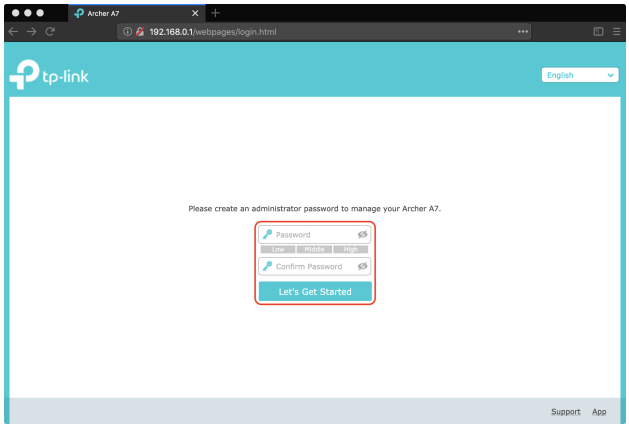
RACECAR-MN Software Build Instructions

Step 0: Set Up the Router (Once Per Router)

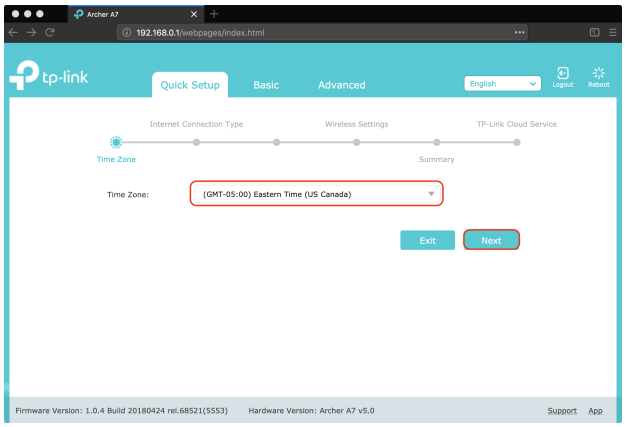
1. Get a TP-Link AC1750 Wi-Fi router.

2. Turn on the router.
3. Look on the bottom of the router to find the default Wi-Fi name and password.

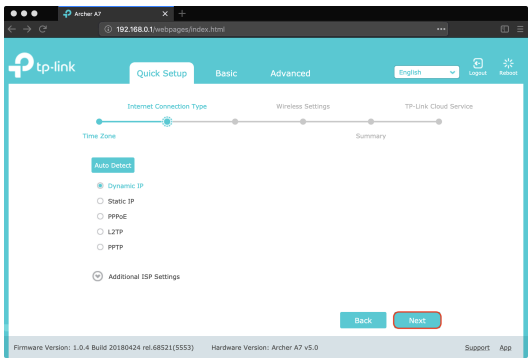
4. Connect to the router Wi-Fi on a computer. It should show up as TP-Link_<number> like it says on the bottom. Use the password on the bottom.
5. Go to `192.168.0.1` in a browser.
6. Choose an admin user name and password. These can be anything, but you will need them again later to log in. Write your username and password down somewhere so that you don't forget it.

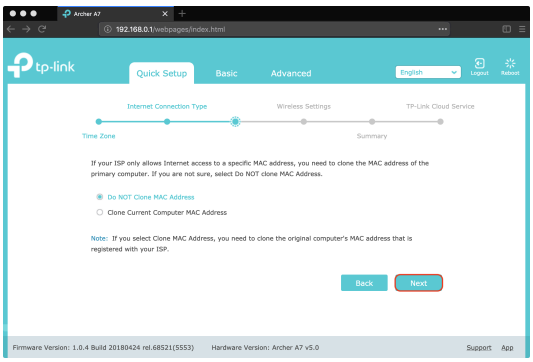


7. Set the time zone to the correct time zone and press “Next”.

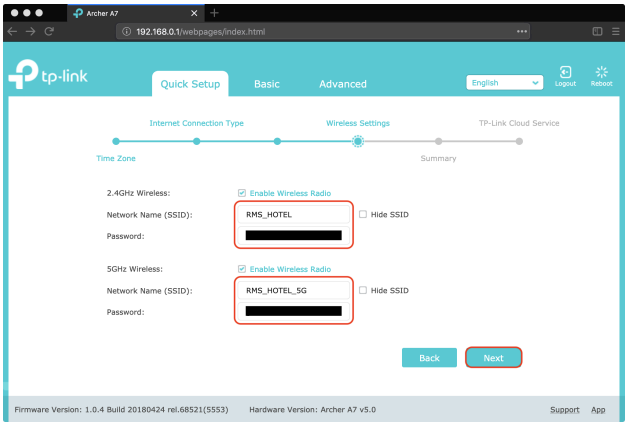


8. For connection type and cloning MAC address, just press “Next”. (Do not change these settings.)

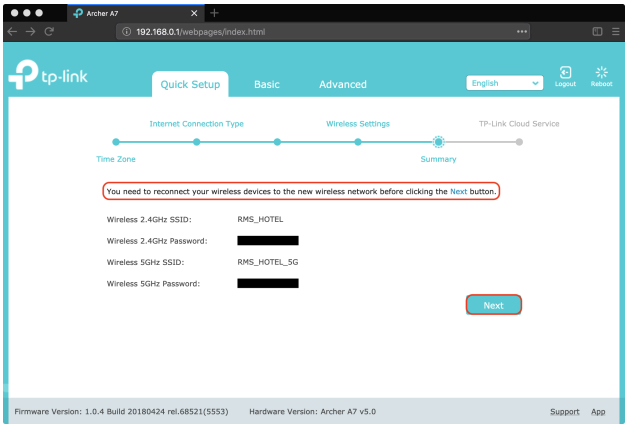




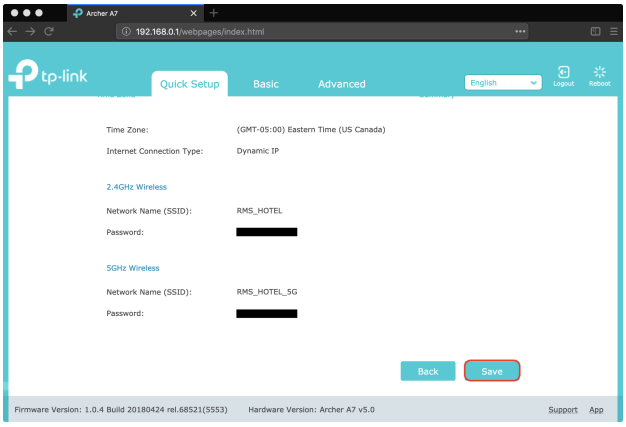
9. Type what you want the Wi-Fi to be called and the password. For 5G, just add “_5G” to the end. Press “Next”.



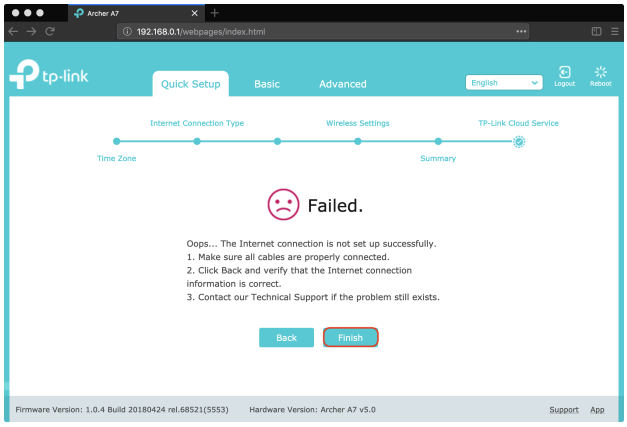
10. Before pressing “Next” again, **RECONNECT TO THE WI-FI**. It should now show up as the name you chose, with the password you chose. **AFTER** you are reconnected, press “Next”.



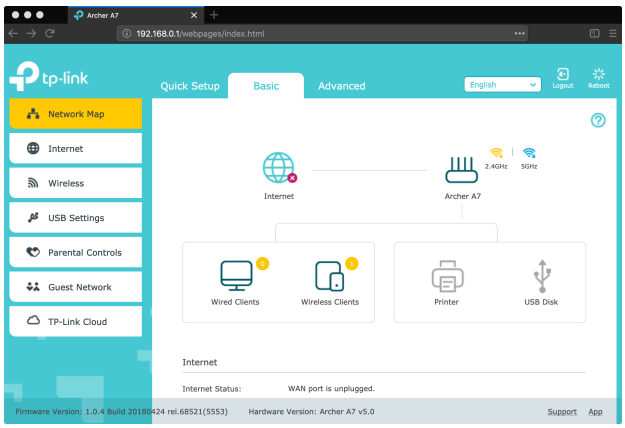
11. Scroll down and press “Save”.



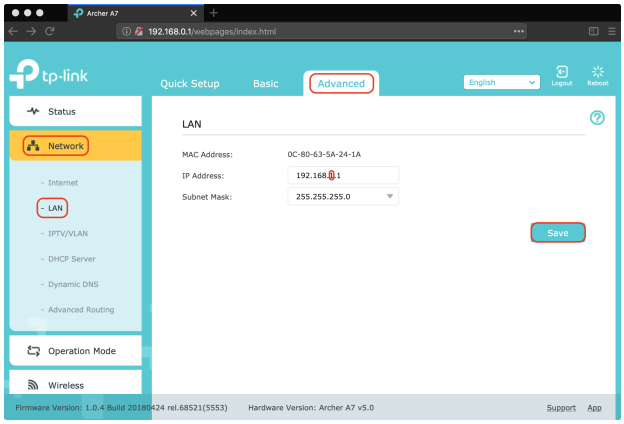
12. If you get this message, ignore it and press “Finish”. (An internet connection is not necessary.)



13. You should be redirected to this screen.



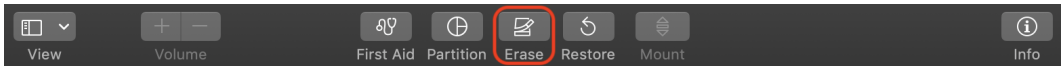
14. Go to “Advanced” > “Network” > “LAN”. Change the IP address from `192.168.0.1` to `192.168.1.1`



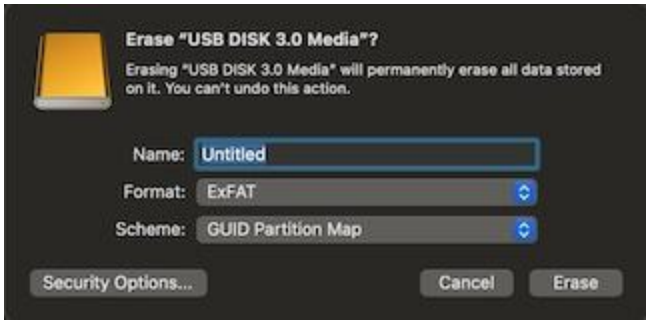
15. Press “Save”. You will be redirected to a new page. Now the router is ready to have cars added to it in Step 5: Set Up Wi-Fi.

Step 1: Flash SD Card

1. Format the SD card.
    a. On a Mac:
        i. Open the Disk Utility application
        ii. Select the SD card from sidebar on the left
            1. **DO NOT SELECT YOUR HARD DRIVE**
        iii. Choose “Erase”



        iv. Choose these settings and click “Erase”



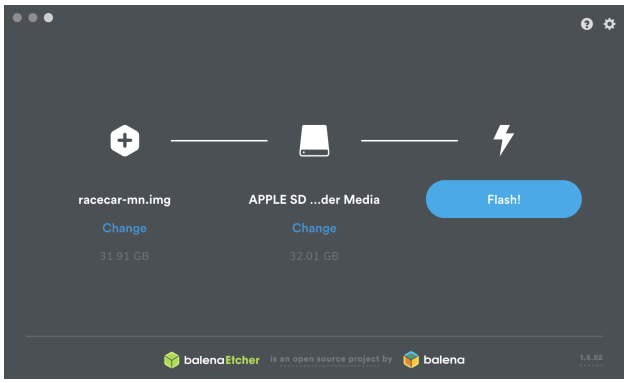
        v. When the SD card is erased, quit the Disk Utility application. It can interfere with flashing the card.

    b. On Windows 10:
        i. Open a **file explorer** window.
        ii. Right-click on the **SD card** in the **file** browser and select "**Format**" to open the **Format SD Card** display.
        iii. Set the **File System** to **exFAT**. Select **Start** to begin.

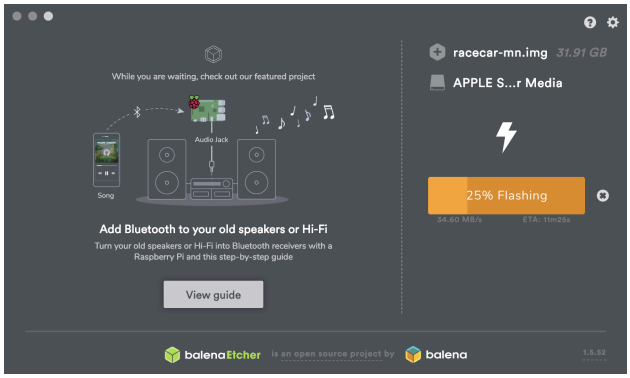
2. Download and install Etcher for Mac or Windows, from https://www.balena.io/etcher/
3. Download the compressed disk image: racecar-mn-hmc-2020-10-11.img.gz
    a. Note that the compressed file is a little under 8GB
    b. You can put it on any SD card larger than 20.32GB, and on first boot it will expand to fill the card.

i. We thought you could use any card, but we have seen that the image on a 32GB or 64GB SD card will not boot. We have also seen that rewriting a 128GB SD card does not boot. We have verified that using a NEW 128GB or a NEW 256GB SD card works.

4. Open Etcher
5. Select racecar-mn-hmc-2020-10-11.img.gz for the image and the SD card for the target

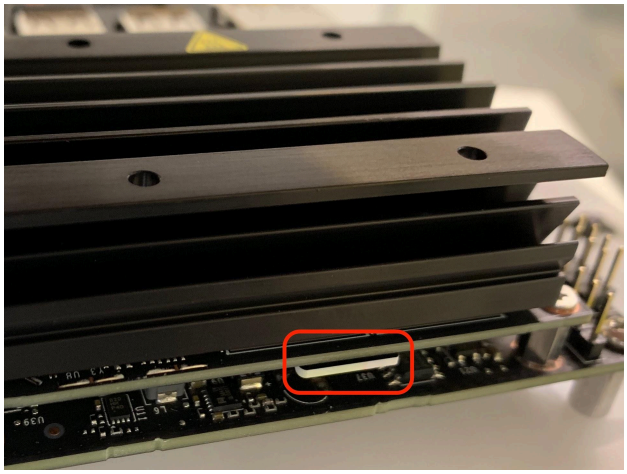


6. Click “Flash!”
7. Enter your password if prompted
8. Wait until the process is done; it should take around 15 minutes



Step 2: Boot Up the Jetson Nano

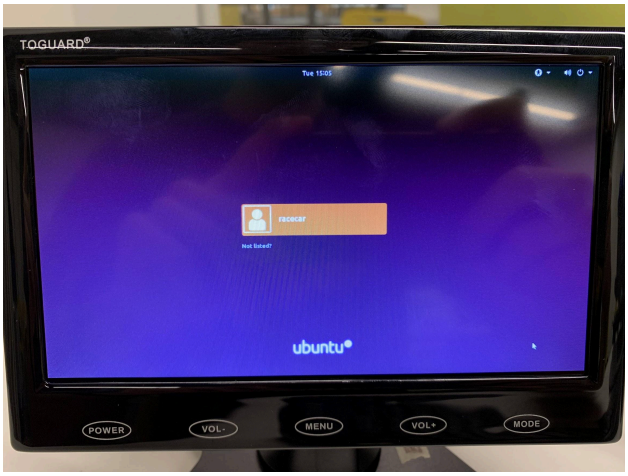
1. Insert SD card into the Jetson



2. Connect a mini monitor and keyboard, place car on a block

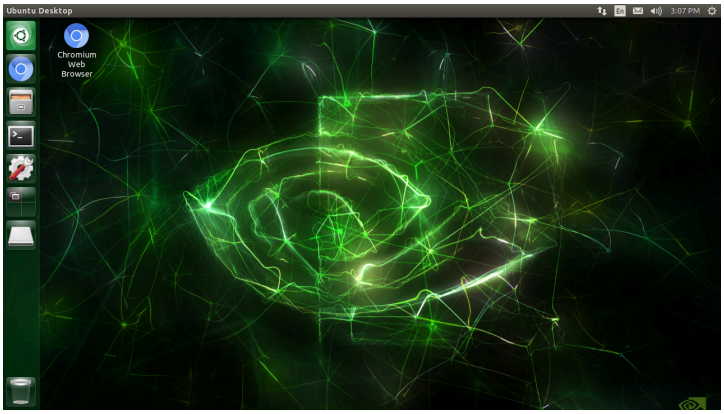
3. Plug in battery (Jetson power into the port with two thunderbolts)

4. You should see the Jetson boot up and reach the login screen



5. Enter the password and log in. The password is: **racecar@mit**.

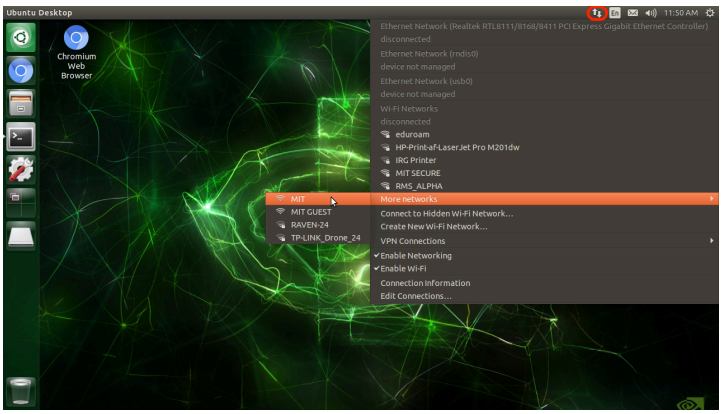
   You should reach the desktop.



Step 3: Git Pull

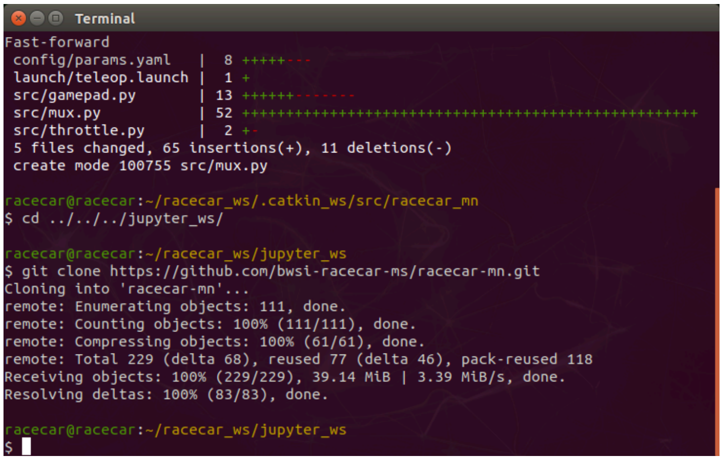
1. Go to connections at the top and connect to a Wi-Fi with an internet connection.

   You might have to go to “More networks”.



2. Next, pull the GitHub that contains your Jupyter Notebook labs:
   - `cd ~/racecar_ws/jupyter_ws/`
   - `git clone https://github.com/mit-bwsi-racecar-ms/online-racecar-mn`

   The link should be to whatever GitHub repository contains your Jupyter Notebook labs.

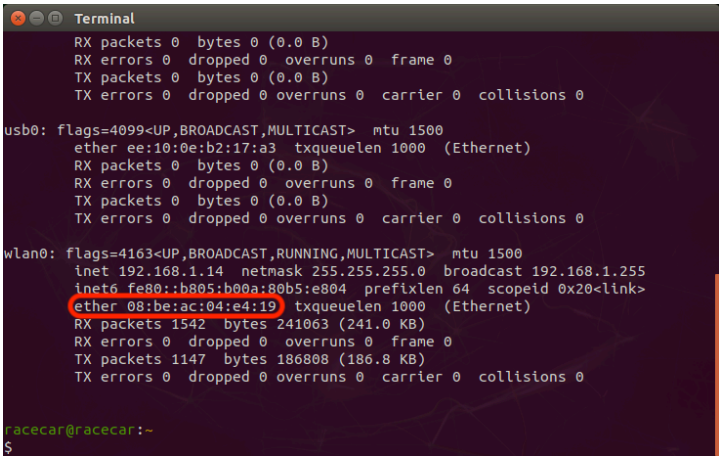


Step 4: Set Up Wi-Fi

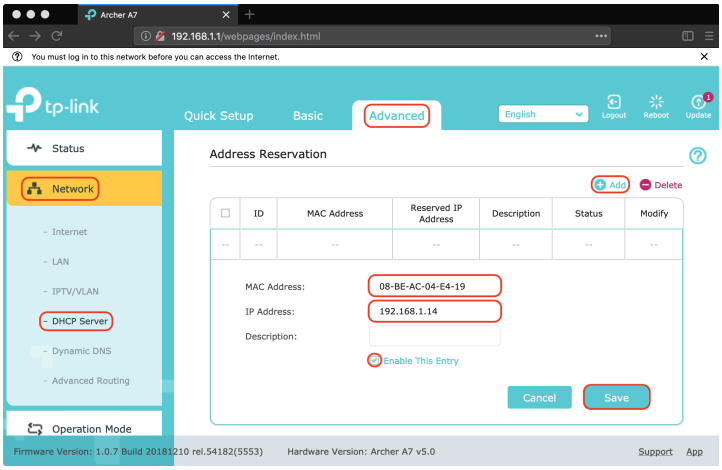
1. Plug in a router which has been previously set up. Wait until the first three lights turn green.

2. On the car, open a new terminal and type:
   - `ifconfig`

   Under “wlan0”, find the MAC address. It will be next to “ether”:

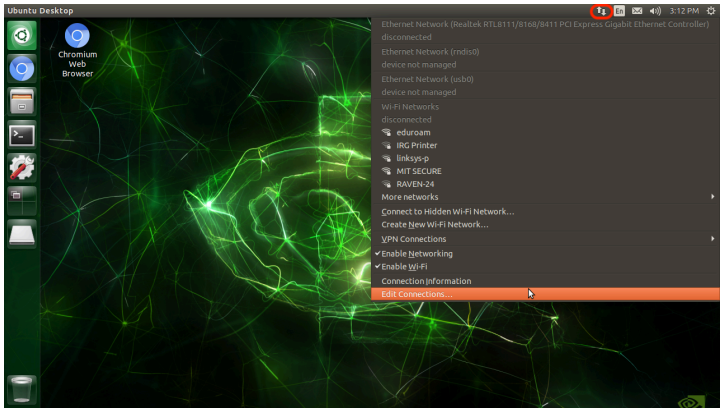


3. On another computer, connect to the router Wi-Fi.
4. In a browser, go to `192.168.1.1` and log in.
5. Go to “Advanced” > “Network” > “DHCP Server”. Scroll down to “Address Reservation” and click “+ Add”.

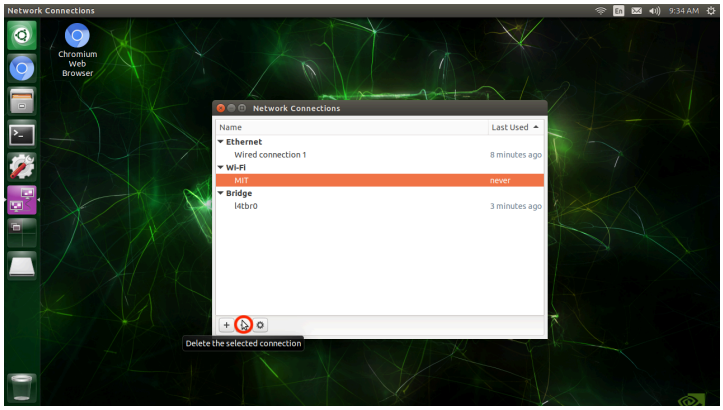


6. For “MAC Address”, type the MAC address found before, with hyphens instead of colons. Use capital letters.
7. For “IP Address”, type:
    - `192.168.1.<car_number>`

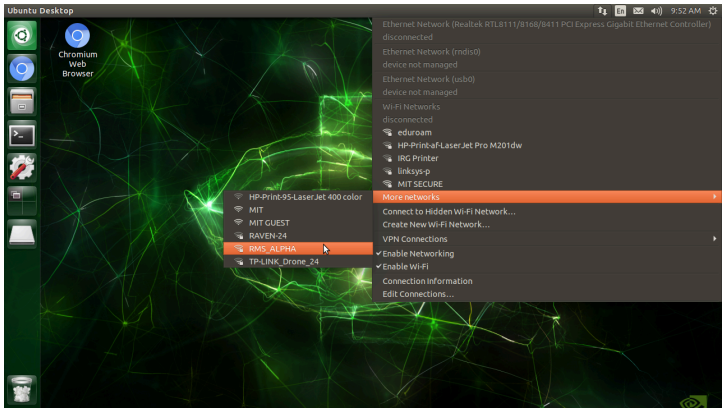
    Replace `<car_number>` with a number of your choice.
8. Check “Enable This Entry”.
9. Press “Save”.
10. On the car, click on connections at the top, then click “Edit Connections…”



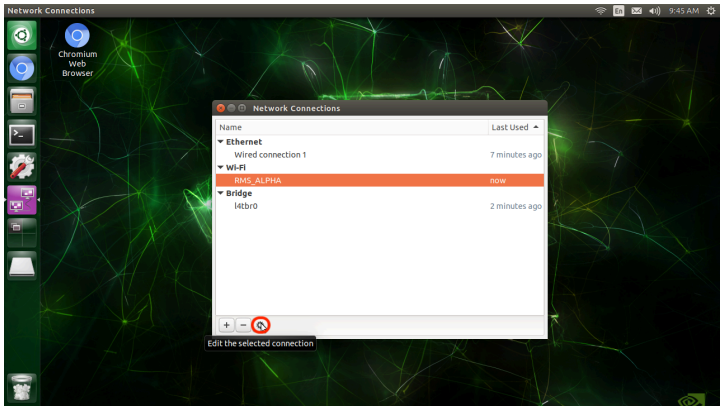
11. Delete all Wi-Fi connections by selecting them and clicking the minus sign.



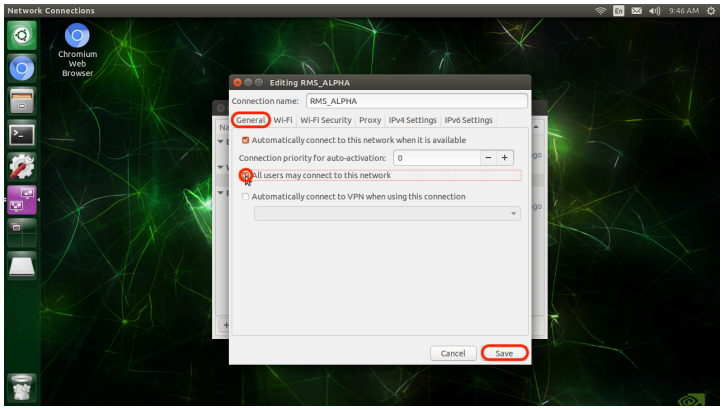
12. Connect the car to the correct router. You might have to go into “More networks” to find it.



13. Go back to “Edit Connections…”, select the Wi-Fi, and click on the gear.



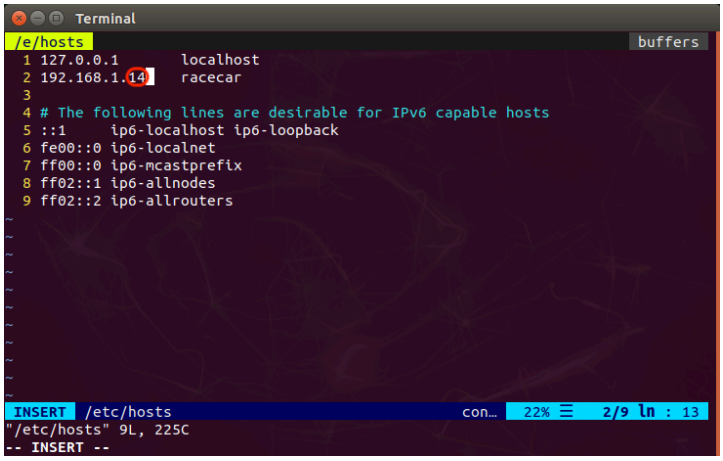
14. Go to “General”, check “All users may connect to this network”, and click “Save”



15. Open a terminal and type:
    - `sudo vim /etc/hosts`

16. Change the last number of the IP address next to “racecar” to the number of the car, so that the full address is:
    - `192.168.1.<car_number>`

    Use the same `<car_number>` that you used to setup the IP Address in Step 5.7

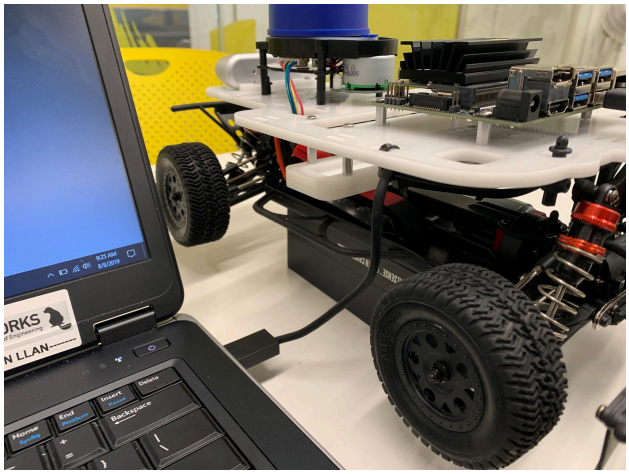


To make an edit to the file:

- `i` (to go into “insert” mode to make changes)
- `ESC`
- `:wq` (to save and exit)

Step 5: Set Up PWM

1. Get a computer running Windows
2. Plug in the PWM. The easiest way is to thread the USB hub through the hole and plug it in like this:

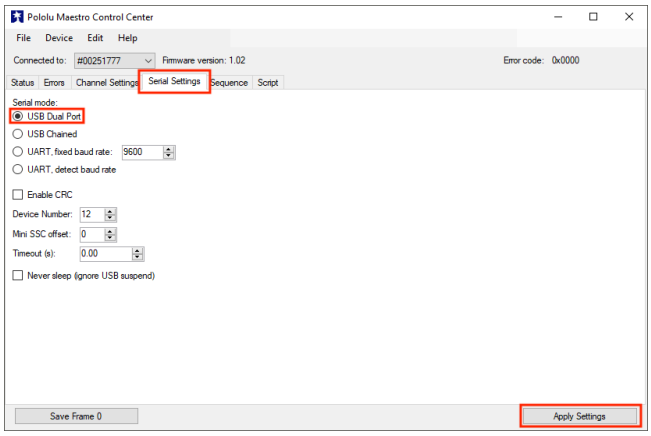


3. Download and install the Maestro Control Center.
    a. Go to the pololu website: https://www.pololu.com/docs/0J40/3.a

b. Download the “Maestro Servo Controller Windows Drivers and Software” zip file.

c. Unzip the file. Open the setup executable, and follow the installation instructions.

4. Open “Maestro Control Center”.
5. Click on “Serial Settings”, change “Serial Mode” to “USB Dual Port”, and click “Apply Settings” to save



6. Change Serial Mode to USB Dual Port
7. Press Apply Settings to save

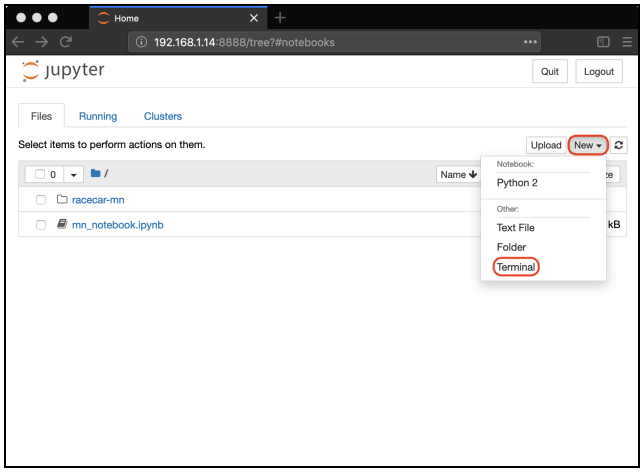
Step 6: Jupyter Notebook

1. Make sure the router is on.
2. Reboot the car. Wait a minute for it to boot up.
3. Disconnect monitor and keyboard from the car.
4. On another computer, connect to the router Wi-Fi.
5. Open a browser and go to:
    - `192.168.1.<car_number>:8888`

    Use the same `<car_number>` that you used to setup the IP Address in Step 5.7
6. Once Jupyter Notebook loads, log in. The Jupyter Notebook password is: **g0_fast!**
7. If the Jupyter Notebook does not load:

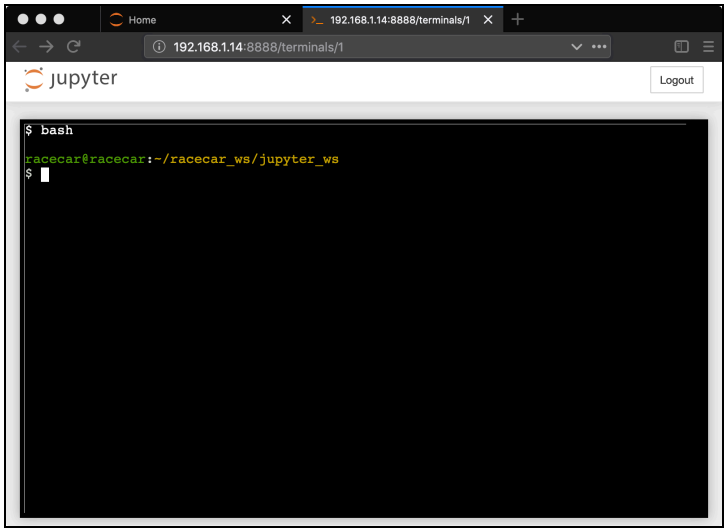
- Make sure the router is turned on.
- Make sure your computer is on the correct Wi-Fi.
- Make sure the correct USB Wi-Fi dongle is plugged in.
- Wait a minute for the car to finish starting up.
- Make sure you used the correct MAC address for the car on the router.
- Make sure “All users may connect to this network” was checked on the car.
- Make sure the IP address was changed correctly in: /etc/hosts
- Reboot the car and try again.

8. Go to “New” > “Terminal”.



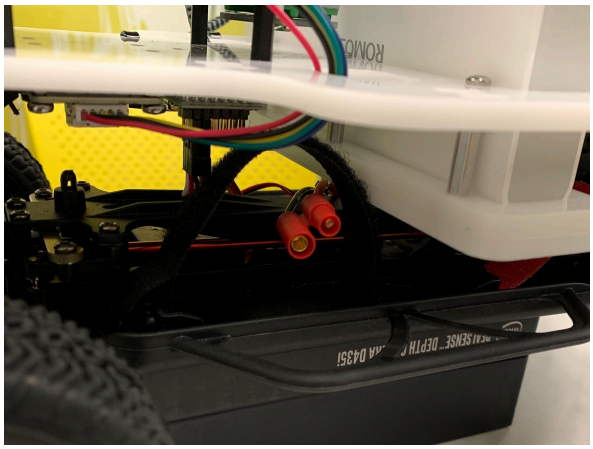
9. Type:
    - `bash`

    It should result in a prompt like this:



Step 7: Teleoperation

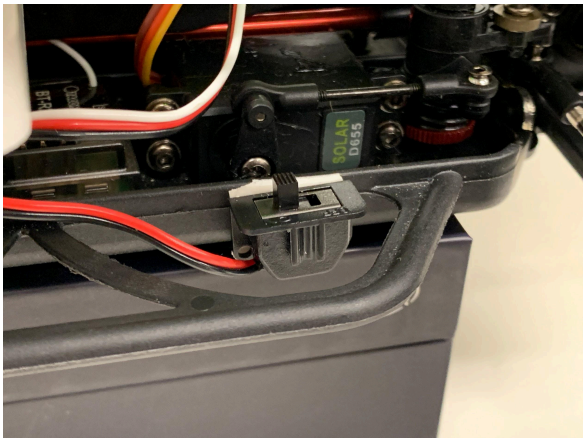
1. On the car, find the battery cable.



2. Plug in a car battery. Make sure the battery is plugged in all the way. (You have to press pretty hard for this to happen.)

3. Put the battery under the velcro to secure it.

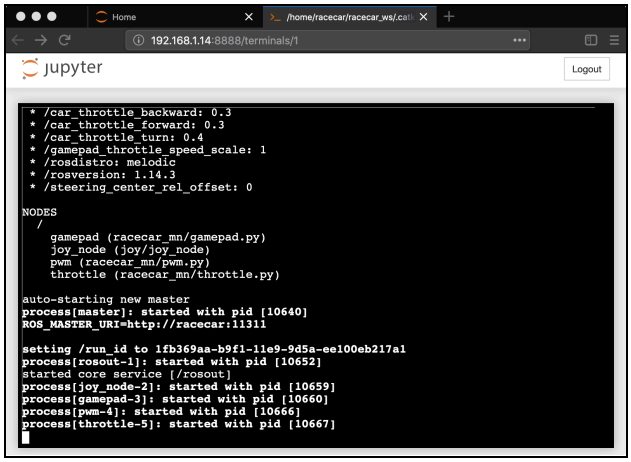
4. Flip the switch on the other side of the car to “ON”.



You should hear a beep. If you do not hear a beep, make sure the battery you are using is charged. (Plug it in until the light turns green.)

5. Plug in the remote dongle. The red light should start blinking.

6. Press the button on the remote and wait for it to pair. Once the remote pairs, the red light should stop blinking.
7. On the Jupyter notebook terminal, type:
    - `teleop`

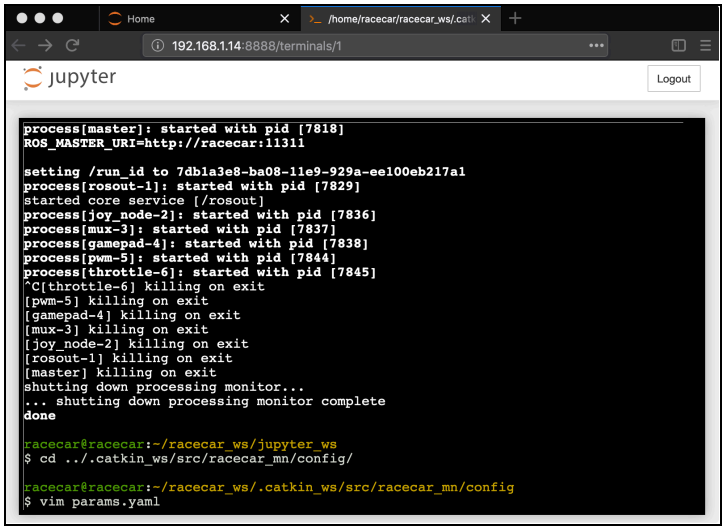


8. At this point, the wheels should straighten and not allow you to turn them. If the wheels do not straighten:
    - Make sure the battery is plugged in all the way.
    - Make sure the switch is turned ON.
    - Make sure the PWM cables are plugged in correctly.
    - Make sure the battery is charged.
    - Make sure that PWM was set up correctly.
9. **MAKE SURE THE CAR IS ON A BLOCK**

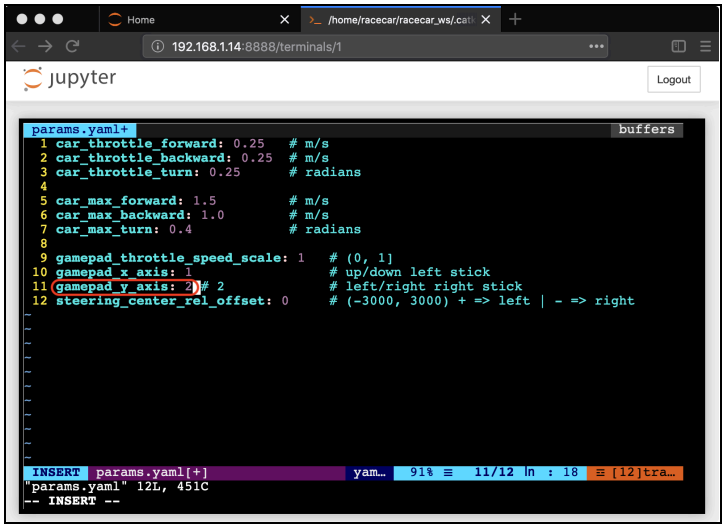
10. Now hold down the “LB” button on the remote and move the joysticks. The car wheels should move.

Step 8: Correct the Steering (If Necessary)

1. Check which direction the steering is. (Up and down or side to side.)
2. If the steering is side to side, skip this section.
3. If the steering is up and down instead of side to side, type the following commands into the Jupyter notebook terminal:
    - `Ctrl + C` to quit teleop
    - `cd ~/racecar_ws/base_ws/src/racecar_mn/config/`
    - `vim params.yaml`



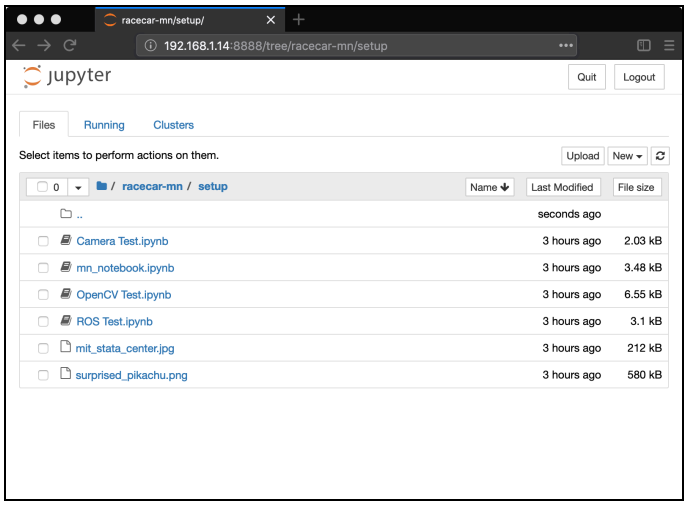
4. Change “gamepad_y_axis” from 3 to 2.



5. Run `teleop` again to verify that the steering is correct (side to side).

Step 9: Run Setup Tests

1. Return to the main Jupyter page at: `192.168.1.<car_number>`
2. Run your setup test files. For our GitHub repository, they were these files:

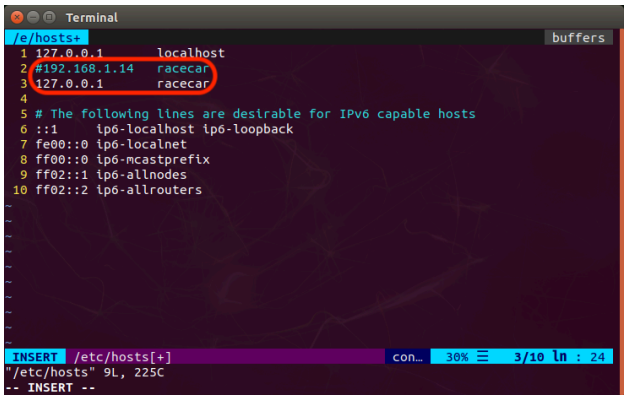


3. These are just to test if essential components, like the camera, ipywidgets, ROS, and OpenCV are working properly.

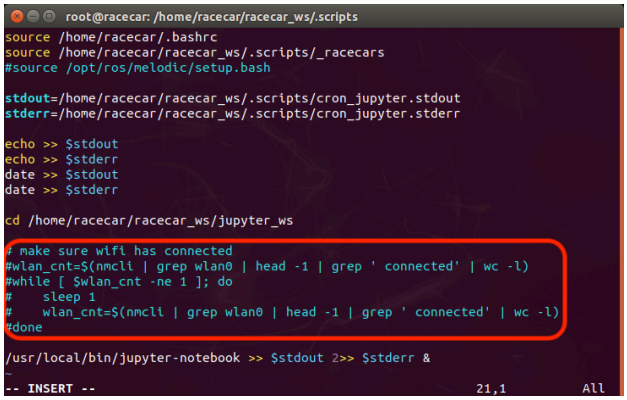
Step 10: If You are NOT Using a Router

1. These steps are necessary to make the Jupyter notebook server work without a router.

2. First, open a terminal on the car and type:
    - `sudo vim /etc/hosts`
3. In this file, comment out the racecar line and add in the line
    - `127.0.0.1     racecar`



4. Before editing the next file, follow the instructions to edit a read only file.
5. Now type the following commands:
    - `cd .scripts/`
    - `vim start_jupyter.bash`
6. In this file, comment out the indicated section. Comment out code by adding a `#` symbol to the beginning of each line. The lines should turn turquoise when commented out:



7. Save your changes to the file:
    - Press `ESC`
    - Then type `:wq!`
8. Exit by typing `exit` and type `reboot` to restart the car.

9. Once the car is restarted, open the browser and go to `racecar:8888` to access the Jupyter notebook directly on the car without a router.
10. If you need router access again, uncomment the commented lines and comment out the line: `127.0.0.1 racecar`