Compact Video Monitoring Systems for Large-Scale Mouse Ethology

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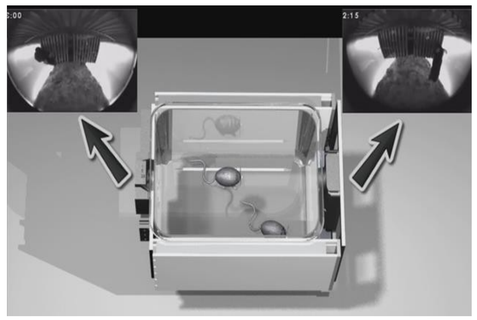
Background and Introduction

The System for Continuous Observation of Rodents in Home-Cage Environment (SCORHE) is an ongoing collaborative effort with many NIH institutes. The SCORHE project aims to develop an automatic behavioral detection system which provides continuous video-based monitoring for animal facilities without home-cage modification. This low-cost system provides accurate data of rodent activity and seeks to eliminate issues common to other mouse-monitoring methods such as acclimation periods and circadian rhythm disruption. Due to the ongoing nature of this project, the work completed this summer focused on improving the current system. The developments can be categorized into the following groups: mechanical prototyping, current software capabilities, and upcoming features.



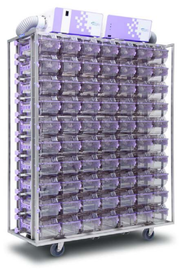
Mechanical Prototyping

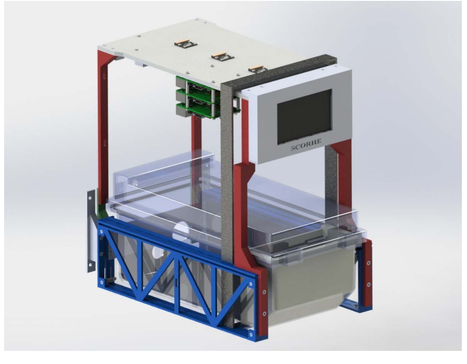
The physical design of the new SCORHE system has been developed to allow 24-hour surveillance of cages in Allentown Inc "NexGen" housing racks. This version of SCORHE is more energy efficient compared to previous designs due to the design requiring less near-infrared LEDs to illuminate the cage during dark hours. The open frame design also allows the cage be lit by room daytime lights. The user does not have to remove it in order to access cages.

Allentown Racks

Improvements in new design:

- Doubled the space between LEDs and diffuser
  - Fewer LEDs → less power → less heat
  - Infrared can be diffused more uniformly
- Open design allows "daylight" into cage
- Easy slide-in/slide-out handling of cages, "set it and forget it"
- Top-down view of cages
- Out-of-rack design available for use independent of preexisting Allentown system



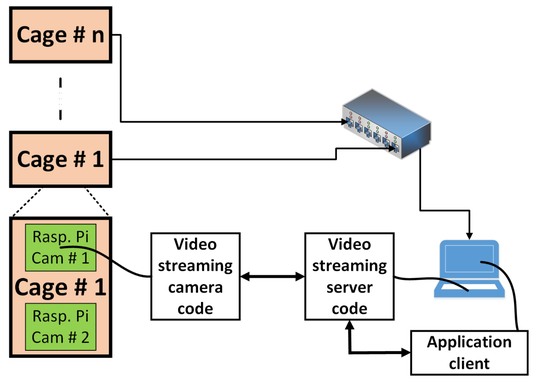


Current Software Capabilities

Basic Structure

An existing local ethernet network was in place, which allows up to 40 clients to connect to a main server, record video, and send recorded video to the server. Each Raspberry Pi is responsible for one camera, and is therefore treated as one client on the network. The diagram below highlights the video acquisition/previewing process.

After recording, a playback application allows the user to easily select the part of the recording to analyze.



Acquisition Features

- Simultaneous live preview and video recording from the Raspberry Pi by using two data pipes
- Low latency, HD previewing using RTP (Real Time Protocol)
- Setting video viewport, compression, color, rotation, ISO, and many other parameters both per camera and collectively

Playback Features

- Video splicing and trimming, so the user can focus only on the important part of the experiment
- Annotation capability, to train a neural network or to use as data on its own.

Score with SCORHE!!

Want to learn more?

https://scorhe.nih.gov/

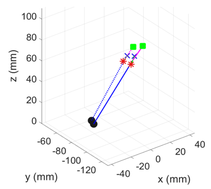
Scan with QR reader

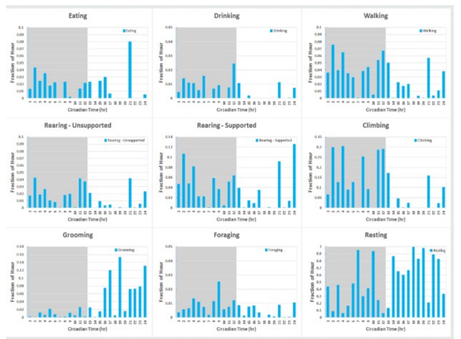
Upcoming Features

- Automated Annotation

  Since annotating hours of video is extremely time consuming and boring, we are working on automating the process.

  On previous systems we had already achieved continuous behavior annotation and 3D pose estimation. In the near future, we plan to provide these tools to the users in a simple interface via the playback application.





- Internet Connectivity

  Since the current system requires full control of its network, it cannot record while connected to the internet. To solve this we are working on reducing our network footprint and also considering switching to a USB based system to eliminate the network altogether.

- Packaged Releases

  We think software should be easy to use, and easy to install. So soon our software package will be installable as a standalone program, with no need to install any additional interpreters.

Conclusion

Our work this summer has delivered the project:

- A new mechanical prototype that integrates with vivarium cage systems. The prototype also mounts the Raspberry Pi's needed to record and connect to the network.
- System infrastructure that supports both recording and live-previewing simultaneously. Recordings are high-quality while previewing has minimal delay.
- A graphic user interface prototype for the server, providing a front-end interaction with network.
- A prototyped editor for editing and splicing of video captured by the cameras.
- Using a custom Python video annotation tool for the system.

References

Salem, G. H., Dennis, J. U., Krynitsky, J., Garmendia-Cedillos, M., Swaroop, K., Malley, J. D., Pajevic, S., Abuhatzira, L., Bustin, M., Gillet, J., Gottesman, M. M., Mitchell, J. B., & Pohida, T. J. (2015). SCORHE: A novel and practical approach to video monitoring of laboratory mice housed in vivarium cage racks. *Behav.Res. Methods, 47*, 1. doi:10.3758/s13428-014-0451-5