

Wireless Network

LAB7: Use Bluetooth module with Arduino

Objective

1. Describe the basic principles of radio communications
2. Understand the usage of Bluetooth serial communication module and AT command to set the control parameters.
3. Learn how use the Bluetooth module for controlling Arduino via Bluetooth communication.

Discussion of fundamentals

Wireless communication systems and their interconnections by networks have become increasingly popular in recent years, particularly with the surge of interest in the Internet of Things (IoT). The most common wireless communication systems use Radio Frequency (RF) waves, which can penetrate objects and operate without direct line of sight between devices. Bluetooth is a short-range wireless data transfer that operates in the 2.4GHz frequency range with multiple data transfer rates possible with real-time two-way rates up to 24Mb/s. Nowadays, Bluetooth devices are seamlessly integrated into our daily lives, in the form of headsets, smart phones, mice, keyboards and portable speakers, and are widely used all over the world. Furthermore, hands-free voice communication devices are becoming increasingly more popular in cars for safety reasons or homes for convenience.

Despite the Bluetooth Special Interest Group releasing newer versions of Bluetooth such as version 5.0 (currently compatible with newer technologies such as Apple AirPods), there is still a huge number of devices in use that use older versions of Bluetooth, such as Bluetooth Smart / Bluetooth Low Energy in version 4.0 and 4.1. In fact, it is estimated that there are over 4 billion Bluetooth Low Energy (BLE) enabled devices in 2018 (using version 4.0 or 4.1).

Piconets and Scatternets

The basic unit of Bluetooth networking is a piconet. The terms piconet and scatternet are typically applied to Bluetooth wireless technology. A brief description of each of the two terminologies is given below:

- Piconet - It is a Bluetooth network that can have up to eight stations, one of which is called as master and the rest are called as slaves as shown in Figure 1
- Scatternet - It is computer network comprising of two or more piconets. A scatternet has the advantage of supporting communication between more than eight devices.

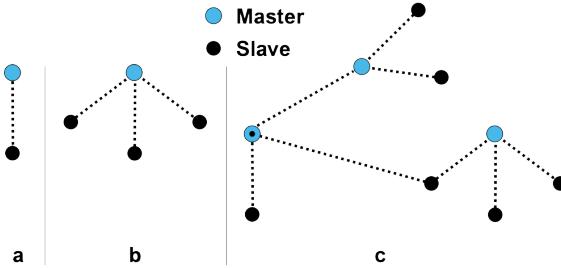


Figure 1: Piconets with a single slave operation (a), a multi-slave operation (b) and a scatternet operation (c).

HC-05 Bluetooth Module

HC-05 Bluetooth Module is a Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Its communication is via serial communication which makes an easy way to interface with controller or PC. HC-05 Bluetooth module provides switching mode between master and slave mode which means it able to use neither receiving nor transmitting data. The bluetooth module has six pins Vcc, GND, RX, TX, Key and State.

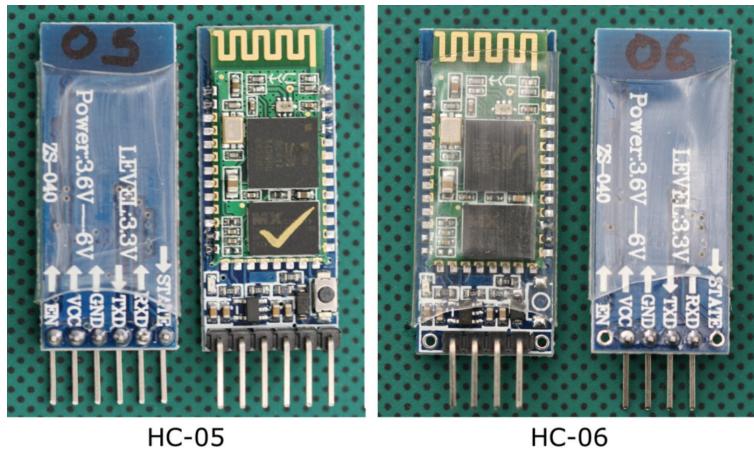


Figure 2: Bluetooth Module

To use the Bluetooth module, simply connect the VCC to the 5V output on the Arduino, GND to Ground, RX to TX pin of the Arduino, and TX to RX pin of the Arduino. If the module is being used for the first time, you will want to change the name, passcode etc. To do this the module should be set to command mode. To program the module, a set of commands known as AT commands are used. Here are some of them:

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

Table 1: AT commands

Exercise 1. AT Command Mode of HC-05 or HC-06 Bluetooth Module

Sometimes it may require to change the default settings like password, name, baud rate, or master/slave role of the module. This exercise shows how to enter AT command mode of HC05/HC-06 bluetooth .

Building Circuit

Before making the connection make sure to unplug the power source from Arduino UNO. Make following circuit.

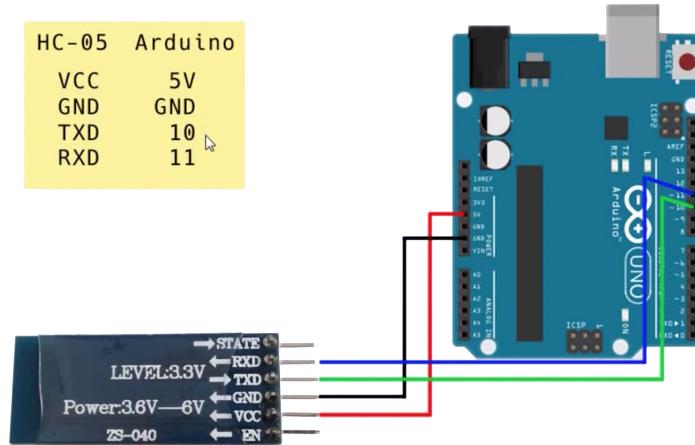


Figure 3: AT commands in Arduino

Configure with AT Mode

After the connection, If you Plug the power source, you will see the HC-05 power on with short rapid blink, which is standard pairing mode of module.

For At Mode, you need 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.

Programming

After configured this in AT Mode, open up the Arduino IDE and write the following code into a new sketch:

```
Code

#include <SoftwareSerial.h> // 'set digital pins for serial communication'
SoftwareSerial wirelessNetworkYT(10, 11); // 'pin 10 as RX, pin 11 as TX'

void setup(){
    Serial.begin(9600); // 'serial monitor communication at 9600 bps'
    Serial.println("Done"); // 'write "Done" on the monitor'
    wirelessNetworkYT.begin(38400); // 'communication at 38400 bps'
}

void loop(){
    if (wirelessNetworkYT.available()) // 'information available from module'
        Serial.write(wirelessNetworkYT.read()); // 'read Bluetooth and send it to Arduino serial monitor'
    if (Serial.available()) // 'information available from the serial monitor'
        wirelessNetworkYT.write(Serial.read()); // 'read serial monitor and send to Bluetooth'
}
```

Changing Codes

Open the serial monitor. Be sure that the baud rate are set to 9600 and Both NL & CR are selected. If you send AT from serial monitor, OK will appear on the screen. Now you can change the name or password of the module, check address, version.

Attention ! When uploading to the microcontroller, the Bluetooth module must be removed. Otherwise the error message appears that the code can not be uploaded. After uploading the module can be used again.

Exercise 2. Control a LED via Bluetooth and Android

Write a program that allows you to turn on and off two LEDs through the Bluetooth module and an App on the mobile phone.

Building Circuit

Before making the connection make sure to unplug the power source from Arduino UNO. Make following circuit.

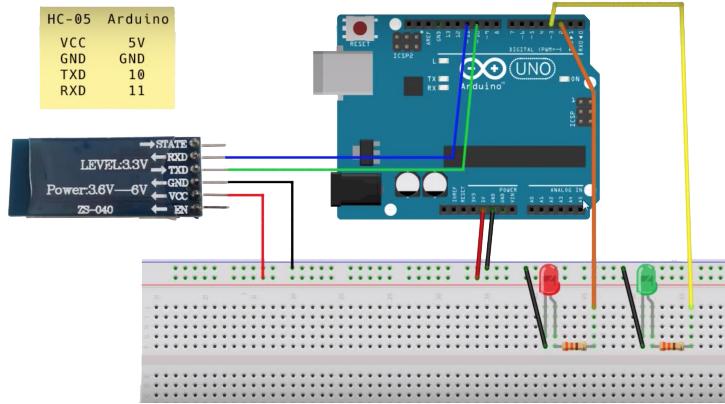


Figure 4: Control a LED via Bluetooth and Android

Programming

Open up the Arduino IDE and write the following code into a new sketch:

```
Code

#include <SoftwareSerial.h> // 'set digital pins for serial communication'
SoftwareSerial wirelessNetworkYT(10, 11); // 'pin 10 as RX, pin 11 as TX'

char DAT = 0; // 'variable to store received character'
int REDLED = 2; // 'Red LED to digital pin number 2'
int GREENLED = 3; // 'Green LED with digital pin number 3'

void setup(){
    wirelessNetworkYT.begin(38400); // 'Serial communication between Arduino and the module at
                                    // 38400 bps'
    pinMode(REDLED, OUTPUT); // 'pin 2 as output'
    pinMode(GREENLED, OUTPUT); // 'pin 3 as output'
}

void loop(){
if (wirelessNetworkYT.available()){ // 'if there is information available from module'
    DAT = wirelessNetworkYT.read(); // 'stores in DATO the character received from module'

    if( DAT == '1' ) // 'if the character received is number 1'
        digitalWrite(REDLED, HIGH); // turn on red LED

    if( DAT == '2' ) // 'if the character received is number 2'
        digitalWrite(REDLED, LOW); // turn off red LED

    if( DAT == '3' ) // 'if the character received is number 3'
        digitalWrite(GREENLED, HIGH); // turn on green LED

    if( DAT == '4' ) // 'if the character received is number 4'
        digitalWrite(GREENLED, LOW); // turn off green LED
}
}
```

Developing Front-end Using CircuitMagic

You can use the free Arduino Bluetooth app from CircuitMagic here in the Google Play Store to control our system. Pair the device with your mobile phone (when you are connecting your Bluetooth module for the first time with your smartphone it will ask for the passcode) and test the project.

Exercise 3. Remote Controlled LED Using HC-05 Bluetooth, Arduino and Mobile Phone App

Write a program that allows to turn on and off two LEDs through the Bluetooth module and an App on the mobile phone. Upon receiving the number 1 it turns on or off the red LED, upon receiving the number 2 it turns on or off the green LED.

Exercise 4. Remote Controlled LED Brightness Using HC-05 Bluetooth, Arduino and Mobile Phone App

Write a program that allows to turn on and off two LEDs through the Bluetooth module and an App on the mobile phone. When receiving the number 1 it turns on or off the red LED, upon receiving the number 2 it increases the brightness of the green LED, upon receiving the number 3 it decreases the brightness of the green LED.

Exercise 5. Voice Controlled LEDs Using HC-05 Bluetooth, Arduino and Mobile Phone App

Write a program for controlling 5 LED (see Figure 5) using voice control. To accomplish this you may use the free Android app "BT Voice Control for Arduino" by SA Tech. LEDs will be On/Off on your voice command

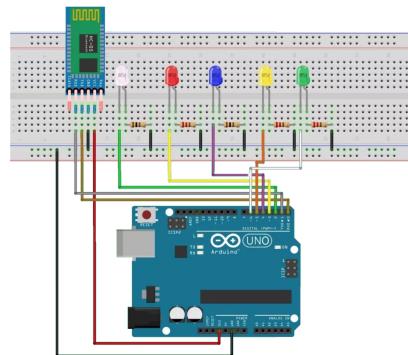


Figure 5: Voice Controlled LEDs

Exercise 6. Frequently Asked Questions about Bluetooth Technology

1. What Is Bluetooth?.
2. Why Is It Called Bluetooth?.
3. What Is the Difference Between Bluetooth and Wi-Fi?
4. What types of Bluetooth are there?
5. Is Bluetooth Safe?
6. Name Few Applications Of Bluetooth?
7. How Many Devices Can Communicate Concurrently?
8. What Is Pairing?
9. What is Piconet?
10. What versions of Bluetooth standards are there?
11. Technology is used to avoid interference in Bluetooth
12. Will other RF (Radio Frequency) devices interfere with Bluetooth Devices?

Exercise 7. Hand-in (at the end of the lab)

1. Write a report considering the following format
 - (a) Course Title, Lab no, Lab title, your name, and date.
 - (b) Section on the lab experiment:
 - Insert all the generated graphics
 - Share your open source code via GitHub
 - (c) The lab report is an important part of the laboratory. The report is individual. Write it carefully, be clear and well organized using L^AT_EX.