Video Monitoring System for Automated Detection of Pain-Related Mice Behaviors

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Background

About 20% of the population experiences chronic itch, which can be a symptom of local or systemic illness. Currently, most drugs to treat chronic itch target GPCRs and the immune system, often with deleterious side effects. Targeting R7BP (recently found to regulate itch without regulating pain) may represent a more effective way to reduce itch sensation while also limiting side effects. To continue this progress, it is important to quantify scratching behavior produced by itch-inducing agents in mice. In order to do so, a mouse monitoring system is being developed with automatic scratch detection using machine learning algorithms. Typically, to capture behaviors of interest from multiple angles, multiple cameras are needed to see every angle within the housing enclosures. We demonstrate a device that utilizes angled mirrors to avoid the use of multiple cameras while still retaining full-view of the mice. The video acquisition of the system is accomplished using a Raspberry PI camera module. We present the different iterations of the hardware setup, along with the tools used for video acquisition and annotation. Overall, the system will significantly cut down the time and man-power needed to analyze videos of the mice behaviors related to itch and pain studies.

Goals

Design and fabricate a compact system that acquires high quality video for mice used in itch and pain studies. The video should have:

1. High frame rate (60 fps or more) to allow capture of fast scratching and wiping movements.
2. High resolution to allow identification of small features on mouse and discrimination between different scratching and wiping behaviors (e.g., scratching eye, back, nose, cheek)

Hardware and Design

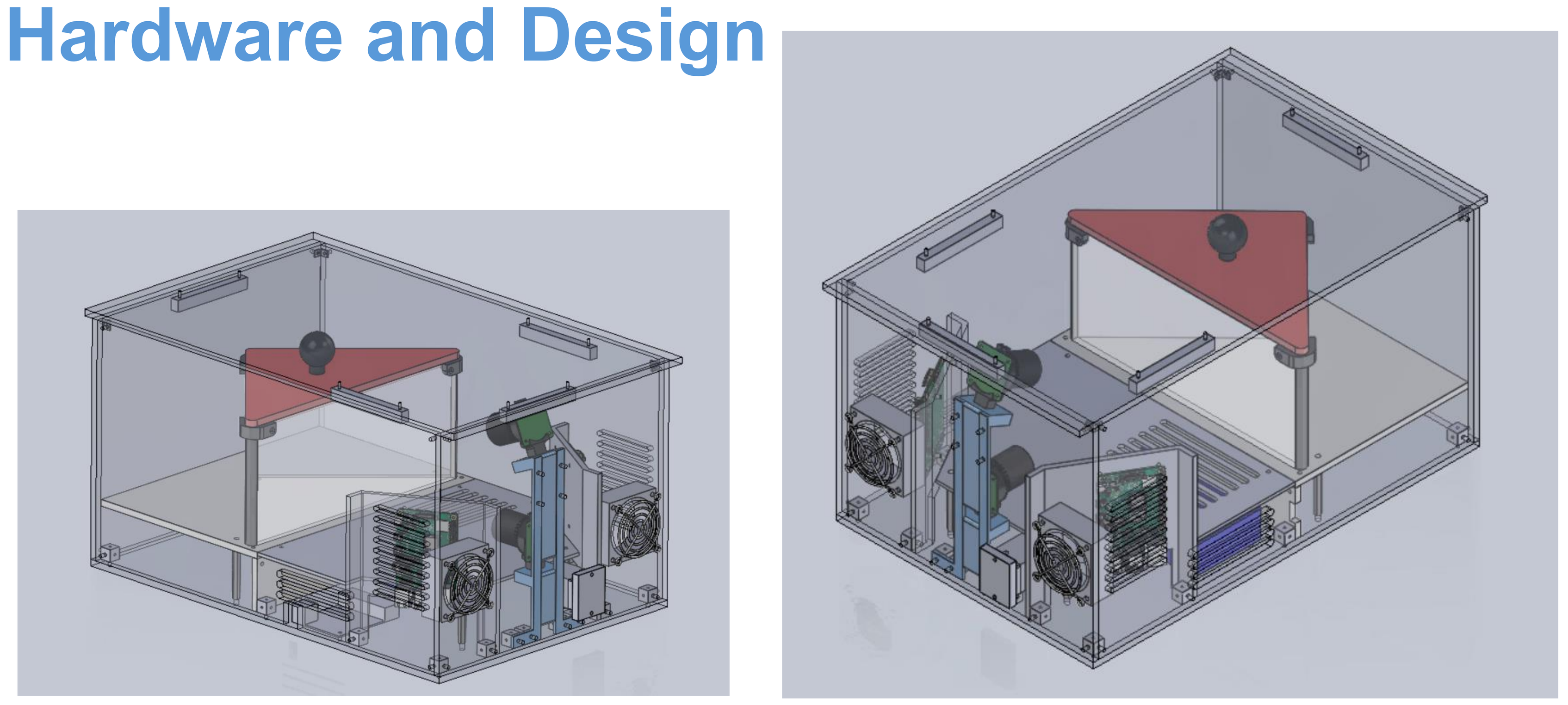

Figure 1: Two view of 3D CAD of monitoring unit

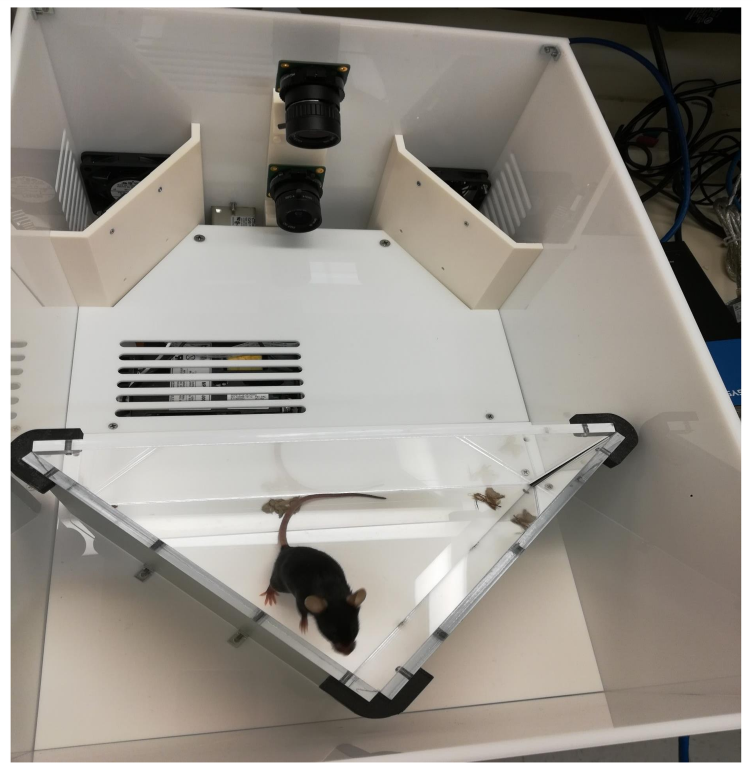

Figure 2: In-house fabricated prototype showing mouse in arena

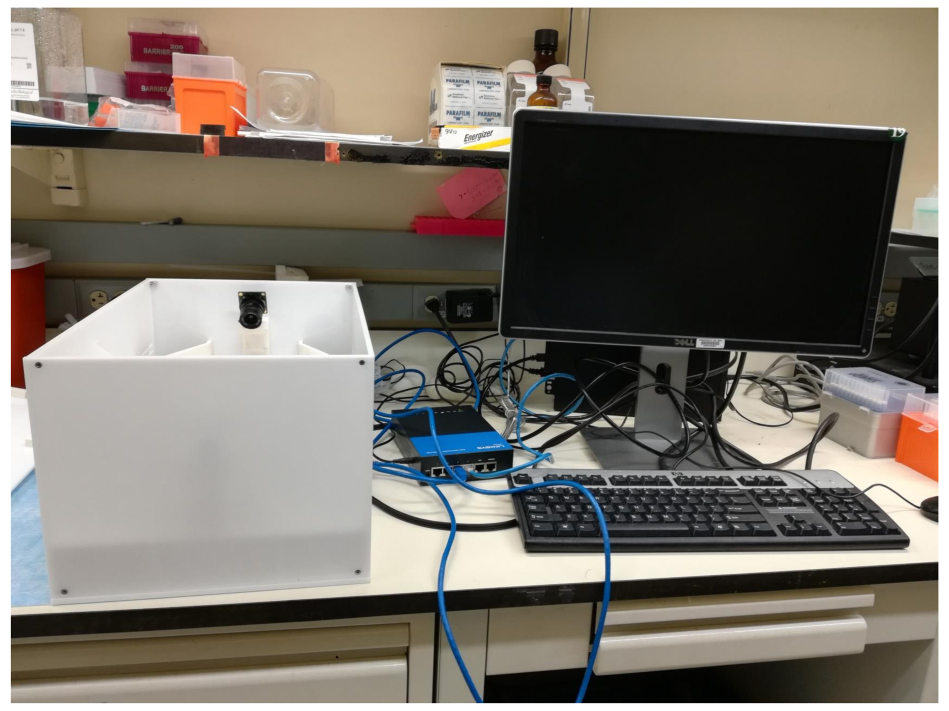

Figure 3: Unit deployed to NIDDK lab for initial testing. The image also shows the compactness of the unit.

Video Software

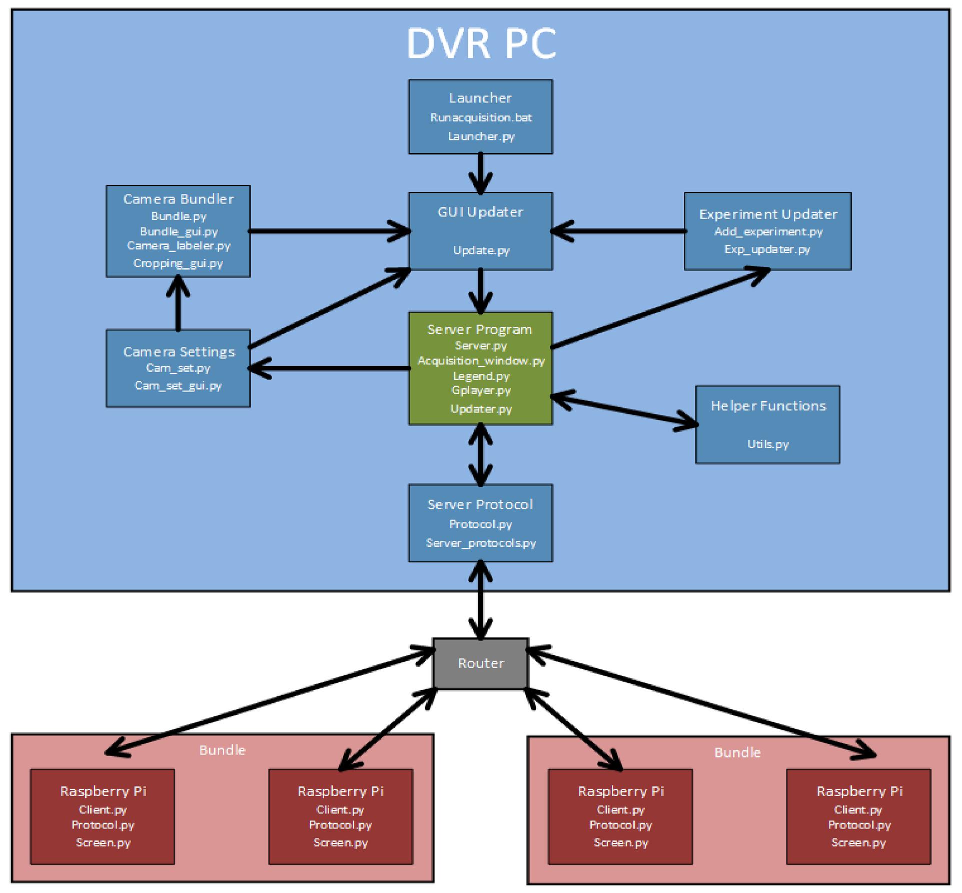

Figure 5. The DVR software model showing the grouping of code files in terms of higher-level function. The diagram shows the code-file to hardware device pairing. In this example diagram, the box labelled DVR PC refers to the computer to which the video is streamed and stored. The example assumes four RPi's each two are bundled as one unit (e.g., two cameras per arena).

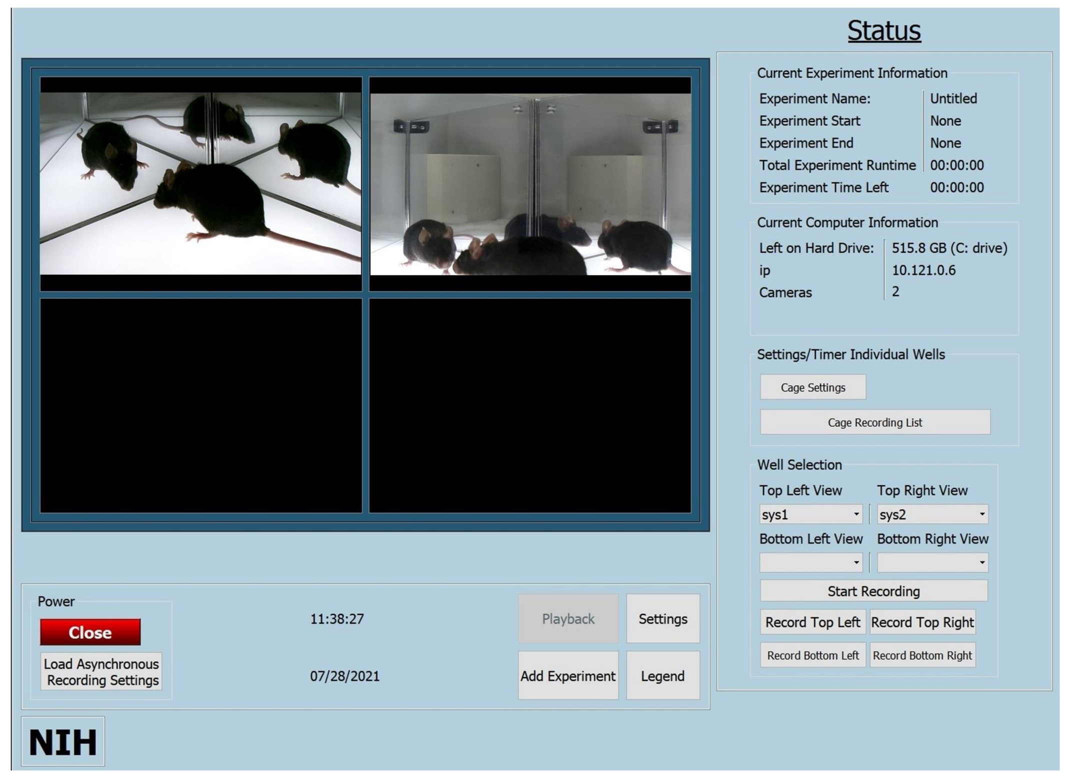

Figure 6: Python based GUI showing two synchronized RPI camera streams. (1 arena being shown)

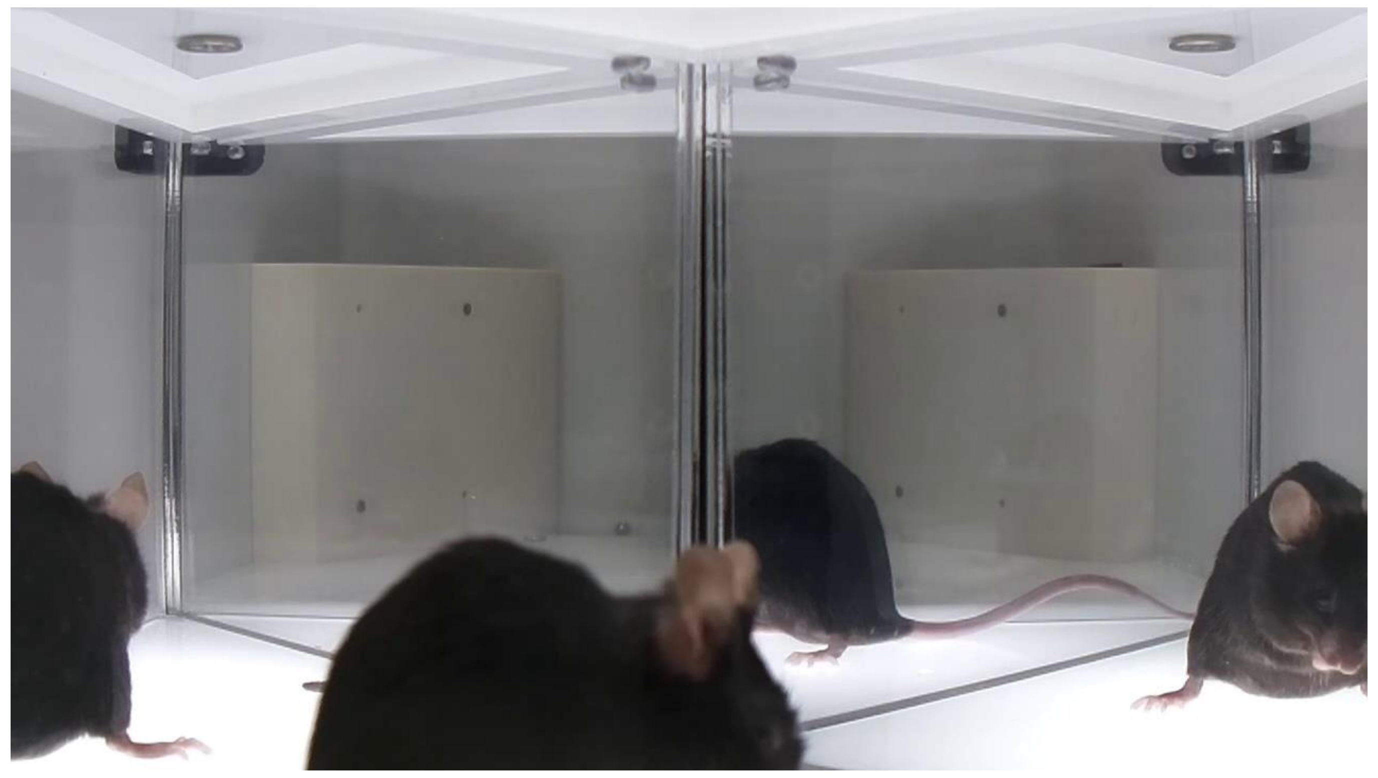

Figure 7: Frame of video highlighting the benefit of having mirrors as walls of the arena. The scratching behavior is captured clearly in the mirror.

Results

- Achieved 60 fps at HD resolution
- Robust to self-occlusion due to mirror walls.

Future Work

- Duplicate systems
- Expand number of cameras which can be connected in the GUI
- Use deep learning object detection to compress video files for efficient storage.
- Develop automated scratching and wiping detection algorithms

National Institutes of Health