



HAE912E – Optimisation et systèmes embarqués

Embedded Systems

Project

1 Introduction

The aim of this module is to discover embedded systems through a mini-project. You will work on this project in groups of two, and we will provide each group with :

- ▷ One raspberry pi 4
- ▷ One pre-assembled Sensor Board (Hat Sense)

Your goal will be to prepare a POC with two Raspberry Pis communicating by TCP/IP : one performing a measure with its sensor, the second displaying it on its LED screen. Each raspberry must be able to play each role.

During this project, you will be asked to open (and update regularly) a git repository. At the end of each step, make a commit and tag it accordingly.

2 Getting ready

The Raspberry Pi is a small computer, running Linux (RaspberryPi-Os, previously call Raspbian). To work on it, you will have to set up its network connection and learn how to use SSH.

Exercice 1 You can use, for the first contact, a screen and a keyboard with your Pi. Nevertheless, to work in the best conditions, you must setup its network connection to auto-connect to a network (wired or wireless). By default, the login is "raspberry" and the password is "pi", but you can reinstall the OS if needed.

You must also create a git repository in which you will work during this project and give an access to all the professors involved. You can host it on the LIRMM's gitlab, or on GitHub.

When you can connect to the Pi, call your professor.

Exercice 2 Gather the documentation you can find about the Sense-Hat. You must enumerate :

- ▷ The different sensors available on the hat.
- ▷ Find their reference and constructor datasheet
- ▷ How and on which pin they are connected to the Pi.

Create a folder called "biblio" at the root of your project folder with all these files and your notes.

- Exercise 3** Check, with the tools available on Linux, that the I2C/SPI buses are correctly configured. What are the I2C addresses used? By which sensor? Add to your repository your notes in a file called "scan.txt".

3 Using the sense hat with Python

As a first contact, you will use the Python language to use your sense hat. A Library is available at :

<https://github.com/astro-pi/python-sense-hat>

For each of the following exercises, create a specific folder with your code and notes. Don't forget : Commit at each step and tag when done !

- Exercise 4** Use this library to measure humidity and temperature, and display it on the terminal.

- Exercise 5** Use the Gyroscope to control the moves of a LED on the screen.

- Exercise 6** Use the Magnetometer and display its coordinates on your computer through network. Is it pointing to the north? Fix it.

4 Let's move to C++

You are now more familiar with the hardware and it is time to move to a C++ implementation. As described before, your goal is to measure on one Pi, and display one of the measures on another Pi using the LED screen. This program must be delivered in two versions.

- Exercise 7** On the first version, you are free to use the libraries and the approach of your choice. You must nevertheless document your work and the network protocol you decided to use.

- Exercise 8** On the second version, Less is better. Because dependencies in code are a pain to manage, you are asked to make an implementation using as few external dependencies as possible. You can, for example, have a look on :

<https://medium.com/geekculture/raspberry-pi-c-libraries-for-working-with-i2c-spi-and-ua>