Mouse Tracking System: Assembly Instructions

You Will Need:

- A computer with (at minimum) a GPU with 4GB of GPU-RAM
- Access to a 3D printer and a supply of PLA
- Laboratory mice with implanted RFID tags
- Access to a laser/waterjet cutter and ¼" acrylic
- 1 ThorLabs metal platform (fits 3 cages)
- Everything listed in the Bill of Materials

Step 0: Preparation

a) I recommend cutting the lid piece ahead of time. Make an order with your machine shop (or cut your own, if you can). The air holes do not have to be exact – the screw holes should be relatively precise, which is why I do not recommend doing this by hand. If doing this by hand, measure very carefully and use a drill press to form the holes.
b) Print the 3D-printed pieces: This will take a while, likely overnight, and may take a few passes to fit all the pieces. Ensure you print the water bottle holster in white if you can.
c) Drill 2 3mm holes on each short side of the cage, 25 mm above the floor. Use the base attachment piece as a reference.
d) Drill 4 2.5mm holes on one side of the cage, to match the water bottle holster.

Step 1: Mechanical Assembly

a) Start with the reader bases. Place the 12mm length M3 bolts through the holes in each breakout board, and screw 4 nuts on the backside to act as spacers. Mount each board on its respective reader, and screw another 4 nuts to fasten them firmly. Repeat for each breakout board.
b) Place the two base attachment pieces with 10 holes (exclusive) between them, flat sides facing inward. Screw them into the platform with the ¼"-20 bolts. The cage should fit nicely between them – if not, count again.
c) Place each reader base with the outward hole side in line with the base attachment piece holes: there should be a line of 6 holes, with the base attachment piece in the middle. These pieces will form the four corners of the cage. Carefully, taking care that the bases stay flush with the platform, screw them in with more ¼"-20 bolts. Alternating the bolt you are screwing in will make this an easier process.
d) Place each RFID reader on its respective breakout board.
e) Either paint the exterior of the cage with nonhazardous white paint, or tape printer paper over the sides, much in the same way as wrapping a package. This ensures a better background for the mice to be seen on. Place the cage on the readers and line up the holes with the base attachment – screw in the 16mm M3 bolts and thread the nuts on the exterior of the cage. The readers should be gently pressing against the floor of the cage.
f) Screw in the camera and LEDs to the mount with the M2/M2.5 bolts, then screw the mount to the lid in the center of the cage.

Step 2: Software Setup

a) Clone https://github.com/Judge24601/MouseTrackingSystem.git to both your Raspberry Pi and the computer you plan to use for processing the videos. (`git clone …`)
b) Follow the instructions in https://github.com/AlexeyAB/darknet 's README for installing darknet. If using CUDA 10.1, edit the .vcxproj files in build/darknet with a text editor to replace 10.0 with 10.1 – this is necessary or the system will not compile.
c) Unzip darknet.zip in the MouseTrackingSystem folder on your computer. Move the files `darknet_video.py, MouseTracker.py, visualize.py` into the darknet folder.
d) If using black mice, you can use the pretrained weights in the repository. Move yolo-obj_best.weights into the folder as well. Otherwise, you will need to train your own network. Follow the instructions in https://github.com/AlexeyAB/darknet to do so. Ensure you prepare 2000+ good quality images – I recommend including non-mouse objects of a similar size and shape to your mice in the dataset. Otherwise, the network can rely too heavily on contrast.

Step 3: Running the System

a) Before plugging in all your USB cables, ensure that you have set up SSH on your Pi – running the system headless will achieve a better framerate.
b) Plug in your external hard drive, and run the following commands:
    a. `sudo apt-get update`
    b. `sudo lsblk -o UUID,NAME,FSTYPE,SIZE,MOUNTPOINT,LABEL,MODEL` (note the location, UUID, and FSTYPE of your HDD)
    c. (if FSTYPE is EXFAT) `sudo apt-get install exfat-fuse`
    d. (if FSTYPE is NTFS) `sudo apt-get install ntfs-3g`
    e. `sudo mkdir /mnt/frameData`
    f. `sudo nano /etc/fstab`
    g. Add the following line: `UUID=<UUID> /mnt/frameData <FSTYPE> defaults,auto,umask=000,users,rw,nofail 0 0`
    h. Exit nano and `sudo reboot`
    i. This will mount your external hard drive on the Pi automatically upon connection.
    j. For any problems, check https://www.raspberrypi.org/documentation/configuration/external-storage.md.
c) Do a test run of the program with a sample RFID tag. Hover the tag over the 4 readers in sequence, and note this sequence. Open the results file, and adjust the readerMap in `RFIDReader.py` so that it matches the actual sequence. This must be done each time the USBs are unplugged, but not as long as they remain plugged in.
d) Put the mice in the cage, along with food and water. Place the lid with the camera mount on top.
e) To preview the video and check lighting, run `preview.sh` through ssh. This will open up a stream that you can view on any computer with VLC Media Player (Media -> Open Network Stream -> `rtsp://:8554 `)
f) Through ssh, run `python RFIDReader.py` – let the system run for as long as you want to collect data for. When done, use Ctrl-C to stop the program.

g) Save the photos onto a hard disk drive, and transfer them to your computer. Copy the files you wish to use into “MouseTrackingSystem/darknet/frameData” and copy the RTS_test.txt file into “MouseTrackingSystem/darknet”.
h) Run `python darknet_video.py,` and enter the tags for your mice.
i) Return later to find a JSON file with all the processed data!