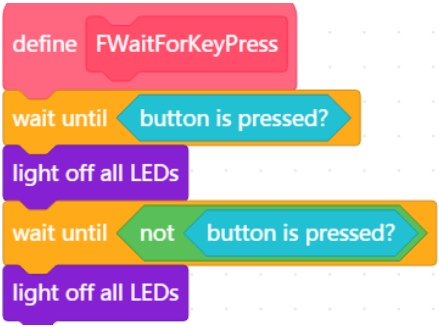
When solving a problem, it is always better to divide it into smaller problems, which will be easier to solve. In programming, the same thing happens, so regardless of the programming environment or language used, it is always better (if possible) to split the program into functions that perform simple and specific tasks.

Another alternative is to create a loop for each task to be performed. These loops will all be executed in parallel when the program is launched.



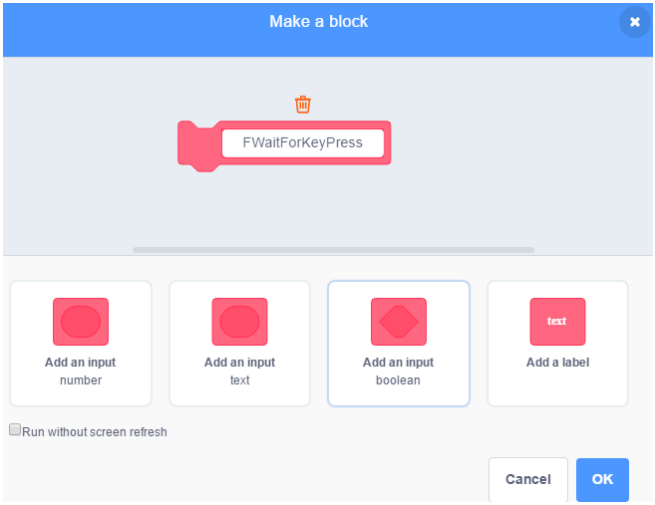
When selecting this group, the option to create a new block appears, as well as the list of blocks that you have already created for the program that is being edited.

The next function waits for the user to press and release the button, confirming the pulsation with a flash of the LEDS.



3.6.11.1.- Create a Block

A function is a set of instructions that perform a specific task, usually returning a result. They are, therefore, small programs within programs. They serve to avoid having to repeat the same instructions throughout the program.



This option allows you to create a new block. When selecting a window opens to indicate the name. Many programming languages do not allow a function and a variable with the same name in the same program. A good way to avoid this situation is to have all the functions start with the letter F, as can be seen in the image of the previous point where we created the function FWaitForKeyPress.

The functions can have input parameters, which allows to pass data to said function. These input parameters are indicated when creating or editing the function and can be of different types: numeric (Number), text (Text) or logical (Boolean).

3.2.12.- Extensions

At the bottom of the programming block palette appears an option that allows you to manage the extensions available for mBlock5.

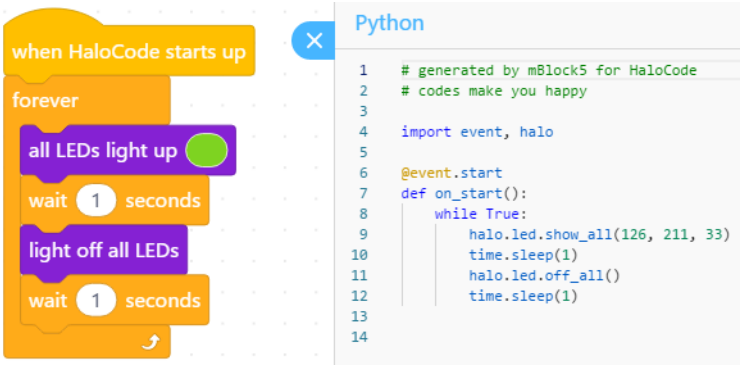
At the time of writing this book in mBlock5 there were no extensions available for Halocode. Accessing to the extension manager only appears the text “Coming Soon…”

Once there are extensions available, to add any of them, it will be enough to click on the plus sign that will be below each extension. Once an

extension has been added, a trash can appears instead of the plus sign in case you want to delete the mBlock5 extension.

3.7.- mBlock5 to Python translation

mBlock5 environment allows the automatic translation of the program in blocks to Python. To do this, simply click on the "</>" symbol that appears in the right margin of the programming area, dividing it into two areas:



4.- STEAM projects with mBlock5

This section deals with STEAM projects programmed with mBlock5. Section 3 details how to obtain the mBlock5 program and its operation.

For all projects, it includes:

- Explanation, where appropriate, of the element to be reproduced.
- Approach of the project, proposed solution, time required and levels of difficulty (in relative terms with respect to the rest of the projects of the chapter).
- Required components
- Pseudocode
- Program in mBlock5

Some of the projects can be used to carry out teaching activities for "Learning WITH Robotics".

The reader can request to the author the collection of all the programs of the projects and activities in this section in mBlock5 format (see last page of the book).

On this summarised edition we include some of the projects from the full book “Educational Robotics with Halocode” from the same author.

To keep the same projects numbering, an empty section is included for the projects not included in this summary edition.

4.1.- With the Halocode board alone

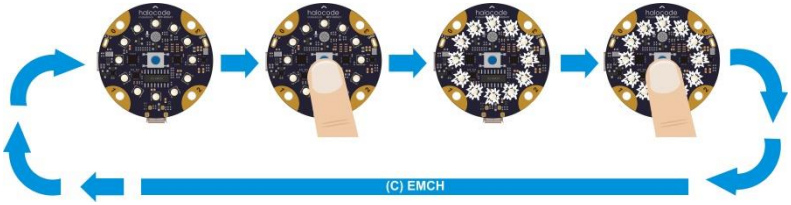
In this section several projects are carried out only with the Halocode board, without additional components.

4.1.1.- Flashlight

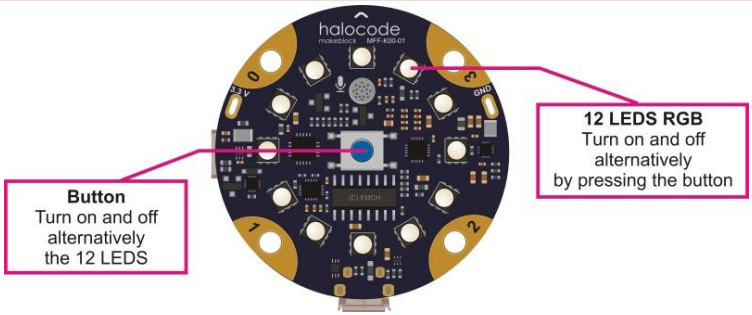
A Flashlight or torch is a portable hand-held electric lightdevice that works with batteries, rechargeable batteries or even small dynamos.



Objetive	Complexity
Carry out with Halocode a flashlight with a button to turn it on and off.	Time 10’
	Program: very low



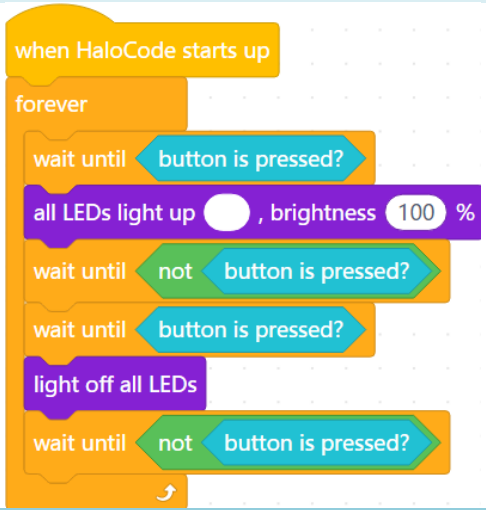
Components used



Proposed pseudocode

```
Forever
    Wait until button pressed
    Turn on all RGB LEDS in white color
    Wait until button released
    Wait for pressed button
    Turn off all RGB LEDS
    Wait until button released
```

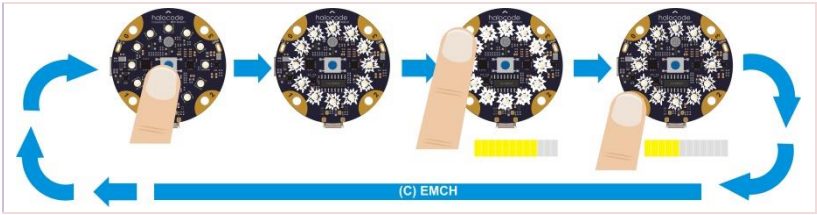
Program developed with mBlock5



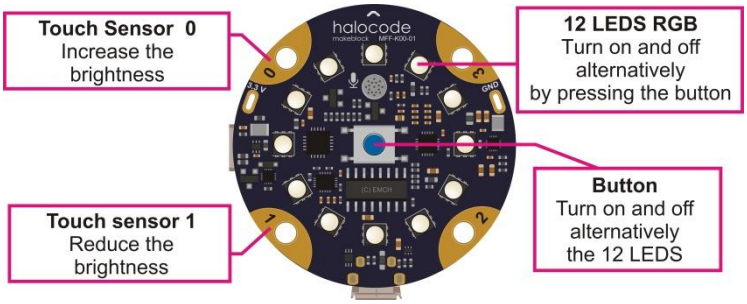
4.1.2.- Flashlight with brightness adjustment

Starting from the previous project, we will add the possibility of adjusting the brightness.

Objetive	Complexity
Carry out a flashlight with a button to turn it on and off with Halocode.	Time 20’
Starting from the previous project, add the possibility of adjusting the brightness using touch sensor 0 and 1.	Program: low



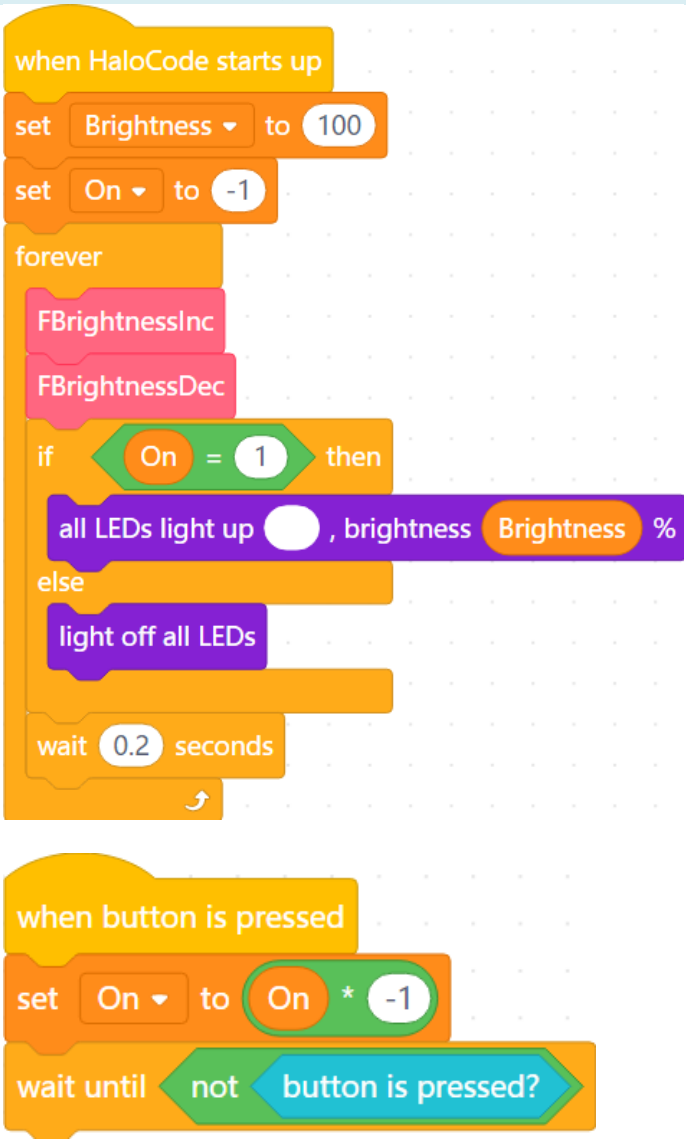
Components used

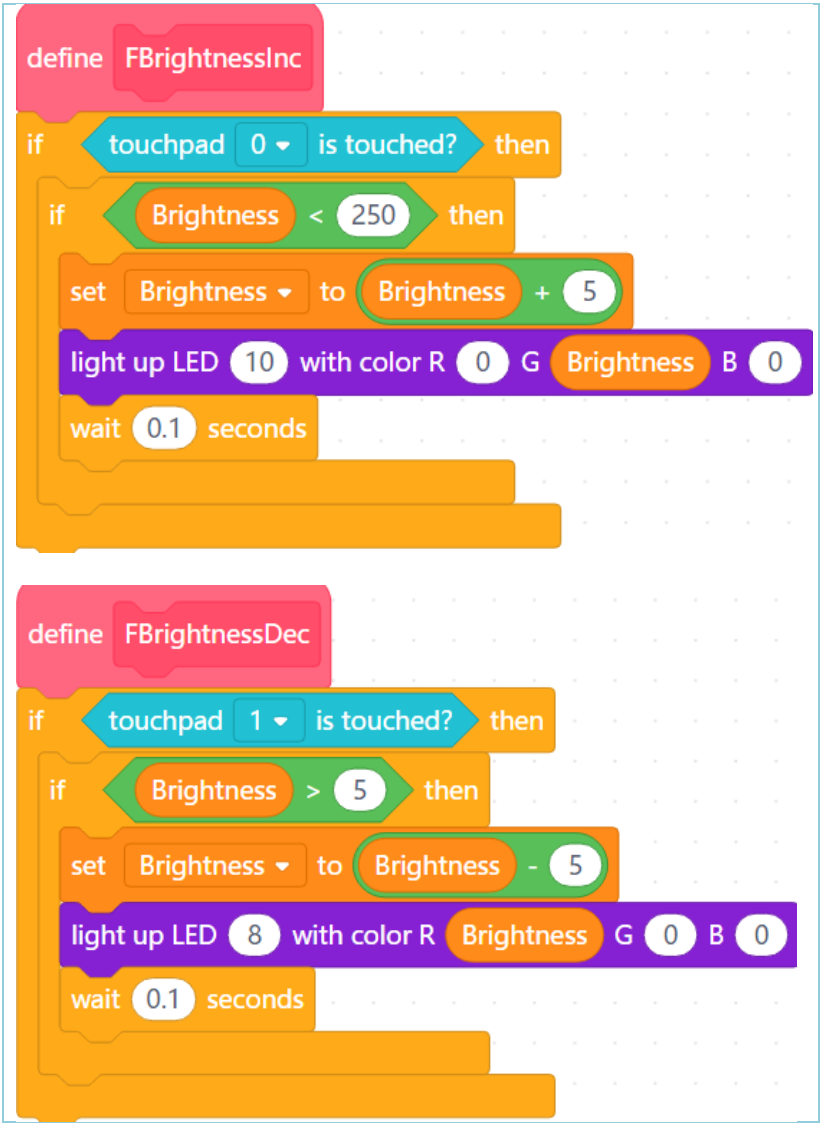


Proposed pseudocode

```
Brightness = 100
On = -1
Forever
    Execute function FBrightnessInc
    Execute function FBrightnessDec
    If On = 1
        Turn On all LEDS in white with intensity = Brightness
    Else
        Turn Off all LEDS
    Wait for 0.2 seconds
Forever
    If button pressed, On = On * (-1)
    Wait until button released
Function FBrightnessInc
    If touch sensor 0 touched
        If Brightness less than 250
            Brightness = Brightness + 5
            Turn On LED 10 in green
            Wait for 0.1 seconds
Function FBrightnessDec
    If touch sensor 1 touched
        If Brightness greater than 5
            Brightness = Brightness - 5
            Turn On LED 8 in red
            Wait for 0.1 seconds
```

Program developed with mBlock5




define FBrightnessInc
if touchpad 0 is touched? then
if Brightness < 250 then
set Brightness to Brightness + 5
light up LED 10 with color R 0 G Brightness B 0
wait 0.1 seconds
define FBrightnessDec
if touchpad 1 is touched? then
if Brightness > 5 then
set Brightness to Brightness - 5
light up LED 8 with color R Brightness G 0 B 0
wait 0.1 seconds

4.1.3.- Flashlight with brightness, colour and blink adjustment

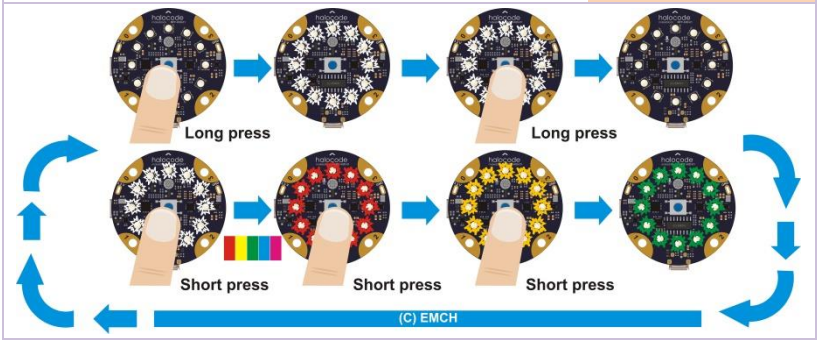
See the full book “Educational Robotics with Halocode” from the same author.

4.1.4.- Emergency vehicle lighting

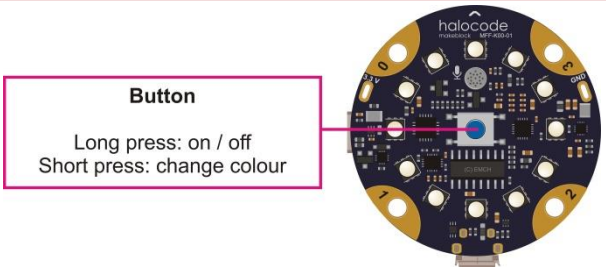
Emergency vehicles, such as ambulances, fire engines, patrol cars, snowplows or cranes are equipped with intense blinking lights that warn of their presence.

The colour of the light identifies the type of vehicle. In most countries, police, fire and medical services carry, respectively, blue, red and yellow lights.

Objetive	Complexity
Carry out an emergency light with Halocode with the following functionalities: • Long press = Turn on or off • Short press = Change color	Time 20’ Program: medium



Components used



In this project we will see how to use the same component, in this case the button, to control two parameters, the status (on or off) and the color, depending on the time that is kept pressed.

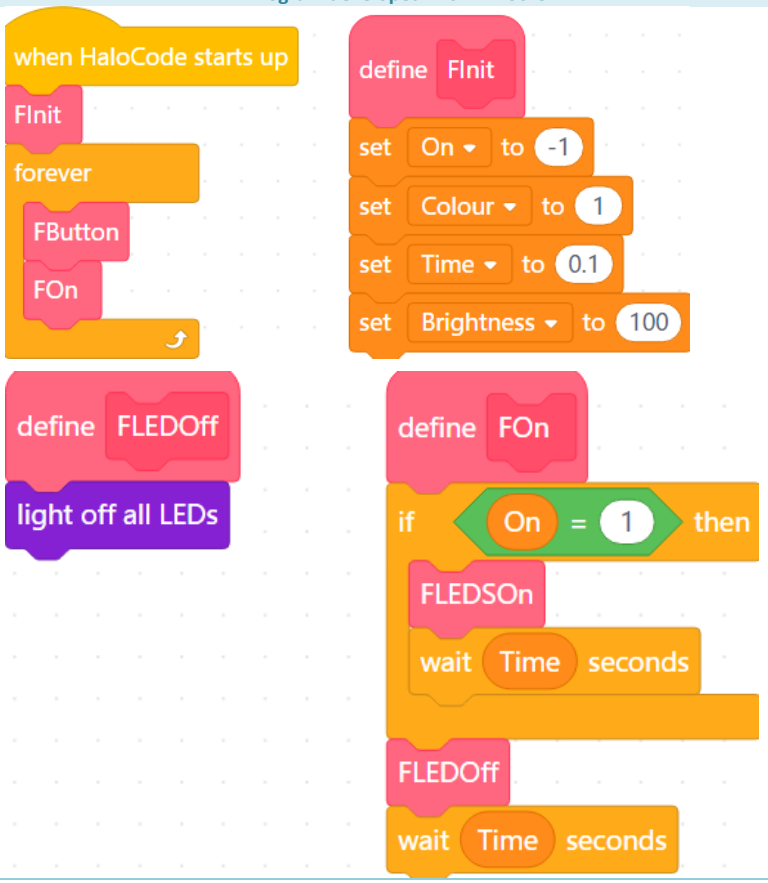
To control the on and off state, the normal thing in robotics is to use a logical variable, for example "OnOff", which contains 1 for the on state and 0 for the off state. To change the states, simply execute the operation "OnOff = opposite that(OnOff)" every time the button is pressed. Although in mBlock5 it is possible to use logical variables, another option is to use a numeric variable whose values will be 1 for on and -1 for off. To change the states, simply multiply the variable by -1 each time the button is pressed.

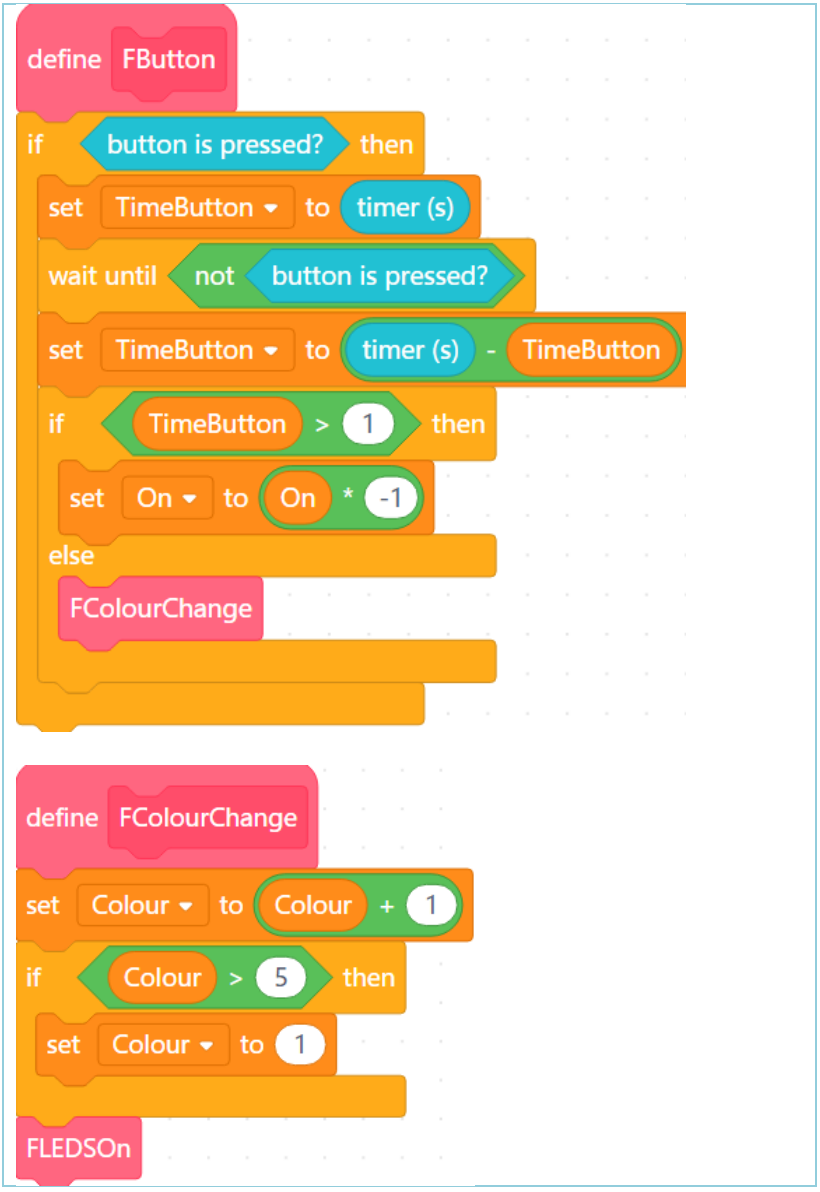
Proposed pseudocode

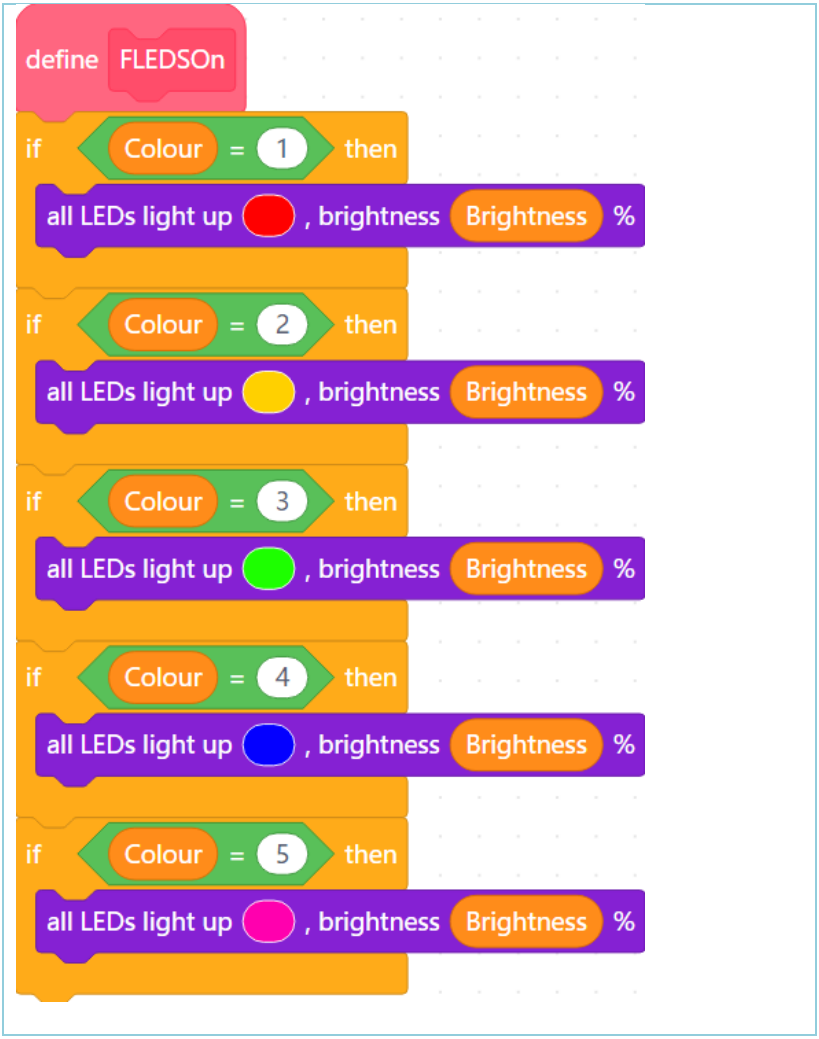
```
Execute function FInit
Forever
    Execute function FButton
    Execute function FOn
Function FInit
    Brightness = 100, On = -1, Colour = 1, Time = 0.1
Function FOn
    If On = 1
        Execute function FLEDSOn
        Wait seconds = Time
    Execute function FLEDOff
    Wait seconds = Time
Function FButton
    If button pressed
        TimeButton = Execution time
        Wait for the button not pressed
        TimeButton = Execution time – TimeButton
        If TimeButton greater than 1
            On = On * (-1)
        Else
```

```
            Execute function FColourChange
Function FColourChange
    Colour = Colour + 1
    If Colour greater than 5, then Colour = 1
    Execute function FLEDSOn
Function FLEDSOn
    If Color=1 turn on all LEDS in red
    If Color=2 turn on all LEDS in yellow
    If Color=3 turn on all LEDS in green
    If Color=4 turn on all LEDS in blue
    If Color=5 turn on all LEDS in magenta
Function FLEDOff
    Turn off all LEDS
```

Program developed with mBlock5




define FButton
if button is pressed? then
set TimeButton to timer (s)
wait until not button is pressed?
set TimeButton to timer (s) - TimeButton
if TimeButton > 1 then
set On to On * -1
else
FColourChange
define FColourChange
set Colour to Colour + 1
if Colour > 5 then
set Colour to 1
FLEDSOn



4.1.5.- Rotating Emergency vehicle lighting

See the full book “Educational Robotics with Halocode” from the same author.

4.1.6.- SOS signal light

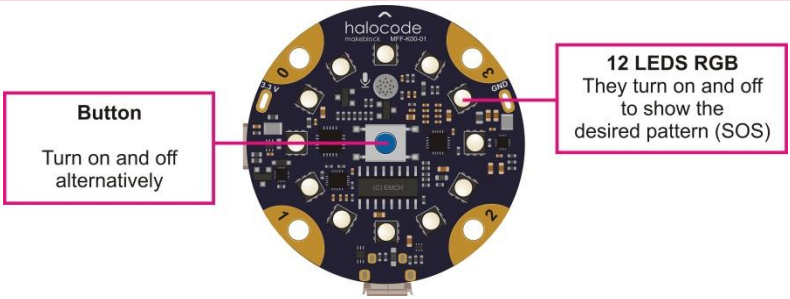
SOS is the most widely used international distress signal since it was approved during an international conference in Berlin in 1906, to replace the previously used "CQD" in telegraphic transmissions in Morse Code. Although Morse code is no longer used today, the SOS signal remains in effect.

This representation was chosen because it could be easily remembered and broadcast, whether by sound, visual, radio, etc. It consists of a sequence of three short pulses (S), three long (O) and three short (S), although it is transmitted continuously, without separating each letter.

Popularly it is assigned different meanings like "Save Our Ship", "Save Our Souls", or "Send Out Succour", but the reality is that is not the acronym of anything.

Objetive	Complexity
Make Halocode emit the visual signal corresponding to the Morse SOS code. The button will be used to alternately activate and deactivate it.	**Time 15'** **Program: medium**

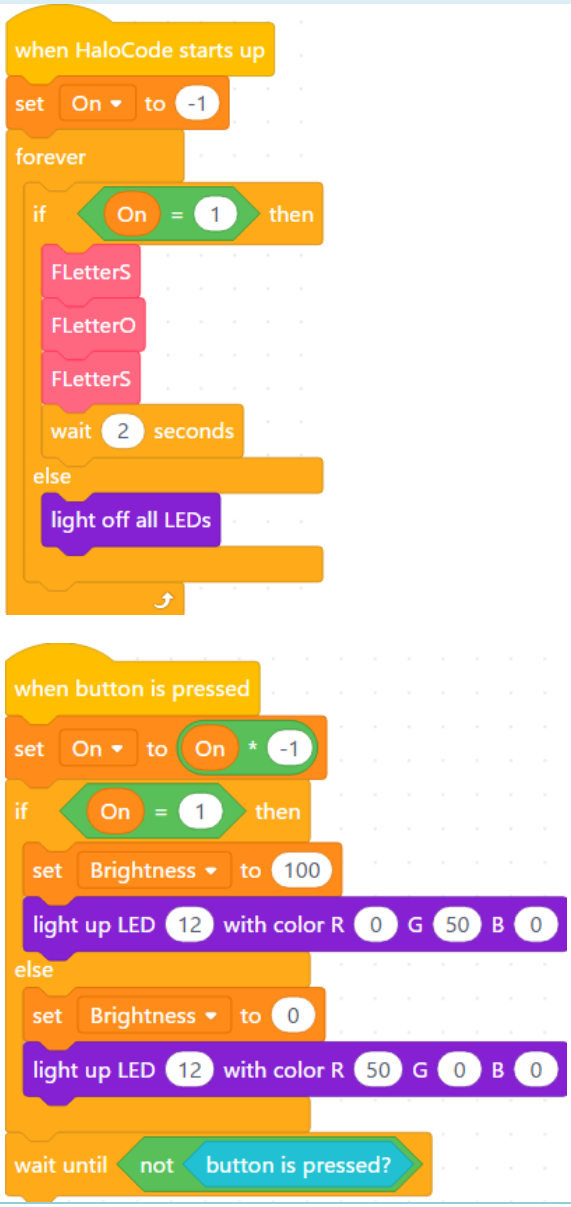
Components used

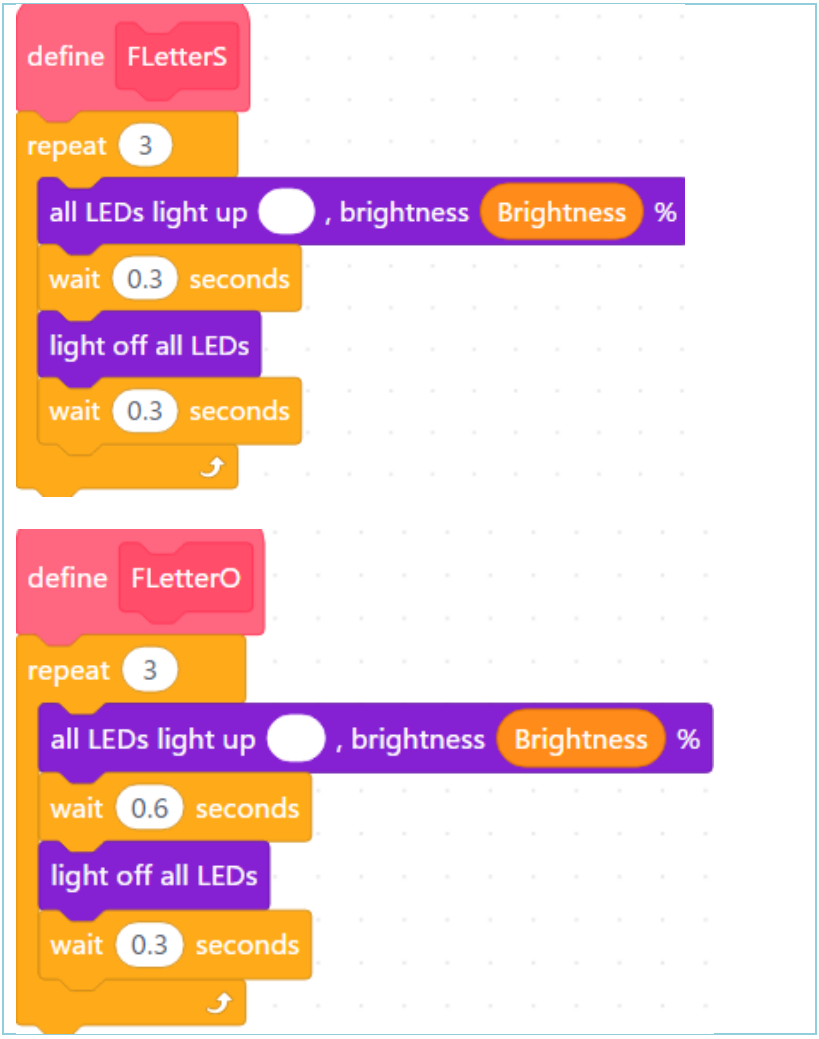


Proposed pseudocode

```
On = -1
Forever
    If On = 1
        Execute function FLetterS
        Execute function FLetterO
        Execute function FLetterS
        Wait 2 seconds
    Else
        Turn off all LEDS
Forever
    If button pressed
       On = On * (-1)
        If On = 1
            Brightness = 100
            Turn on LED 12 in green
        Else
            Brightness = 0
            Turn on LED 12 in red
        Wait for button not pressed
Function FLetterS
    Repeat 3 times
        Turn on all LEDS in white with Brightness = Brightness
        Wait 0.3 seconds
        Turn off all LEDS
        Wait 0.3 seconds
Function FLetterO
    Repeat 3 times
        Turn on all LEDS in white with Brightness = Brightness
        Wait 0.6 seconds
        Turn off all LEDS
        Wait 0.3 seconds
```

Program developed with mBlock5





4.1.7.- Kids night light

See the full book “Educational Robotics with Halocode” from the same author.

4.1.8.- Metronome with light

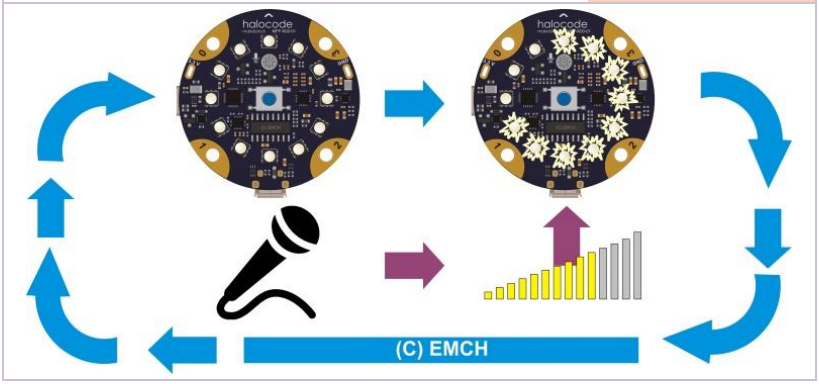
See the full book “Educational Robotics with Halocode” from the same author.

4.1.9.- Sound meter with light indicator

A sound level meter is a measuring instrument used to measure the level of ambient noise, displaying the value in decibels on the screen.

To carry out this project a sound sensor is required. In the market there are sensors that return the value of ambient sound and others that function as a sound switch, returning a 1 when the sound exceeds a threshold. Only the first ones serve to carry out this project.

Objetive	Complexity
Make a light sound meter with Halocode. The number of LEDs lit will be proportional to the sound level.	Time 20’ Program: medium

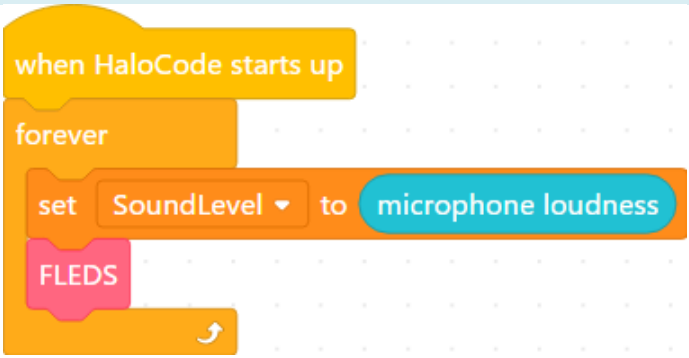


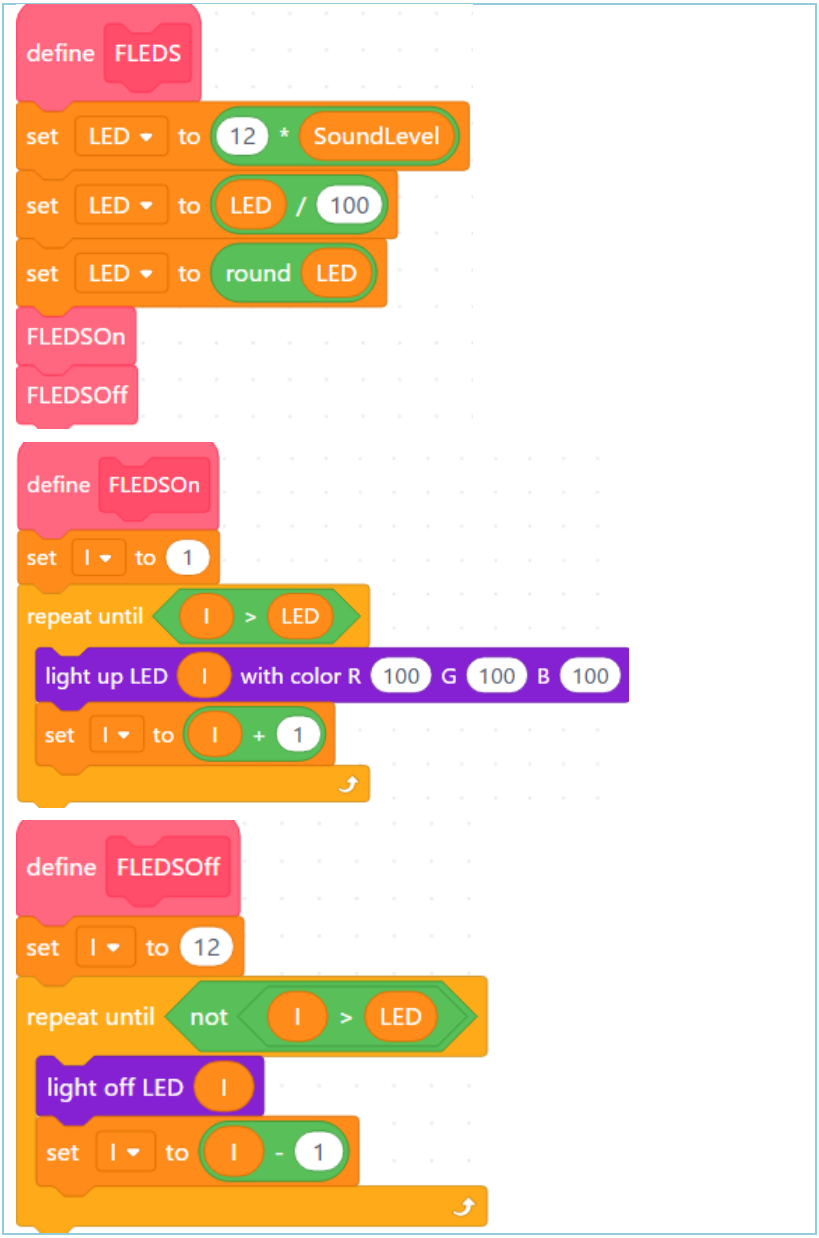
Components used

Proposed pseudocode

```
Forever
    SoundLevel = Microphone volume
    Execute function FLEDS
Function FLEDS
    LED = Round (12 * Level / 100)
    Execute function FLEDSOn
    Execute function FLEDSOff
Function FLEDSOn
    I = 1
    Repeat until I > LED
        Turn on LED = I in white
        I = I + 1
Function FLEDSOff
    I = 12
    Repeat while I less than LED
        Turn off LED = I
        I = I - 1
```

Program developed with mBlock5

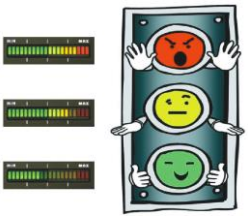



define FLEDS
set LED to 12 * SoundLevel
set LED to LED / 100
set LED to round LED
FLEDSOn
FLEDSOff
define FLEDSOn
set I to 1
repeat until I > LED
light up LED I with color R 100 G 100 B 100
set I to I + 1
define FLEDSOff
set I to 12
repeat until not I > LED
light off LED I
set I to I - 1

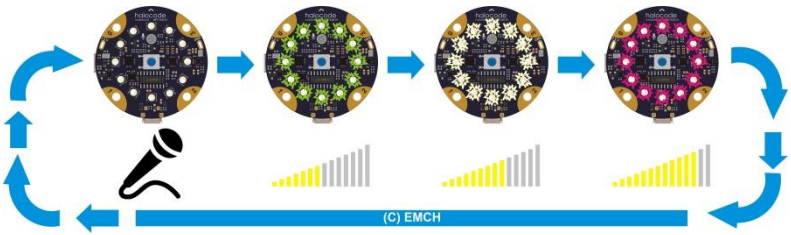
4.1.10.- Noise classroom traffic light

A noise classroom traffic light is a effective way to control the acceptable noise level in the classroom, that will depend on the activity to be developed.

Once this level is set, when the noise in the classroom exceeds it, the traffic light will warn students to lower their voice.



Objetive	Complexity
Carry out with Halocode a classroom noise traffic light.	Time 15'
	Program: medium



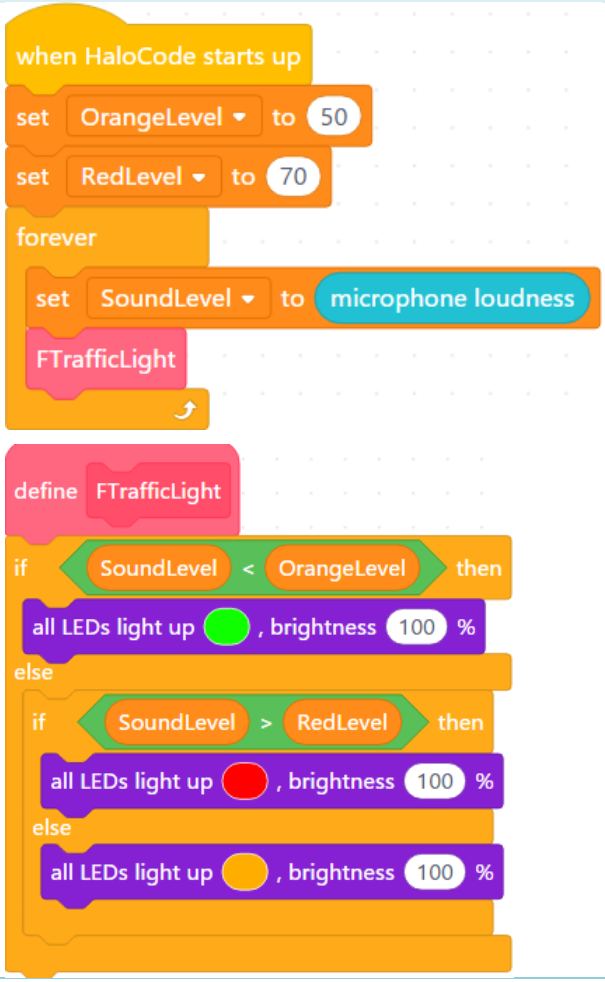
Components used

Proposed pseudocode

```
OrangeLevel = 50
RedLevel = 70
Forever
```

```
SoundLevel = Microphone volume
If SoundLevel less than OrangeLevel
    Turn on all LEDS in green
Else
    If SoundLevel greater than RedLevel
        Turn on all LEDS in red
    Else
        Turn on all LEDS in orange
```

Program developed with mBlock5



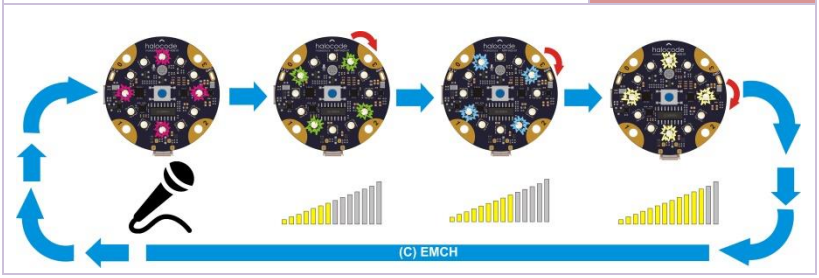
4.1.11.- Rhythm meter

See the full book “Educational Robotics with Halocode” from the same author.

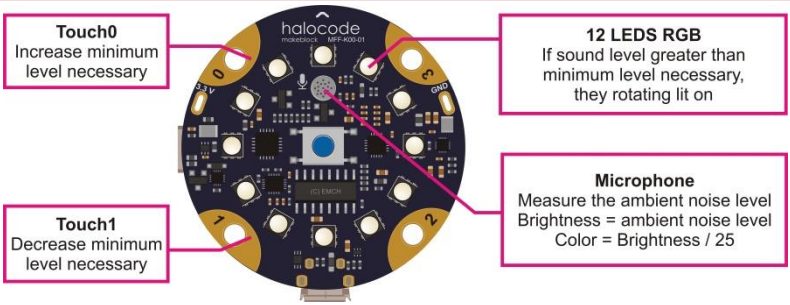
4.1.12.- Disco Light

The disco lights show different patterns of lights and colors that follow the rhythm of the music through a microphone that measures both the volume and the frequency of the sound. The simplest ones work with LED lights and have a series of selectable patterns, while the most sophisticated ones work with laser light and allow to create and personalize the patterns.

Objetive	Complexity
Carry out a disco light with Halocode, making the lights turn and change colour to the rhythm of the music. With the contact sensors 0 and 1, the sensitivity of the microphone can be adjusted.	Time 15’
	Program: high



Components used

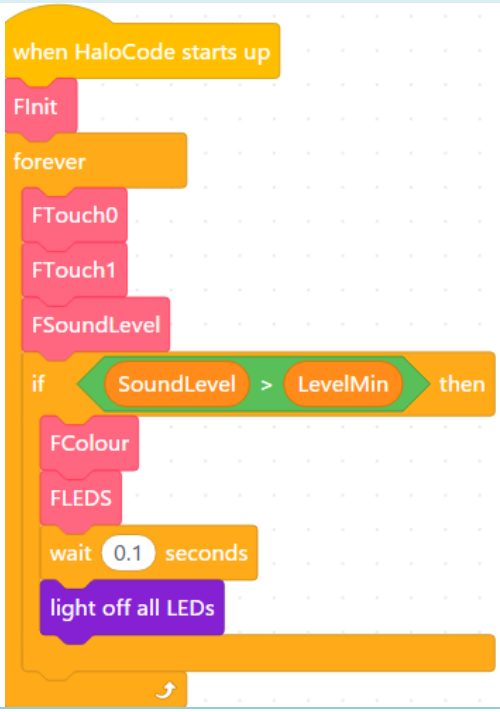


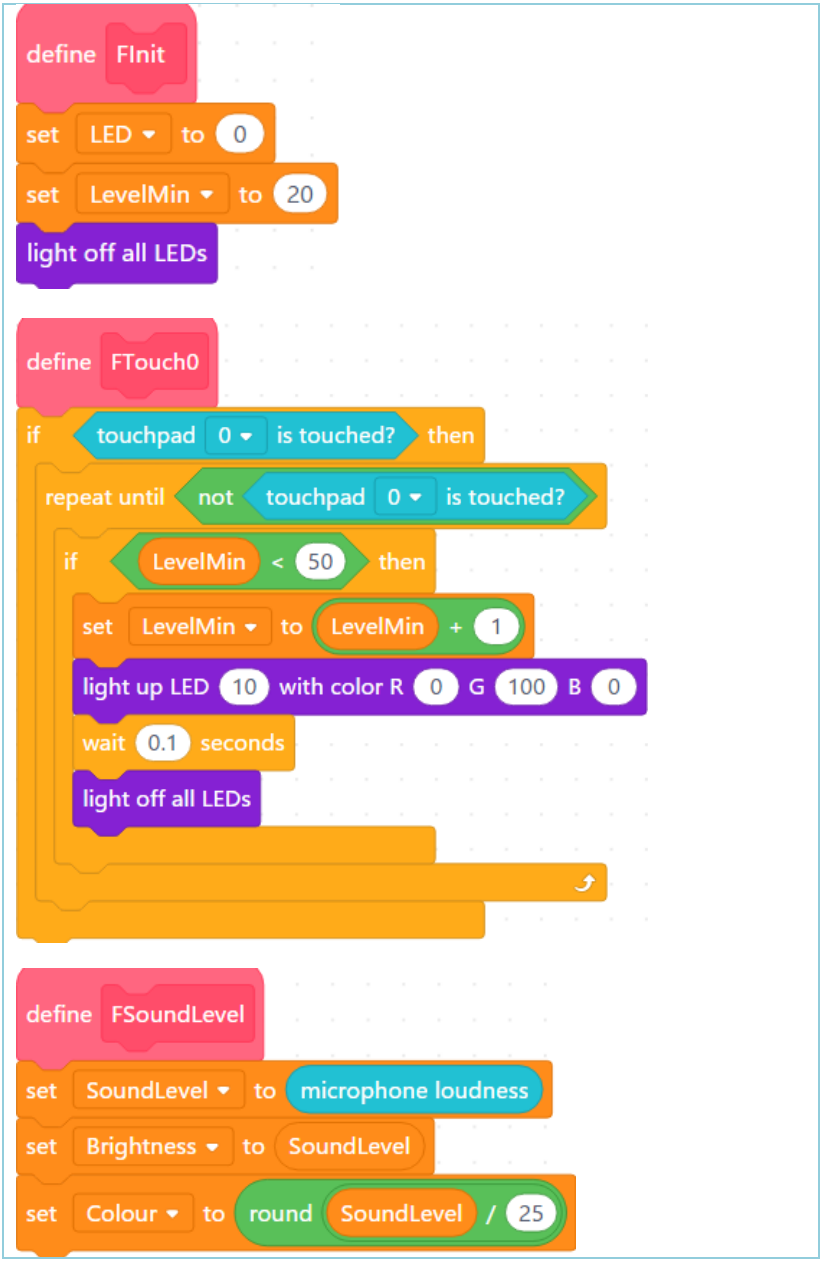
Proposed pseudocode

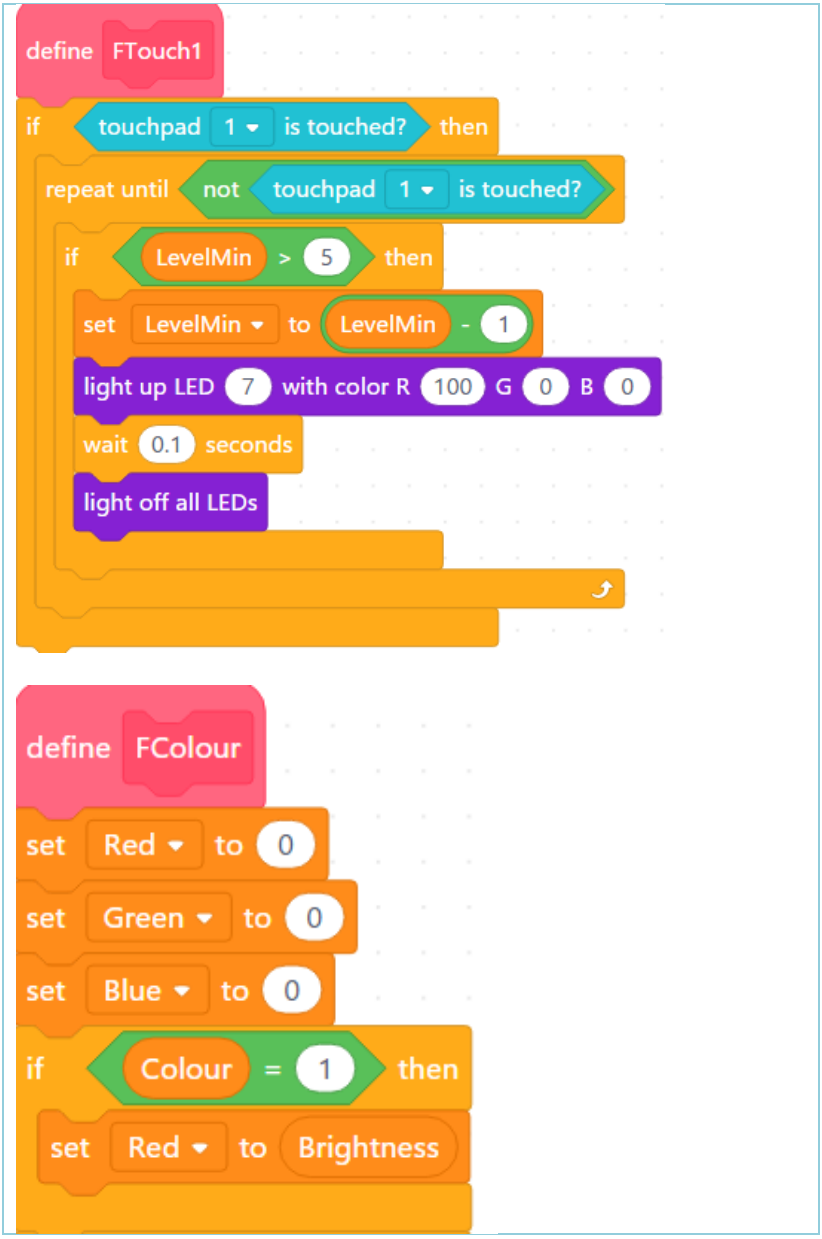
```
Execute function FInit
Forever
    Execute function FTouch0
    Execute function FTouch1
    Execute function FSoundLevel
    If SoundLevel greater than LevelMin
        Execute function FColour
        Execute function FLEDS
        Wait 0.1 seconds
        Turn off all LEDS
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Function FInit
    LED = 0, LevelMin = 20
    Turn off all LEDS
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Function FTouch0
    If contact sensor 0 touched
        Repeat until contact sensor 0 no touched
            If LevelMin less than 50
                LevelMin = LevelMin + 1
                Turn on LED 10 in green
                Wait 0.1 seconds
                Turn off all LEDS
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Function FTouch1
    If contact sensor 1 touched
        Repeat until contact sensor 1 no touched
            If LevelMin greater than 5
                LevelMin = LevelMin - 1
                Turn on LED 7 in red
                Wait 0.1 seconds
                Turn off all LEDS
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Function FSoundLevel
```

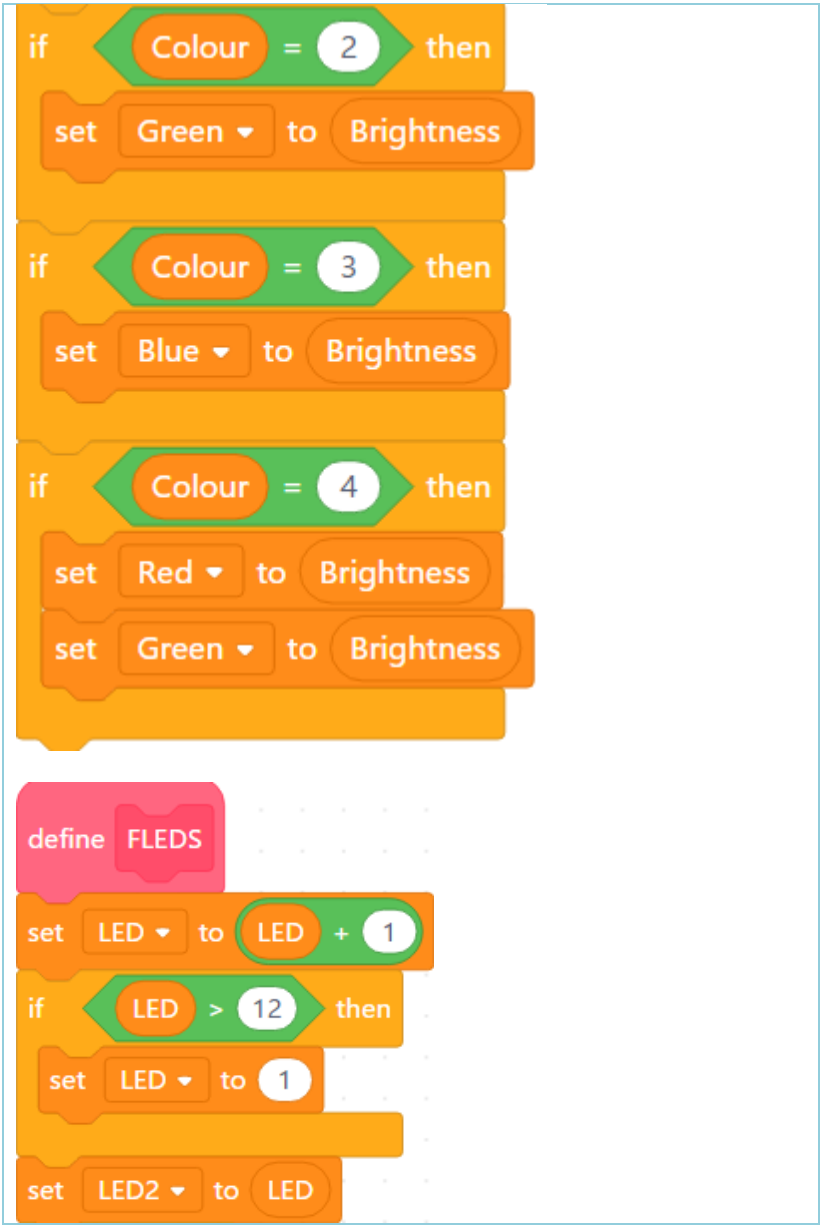
```
    SoundLevel = microphone volume
    Brightness = SoundLevel
    Colour = round (SoundLevel / 25)
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Function FColour
    Red = 0, Green = 0, Blue = 0
    If Colour = 1, then Red = Brightness
    If Colour = 2, then Green = Brightness
    If Colour = 3, then Blue = Brightness
    If Colour = 4, then Red = Brightness and Green = Brightness
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Function FLEDS
    LED = LED + 1
    If LED greater than 12, then LED = 1
    LED2 = LED
    Repeat 4 times
        Turn on LED = LED2 with Red, Green and Blue
        LED2 = LED2 + 3
        If LED2 greater than 12, then LED2 = LED2 - 12
```

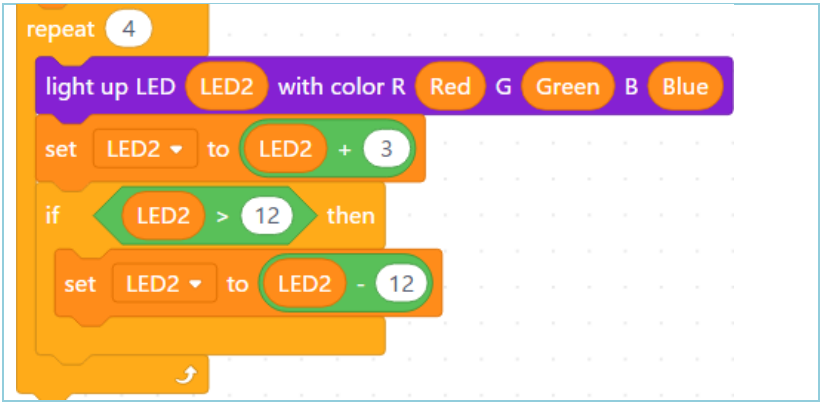
Program developed with mBlock5




define FInit
set LED to 0
set LevelMin to 20
light off all LEDs
define FTouch0
if touchpad 0 is touched? then
repeat until not touchpad 0 is touched?
if LevelMin < 50 then
set LevelMin to LevelMin + 1
light up LED 10 with color R 0 G 100 B 0
wait 0.1 seconds
light off all LEDs
define FSoundLevel
set SoundLevel to microphone loudness
set Brightness to SoundLevel
set Colour to round SoundLevel / 25


define FTouch1
if touchpad 1 is touched? then
repeat until not touchpad 1 is touched?
if LevelMin > 5 then
set LevelMin to LevelMin - 1
light up LED 7 with color R 100 G 0 B 0
wait 0.1 seconds
light off all LEDs
define FColour
set Red to 0
set Green to 0
set Blue to 0
if Colour = 1 then
set Red to Brightness


if Colour = 2 then
set Green to Brightness
if Colour = 3 then
set Blue to Brightness
if Colour = 4 then
set Red to Brightness
set Green to Brightness
define FLEDS
set LED to LED + 1
if LED > 12 then
set LED to 1
set LED2 to LED



4.1.13.- Heads or tails

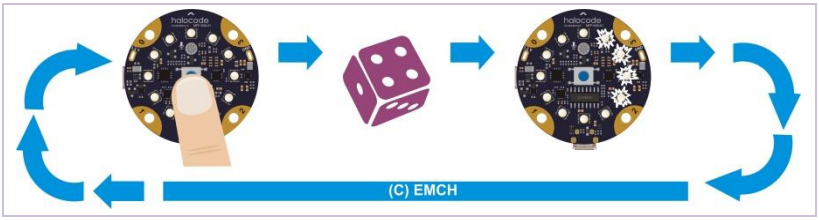
See the full book “Educational Robotics with Halocode” from the same author.

4.1.14.- Dice

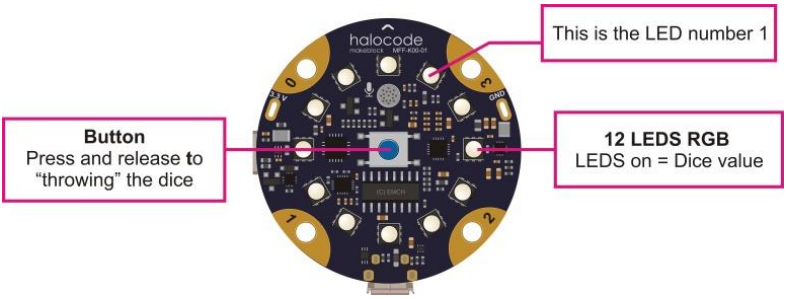
A die is a cube, with each of its six faces showing a different number of dots from one to six. Dice are suitable as gambling devices for games like craps and are also used in non-gambling tabletop games.

The electronic variant can have a similar shape or represent the value by means of a set of LEDS on a single face.

Objetive	Complexity
Carry out an electronic die with Halocode. To “throwing” the dice just press and release the button, after which Halocode will show random number, between 1 and 6, until it stops.	**Time 20’**
	Program: medium



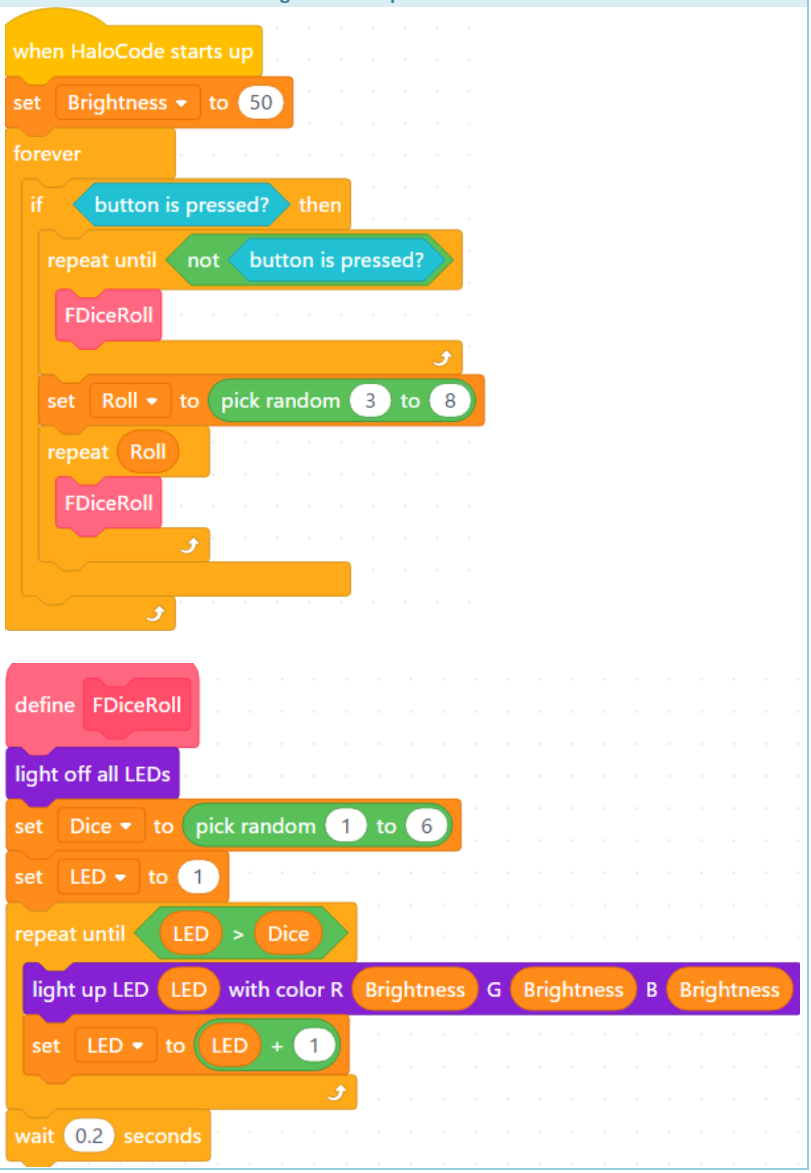
Components used



Proposed pseudocode

```
Brightness = 50
Forever
    If button pressed
        Repeat until button is not pressed
            Execute function FDiceRoll
        Roll = random value between 3 and 8
        Repeat times = Roll
            Execute function FDiceRoll
Function FDiceRoll
    Turn off all LEDS
    Dice = Random value between 1 and 6
    LED = 1
    Repeat until LED greater than Dice
        Turn on LED = LED in white
        LED = LED + 1
    Wait 0.2 seconds
```

Program developed with mBlock5



4.1.15.- Quiniela (Football Lottery)

See the full book “Educational Robotics with Halocode” from the same author.

4.1.16.- Rock-paper-scissors

See the full book “Educational Robotics with Halocode” from the same author.

4.1.17.- Chronometer

See the full book “Educational Robotics with Halocode” from the same author.

4.1.18.- Timer

See the full book “Educational Robotics with Halocode” from the same author.

4.1.19.- Wristwatch

See the full book “Educational Robotics with Halocode” from the same author.

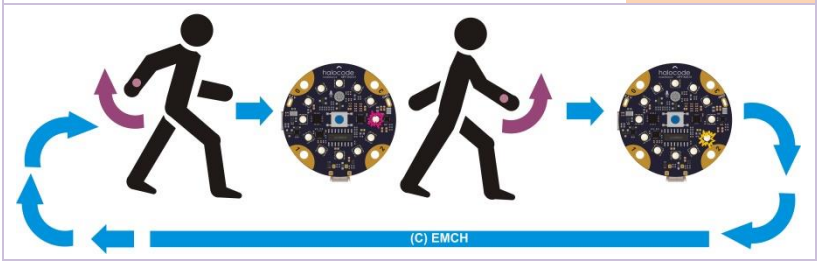
4.1.20.- Pedometer

A pedometer is a device, usually portable and electronic or electromechanical, that counts each step a person takes by detecting the motion of the person's hands or hips.

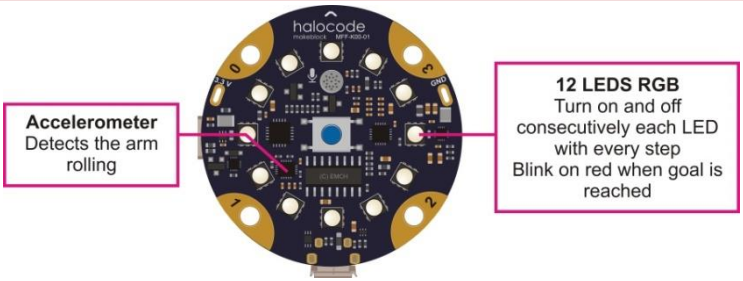
Its operation is based on an accelerometer.

Today many devices (smartphones, digital watches, etc.) incorporate the pedometer function.

Objetive	Complexity
Carry out a wrist pedometer with Halocode capable of indicating and count each step taken. Once the target is reached, it will warn by flashing the LEDS in red.	Time 20' Program: medium



Components used



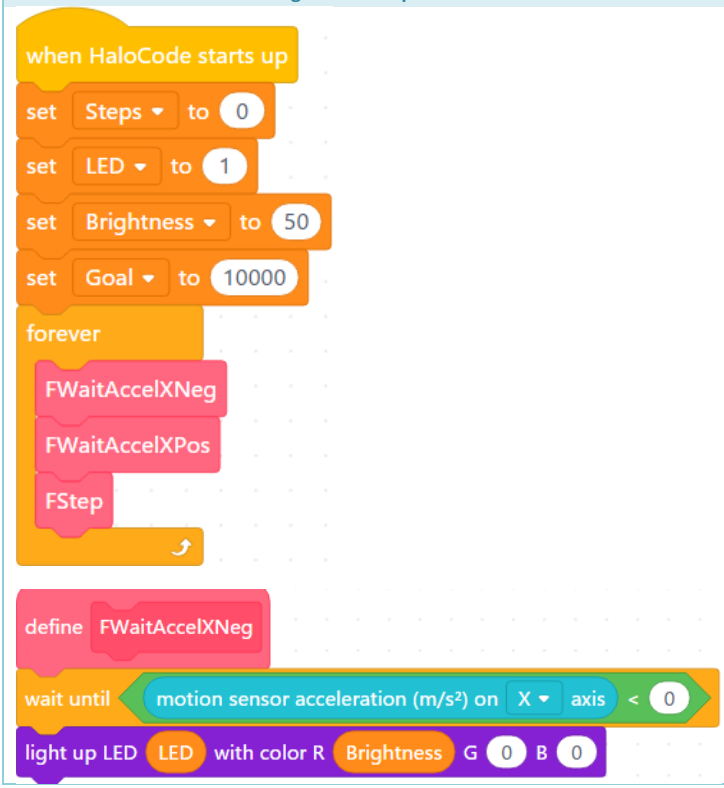
The key of the algorithm that we propose is to take advantage of the swing of the arm that is made when walking and detect when it changes direction, which in turn will cause the change of sign in the value of the acceleration in the X axis.

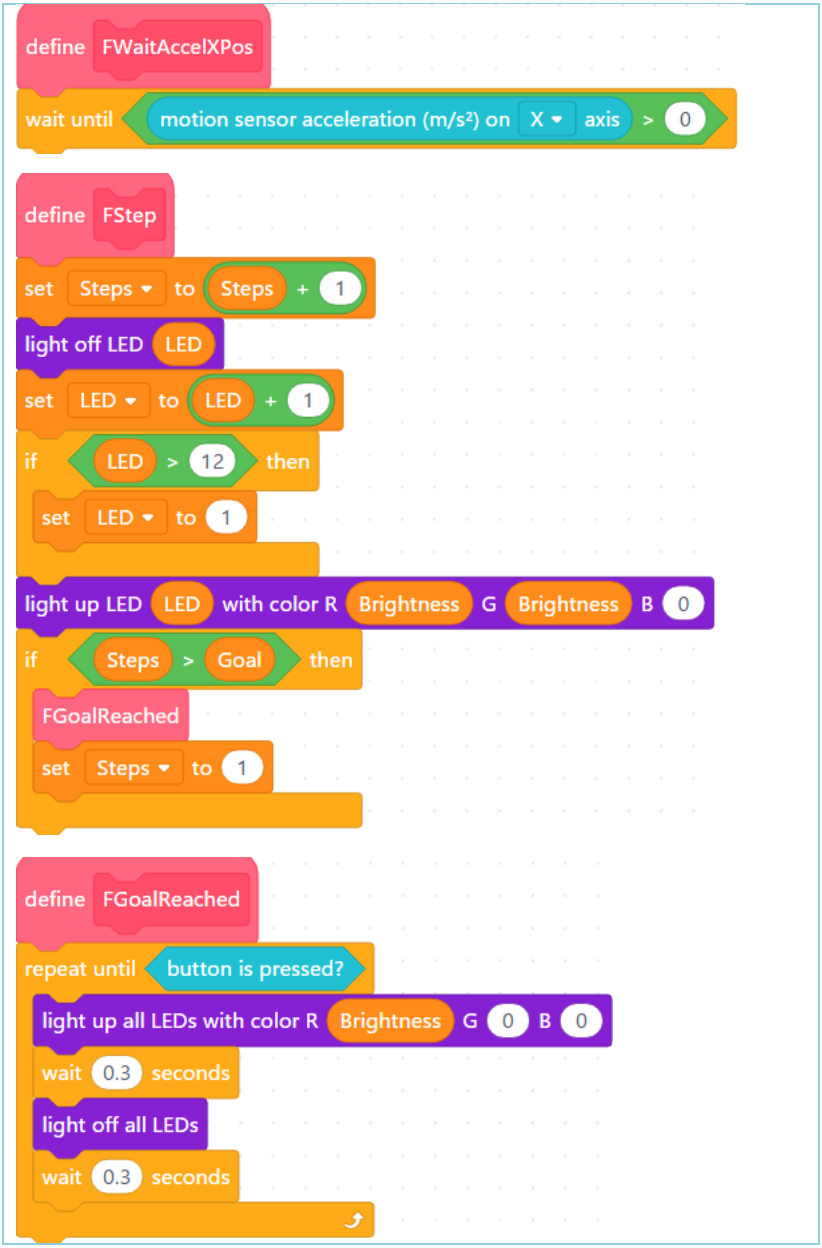
Proposed pseudocode

```
Steps = 0, LED = 1, Brightness = 50, Goal = 10000
Forever
    Execute function FWaitAccelXNeg
    Execute function FWaitAccelXPos
    Execute function FStep
-----------------------------------
Function FWaitAccelXNeg
    Wait until acceleration X axis less than 0
    Turn on LED number = LED in red
-------------------------------------
Function FWaitAccelXPos
    Wait until acceleration axis X greater than 0
-----------------------------------
Function FStep
```

```
    Steps = Steps + 1
    Turn off LED number = LED
    LED = LED + 1
    If LED greater than 12, then LED = 1
    Turn on LED number = LED in yellow
    If Steps > Goal
        Execute Function FGoalReached
        Steps = 1
-----------------------------------
Function FGoalReached
    Until button pressed
        Turn on all LEDS in red
        Wait 0.3 seconds
        Turn off all LEDS
        Wait 0.3 seconds
```

Program developed with mBlock5




define FWaitAccelXPos
wait until motion sensor acceleration (m/s²) on X axis > 0
define FStep
set Steps to Steps + 1
light off LED LED
set LED to LED + 1
if LED > 12 then
set LED to 1
light up LED LED with color R Brightness G Brightness B 0
if Steps > Goal then
FGoalReached
set Steps to 1
define FGoalReached
repeat until button is pressed?
light up all LEDs with color R Brightness G 0 B 0
wait 0.3 seconds
light off all LEDs
wait 0.3 seconds

4.1.21.- Drop

See the full book “Educational Robotics with Halocode” from the same author.

4.1.22.- Bubble level

See the full book “Educational Robotics with Halocode” from the same author.

4.2.- Halocode and speech recognition

This section includes several projects in which the voice recognition function is used, thus entering the exciting world of Artificial Intelligence.

Just recently, various proposals for domestic devices that can be controlled by the voice have arrived to the market, something that undoubtedly attracts a lot of attention but, as we will see below, it is extremely easy to do thanks to the facilities that companies, like Microsoft, offering to users through Cognitive Services, a set of tools, supported by Microsoft Azure, that make use of artificial intelligence to solve situations in which large data analysis or complex algorithms are required, such as the case of facial recognition or speech recognition.

The resources to be able to use these cognitive services from Microsoft are available on https://github.com/topics/microsoft-cognitive-services, although in our case it will be enough to use two mBlock5 programming blocks.

4.2.1.- Turn LEDS on and off with voice

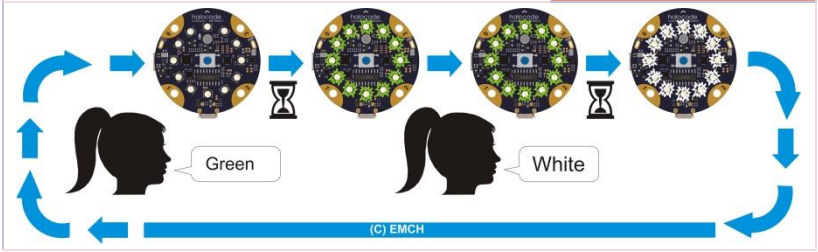
See the full book “Educational Robotics with Halocode” from the same author.

4.2.2.- Halocode shows the indicated color

One of the most typical functionalities of domestic virtual assistants is to be able to turn on and off lights with the voice.

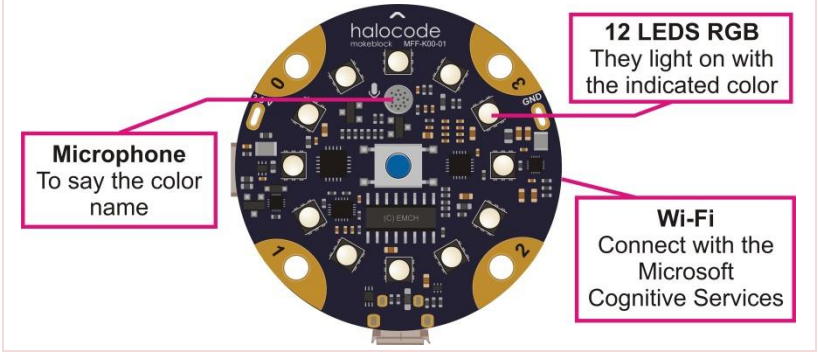
In some cases they also allow to choose the light color.

Objetive	Complexity
Control the Halocode LEDS colour with the voice.	Time 20’
	Program: high



After pressing and releasing the button, the name of the desired colour is indicated. It must be pronounced correctly in English because, otherwise, the program will not be able to understand it. Indicating "Off" the LEDS will turn off.

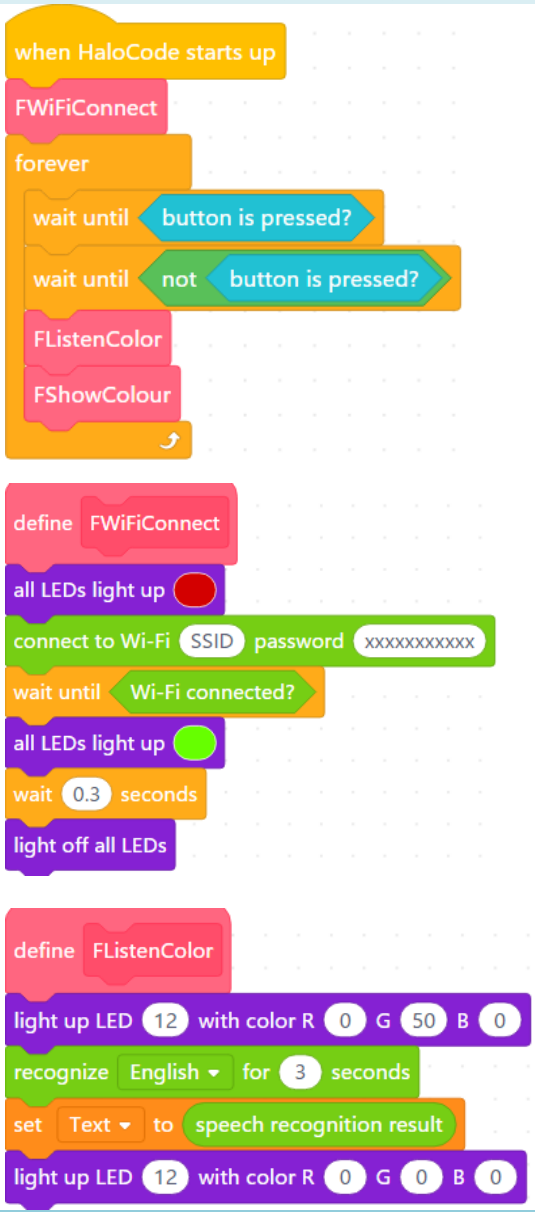
Components used

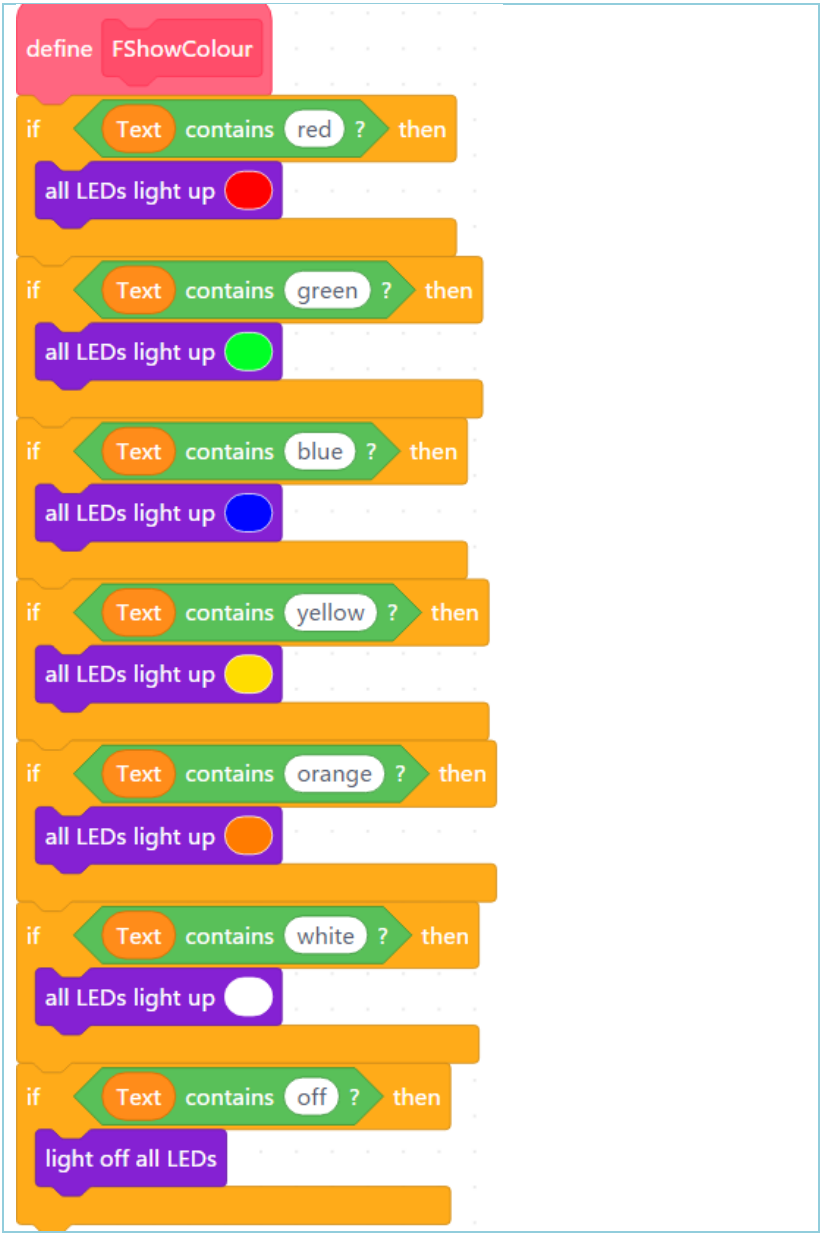


Proposed pseudocode

```
Execute function FWiFiConnect
Forever
    Wait until button pressed
    Wait until button not pressed
    Execute function FListenColor
    Execute function FShowColour
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Function FWiFiConnect
    Turn on all LEDS in red
    Connect with WiFi network in SSID..... and key ....
    Wait until WiFi connected
    Turn on all LEDS in green
    Wait 0.3 seconds
    Turn off all LEDS
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Function FListenColor
    Turn on LED 12 in green
    Text = Recognize voice English language during 3 seconds
    Turn off LED 12
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Function FShowColour
    If Text contains “red”
        Turn on all LEDS in red
    If Text contains “green”
        Turn on all LEDS in green
    If Text contains “blue”
        Turn on all LEDS in blue
    If Text contains “yellow”
        Turn on all LEDS in yellow
    If Text contains “orange”
        Turn on all LEDS in orange
    If Text contains “white”
        Turn on all LEDS in white
    If Text contains “off”
        Turn off all LEDS
```

Program developed with mBlock5

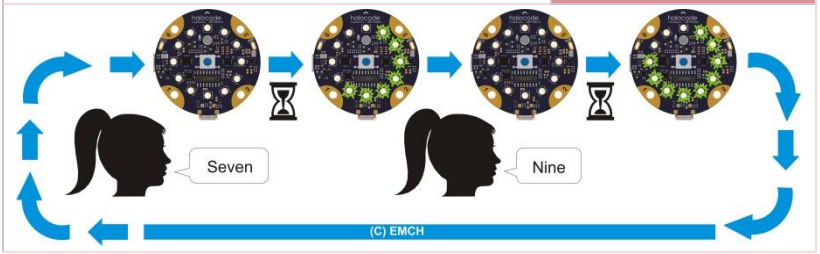



define FShowColour
if Text contains red ? then
all LEDs light up
if Text contains green ? then
all LEDs light up
if Text contains blue ? then
all LEDs light up
if Text contains yellow ? then
all LEDs light up
if Text contains orange ? then
all LEDs light up
if Text contains white ? then
all LEDs light up
if Text contains off ? then
light off all LEDs

4.2.3.- Control the lit LEDS number

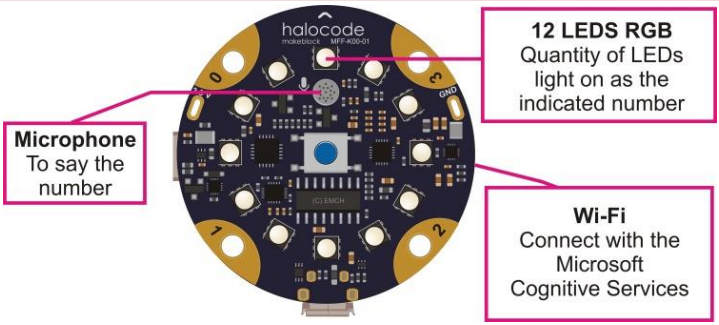
Today there are many devices that you can control with your voice. Have you ever wondered how they do it? In this project you will see how easy it is!

Objetive	Complexity
Control with the voice the lit LEDS number.	Time 30'
	Program: high



After pressing and releasing the button, the name of the desired number is indicated. It must be pronounced correctly in English because, otherwise, the program will not be able to understand it and will turn on all LEDS in red.

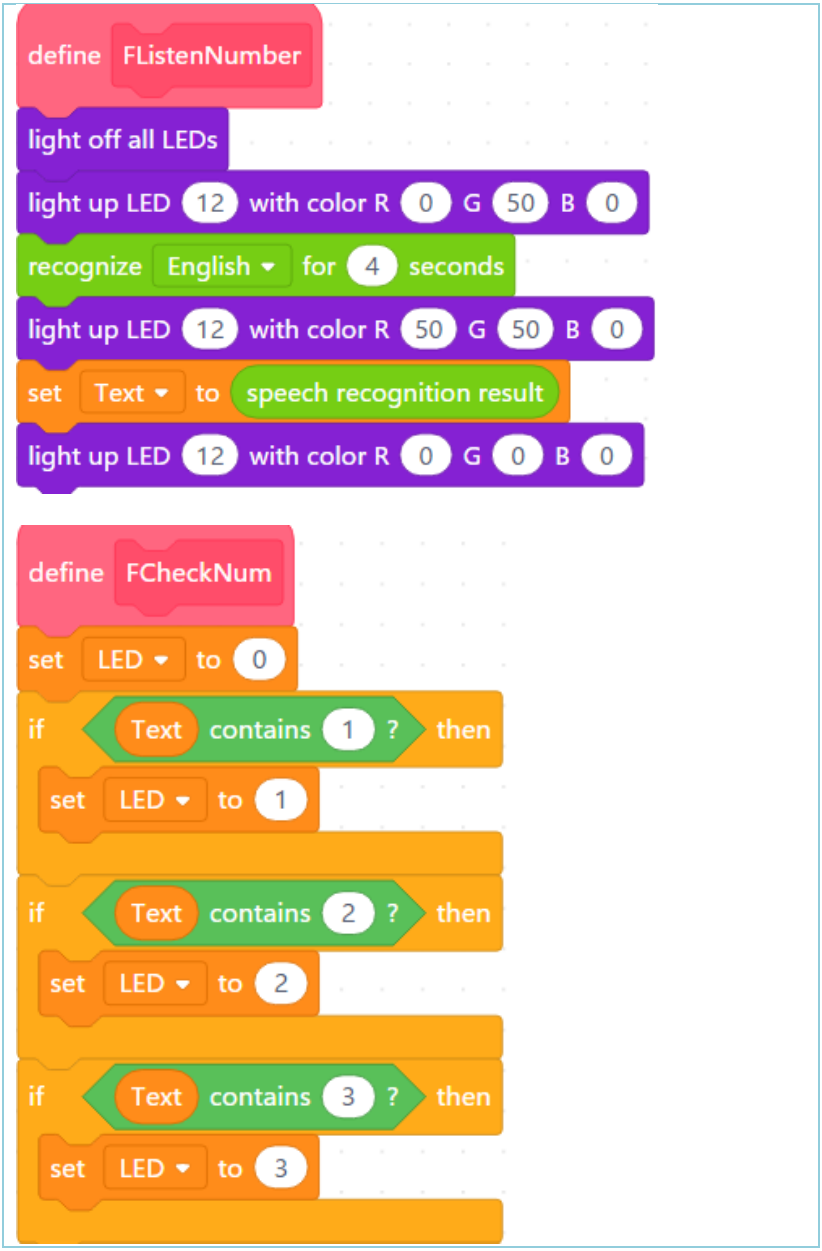
Components used

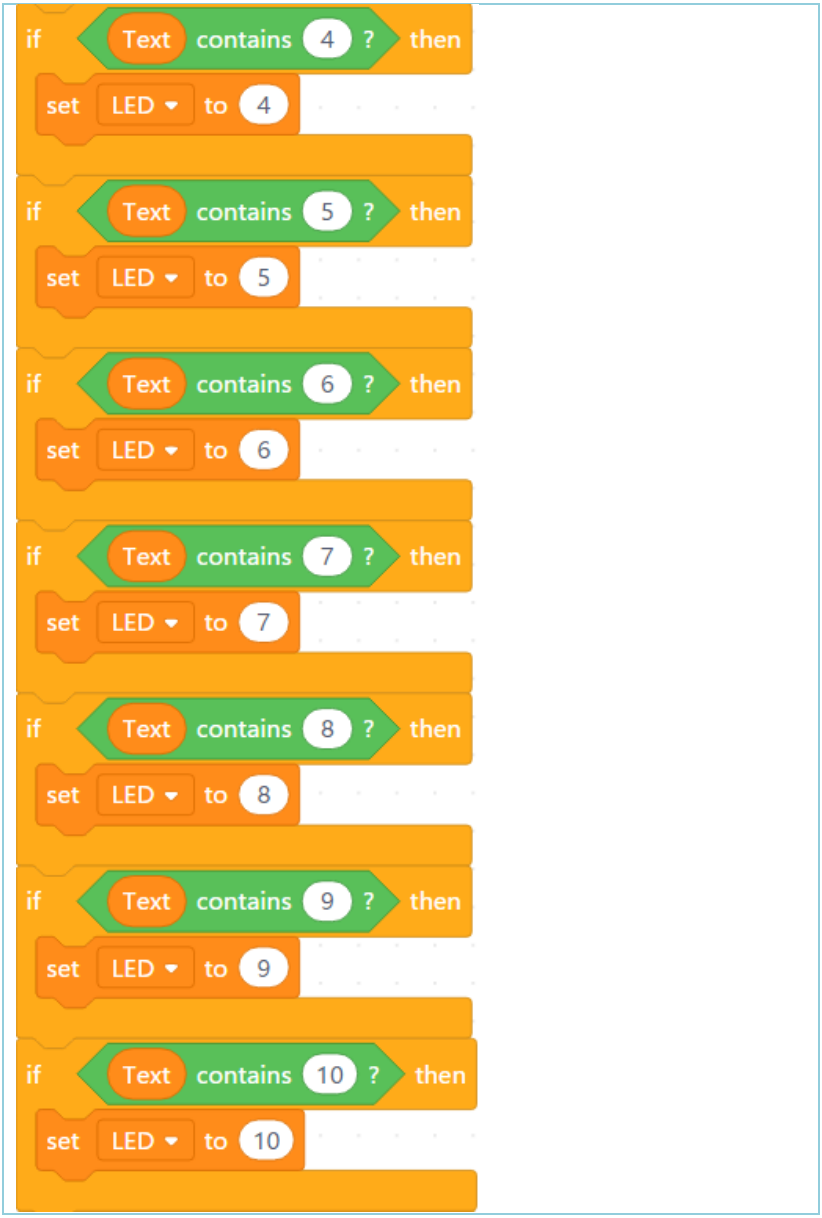


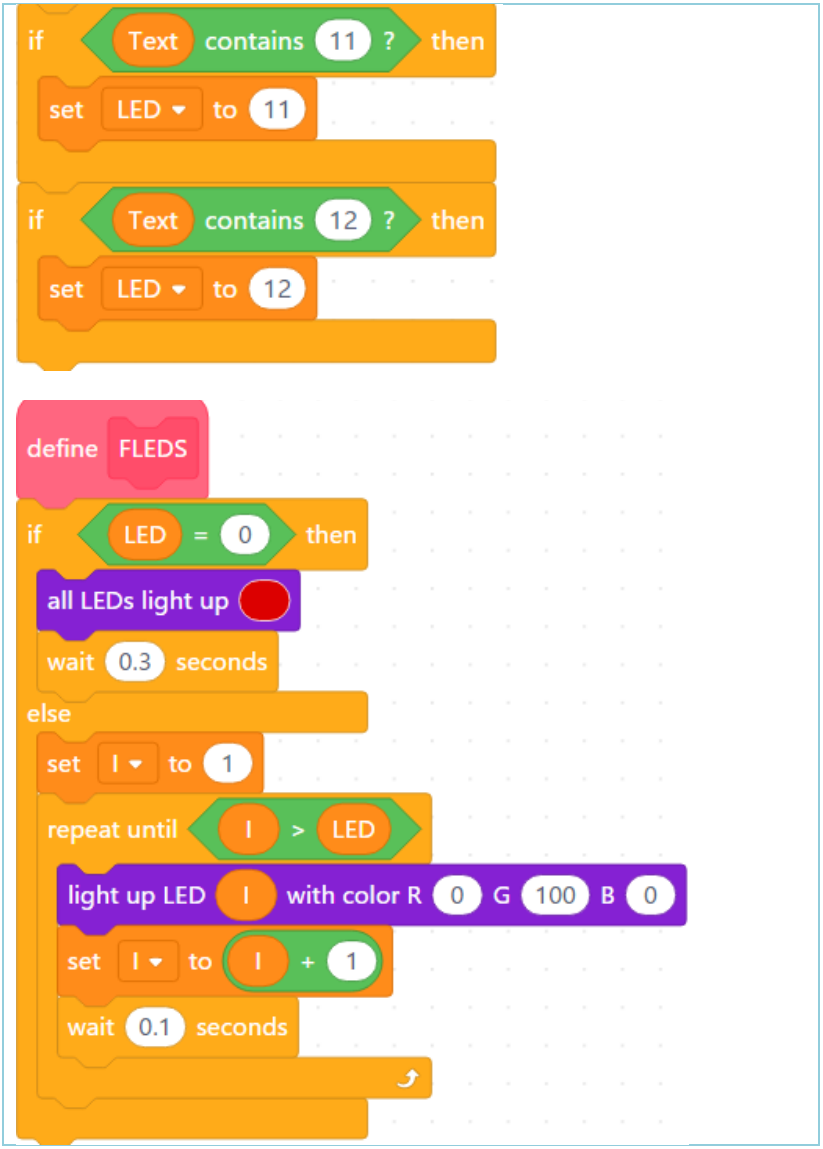
Proposed pseudocode

```
Execute function FWiFiConnect
Forever
    Wait until button pressed
    Wait until No button pressed
    Execute function FListenNumber
    Execute function FCheckNum
    Execute FLEDS
Function FWiFiConnect
    Turn on all LEDS in red
    Connect with WiFi network in SSID..... and key ....
    Wait until WiFi connected
    Turn on all LEDS in green
    Wait 0.3 seconds
    Turn off all LEDS
Function FListenNumber
    Turn off all LEDs
    Turn on LED 12 in green
    Text = Recognize voice English language during 4 seconds
    Turn off LED 12
Function FCheckNum
    LED = 0
    If Text contains “1”, then LED = 1
    If Text contains “2”, then LED = 2
    If Text contains “3”, then LED = 3
    If Text contains “4”, then LED = 4
    If Text contains “5”, then LED = 5
    If Text contains “6”, then LED = 6
    If Text contains “7”, then LED = 7
    If Text contains “8”, then LED = 8
    If Text contains “9”, then LED = 9
    If Text contains “10”, then LED = 10
    If Text contains “11”, then LED = 11
    If Text contains “12”, then LED = 12
Function FLEDS
    If LED = 0
        Turn on all LEDS in red
        Wait 0.3 seconds
    Else
        I = 1
        Repeat until I greater than LED
            Turn on LED = I in green
            I = I + 1
            Wait 0.1 seconds
```

Program developed with mBlock5


define FListenNumber
light off all LEDs
light up LED 12 with color R 0 G 50 B 0
recognize English for 4 seconds
light up LED 12 with color R 50 G 50 B 0
set Text to speech recognition result
light up LED 12 with color R 0 G 0 B 0
define FCheckNum
set LED to 0
if Text contains 1 ? then
set LED to 1
if Text contains 2 ? then
set LED to 2
if Text contains 3 ? then
set LED to 3


if Text contains 4 ? then
set LED to 4
if Text contains 5 ? then
set LED to 5
if Text contains 6 ? then
set LED to 6
if Text contains 7 ? then
set LED to 7
if Text contains 8 ? then
set LED to 8
if Text contains 9 ? then
set LED to 9
if Text contains 10 ? then
set LED to 10


if Text contains 11 ? then
set LED to 11
if Text contains 12 ? then
set LED to 12
define FLEDS
if LED = 0 then
all LEDs light up
wait 0.3 seconds
else
set I to 1
repeat until I > LED
light up LED I with color R 0 G 100 B 0
set I to I + 1
wait 0.1 seconds

4.2.4.- Control the LEDS from a remote Halocode

See the full book “Educational Robotics with Halocode” from the same author.

4.2.5.- Send messages to mBlock5 stage

See the full book “Educational Robotics with Halocode” from the same author.

4.3.- With Halocode board and one more component

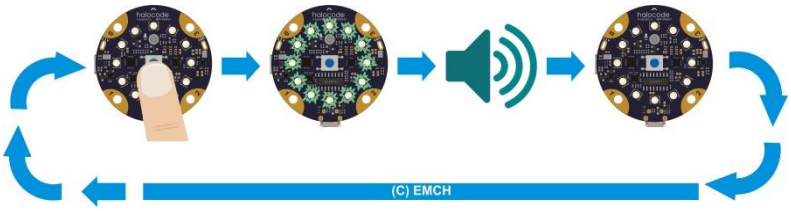
In this section several projects are proposed in which an additional component is added to Halocode.

4.3.1.- Doorbell

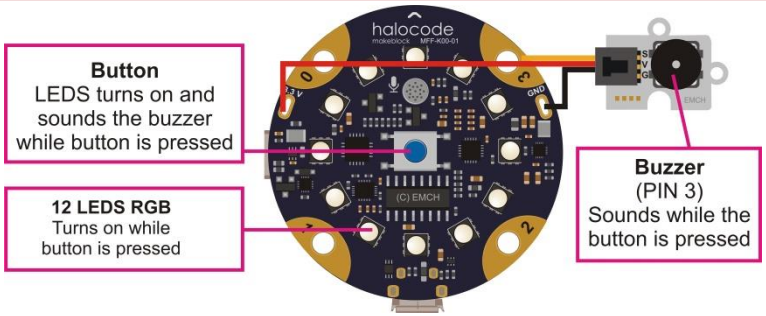
An electric bell is a device that produces an audible signal when button is pressed.

It has many applications, being one of the most common, the doorbell.

Objetive	Complexity
Carry out with Halocode a simple bell that emits a mono tonal acoustic signal and light up while the button is pressed.	Time 10’ Program: low



Components used

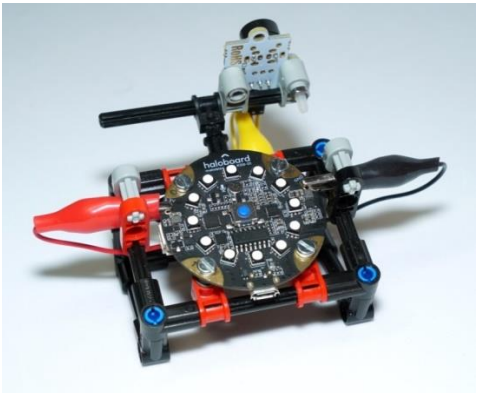


Proposed pseudocode

```
Forever
    If button pressed
        Turn on all LEDS RGB in green
        Repeat 500 times
            Write in pin 3 (buzzer) the value 1023
            Write in pin 3 (buzzer) the value 0
        Turn off all LEDS
```

Program developed with mBlock5

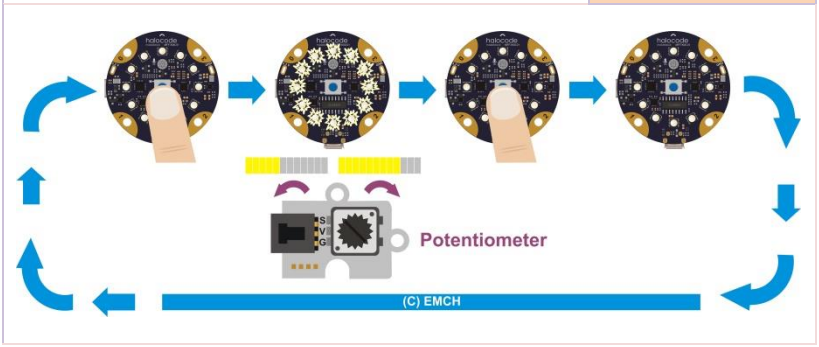
In this project it is necessary to take care that the clamps connected to the power and ground pins do not make contact with any other element of the board. The structure described in section 2.9.2 helps reduce this risk.



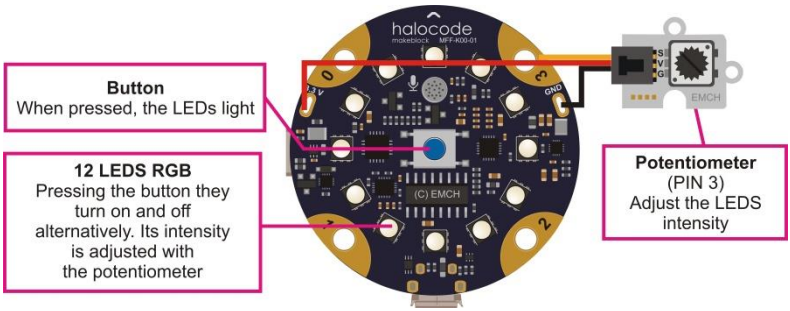
4.3.2.- Adjustable intensity light (with potentiometer)

Nowadays most ambient lights allow to regulate their intensity, so we are going to add this functionality to the project seen in section 4.1.1 through the use of a potentiometer.

Objetive	Complexity
Carry out with Halocode a light that can be turned on and off, as well as adjust the intensity using a potentiometer.	**Time 30'**
	Program: medium



Components used

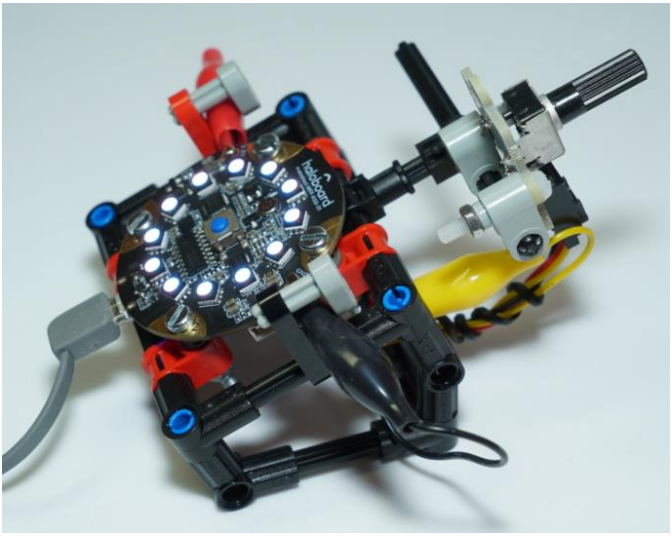


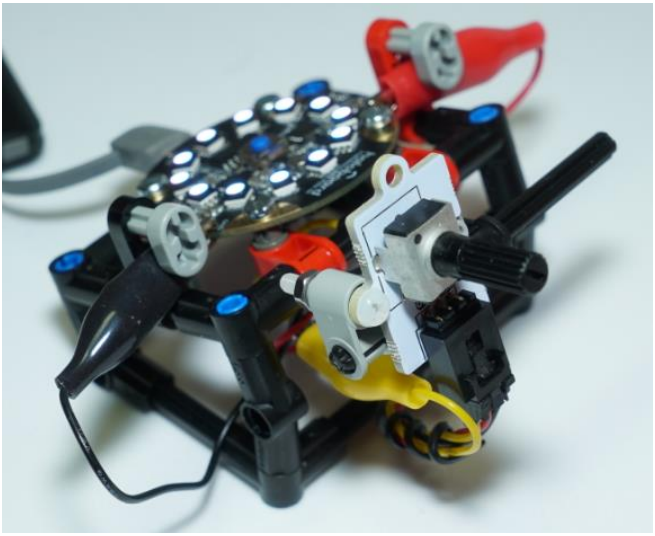
Proposed pseudocode

```
On = -1
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Forever
    Execute function FButton
    Execute function FOnOff
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Function FButton
    If button pressed
        On = On * (-1)
        Wait until button not pressed
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Function FOnOff
    If On = 1
        Potentiometer = analog value from pin 3
        Brightness = round (Potentiometer * 255) / 1023
        Turn on all LEDs in white and brightness = Brightness
    Else
        Turn off all LEDS
```

Program developed with mBlock5

In this project it is necessary to take care that the clamps connected to the power and ground pins do not make contact with any other element of the board. The structure described in section 2.9.2 helps reduce this risk:

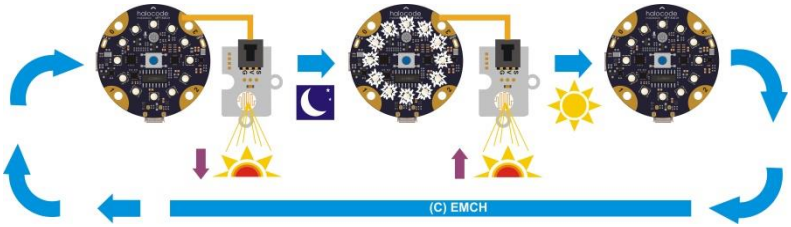




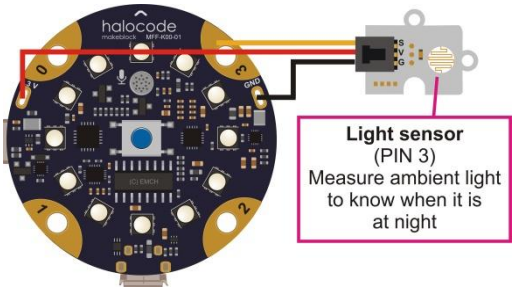
4.3.3.- Twilight light

A twilight light is a light that is located in transit areas, equipped with a sensor that turns it on automatically at dusk, and turns it off at dawn, thereby reducing day energy consumption.

Objetive	Complexity
Carry out a twilight light that turns on automatically at dusk and goes out at dawn.	Time 20'
	Program: medium



Components used

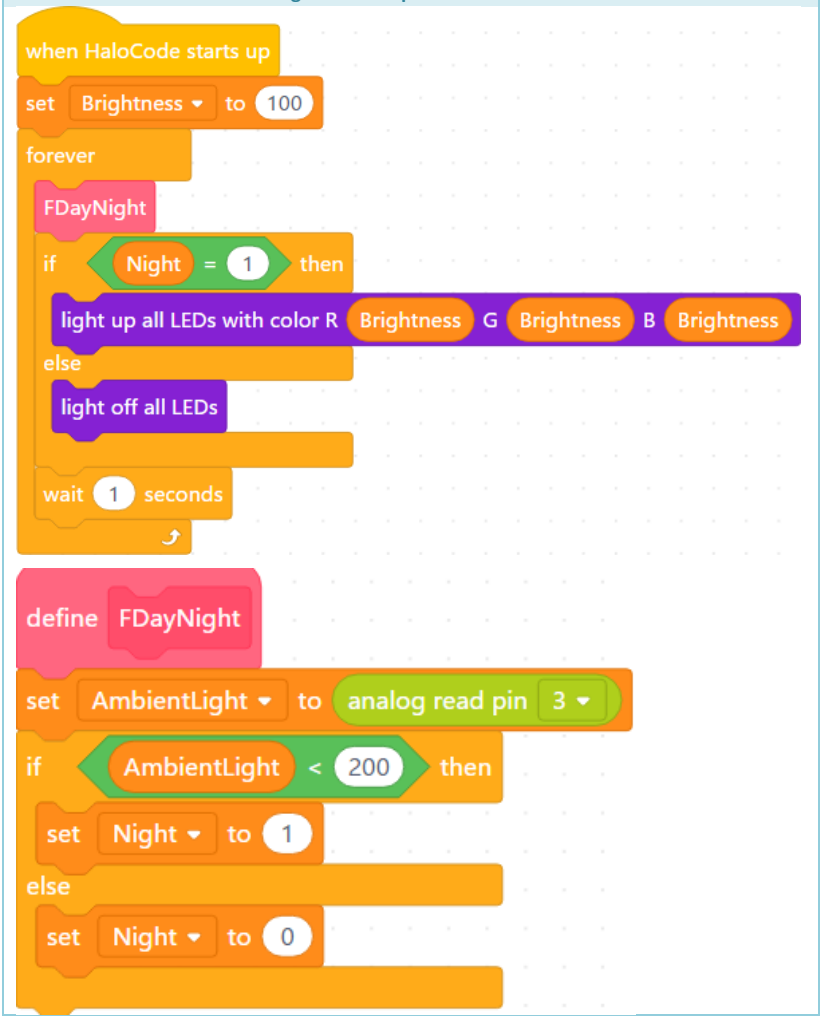


Proposed pseudocode

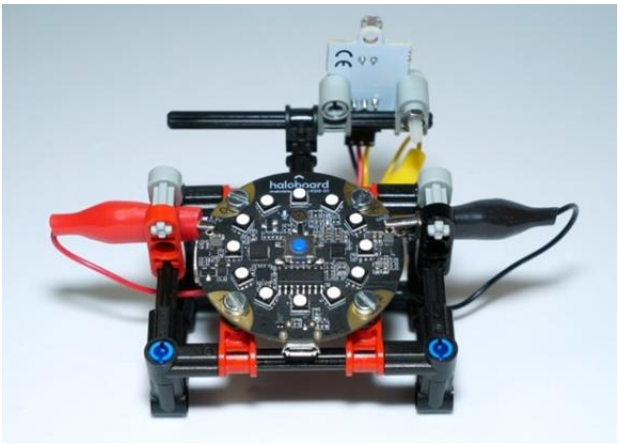
```
Brightness = 100
-----------------------------------
Forever
    Execute function FDayNight
    If Night = 1
        Turn on all LEDS in white and brightness = Brightness
    Else Turn off all LEDS
    Wait 1 second
-----------------------------------
```

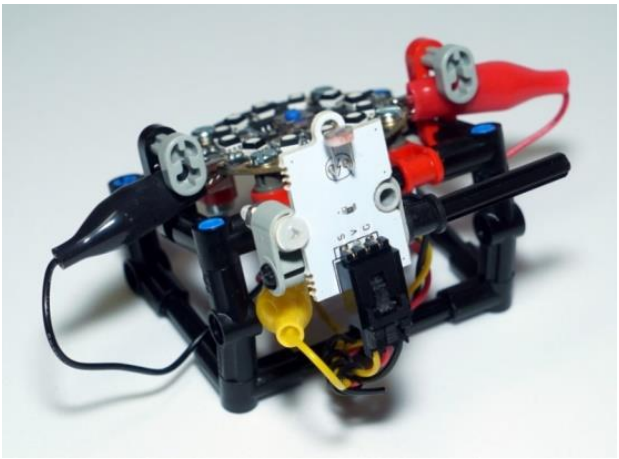
```
Function FDayNight
    AmbientLight = analog value pin 3 (light sensor)
    If AmbientLight less than 200
        Night = 1
    Else
        Night = 0
```

Program developed with mBlock5



In this project it is necessary to take care that the clamps connected to the power and ground pins do not make contact with any other element of the board. The structure described in section 2.9.2 helps reduce this risk:

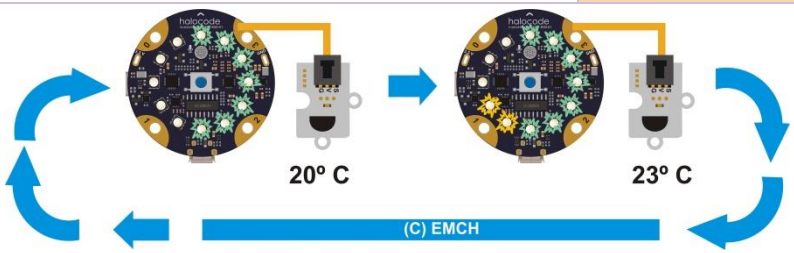




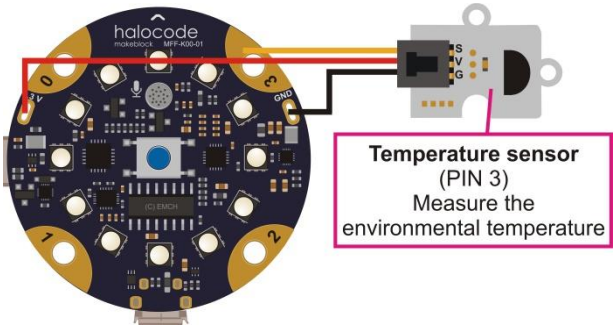
4.3.4.- Environmental thermometer

An environmental thermometer is a measurement instrument that allows to know the ambient temperature, either from a room or from outside.

Objetive	Complexity
Carry out with Halocode an ambient analog thermometer. For this, a proportional analog temperature sensor TMP36 will be used.	Time 20'
	Program: medium



Components used



The analog temperature sensors do not directly return a value in degrees centigrade, so the gross value obtained must be processed. The TMP36 sensor, unlike thermosistors, does not use a resistance-sensitive resistor. Instead this sensor takes advantage of the property of the diodes to vary the voltage proportional to the temperature, so it is enough to read the output value and apply a rule of three.

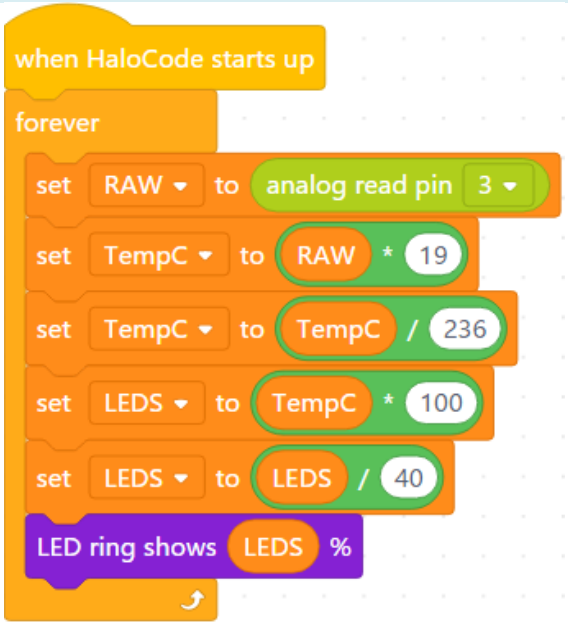
On the other hand we will use a very specific block of mBlock5 that allows to directly display a value, within the scale 0 to 100, with a colour graduation. Up to 60, it shows the LEDS in green, above 60 and up to 80, it shows them in orange and, above 80, it shows them in red.

In general we do not recommend making use of such specific blocks since the reader will not find them in other environments. For this reason for this project we show a second more elaborate solution that, although it has the same functionality, is carried out with usual instructions in any environment.

Proposed pseudocode (mBlock5 specific solution)

```
Forever
    RAW = read analog value from pin 3 (temperature sensor)
    TempC = RAW * 19 / 236
    LEDS = TempC * 100 / 40
    Show in LEDS ring the value LEDS
```

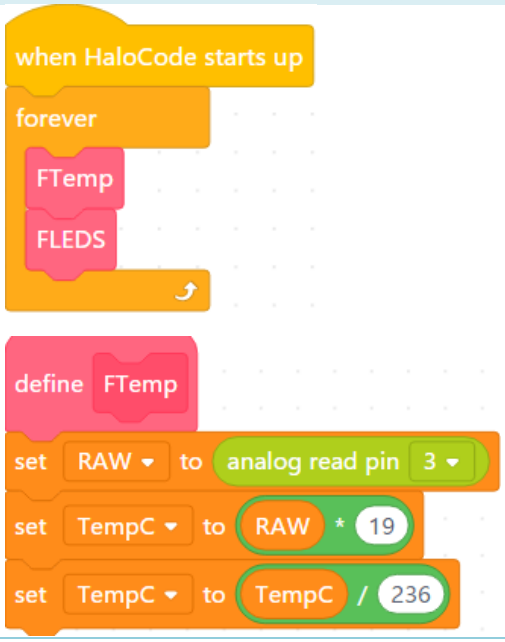
Program developed with mBlock5

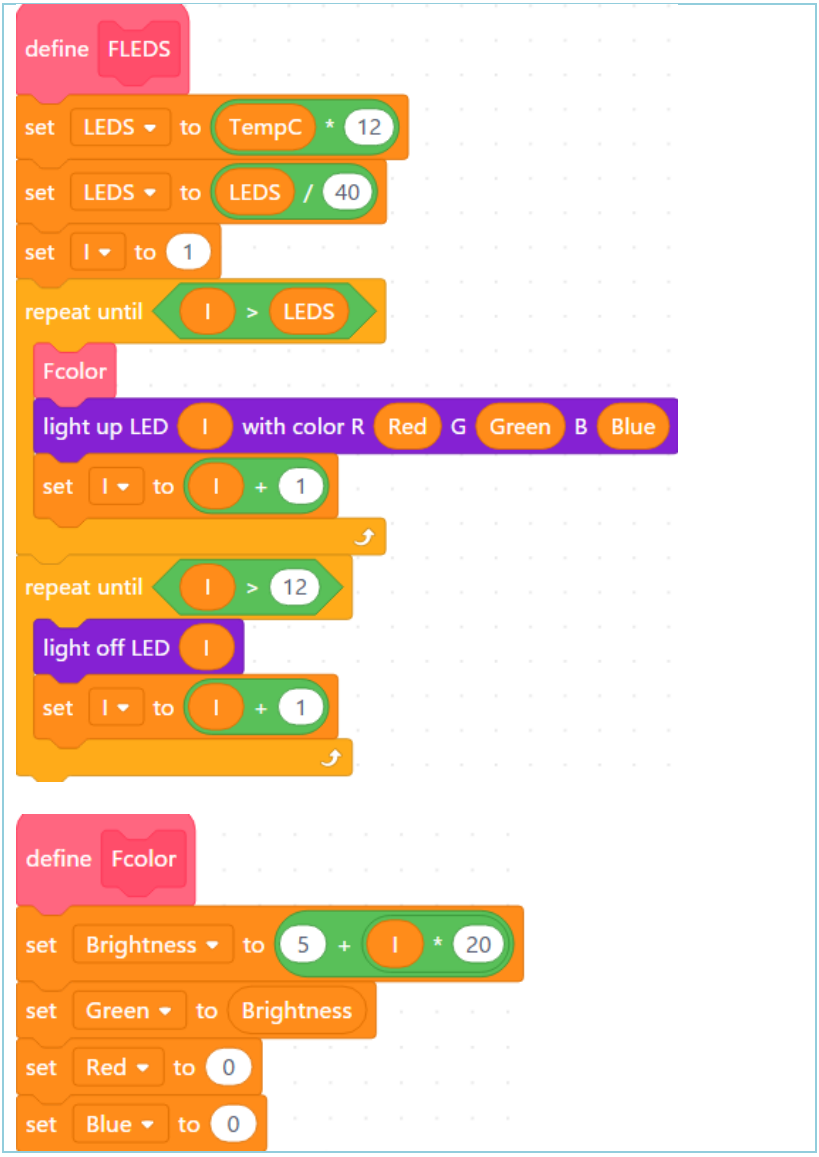


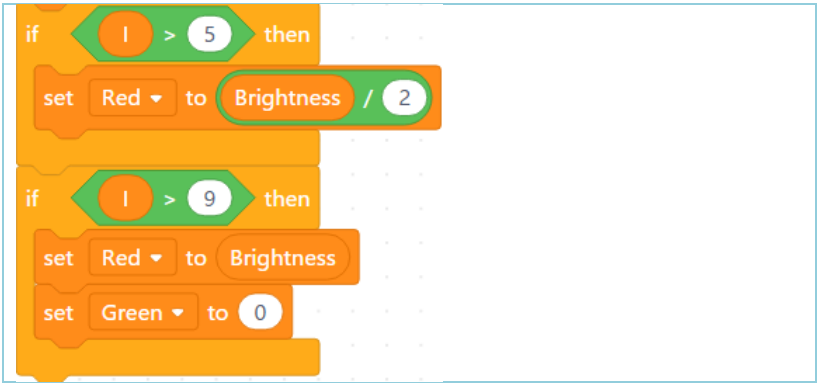
Proposed pseudocode (standard solution)

```
Forever
    Execute function FTemp
    Execute function FLEDS
Function FTemp
    RAW = Read analog value from pin 3 (temperature sensor)
    TempC = RAW * 19 / 236
Function FLEDS
    LEDS = TempC * 12 / 40
    I = 1
    Repeat until I greater than LEDS
        Execute Function FColour
        Turn on LED = I with values Red, Green, Blue
        I = I + 1
    Repeat until I greater than 12
        Turn off LED I
        I = I + 1
Function FColour
    Brightness = 5 + (I * 20)
    Green = Brightness, Red = 0, Blue = 0
    If I greater than 5 then Red = Brightness / 2
    If I greater than 9 then Red = Brightness and Green = 0
```

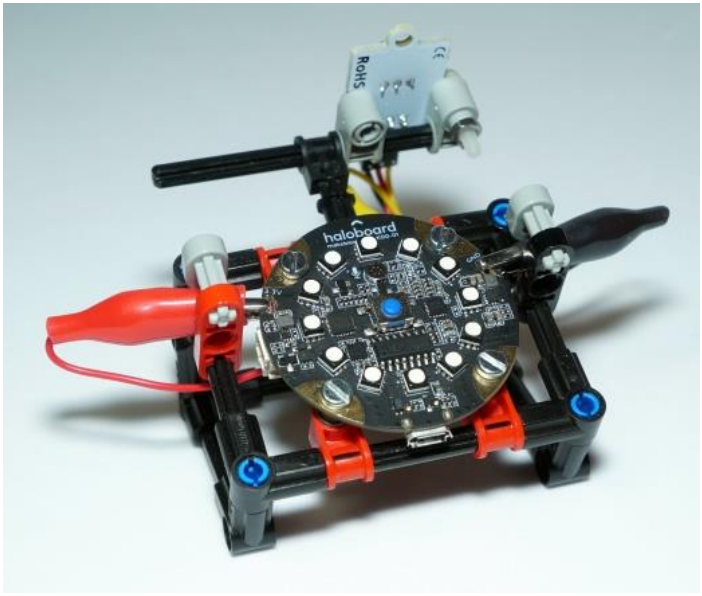
Program developed with mBlock5

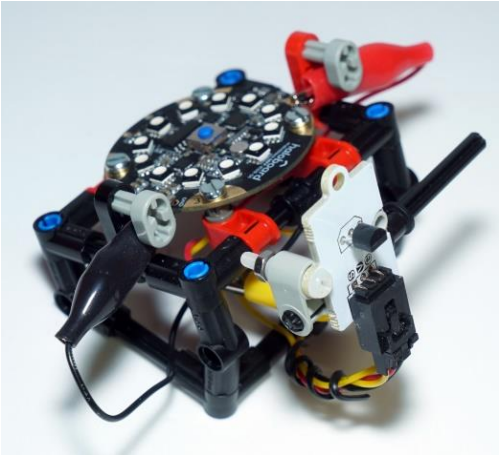



define FLEDS
set LEDS to TempC * 12
set LEDS to LEDS / 40
set I to 1
repeat until I > LEDS
Fcolor
light up LED I with color R Red G Green B Blue
set I to I + 1
repeat until I > 12
light off LED I
set I to I + 1
define Fcolor
set Brightness to 5 + I * 20
set Green to Brightness
set Red to 0
set Blue to 0



In this project it is necessary to take care that the clamps connected to the power and ground pins do not make contact with any other element of the board. The structure described in section 2.9.2 helps reduce this risk:



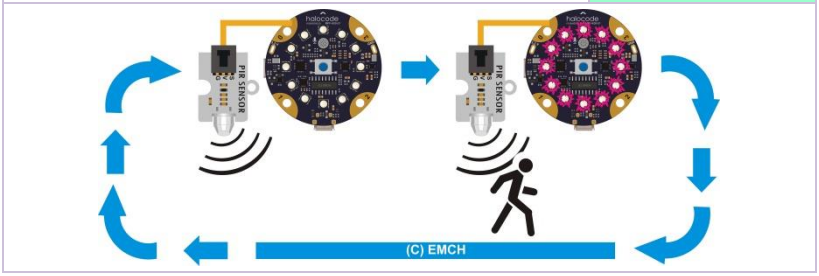


4.3.5.- Alarm of presence

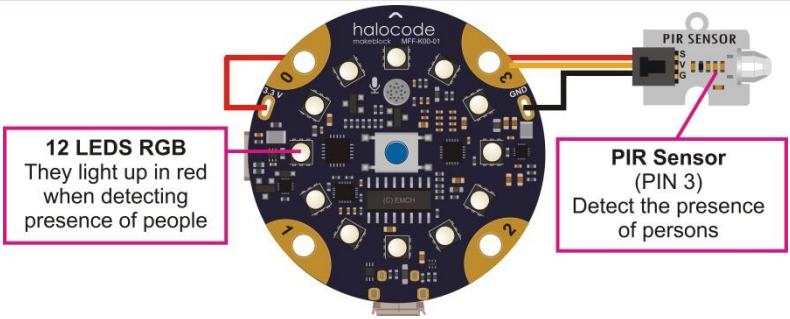
A presence alarm is a device that emits a warning, usually sound, when detecting the presence of a person. Normally it is located on the doors of shops and offices.

Conceptually it is an element very similar to the alarm based on a presence sensor, but it incorporates a loudspeaker to emit a warning sound, as well as an LED in case you want it to work in silent mode.

Objetive	Complexity
Using the PIR sensor carry out a visual presence alarm.	Time 10'
	Program: low



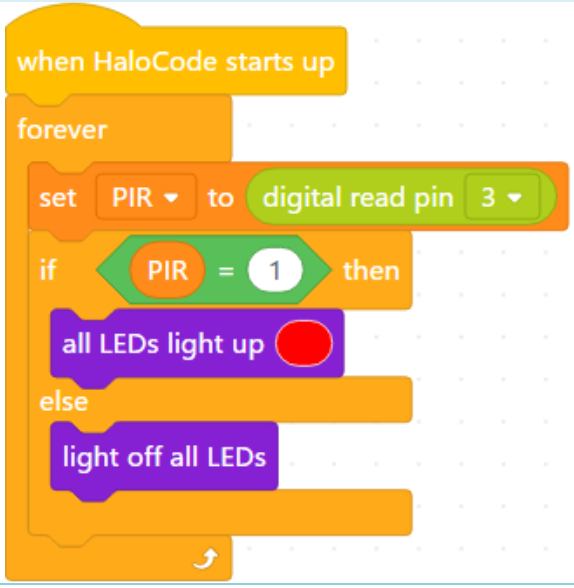
Components used



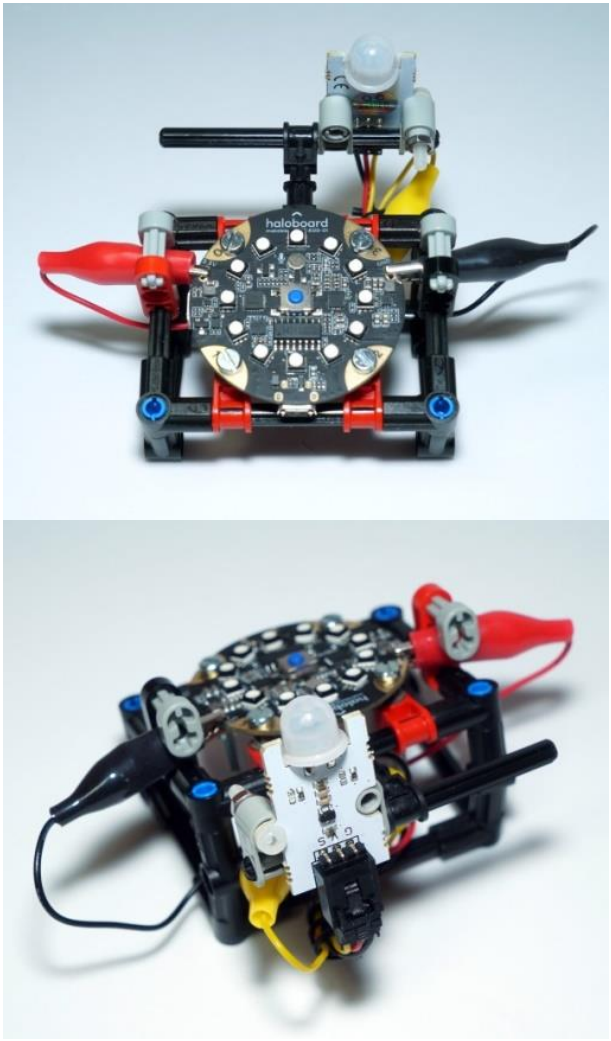
Proposed pseudocode

```
Forever
    PIR = Read digital value pin 3
    If PIR = 1
        Turn on all LEDS in red
    Else
        Turn off all LEDS
```

Program developed with mBlock5



In this project it is necessary to take care that the clamps connected to the power and ground pins do not make contact with any other element of the board. The structure described in section 2.9.2 helps reduce this risk:



4.3.6.- Multi colour light with remote control

See the full book “Educational Robotics with Halocode” from the same author.

4.4.- With Halocode and two more components

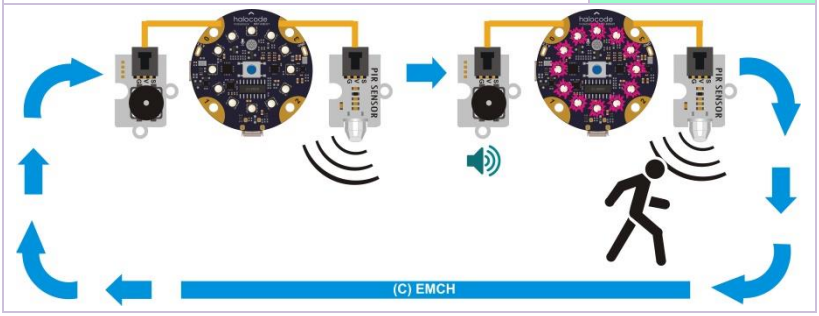
In this section several projects are proposed in which two additional components are added to Halocode board.

4.4.1.- Sound presence alarm

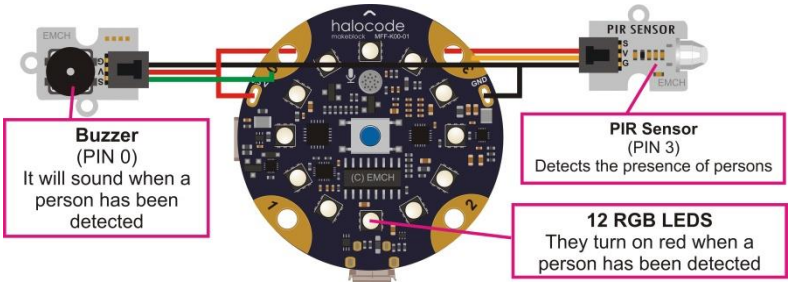
A presence alarm is a device that emits a warning, usually sound, when detecting the presence of a person. Normally it is located on the doors of shops and offices.

Conceptually it is an element very similar to the alarm based on a presence sensor, but it incorporates a loudspeaker to emit a warning sound, as well as an LED in case you want it to work in silent mode.

Objetive	Complexity
Using the PIR sensor carry out a visual and audible presence alarm.	Time 10’
	Program: low



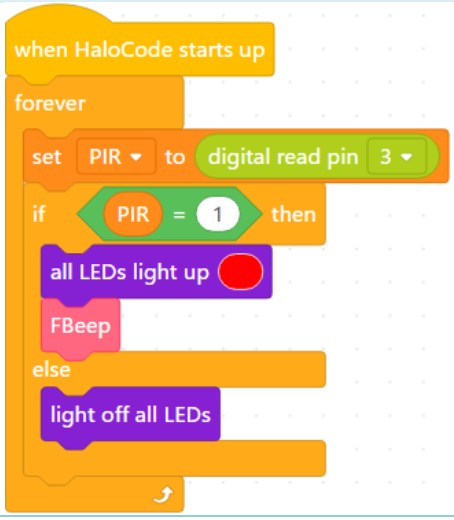
Components used

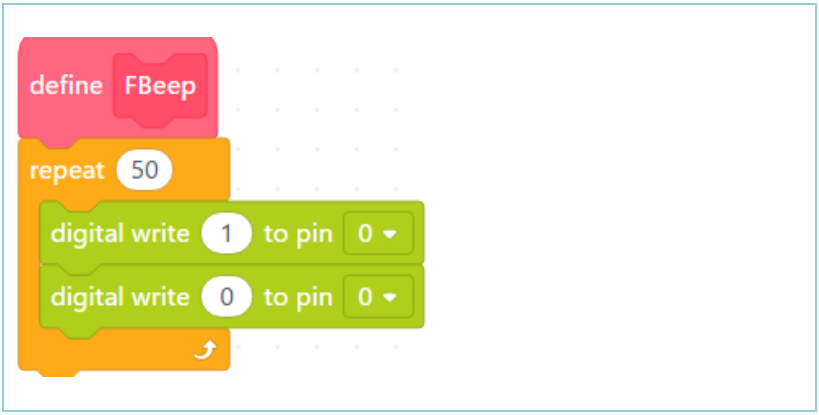


Proposed pseudocode

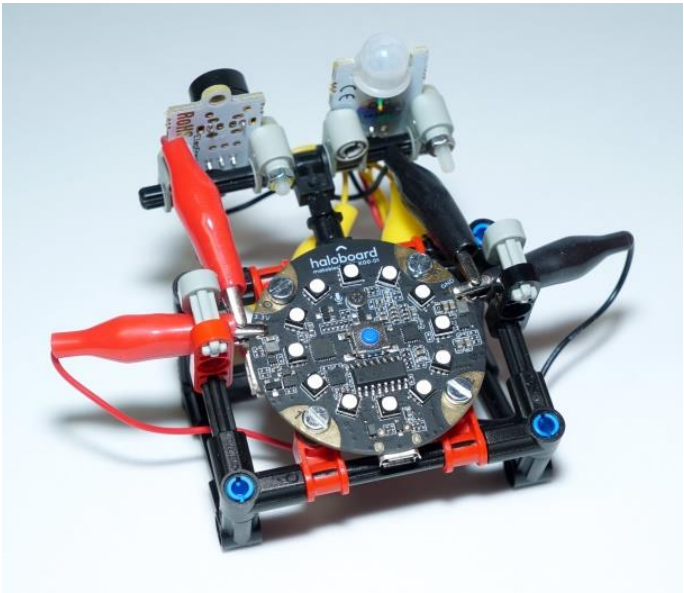
```
Forever
    PIR = Read digital value pin 3
    If PIR = 1
        Turn on all LEDS in red
        Execute function FBeep
    Else
        Turn off all LEDS
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Function FBeep
    Repeat 50 times
        Write 1 in digital pin 0
        Write 0 in digital pin 0
```

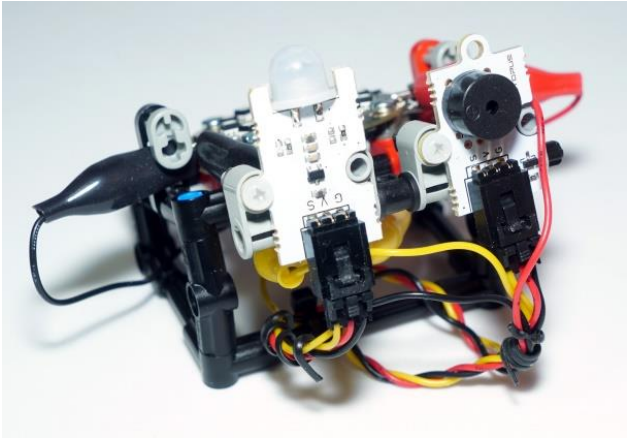
Program developed with mBlock5





In this project it is necessary to take care that the clamps connected to the power and ground pins do not make contact with any other element of the board. The structure described in section 2.9.2 helps reduce this risk:



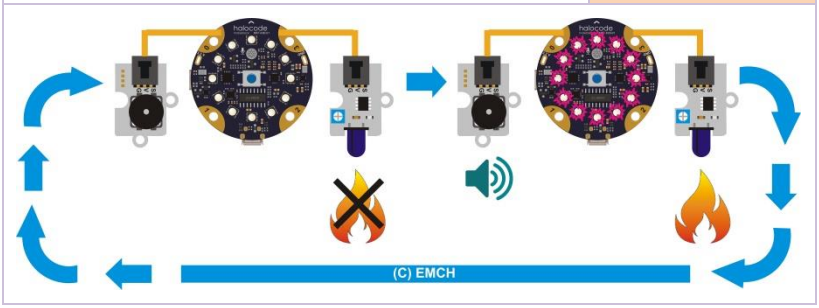


4.4.2.- Fire alarm

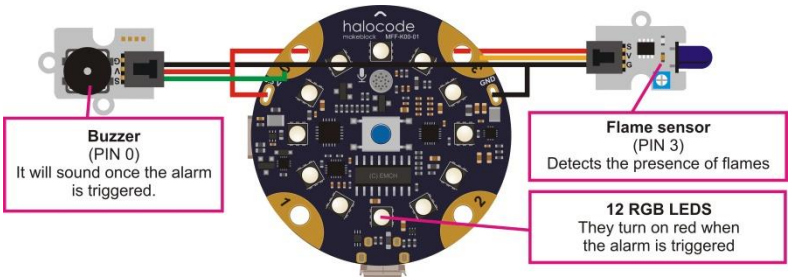
The fire alarm is a device that detects the presence of flames, emitting a sound and visual warning.

In some cases they can also activate the fire extinguishing system.

Objetive	Complexity
Carry out with Halocode a fire alarm that is triggered when detecting the presence of flames. Once triggered by pressing the button it will reset.	Time 10’
	Program: medium



Components used

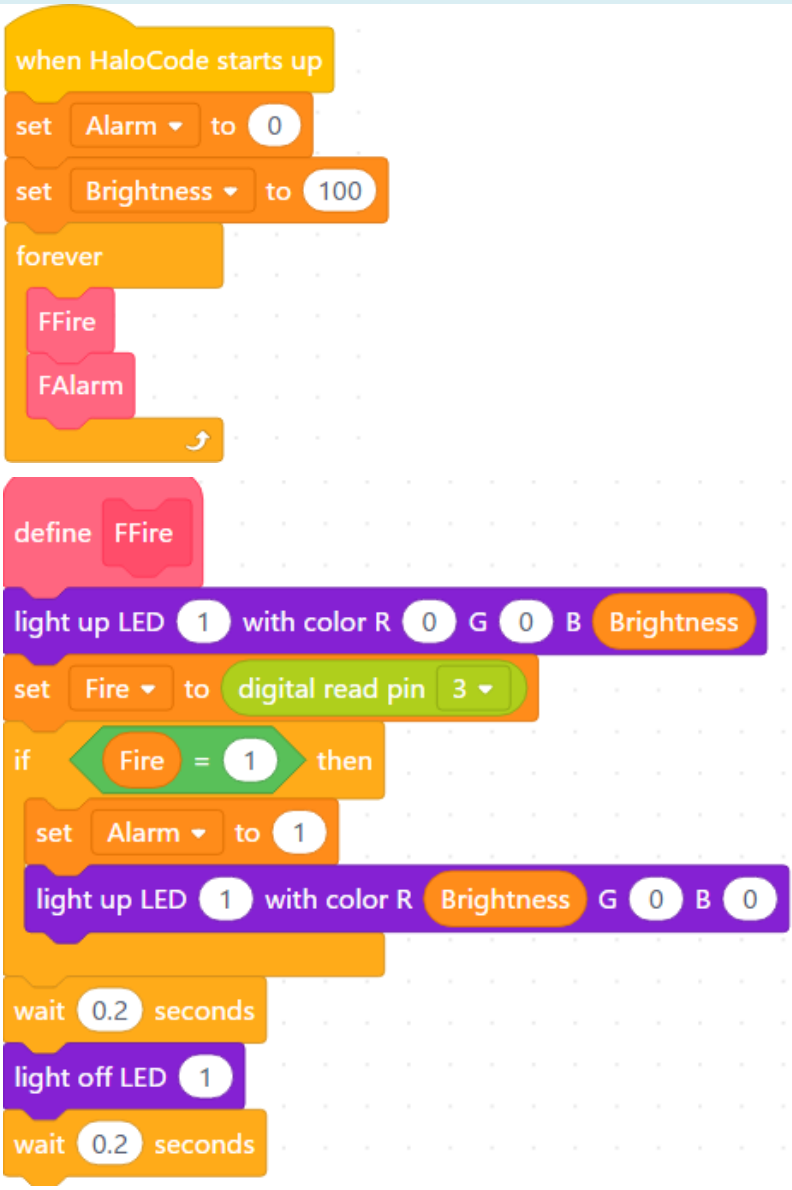


The flame sensor has a potentiometer through which you can adjust its sensitivity (left = increase sensitivity, right = reduce sensitivity).

Proposed pseudocode

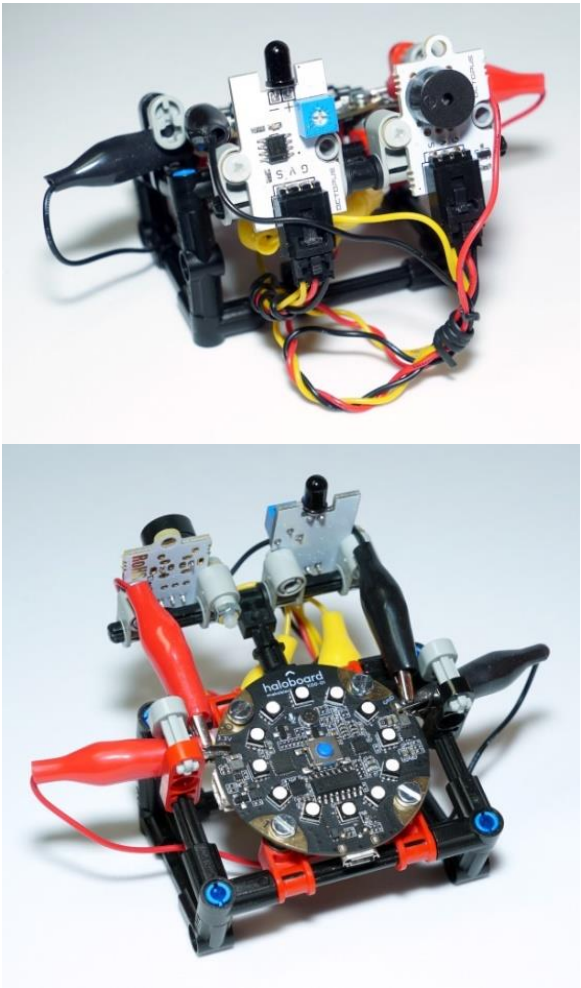
```
Alarm = 0, Brightness = 100
Forever
    Execute function FFire
    Execute function FAlarm
Function FFire
    Turn on LED 1 in blue
    Fire = Read digital value pin 3
    If Fire = 1
        Alarm = 1
        Turn on LED 1 in red
    Wait 0.2 seconds
    Turn off LED 1
    Wait 0.2 seconds
Function FAlarm
    If Alarm = 1
        Repeat until button pressed
            Turn on all LEDS in Red
            Execute function FBeep
            Turn off all LEDS
            Execute function FBeep
        Repeat until Fire = 0
            Execute function FFire
        Alarm = 0
Function FBeep
    Repeat 50 times
        Write value 1 in pin 0
        Write value 0 in pin 0
```

Program developed with mBlock5




define FBeep
repeat 50
digital write 1 to pin 0
digital write 0 to pin 0
define FAlarm
if Alarm = 1 then
repeat until button is pressed?
all LEDs light up
FBeep
light off all LEDs
FBeep
repeat until Fire = 0
FFire
set Alarm to 0

In the projects that are added components it is necessary to take care that the clamps connected to the power and ground pins do not make contact with any other element of the board. The structure described in section 2.9.2 helps reduce this risk:



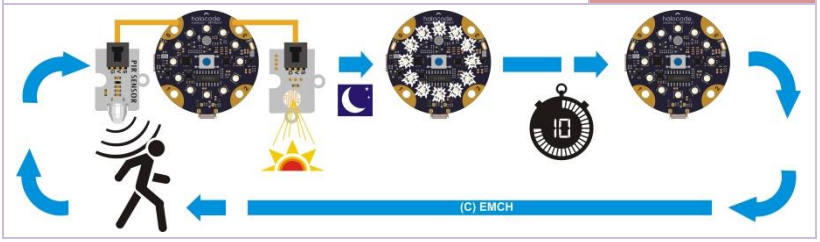
4.4.3.- Motion and noise alarm

See the full book “Educational Robotics with Halocode” from the same author.

4.4.4.- Twilight courtesy light

A twilight courtesy light is a light that is located in areas of passage and turns on automatically when detected by a PIR sensor the presence of a person, turning off after a while. Some are equipped with a light sensor so that it only lights at night, reducing energy consumption during the day.

Objetive	Complexity
Carry out a twilight courtesy light that, when it is at night, automatically turns on when detecting the passage of a person. Failing to detect a person, it will turn off after a delay time set in the program.	Time 30’
	Program: high



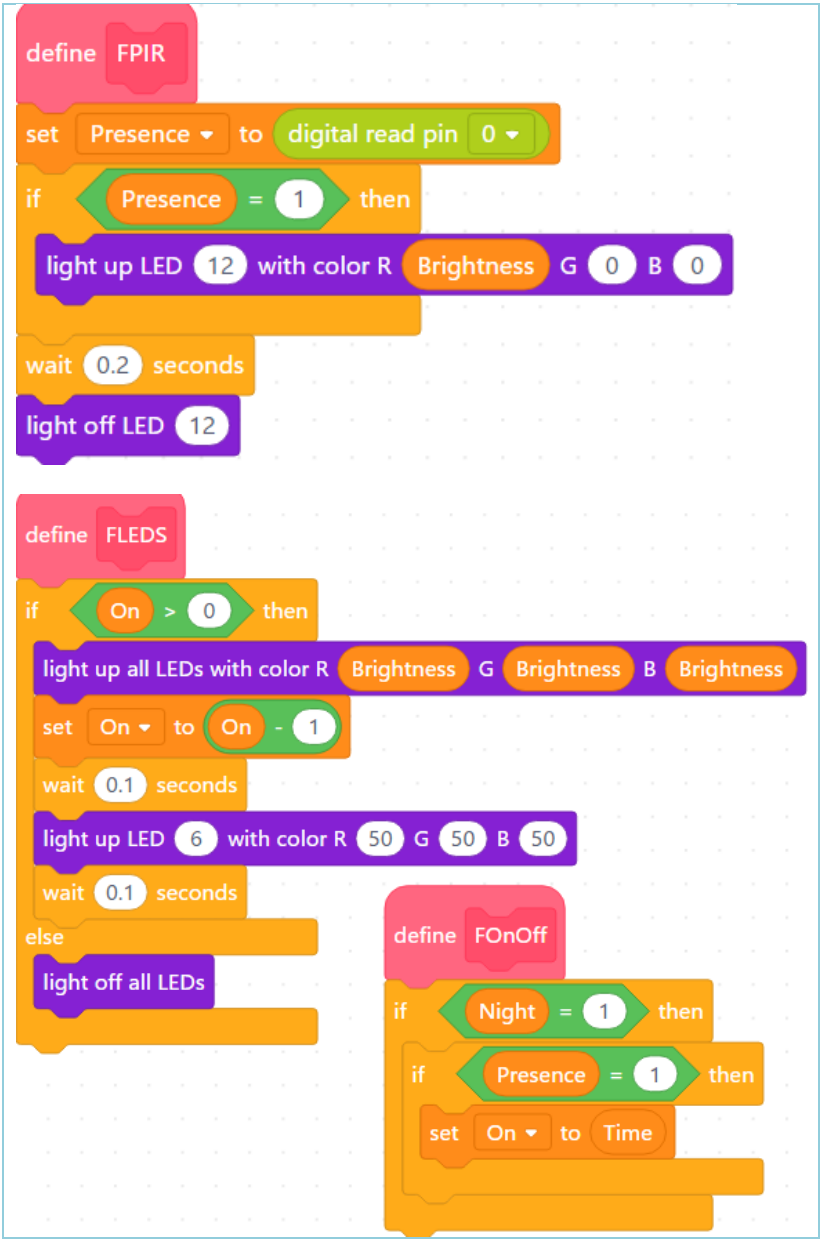
Components used

The delay time that we have set in our case, 10 seconds, may seem scarce, but note that in the objective description, this time is counted once the sensor failing detecting the person, therefore the light will be on while the person is passing, and will continue for 10 seconds, once the sensor failing detecting it.

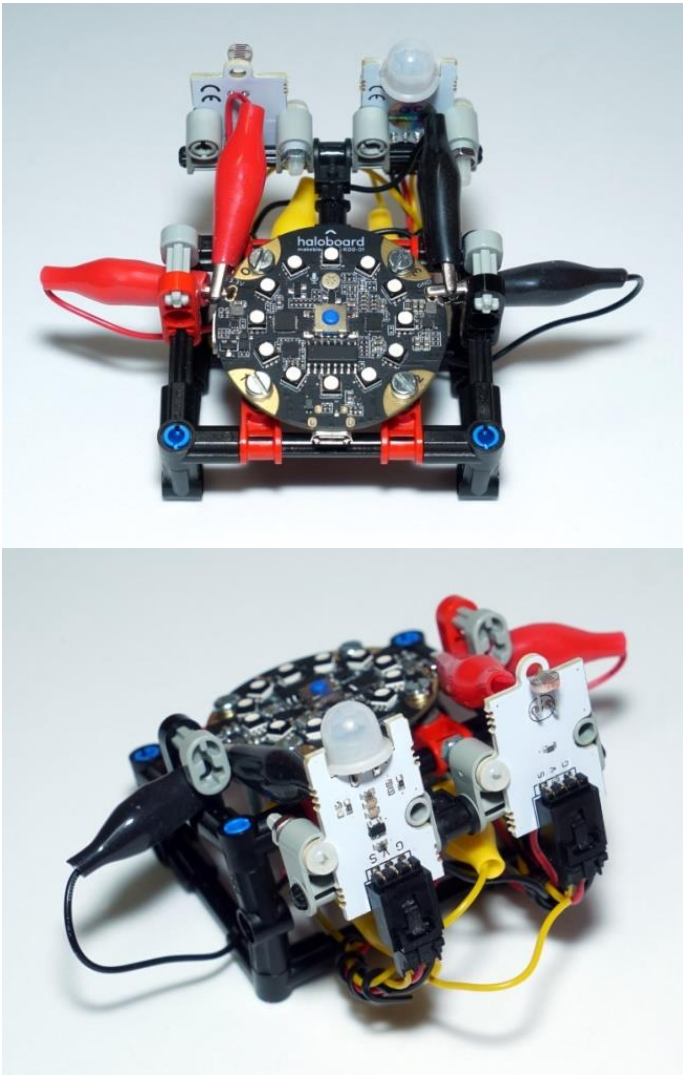
Proposed pseudocode

```
Execute function FInit
Forever
    Execute function FDayNight
    Execute function FPIR
    Execute function FOnOff
    Execute function FLEDS
    Wait 1 second
Function FInit
    Brightness = 100
    Night = 0
    Presence = 0
    Time = 10
Function FDayNight
    AmbientLight = Read analog value pin 3
    If AmbientLight less than 200
        Then Night = 1
    Else, Night = 0
Function FPIR
    Presence = Read digital value pin 0
    If Presence = 1
        Turn on LED 12 in red
    Wait 0.2 seconds
    Turn off LED 12
Function FOnOff
    If (Night = 1) and (Presence = 1)
        On = Time
Function FLEDS
    If On greater than 0
        Turn on all LEDS in white and brightness = Brightness
        On = On – 1
        Wait 0.1 seconds
        Turn on LED 6 in white and brightness = 50
        Wait 0.1 seconds
    Else Turn off all LEDS
```

Program developed with mBlock5


define FPIR
set Presence to digital read pin 0
if Presence = 1 then
light up LED 12 with color R Brightness G 0 B 0
wait 0.2 seconds
light off LED 12
define FLEDS
if On > 0 then
light up all LEDs with color R Brightness G Brightness B Brightness
set On to On - 1
wait 0.1 seconds
light up LED 6 with color R 50 G 50 B 50
wait 0.1 seconds
else
light off all LEDs
define FOnOff
if Night = 1 then
if Presence = 1 then
set On to Time

In the projects that are added components it is necessary to take care that the clamps connected to the power and ground pins do not make contact with any other element of the board. The structure described in section 2.9.2 helps reduce this risk:



4.4.5.- Automatic watering

See the full book “Educational Robotics with Halocode” from the same author.

4.4.6.- Alarm of presence with remote control

See the full book “Educational Robotics with Halocode” from the same author.

4.5.- Real home automation with Halocode

See the full book “Educational Robotics with Halocode” from the same author.

5.- Further material

On the full book “Educational Robotics with Halocode” etition, from the same author, you will find a voucher to download the the complete collection of the programs corresponding to the projects of that book in mBlock5 format.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Full version
This book is a summarised edition from the "Educational Robotics with Halocode" book