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UNIVERSITY OF EXPERIMENTAL TECHNOLOGICAL RESEARCH
YACHAY TECH

WIRELESS NETWORKS

LAB N°7

Use Bluetooth module with Arduino

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1 Introduction

Nowadays, a branch known as the Internet of Things or IoT is being disseminated. Together with this technology, we are increasing the use of communications via Bluetooth. When we connect the headphones, when we pair our cell phone to the TV or compute, we are using Bluetooth. The Bluetooth communication operates at a frequency of 2.4 GHz and can reach 24Mb / s. Although a new version of Bluetooth has been developed, such as 5.0, there are still many devices that use versions 4.0 and 4.1. In the following report different exercises are presented in which communication via Bluetooth will be used. The code will be included in the link to GitHub

2 Objectives

- Make different experiments that involve the Bluetooth communication.
- Learning the basic concepts of Bluetooth communication.
- Learning to use Bluetooth HC-05 module as well as AT table.
- Learning to use free Android apps that help us to pair the module.

3 Theoretical Basis

- Piconet

A piconet is a computer network whose nodes are connected using Bluetooth. An The connection is established between two or more Bluetooth-enabled devices, such as modern cell phones or PDAs. Bluetooth-enabled devices are "equal units" because they can act as master or slave.

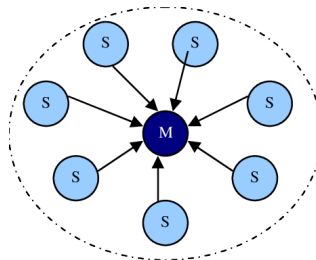


Figure 1: Piconet connection

- Scatternet

A scatternet is a type of computer network that consists of two or more piconets. It supports communication between more than 8 devices. Scatternets can be formed when a member of a piconet (either the master or one of the slaves) chooses to participate as a slave in a separate second piconet.

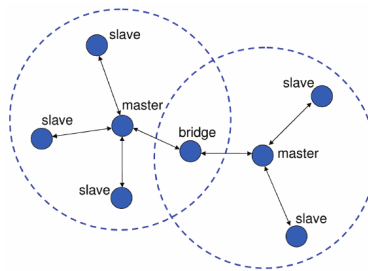


Figure 2: Scatternet

- Baud rate

It is also known as baudaje and it is the number of signal units per second. A baud can contain several bits. Although baud is sometimes confused with bits per second, they are different concepts. For example we have in digital transmission that encoded in bits, can not normally be sent directly by the transmission medium. When coding the bits as an electrical level, the signal undergoes very fast transitions, which generates very high frequencies. For example, if you want to transmit a 1 and then a 0, you must go from 5 V to 0 V immediately.

One way to solve this is by encoding the bits in another way; for example, associating each bit with a signal that the medium admits, such as sines and cosines; if the medium limits to signals that are in the range of 1 kHz and 4 kHz, we can transmit a sinusoidal signal of 2 kHz to express a 1 and another of 3 kHz to express a 0, which would be a primitive way of modulation FSK (frequency shift keying or 'coding by frequency offset'). These signals have a duration time commonly called symbol time T, so that every T seconds one of the two signals is transmitted. As each signal encodes 1 bit, each T seconds is transmitted 1 bit, then the bit rate is $1 / T$ bps (bits per second), which in this case coincides with baud rate

- HC-05 Bluetooth Module

The Bluetooth module HC-05 is a Bluetooth module in which the communication is done in series, which facilitates the interface with the controller or the PC. The Bluetooth module HC-05 provides a switching mode between master mode and slave mode, which means that you can not use or receive or transmit data. This Bluetooth module has six Vcc, GND, RX, TX, Key and State pins.

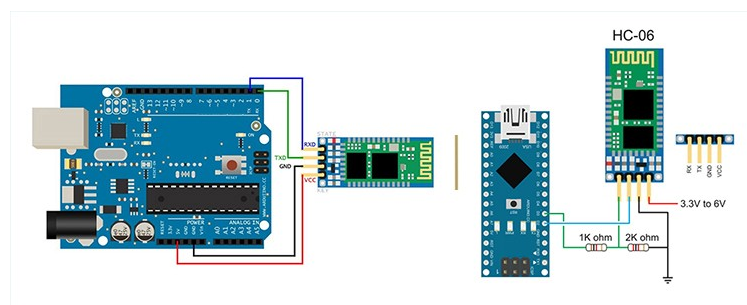


Figure 3: HC-05 characteristics and connections

To connect the Bluetooth module to the Arduino board, you must connect VCC to the 5V pin of Arduino, GND to ground, Rx to pin TX and TX to pin Rx of Arduino. Once connected, we can configure the module according to the

following table:

AT commands	Description
AT	Check connection status.
AT+NAME ='ModuleName'	Set a name for the device
AT+ADDR	Check MAC Address
AT+UART	Check Baudrate
AT+UART=9600	Sets Baudrate to 9600
AT+PSWD	Check Default Passcode
AT+PSWD=1234	Sets Passcode to 1234

Figure 4: AT commands

4 Materials

- Arduino 1
- Bluetooth module HC-05
- 5 LEDS
- Male to male wires.

5 Lab experiments

5.1 Configuring Bluetooth module based in AT table

In order to configure the Bluetooth module we can use the table of the figure N° 4, First we have to perform the next connections:

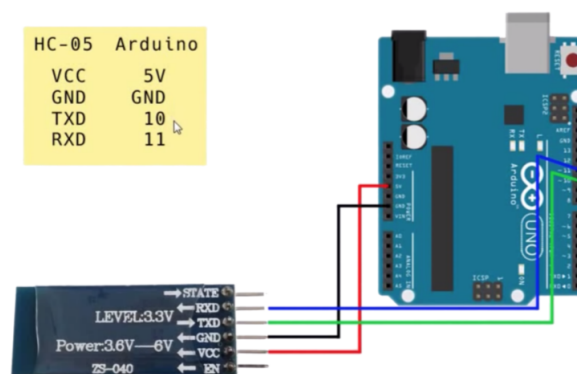


Figure 5: Basic connections of Bluetooth module to Arduino

In order to use the AT mode we have to plug the power source while holding down the reset button on the module. The long slow blinks shows that we are in AT Command mode.

Now we have to configure the baud rate to 9600 and be sure that NL CR are selected. Once we have connected and configured properly the module, we can configure the name of the device, the password, etc.

5.2 Control a LED via Bluetooth and Android

For this experiment we are going to make a basic connection of LED's in the protoboard and through an Android App we are going to turn on and turn of the LED's.

The connections are the next:

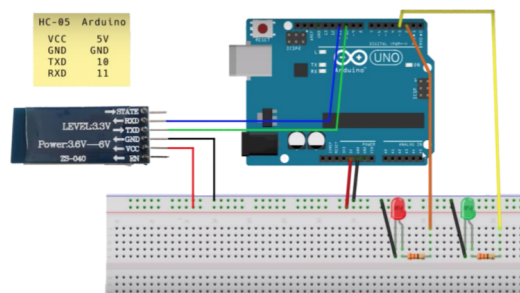
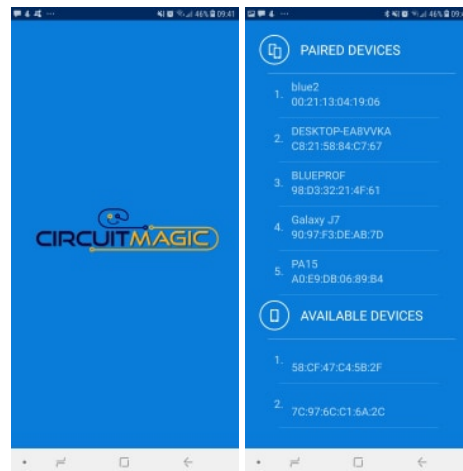


Figure 6: Connections of LED's, Bluetooth module and Arduino

Once we have connected properly the module and the LED's we pair our cellphone with the Bluetooth module and we can use the AP CircuitMagic:



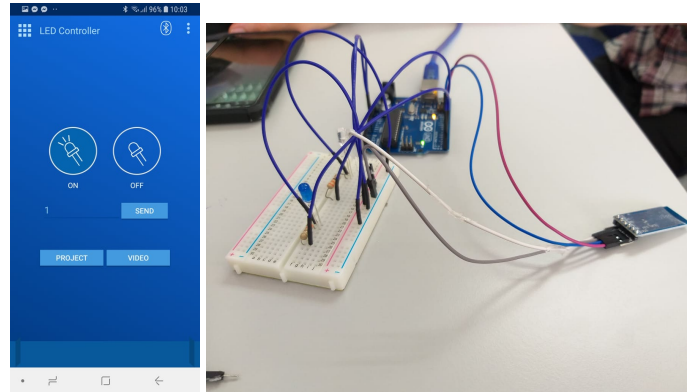
(a) App screen

(b) App connection

Figure 7: CircuitMagic app

5.3 Remote Controlled LED Using HC-05 Bluetooth, Arduino and Mobile Phone App

Using the connections of the previous exercise we write a code that allow us to turn on or turn off the first LED using the number 1 of the app and turn on or turn off the second led using the number 2 in the app, The result is the next:



(a) App controller

(b) Resultant circuit

Figure 8: Circuit and App connection

5.4 Remote Controlled LED Brightness Using HC05 Bluetooth, Arduino and Mobile Phone App

For this exercise we use all the configurations of precious exercises but in this case we edit the code so we can be able to change the brightness of the LEDS. The result was the next:

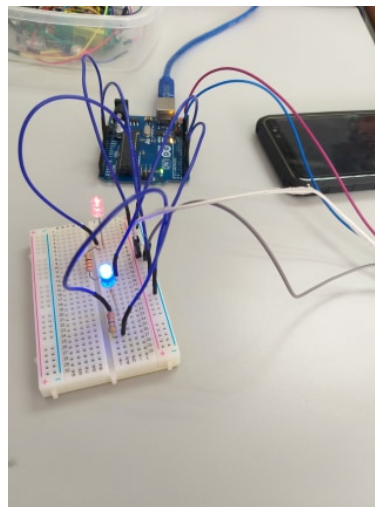


Figure 9: Remote controlled led brightness

5.5 Voice Controlled LEDs Using HC-05 Bluetooth, Arduino and Mobile Phone App

For this exercise we are going to use the ANDroid app to turn on and turn of the LED's but in this case using voice commands. The app will transform the command in a string the will say the Arduino which action to perform.

First of all we have to be sure that the circuit is properly connected by using first the codes of the previous exercises and then use the code of voice commands.

The circuit is the next:

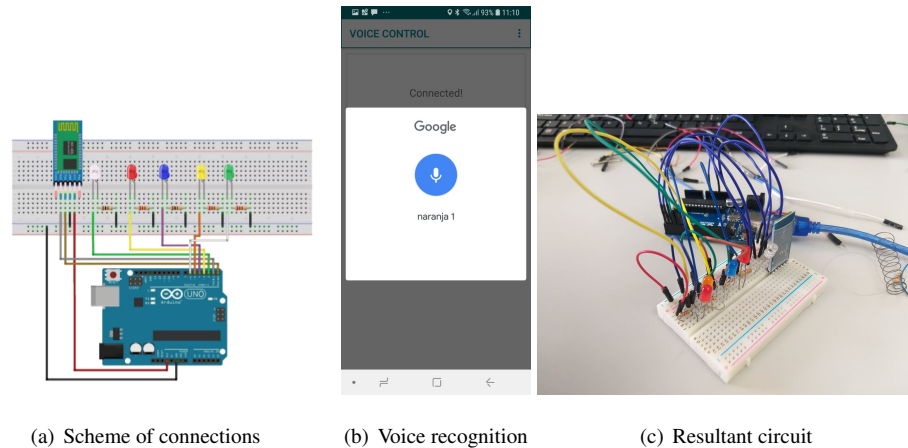


Figure 10: Voice controller connections and result

5.6 GitHub Repository

<https://github.com/HectorUtreras/Bluetooth-HC-05-module-connection-to-Arduino>

5.7 Questions

1. What Is Bluetooth?.

It is a short-range wireless communication technology that allows devices such as mobile phones, computers, and peripherals to transmit data or voice wirelessly over a short distance.

2. Why Is It Called Bluetooth?.

It was called like this because of Harald Bluetooth who was the Viking king of Denmark between 958 and 970. King Harald was famous for uniting parts of Denmark and Norway into one nation and converting the Danes to Christianity.

So, what does a turn-of-the-last-millennium Viking king have to do with wireless communication? He was a uniter as the bluetooth was in the 90 decade.

3. What Is the Difference Between Bluetooth and Wi-Fi?

WiFi means wireless connectivity which allows you to surf the Internet, browse websites, and in the other hand bluetooth is a technology which is installed on the latest devices and allows them to communicate with one another using a wireless connection.

4. What types of Bluetooth are there?

- Stereo Headset.
- In-Car Bluetooth System.
- Bluetooth-Equipped Printer.
- Bluetooth GPS Device.
- Bluetooth Keyboard.

5. Is Bluetooth Safe?

Though Bluetooth technology is relatively safe, especially compared to Wi-Fi networks, it is not perfect or impervious to cyberattacks. For example some attacks are Blueborne, Bluebugging, Bluejacking.

6. Name Few Applications Of Bluetooth?

Connecting distinct devices like mouse, headphones etc, Automatic synchronization, Multimedia Transfer.

7. How Many Devices Can Communicate Concurrently?

Two devices.

8. What Is Pairing?

Establishing a connection between two Bluetooth devices. For example, to pair a headset with a phone.

9. What is Piconet?

It is a computer network whose nodes are connected using Bluetooth.

10. What versions of Bluetooth standards are there?

- Bluetooth v1.0 y v1.1
- Bluetooth v1.1 (2002)
- Bluetooth v1.2 (2003)
- Bluetooth v2.0 + EDR (2004)
- Bluetooth v2.1 + EDR (2007)
- Bluetooth v3.0 + HS xxx (2009)
- Bluetooth v4.0 (2010)
- Bluetooth v5.0 (2016-2017)
- Bluetooth v5.1 (2019)

11. Technology is used to avoid interference in Bluetooth

Interference is being avoided by utilizing the frequency-hop(FH) spread spectrum technology. It is adaptable for low-power, low-cost radio implementations and also used in certain wireless LAN products.

12. Will other RF (Radio Frequency) devices interfere with Bluetooth Devices?

RF communications like WIFI or microwave could interfere but as we saw previously it doesn't happen because of spread spectrum frequency hopping.