CNT5517/CIS4930 Mobile Computing

Fall 2021

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Lab 1 – Virtual Smart Space (VSS)

Due Date: 11:55am,16 September 2021.

Background: A virtual smart space is required for the lab assignments as well as the term project, all of which will be based on group and collaborative work. Starting week 1, you will be required to form three-member groups. Details of how the grouping will happen will be discussed in the first week as well. Each group will create and name its own Virtual Smart Space (VSS). Each group will use the VSS to do Lab assignments as well as the term project. It is therefore crucial that the VSS (this assignment) is fulfilled correctly if not optimally. Proof of setup readiness will be required by the due date as shown at end of this assignment.

VSS Structure: The VSS space will consist of three layers: Cloud, Edge and IoT Things. Things are defined and attached through IoT platforms such as Raspberry Pi's, Arduino, etc. To set up your VSS you will need one or two (1-2) laptops as Edge Computers, and one (1) laptop as a private cloud. You will also need three (3) IoT platforms which are **required** to be Raspberry Pi 3 Model B.

VSS Connectivity: A local private WiFi network should be used to connect the three layers (the laptops and the RPi's). A wireless hub or router can be used to create such private network. The RPi's may connect to the wireless LAN directly or to the edge computers through a USB interface.

Bill of Materials: You will need to purchase your RPi from any of the vendors listed on the Raspberry Pi web site (https://www.raspberrypi.org/). You will also need a variety of sensors or actuators such as those listed in the following Raspberry Pi tutorial page: https://tutorials-raspberrypi.com/raspberry-pi-sensors-overview-50-important-components/ Additional material usually needed to connect sensors and actuators to your RPi, and to connect your laptop to the RPi include the following:

- Online manuals and programming tips for RPi (available online).
- A wireless hub or router
- One breadboard
- Jumper wires (male to male to use on the breadboard, and female to male jumper wires to connect your IO port on your Pi to the breadboard)
- Resistors
- LED's: consider at least two different colors: Green and Red.
- Pushbuttons (get two of those)
- USB-x to Ethernet adaptor cable to connect your RPi to your laptop. This way you will be able to use *ssh* to connect to your RPi from your laptop, which avoids having to connect a monitor, keyboard, and mouse to the RPi (this proves to be very convenient). Also, UF WiFi may not allow you to do *ssh* from your laptop to your RPi wirelessly, hence the tethered connection. For more information on how to set up this connection, see Appendix 1 below titled: "**Configuring your Raspberry Pi Remote Connection.**"

The Assignment. In this assignment, your group will immediately meet to coordinate purchase of the RPi's, wireless hub, and the other materials. This should be done soonest given occasional supply chain delays due to COVID-19.

Once received, the group should convene periodically to set up the wireless private network connecting the cloud, edge and IoT Platform, establish a working *ssh* connection from the laptops to the RPi's, and develop simple programs to get at least one sensor reading from a sensor and to actuate at least one actuator.

The Deliverables: as a group, you will deliver the following

1. A link to a YouTube video - a short 90 second video that shows your VSS in action, showing the connections, ssh interactions, showing sensors and actuators connected to your RPi's, showing the listing of your program, ad showing the program in execution.

2. The first 5 second of the video should show the Group ID (a number), The group members' names, individual or group photo, and the name and logo chosen for your VSS.

3. A 1-page pdf report that includes the Group ID, group members' names, and the VSS chosen name, the URL for the video, and a few paragraph stating who did what and the relative % of effort each contributed. Include photos next to names please.

Appendix 1

Configuring your Raspberry Pi Remote Connection

The Raspberry Pi 3 comes equipped with a variety of connectivity capabilities. This includes:

- WiFi connectivity for joining a wireless network.
- Display out ports for connecting to a monitor with a keyboard/mouse.
- A wired Ethernet adapter.

The fastest way to get started is to connect to a monitor, however this is not always feasible. SSH over WiFi is also convenient, but if you do not administer your network it may be hard to connect from your development computer (this is often the case for UFL-administered networks). Barring these options, a direct connection can be made between your computer and the Raspberry Pi.

This Appendix will describe configuring a new Raspberry Pi and setting it up for SSH from your laptop. It focuses on the Ethernet connection method, although the steps to configure WiFi are also mentioned.

Requirements

Raspberry Pi 3 Model B

A microSD card flashed with the latest [Raspberry Pi OS](#)

An Ethernet-to-USB adapter (if your computer lacks an extra Ethernet port).

Setting up the First Boot

If you are running your RPi headless, that is, without a monitor connected, some steps must be taken first to enable SSH and set up networking.

1. **Enable SSH:** At the top-level of the micro SD card, create an empty file called `ssh`. It is important that this file has no extension.

2. **Configure Networking**
   a. **With WiFi:** Create a new file in the same directory as step 1, called `wpa_supplicant.conf`. Edit the contents of this file as described in the [Raspberry Pi Documentation](), under "adding the network details".
   b. **With Ethernet:** Locate the file `cmdline.txt` in the SD card root. Inside the file, at the end (after `rootwait`) add `ip=10.254.254.64` on the same line, replacing the IP with your own desired one. This IP should not be within the range of any networks you are currently connected to. Note that this step is not necessary if you are connecting your RPi to a *router*, and not directly to your PC.

Configuring the USB-Ethernet Adapter

If you are not using the adapter, this section may be skipped.

1. **On Mac:**
   a. With the adapter connected, go to System Preferences, under the *Network* tab, and click the "+" button below the list of interfaces.
   b. Select the USB adapter from the interface dropdown (called "USB 10/100 LAN", for example), and give it a descriptive name.
   c. Ensure *Configure IPv4:* is set to "Manually", and enter an IP address within the range of the IP you specified in `cmdline.txt` (but do not use the exact same IP address).
   d. The subnet mask should be 255.255.255.0 for most cases, and the *Router:* field can be left blank.
   e. Ensure the *Apply* button is clicked before exiting Preferences.
2. **On Windows 10:**

a. With the adapter connected, in the Control Panel, click *Network and Internet*, followed by *Network and Sharing Center.* Select *Change adapter settings.*

b. Select *More Options,* and click *Details.* Identify the USB adapter, and double click on it to open Properties.

c. Double click the *Internet Protocol Version 4 (TCP/IPv4)* property.

d. Select *Use the following IP address*, and enter an IP address within the range of the IP you specified in `cmdline.txt` (but do not use the exact same IP address).

e. The subnet mask should be 255.255.255.0 for most cases, and the *Default gateway:* field can be left blank.

Accessing the Raspberry Pi Shell

The RPi should now be configured for SSH access. With everything connected, plug in the power to the board and wait a little for it to boot. You should then be able to use the SSH command as follows (Terminal on Mac, Powershell on Windows 10):

```
ssh pi@10.254.254.64
```

Note that the IP should be the one you set in `cmdline.txt`. The default RPi user is `pi`, and the password is `raspberry` (you should change this immediately).

If you are using the USB-Ethernet adapter, note that your device does not receive an internet connection from your computer. You should use `raspi-config` to set up a WiFi connection (the school UFL network will work in this regard). Follow the steps on page 2 to do this.

First Time Setup

With your RPi connected to the internet and under your control, you should first update the current packages:

```
sudo apt update
sudo apt upgrade
```

Then install some necessary packages for development. Note that this may take a while.

```
sudo apt install gcc-6 g++-6 build-essential
sudo apt install cmake libboost-all-dev
```