Turner Kaminski - Team 3
Welcome to the user manual for piTrainer!

Set-Up

RPI Section

To get started, we will set up the raspberry pi. You are expected to have a conda environment on the raspberry pi already.

MQTT broker

With this environment activated please install the following packages to set up the mqtt broker.

pip install paho-mqtt==1.6.1

sudo apt install mosquitto

sudo apt install mosquitto-clients

Next, please paste the mosquitto.conf file from the Team3/RPI into /etc/mosquitto rewriting the conf file currently there. There is no need to make any changes to this config file. After a restart, the RPI should have a mosquitto broker running.

You can check this using the systemctl status mosquitto command.

Code

When it comes to code to be run on the rpi, it is just the mainScript.py script that should be run. You should not have to make any changes to this script unless you want to use unique mqtt topic names or mqtt client names.

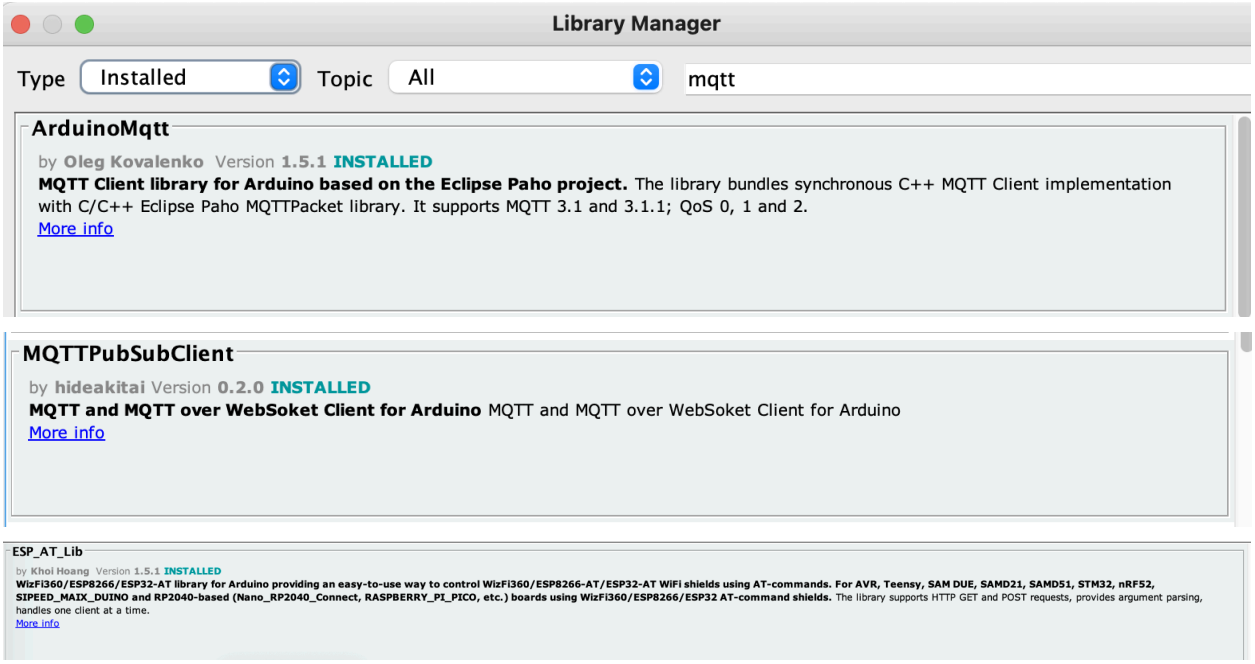
This code only needs to be run when you are using the PCB/IMU in tandem with the laptop code, which is not always required for full functionality depending on the exercises (this will be described in the usage section).

PCB

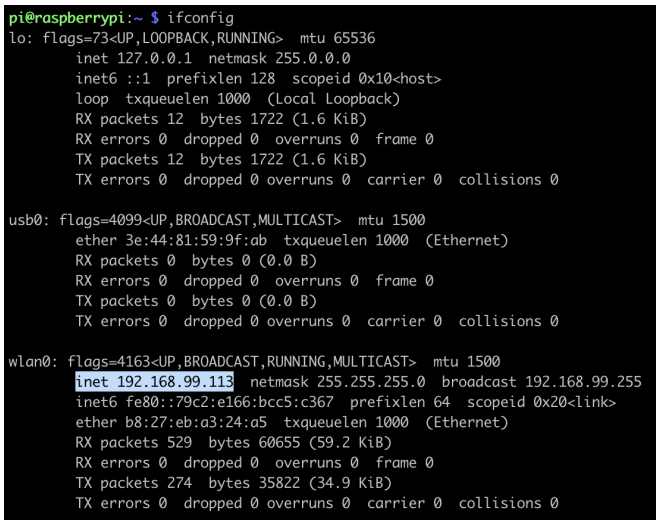
As previously mentioned, the PCB/IMU is not required to be used for full functionality on some exercises, and you can still maintain partial functionality without using it for all exercises.

Now, let's set up one of our custom PCB's for use with the IMU. You must have the old arduino IDE installed (circle icon, not square). Please make sure that this arduino IDE also has the

ESP32, and MQTT packages installed in board managers.



From this, open the ESP32-IMU folder from the github into the Arduino IDE. Change the SSID and password constants to your respective hotspot/wifi name and password in the main arduino-BerryIMU script. Please also change the mqtt_server constant to the ip address of your RPI mqtt broker. You can find this by outputting ifconfig on the RPI and its the inet address of wlan0 as shown in the screenshot below



After changing these constants, select the “ESP32S3 Dev Module” board under tools, and enable the “Erase all flash before sketch upload” setting under tools as well. Finally select the correct port under tools, and then upload this sketch to the PCB.

Once you have powered the PCB with this sketch uploaded, clicking the top most button will restart the program and get the PCB working. This PCB will not work with eduroam, so please use a hotspot or home wifi.

Laptop

Let us finally set up the final component, the laptop. It is expected that you will also have a conda environment set up in the terminal of your laptop. Please ensure that the following packages are installed

pip opencv-python==4.8.0.74
pip pillow==9.4.0
pip install customtkinter
pip install mediapipe
pip install paho-mqtt==1.6.1
pip install SpeechRecognition
conda install -c conda-forge portaudio
pip install pyaudio

After installing the required packages, please navigate to the Team3/Laptop folder.

We have also added a yml file you are free to use if you like, this file is inside the Team3/Laptop folder and here is how you can use it.

conda env create --file=environment.yml

conda activate piTrainer-Laptop

After this, you will not need to install any of the packages manually.

Code

The script you will be using from this folder is mainScript.py.

In this file, you will need to change the ip address of the mqtt broker, the same way you did for the PCB. Also feel free to use cap = cv2.VideoCapture(1) instead of (0) if you have an external webcam, or if your video feed is showing up blank.

The other code within this folder was just for testing and debugging purposes, and is not relevant to the user

Usage

Now that you have all the required setup, we can now workout!

The laptop code will give you the following functionality for ALL exercises: GUI, PAUSE/GO instructor, rep counter, and time in use. It will also give you errors for leg raise, and good time/bad time for plank.

The RPI code will give you the following functionality for Bicep curl, Squat, and pushup: Error counting. If you would like to use the trainer without the IMU, it is still possible you will simply lose these features.

If you are using the IMU, please start the RPI mainScript from a terminal, then switch over and start the laptop script from the terminal. You will see the laptop terminal has instructions to follow the speech recognition. After choosing your exercise, please take as much time as you would like to get in the position you would like the system to calibrate for, then give the start command.

This calibration position should be the position relevant to the exercise, you can look at the videos linked at the end of this manual if you require an example.

The GUI will then pop up and show further instructions, including to pause any movement during the calibration process. Once you see the pause button switch to GO, feel free to begin the exercise. Please pay attention to any pause/go instructions during your reps if relevant and watch for reps to be counted, or errors to be counted so you can adjust your workout form for best results. For further information on system feedback, please look towards the end of the manual.

Important! For the best results, you must have the camera in a relevant position to view the largest amount of your body possible. For exercises bicep curl, squat, plank please use a side profile camera view, and have your right side of body facing the camera. For the exercise push up, please try and have the camera near your eye level or so while fully extended for the pushup, and have it so youre looking directly at the camera. For the exercise leg raise, please face the camera with the left side of your body, opposite that of the plank, squat, and bicep curl.

As previously mentioned, we have provided example videos below of exercise performances if you would like a demonstration, or to see usable camera angles that supply you with the best results.

Squat - 180DW piTrainer Squat Demonstration
Pushup - 180DW piTrainer Pushup demonstration
Plank - 180DW piTrainer plank demo
Leg Raise - 180DW piTrainer Leg Raise demo

Some additional information on how our system classifies errors and reps that may be useful in interpreting the system feedback:

When performing our exercises with proper form, we wanted to emphasize time under tension for best results. Because of this, there is a limit as to how many reps will be counted properly if they are performed too quickly in succession. If you find some of your reps not being counted, please try performing your reps slower, or look at the following point.

There is also a minimum range of motion for a rep to be fully considered. For example, if you do not bring your wrist high enough in a bicep curl, or your hips low enough in a squat, these will not be counted as reps as they did not meet our minimum requirement for the range of motion, so if you find some of your reps not being counted, please try to exercise a fuller range of motion.

For errors, we have different classifications based on the exercise, but some key points to keep in mind for best results are: keeping your elbow still and isolating the movement to the bicep alone in bicep curl, pausing and holding a still position at the depth on your squat, pausing and holding a still position at the depth of your pushup, holding the position at the top of a leg raise, and keeping a straight body through your core to legs in the plank.

For any exercise that requires you to pause your reps, please watch the pause/go instruction on the GUI while exercising and that will ensure you are pausing properly for long enough.