Milestone 1: Teleoperating the Robot with your Keyboard

Lab 1: Setting up the Alphabot2

We will be using the Alphabot2-Pi robot for our lab project. This first milestone will allow you to become more familiar with the robot, and with some useful controls.

How the codes/file structures work

There will be two sides of codes, the server side (the robot) and the client side (your pc). On the server side, the codes are responsible for low-level control of the robot. The robot will run a script (listen.py) which actively listens for requests from the client to either move the robot (forward, backward, left, right, stop) or get a screenshot from the camera. The scripts on the server side will be provided for you through a public github repo (detailed description below). All robots will run the same script and you are not required to edit the scripts here.

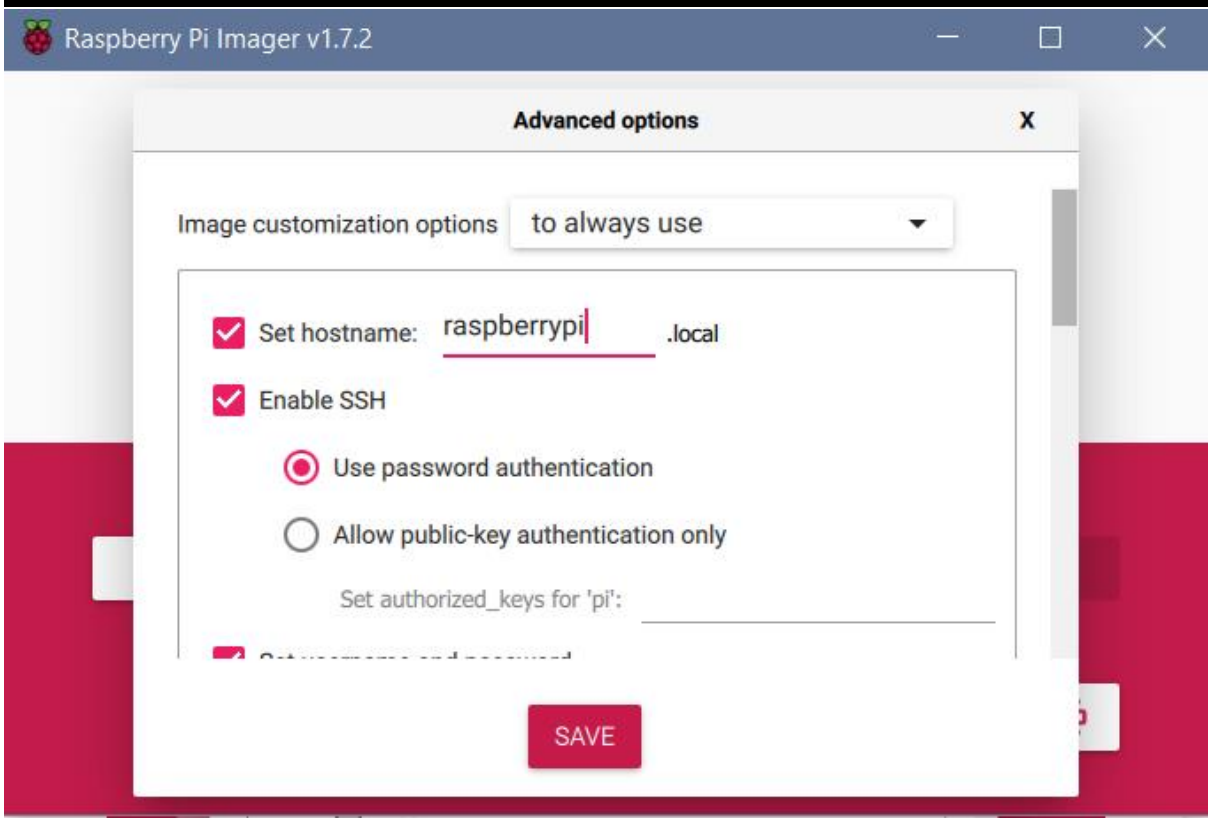
The client side is where all the processing, computation and high-level control will be executed. For every milestone, skeleton code and files will be provided for you in Moodle/Google Drive, and you are required to download and modify the TO-DO sections in the scripts. The scripts will be run on your PC, and you can work on them together via GitHub. Further setting up instructions will be described below.

Objective 1: Setting up the server side (Raspberry Pi, RPi)

Part A - First Time Setting Up the RPi

1. Insert the SD Card (it might be inside the robot already) into the appropriate adaptor, and plug it into your laptop via USB.
2. Flash the SD Card with Raspberry Pi OS using the Raspberry Pi Imager: https://www.raspberrypi.com/software/
3. Run the Imager (imager_1.7.5.exe) and Select “Choose OS” > Raspberry Pi 32 bit
4. In Choose Storage > Select the inserted SD Card

5. Click on the Gear (Settings).



6. Perform several items to ease future processes. Click the gear icon to open Advanced Options.
   (a) Enable SSH
   (b) Set username and password - put username: pi , password: raspberrypi.

(These credentials are needed when connecting to the pi/robot via PuTTY, and it is encouraged that everyone of you use this username/password pair).

(c) Configure wireless LAN - put a SSID and password of your choice (each group should have a unique SSID; do not use the same SSID as another group). Change Wireless LAN country to MY

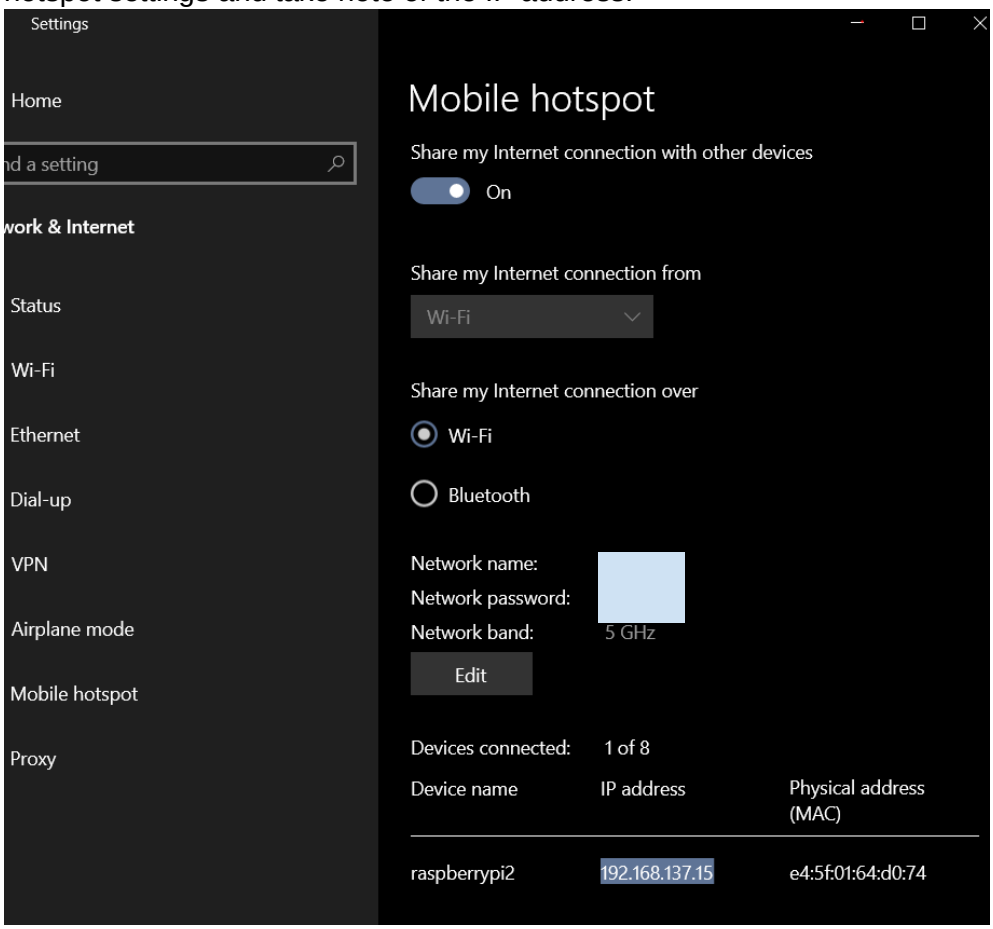
7. Click on Save and then Write

Part B - Setting up Mobile Hotspot in Laptop/PC (Windows)

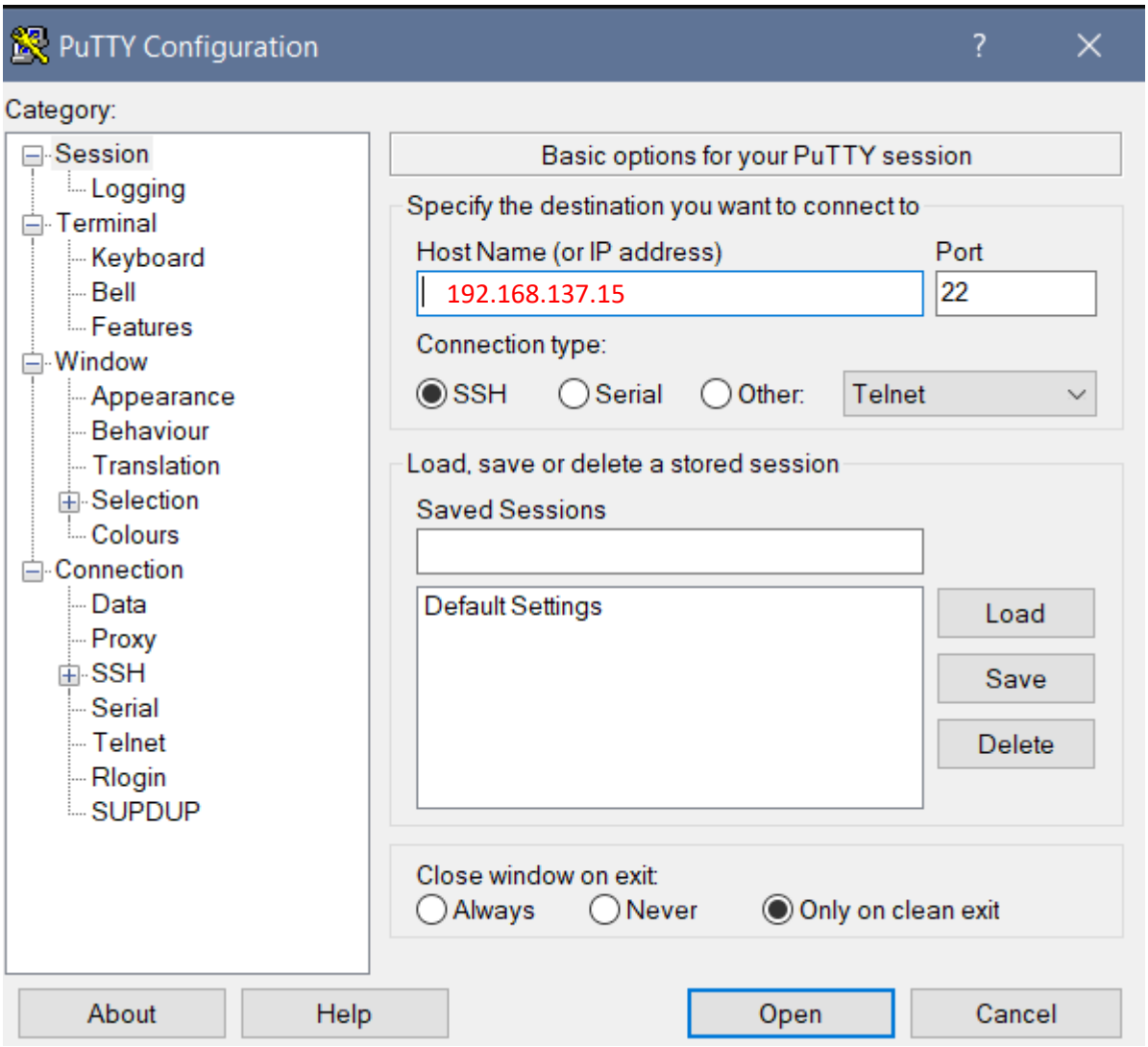
1. Click on the WiFi icon and turn on your laptop's mobile hotspot.
2. Right click on the mobile hotspot icon and go to the settings.
3. Enable "Share my Internet connection with other devices" and modify your mobile hotspot name and password to the SSID and password that you set in Part A-6-(c) above.
4. Ensure the Network band is set to 2.4GHz.
5. Turn on the Alphabot, and you should see it connected to your hotspot.

Part C - Enable Interfacing in RPi Config

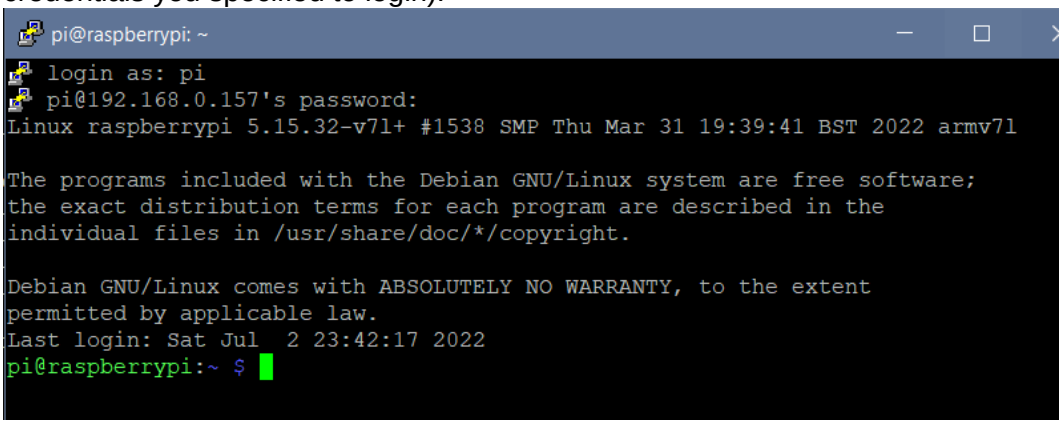
1. Once RPi is connected to your PC's mobile hotspot, open the (Windows) mobile hotspot settings and take note of the IP address.



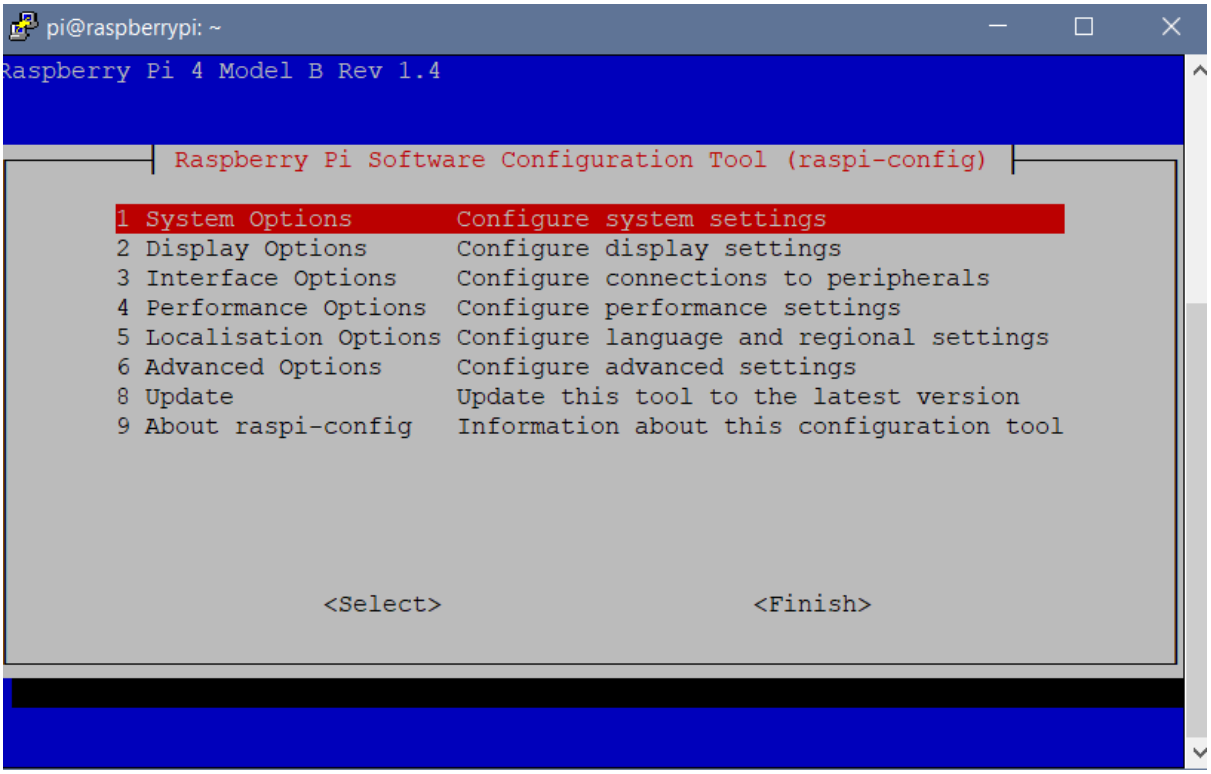
2. Install PuTTY (https://www.putty.org/) for SSH connection to RPi
3. Now enter your obtained RPi IP address into PuTTY (in Host Name, shown in Red). Then, click "Open".



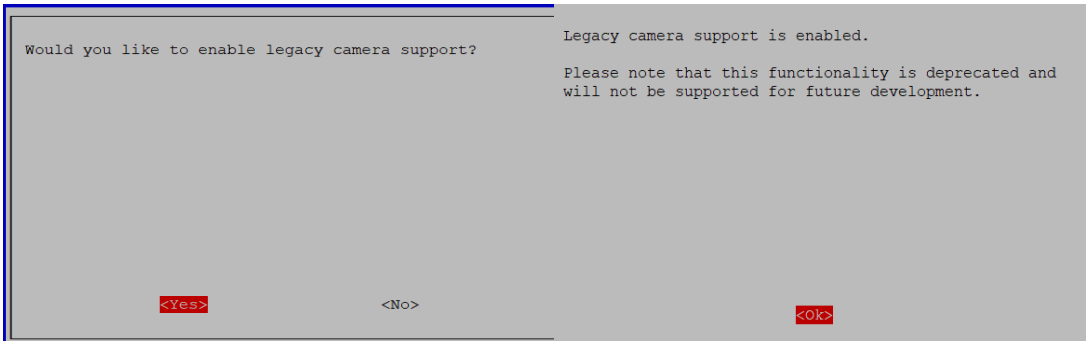
4. Enter username pi and password raspberrypi to login (unless you specified a different hostname and password during flashing in Part A Step 6(b); then use the credentials you specified to login).



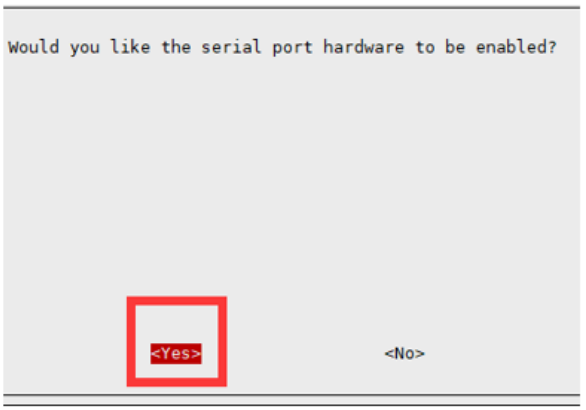
5. In the RPi Terminal, type sudo raspi-config



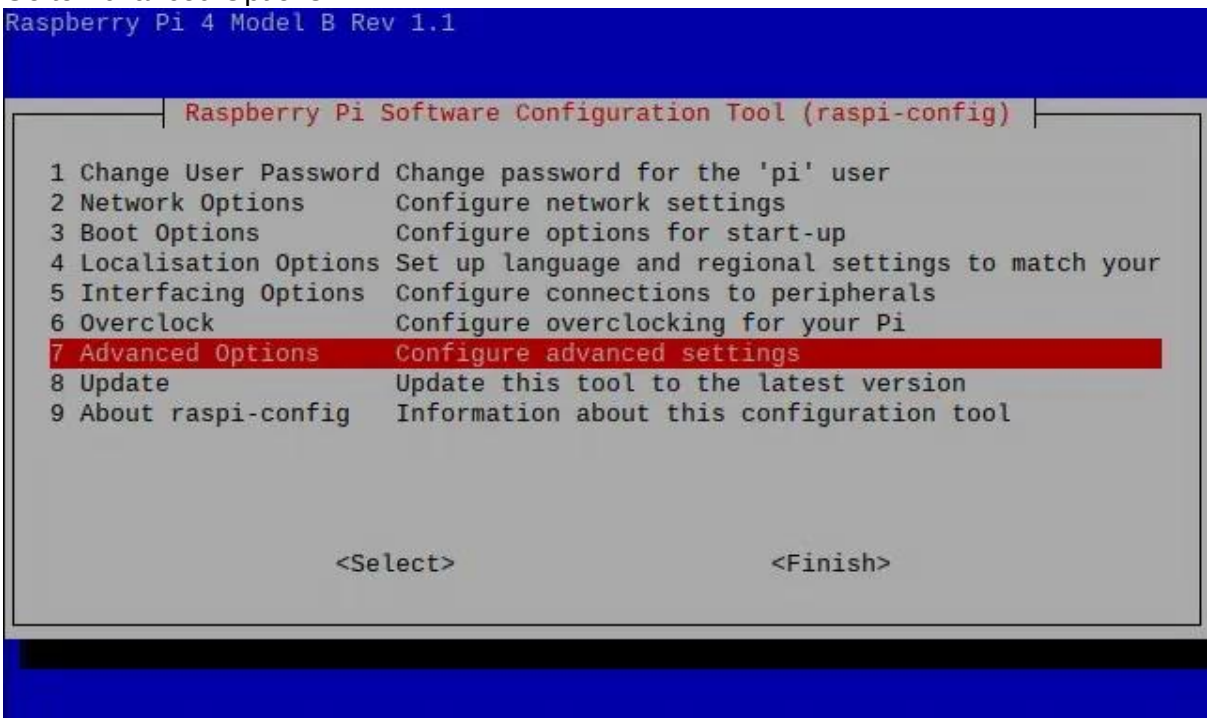
6. Use Arrow Keys and Enter to navigate to Interface Options and select Yes for Legacy Camera, VNC, SPI, and I2C.



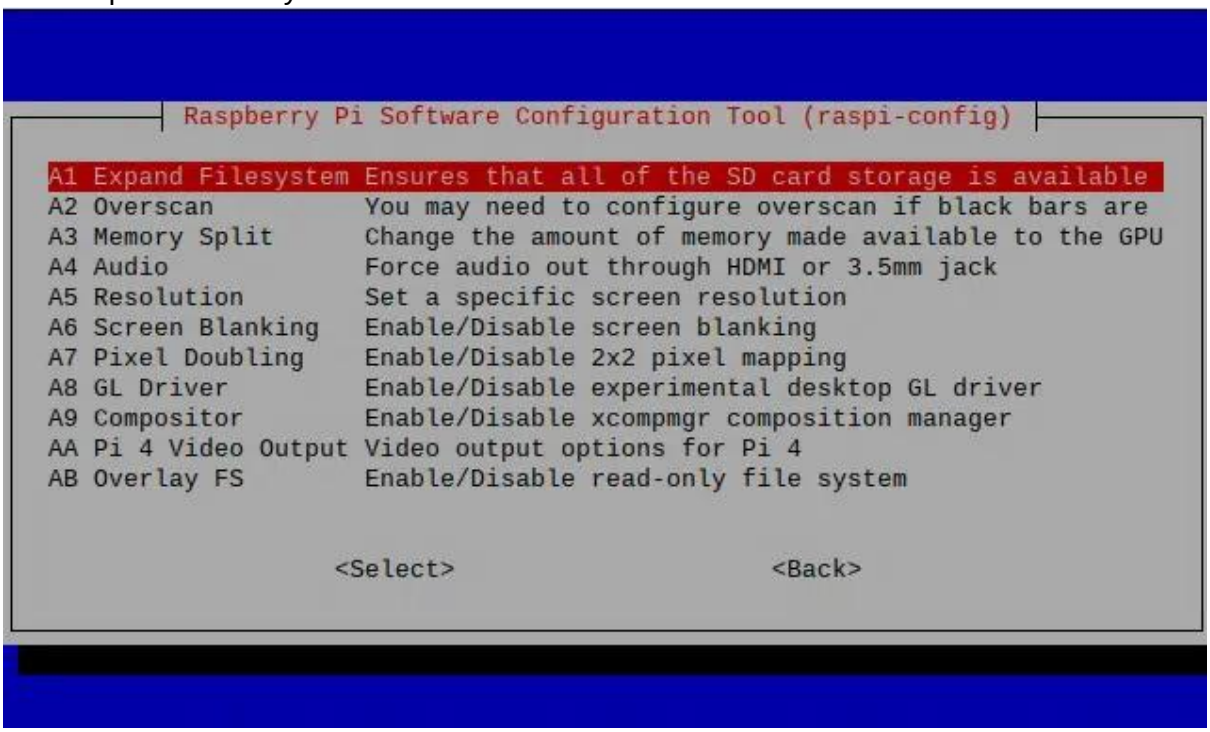
7. Navigate to Interface Options, go into Serial, and
   - select No for “Would you like a login shell to be accessible over serial”?
   - then select Yes for “Would you like the serial port hardware to be enabled”?.



8. Go to Advanced Options



Then expand the filesystem



9. Select Finish, and Yes when for “Would you like to reboot now”?
10. Connect to the robot again using Step 3 and 4.
11. Install some packages by typing the command:

```
sudo pip install bottle
sudo pip install opencv-python
sudo pip install -U numpy
sudo apt-get install libatlas-base-dev
```

12. Next, get the server files and codes using the command:

```
git clone https://github.com/clow0003/ECE4078_MY_Lab_2022.git
```

Note that you can paste in the PuTTY terminal by pressing the right mouse button.

13. Then, `cd` into the cloned repo (type `cd ECE4078_MY_Lab_2022`), and run the server script using `python listen.py`
14. Take note of the shown IP address, which will be used later in the client side to make requests to the robot.

```
pi@raspberrypi:~/ECE4078_MY_Lab_2022 $ python listen.py
Bottle v0.12.21 server starting up (using WSGIRefServer())...
Listening on http://192.168.137.175:8000/
Hit Ctrl-C to quit.
```

Note: Every robot will run the same server script. You can have a look at the scripts to see how the robot is controlled, however it is unlikely that you are required to modify the codes here. We will ask you to pull any new changes in the event that the server codes are updated in subsequent labs.

15. For future connection (including when your robot gets disconnected), you just have to do Part C Step 1, 3, 4, and 13.

Part D - Alphabot2-Pi Assembly Instructions (you most likely don't have to do this)

1. https://www.waveshare.com/w/upload/1/1a/Alphabot2-pi-assembly-diagram-en.pdf
2. https://www.youtube.com/watch?v=ONg0qpxYWQo (Starts at 0:30)
    a. No need to cut the cross-shaped rocket arm. Use the spare part (smaller) cross shape rocket arm provided in the kit
    b. You can ignore the ultrasonic sensor instructions.
3. Alphabot Wiki Page https://www.waveshare.com/wiki/AlphaBot2-Pi

Additional Notes :-

If you are configuring RPI through monitor:

1. Connect the RPi to a steady power supply, Monitor, Keyboard and Mouse and switch it on. Log In with default credentials username pi and password raspberrypi. Boot into the desktop and connect to the network (Top Right).
2. Enable 'Network on Boot' and 'SSH' in RPi Configuration settings (Top Left Menu). Reboot.
3. Record the IP address of the network by typing ifconfig in the Terminal and write down the inet address of the wlan0.
4. You can now disconnect the RRPi from the Monitor, Keyboard and Mouse.

Objective 2: Setting up the client side

Part A: Setting up Python environment in your PC

First, we need to download and set up Python on your PC. Note that this guide is for Windows operating system only. Also note that if you have prior experience with Python and you already have Python installed in your computer, you can skip step 1.

1. Download python from https://www.python.org/downloads/. Launch the installer, **check the option for "Add Python to PATH"**, and click install now. You can also go for a customized installation if you want. After installation, ignore "disable path length limit" and click close.
2. Open up a window's command prompt and type "python". If the symbol ">>>" appears, then the installation is successful.

3. Press Ctrl+Z then Enter to exit the python environment. Then, install some packages by typing the command:
   `pip install numpy opencv-contrib-python pygame requests`
4. Close the terminal when done.
5. To edit python scripts, there are many kinds of editor/IDEs available on the internet. We recommend using the simple Notepad++, but feel free to use other IDEs.

Part B: Running the client scripts

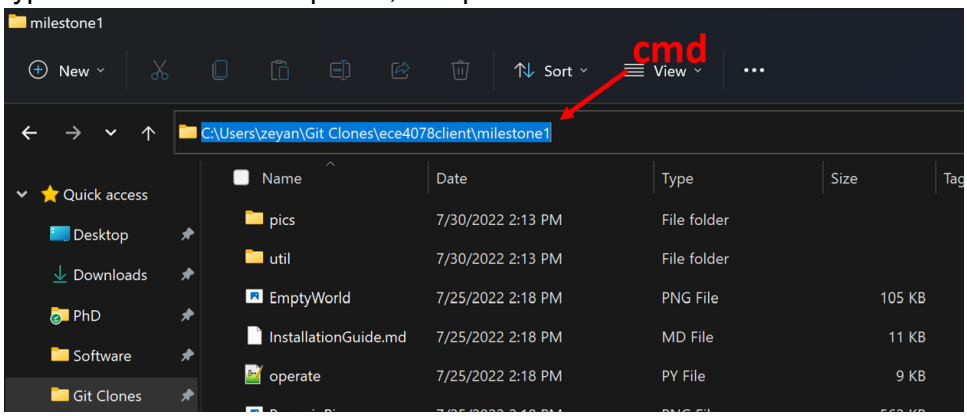
1. Download the skeleton codes (milestone1.zip) from Moodle.
2. Unzip it and move the content to a local folder on your PC. The files structure in your PC should look like this:

```
YOUR_FOLDER_NAME
└ milestone1
      └ <files in milestone1>
└milestone2 (next time)
```

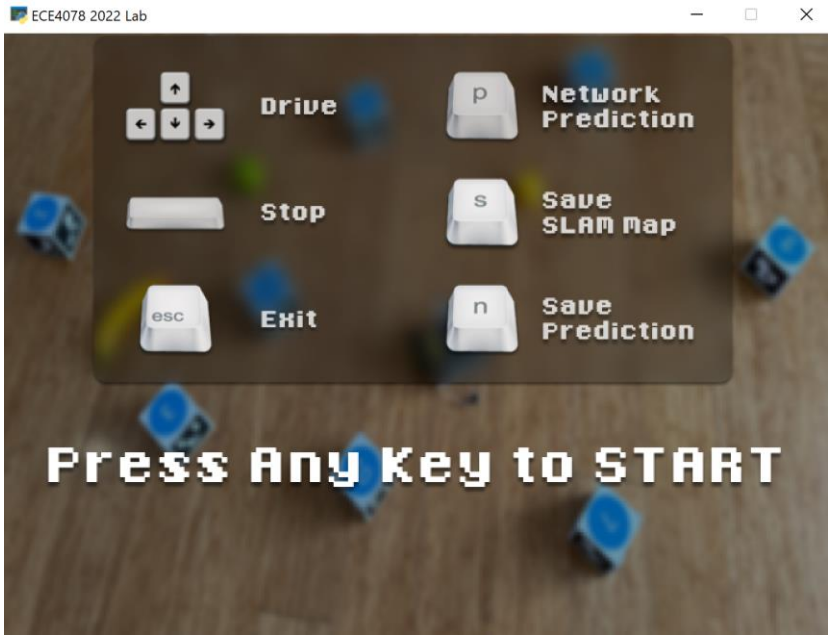
Every teammate can contribute to the code, but only 1 PC is needed to run the script to demo / control the PiBot. So, you should discuss with your team on how you are going to share and manage the codes, such as using Github Desktop or Google Drive.

3. Open a window command prompt and `cd` to the milestone1 folder. Alternatively, you can open the milestone1 folder, click the location bar at the top of the File Explorer,

type “cmd” without the quotes, and press Enter.



4. In the terminal, run the client script by typing the command:
   `python operate.py --ip IPADDRESS --port 8000`
   Replace `IPADDRESS` with the address found from Objective 1(PuTTY terminal).
5. A Pygame window should pop up as follows.



   Press any key, and you should see the window changes to the main interface which shows the images captured by the bot. If you can see it, all the set up have been done successfully. Press Ctrl+C in the terminals to stop the program.
6. Your task: Implement keyboard teleoperation by editing line 137 - 150 of `operate.py`. Study the codes in `operate.py` and `util/pibot.py` to determine what lines you have to write.
7. Test your implementation by running step 4 again. Make sure that the server script is running before you run the client script.

You don't have to use the provided scripts. Feel free to be creative and write your own scripts for teleoperating the robot with a keyboard.

Marking Guidelines

Basic implementation submitted on Moodle (80pt):

- Drive forward +20pt
- Drive backward +20pt
- Turn left +20pt
- Turn right +20pt

Demonstration (20pt): demonstrate your teleoperation in the lab to the demonstrators during Week 2 lab session.