CHILLER: Assembly & Setup Guide

Ripollés Lab

Purpose:

Detailed guide on how to build and set up a CHILLER. Bolded words are clickable links!

S1. Required Hardware and Equipment:

Components of the CHILLER:

Note that these items are required components of the device itself and will 'consumed' during assembly.

- 1 x **Raspberry Pi Zero WH**, which includes a built in 2x20 pin strip
- Alternative: 1 x **Raspberry Pi Zero W** (without built-in 2x20 pin strip) & 1 x **2x20 pin strip dual male header**: this model of the Raspberry Pi Zero W does not come with a 2x20 GPIO pin strip pre-installed; as this strip is needed the to connect the LED strip for biofeedback, it must be purchased separately and installed manually
- 1 x Raspberry Pi Camera Board (5 or **8 megapixels with adjustable focus**)
- Included camera cable may not be compatible; adapter cable may also be required (i.e. hbv-raspberry-160fpc cable); check compatibility between choice of camera and raspberry pi model!
- 1 x MicroSD card to act as a hard drive (**SanDisk** or equivalent with minimum memory of 8GB, preferably with MicroSD-SD adapter included preferred)
- 1 x Ultra-Slim 2500mAH Power Bank (**Kolumb** or equivalent with same dimensions or smaller)
- 1 x USB pluggable Mini-LED Stick for illuminating the skin while recording (**Drock** or similar stick-mounted USB-pluggable style)
- 1 x 'Female-to-Male' USB-MicroUSB adapter (**Monoprice** or similar length with right-angled MicroUSB end; MicroUSB end must be 'male' and USB end must be 'female'). This will be used first to connect a Keyboard-Mouse combination setup (See S1, under Equipment) during configuration and then during to illuminate the skin using the Mini-LED stick (see above) while the device is in use.
- 1 x LED strip for biofeedback (**Pimoroni Blinkt**)
- 1 x 3D-printed CHILLER case (the file to print it is in this repository)
- 2 x Velcro straps to attach the assembled CHILLER to the arm (~18" length)

Equipment for CHILLER setup:

Note that these items are required for setting up the CHILLER, but they will not be consumed in the process.

- *Access to a computer for installing software on the MicroSD card*
  - Option 1: Computer has an SD card reader slot and you have a MicroSD-SD adapter for your MicroSD card (most MicroSD cards come with one of these adapters included)
  - Option 2: Computer has no SD slot or you have no MicroSD-SD adapter, but computer does have a USB port. You will then need a **USB-MicroSD Adapter**

- *Access to a computer monitor or equivalent screen (must be HDMI-compatible) for Raspberry Pi setup (Software, step #)*

- *Access to an HDMI-MiniHDMI cable setup for connecting the Raspberry Pi to the screen:*
  - Option 1: standard HDMI cable (**Twozho** or similar) + MiniHDMI-HDMI adapter (**CableMatters** or similar)
  - Option 2: HDMI-MiniHDMI cable (**Rankie** or similar)
- *Access to a Keyboard-Mouse combination setup:*
  - **Mouse-Keyboard all-in-one combination**
  - 1 x keyboard (standard USB connectable) + 1 x mouse (standard USB connectable) + 1 x USB Hub (**Anker** or equivalent) so that input from both keyboard and mouse can be delivered through a single USB port.

- *Access to a 3D printer for printing the case*

- *Access to an Internet connection:*
  - Option 1: Wifi connection (non-WPA2 wifi; Raspberry Pi Zero models are not pre-compatible with wireless networks that use WPA2 security; networks that use WPA or other less stringent/unrestricted protocols should be compatible)
  - Option 2: While this is not preferred and may be difficult to achieveEthernet connection using an Ethernet to MicroUSB adapter; this is NOT

S2. Software Installation, Configuration, and Hardware Testing:

Note that detailed information about each piece of hardware and equipment referenced below can be found in Section 1.

Installing Raspbian (Linux-based operating system for Raspberry Pi) on the MicroSD card:

1. Connect the MicroSD card to your computer. You will need a MicroSD reader or a laptop with a SD reader and a MicroSD-SD adapter (most MicroSD cards come with a MicroSD-SD adapter; the MicroSD is the small card, and the adapter is the larger card into which the MicroSD can be inserted; see S1, under Components).
2. Install Raspberry Pi Imager on your computer, and use it to install Raspbian (the Raspberry Pi OS). Follow the instructions on https://www.raspberrypi.org/software/
3. Once Raspbian has been successfully installed, eject the MicroSD card from the computer and remove it from the adapter.

Preparing the Hardware for Configuration:

Note that final assembly with the 3D printed case will take place later, so there is no need to touch the case or to do anything more than connect the components to their slots in this section. We are simply going to connect, configure, test, and then disconnect the components in this section.

1. Insert the MicroSD Card into the Raspberry Pi Zero slot labeled "MICRO SD CARD".

2. Connect the Raspberry Pi Zero to the screen using your MiniHDMI-HDMI cable setup. First insert the HDMI end of the cable setup into your screen's HDMI port, then insert the MiniHDMI end of the cable setup into the compatible slot on the Raspberry Pi Zero (this slot may not be labeled, but it is the only one with the appropriate shape for a MiniHDMI connection).
3. Connect the Keyboard-Mouse combination setup to the Raspberry Pi Zero via the USB-MicroUSB adapter. The Raspberry Pi Zero only has one micro USB port, which is labeled "USB". There is a second slot with a similar shape, labeled "PWR IN", but this is only for powering the device. You will therefore need a Keyboard-Mouse combination setup with a single USB output (see S1, under Equipment) to use the Raspberry Pi Zero. First connect the USB output of the Keyboard-Mouse combination setup to the USB end of the USB-MicroUSB adapter, then connect the MicroUSB end of this adapter to the Raspberry Pi Zero slot labeled "USB".
4. Connect the camera.
   - Loosen the 'port locks'
     - Looking at the back of the camera mount, you will see that the there is a single large port encased in white plastic with a black plastic strip on the outside edge. Loosen the black strip by gently pushing on its two ends (these stick out slightly) until the strip slides outwards. This "unlocks" the port, allowing the connector strip to be inserted.
     - Repeat this process with the Raspberry Pi Zero's camera port to unlock it (the port is on the opposite end from the SD CARD slot, and is labeled "TV").
   - Connect the cable
     - First insert the wide end of camera cable into the unlocked camera mount port, with the cable's dark side facing away from the mount (away from the side with the lens, such that the shiny side faces the chip).
     - With the cable inserted into the camera port, gently push the port's black plastic lock back into the locked position; the cable should now remain attached securely to the camera mount.
     - Repeat the procedure with the Raspberry Pi Zero: insert the thin end of the cable into the Pi Zero's unlocked camera port with the cable's dark strip facing outwards (away from the chip), then gently push the black plastic port lock back into the locked position; the cable should now remain attached securely to the Pi Zero.
5. Connect the LED Strip to the Pi Zero pin header The two strips of 20 pins should fit into the back of the strip; push gently downwards to connect.

Configuring Raspbian and Updating via Wifi:

1. Connect the Raspberry Pi Zero to the Ultra-Slim 2500mAH Power Bank. Raspbian will start up, as you should be able to see on the screen.
2. Using the mouse and keyboard, follow the on-screen instructions to configure the OS. The default user will be "pi" (no need to change it); for the password, select one of your choosing.
3. Connect to a Wi-Fi network as you would on a normal computer.
4. Once connected to wifi, check for updates to the operating system, install them, and reboot as needed.

Configuring Camera and Connectivity:

We will now enable the camera and remote access to the Pi via VNC.

1. Open a terminal window (look for the terminal icon on the top left).
2. In the terminal window, type the following command then hit the Enter key to execute it: *$ sudo raspi-config*
3. In the Settings window that appears, select 'Interfacing Options'.
4. Now select the 'Camera' option, and hit the Enter key to enable it.
5. Navigate back to the 'Interfacing Options' menu.
6. Now select 'VNC'.
7. At the prompt to enable VNC, select Yes ('Y')
8. To confirm, select 'OK'
9. Repeat this procedure to enable SSH.

10. With VNC and SSH now enabled, select "Finish".
11. Reboot your Raspberry Pi.

Note on remote access, a.k.a. "Headless Mode": The SSH and VNC options were activated so that you can access your Raspberry PI remotely in future if you want to (without the need to have it physically connected to a screen). We use RealVNC, but there are multiple VNC options out there, and this step is ultimately optional.

Testing the Camera:

We will now confirm that the camera works.

1. After restarting your Pi Zero, open up a new terminal window.
2. In the terminal window, write and execute the following command: *$raspivid -o video.h264 -t 10000*

   In the above command:

   - "videoname" is the name of the video file that will be saved to your home folder.
   - "10000" is the number of milliseconds of camera feed that will be recorded to the file.
   - If you do not provide "–o videoname", you will just see what the camera is recording and no file will be saved.
3. Focus the camera. *It is very important that you use the focus tool (white ring-shaped device, or similar) that came with the camera to adjust the lens focus.*

   - Attach the focusing tool to the lens by carefully placing it on the lens and gently pushing downwards.
   - Using the tool, rotate the lens counterclockwise as much as you can, making sure that the lens does not fully unscrew and fall out. If it does fall out, carefully place it back and use the focus tool to screw the lens a tiny bit in the clockwise direction.

Configuring the LED Strip

The instructions here assume that you are using Pimoroni's Blinkt as your LED strip.

1. Install Blinkt by following the instructions on https://github.com/pimoroni/blinkt
2. Open a terminal window and input "python" to open a python console.
3. Check whether the LED strip works. For example, you can execute the following lines of code, line by line, to see how the LEDs light up in response:

   $ import blinkt

   $ blinkt.set_all(255,255,255, brightness=None)

   $ blinkt.show()

Getting the IP address of your Raspberry Pi Zero:

There are multiple ways to get the IP address of the Raspberry Pi in your network. Here, we will do so by looking for the information in your router's system. An easy way to do this is by executing the following command in a terminal window:

$ hostname -I

This will return an IP address (e.g. '192.168.1.100').

Installing MATLAB's Raspberry Pi Hardware Add-on

Here we will be installing the "MATLAB Support Package for Raspberry Pi Hardware". For this to work properly, both your computer running MATLAB and you Pi Zero should be connected to the same Wi-Fi network (with working internet access). You will need to input the IP you collected in the previous step.

1. Open MATLAB.
2. Click on the "APPS" tab (it's on the upper left of the window, next to "HOME" and "PLOTS" tabs).
3. Click the "Get More Apps" button (on the upper left of the window, just under the tabs bar).
4. In the "Add-On Explorer" window that pops up, locate the add-on "MATLAB Support Package for Raspberry Pi Hardware".
    - This add-on should be among the first results if you type "Raspberry Pi" in the search bar on the upper right.
    - You can also find it by scrolling down until "Filter by Type" appears in the navigation column on the window's left edge, clicking the checkbox next hardware support packages", and scrolling through the add-ons that appear until you locate the correct one.
5. Choose the version for the Pi Zero and then select "modify software" (do not reinstall raspbian) to install.

S3. Assembling the CHILLER

Now that all hardware is tested and the software is in place is time to build the CHILLER. *[WE WILL ADD A STEP-BY-STEP PROCESS HERE FOR ASSEMBLING THE CHILLER, WITH PICTURES]*

S4. Running the CHILLER

You need to have a computer/laptop using MATLAB and the CHILLER connected to the same Wi-Fi network; it does not matter if the network is local and not connected to the internet. Once again, you need to know the IP address of the CHILLER in your network.

1. Position the CHILLER on your forearm [add picture] and secure it in place using the velcro straps.
2. Input the IP address into the CHILLER.m script and run it. [add script, script location, and more detailed instructions] *You will find documentation about how to run the code in the comments of the script itself.*
3. Remain as still as possible until the LED strip lights are no longer red.

The camera feed and biofeed back will now begin to run:

- You will be able to see what the camera is recording in real time, along with a plot showing the intensity of the goosebumps whenever they are detected.
- Whenever you experience goosebumps, the LED will become green.

If the image is blurry, it means that you need to readjust the camera lens using the focus tool. Move it counter-clockwise until you can see the patch of skin without much blurriness.

Congratulations! You have successfully set up and can now use your very own CHILLER.