CageView™: A smart monitoring system and food control for phenotypical research in vivo

Problem & solution on rodent medical research using Artificial Intelligence

Cage View TM WHITE PAPER





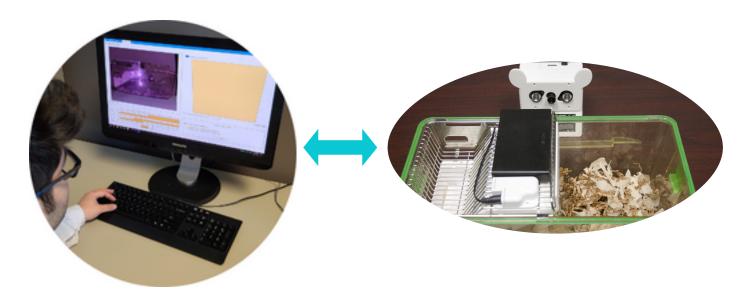


Biomedical researches using mice and rodents

Animal studies, as an inevitable part of biomedical research, require housing rodents in tightly controlled conditions. Researchers often required to measure precise food and water intake and monitor the behavior, drug ingestion, and exercise intensity and duration of the rodent. Manual switching between foods and alternating between fasting and fed status can be time-consuming and challenging, especially when high numbers of cages are involved and timing lies on the weekends or after hours.

Experimental studies on rodents require housing under highly regulated and controlled conditions. A major requirement for all animal housing in experimental facilities is health monitoring, which requires one or more of a variety of health care assessment techniques. One of the most basic techniques in animal health monitoring is a simple assessment of the degree and freedom of movement. This is particularly important when an experiment reaches humane endpoints (the point at which an experiment must be terminated to prevent unnecessary suffering) or following surgical procedures, as reduced physical activity is a valuable surrogate for discomfort in experimental animals. In addition, reduced physical activity can also be used as an indicator of the onset of labor and birth in pregnant rodents, which can be sued to give an indication of the approximate time of birth, which may be of value in some experimental settings. While physical monitoring of experimental animals is straightforward during scheduled working hours, standards of animal care often require additional monitoring outside scheduled working hours.

Scheduling of staff outside regular working hours is also required when a fasting regime is part of an experimental design. Under normal housing conditions, rodents are given access to food ad libitum, i.e., as desired. However, there are many experimental circumstances where food intake must be restricted, for example, positron emission tomography (PET) experiments utilizing glucose analogs as a tracer. Such food restrictions are often required to be initiated outside regularly scheduled work hours.



CageView: Anywhere, Anytime Remote Cage Monitoring and Food Control



A case study: PET scan experiment

Preparing the animals for positron emission tomography (PET) or measuring glucose tolerance test (GTT) are two major examples. For PET scan, animals are required to be fasted for 8 hours prior to administration of fluorodeoxyglucose (FDG) to visualize the maximum uptake of FDG to the affected tissue. In order to observe consistent data when dealing with a high number of animals, their fasting should be scheduled in a timely manner. Also, for GTT measurements, the same principles apply and consistency will result in generation of data with the least deviation. On a human resources front, this means that a technician/HQP has to remove food every hour between about 3 and 7 AM when a group of mice/rodents are studied. Furthermore, with respect to the recent COVID-19 pandemic and imposed limitation for in-person presence, the proposed solution will enable researchers to carry out their research fully remotely.

Current state: Procedural steps for PET experiment with six mice

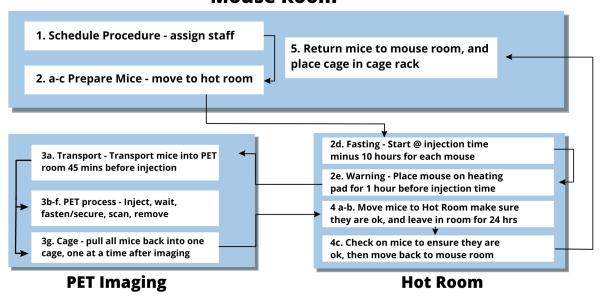
PET scan experiment is considered a comprehensive experiment in animal sciences. In order to elaborate on the common procedural steps in conducting the experiment (current state), we consider a case study of 6 mice (typical number of mice in a one-day experiment) undergoing the experimental process. It should be noted that the maximum capacity of conducting experiments in one single day depends on factors such as the amount of FDG which has a half-life of approximately 110 minutes.

- Animals are warmed one hour before the injection (done in the so-called Hot room)
- One hour is considered for each experiment and they are done consecutively
- Imaging is done for one mouse at a time
- After finishing the imaging, the animal must be isolated for 10 half-lives
- Thus, roughly, one day is needed for after imaging isolation (24 hours)
- Within that 24 hours, the mouse should be checked to make sure of its well-being

NOTE: PET experiment is usually not done on Mondays (because the preparation should be done on the weekend that is not convenient) or on Fridays (that is not preferred because the animal should then be alone for 2-3 days).

PET scan procedure: Location Trace

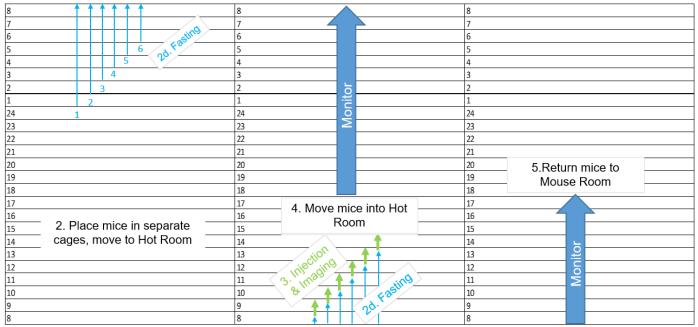
Mouse Room





PET FDG Animal Imaging	g - Process (C	Current State)									
Procedure Steps (assume 6 mice)	Mouse Location	TIME Stamps	MOUSE #1	MOUSE #2	MOUSE #3	MOUSE #4	MOUSE #5	MOUSE #6			
1) Schedule the procedure	Mouse	Several days before									
a Schedule the imaging equipment to be used ("I" = start of imaging)	Room ¹	Imaging Day	"I" minus 3 to 4 days								
b Assign a staff person to prep, image and monitor the mice	KOOIII										
2) Prepare mice for experiment											
a Typically, 4-6 mice for imaging sessions (assume 6 mice)											
b Place mice in separate cages (as they have separate fasting schedules)		1 day before imaging									
c Move mice from Mouse Room to Hot room		(any time during	I minus 1 day								
	Hot 2	business hours)									
d Start fasting for each mouse to start 10 hours before injecting FDG	Room ²	10 hours before FDG									
(different fasting start time for each mouse)		injection	0:00	1:00	2:00	3:00	4:00	5:00			
		,									
e Move first mouse onto heating pad (get body temp up)		I - 90 mins	8:30	9:30	10:30	11:30	12:30	13:30			
3) PET Imaging process											
a Transport first mouse into PET imaging room											
b Inject first mouse with FDG		I - 30 mins	9:30	10:30	11:30	12:30	13:30	14:30			
c Wait for FDG uptake	PET										
d Move and secure mouse in PET scanner	room ³										
e PET Scan (I _x) - one mouse at a time (1 hour intervals)	100111	I ₁ - I ₆	10:00	11:00	12:00	13:00	14:00	15:00			
f Remove mouse from PET scanner, place back in cage		I + 5 mins									
g All 6 mice can go into one cage											
4) Post Imaging											
a Move all mice back to Hot Room after all imaging is completed	Hot										
b Mice remain in Hot room for 24 hours	Room ²										
c Check on mouse to ensure they are ok	KOOIII	I + 1 day									
5) Return Mice to Mouse Room	Mouse										
a Return mice to Mouse Room (keep in same cage or redistrbute)	Room ¹										
b End of procedure											

PET scan procedure: Time Trace



Step 1. Schedule procedure (3 days prior)

1 2 3 4 5 6



Proposed solution: CageView™

CageView is a programmable, sensorized and easy-to-handle cage monitoring system which can be used in different types of *in vivo* studies. It is designed to provide tightly controlled conditions where the food and water intake, behavior, drug ingestion, and exercise intensity are required to be accurately measured. It reduces the workload on the technicians need to alternate between foods, fed/fast status and measuring intake. It also gives the operator remote access for condition control and monitoring. Although it has comprehensive and unique features, CageView has a competitive price compared to similar products and is completely affordable for research laboratories.

CageView is a programmable and remotely operable system such that

- an experimenter at a remote workstation may set up a feeding/fasting schedule that allows feeding/fasting without the requirement of the physical presence of a staff member;
- the experimenter can control access to food in real time regardless of the pre-set schedule;
- the experimenter has real-time access to a live video feed to assess the mouse;
- an artificial intelligence system tracks the mouse's location and physical activity; and
- a record is kept of activity which can be displayed as a 2D representation of mouse movement or a histogram showing mouse movement in 15 minute blocks for the duration of the experiment.



Summary of issues and the proposed solution

Current issues

- Lack of remote tool to control animal's access to food and record the process
- Experimentalist's inconvenience for changing animal access to food or starting its fasting period
- Lack of monitoring system in the absence of experimentalist
- Limited testing hours and experimentalist's availability

Solutions to the current issues

- Scheduled feeding using SmartFeeder
- Remote control of fasting/eating mode
- Dispensing food to the animal according to the experimentalist's need
- Record the animal access to the food for unlimited days
- Trained artificial intelligence system to identify the mouse
- Record the motion tracking using SmartVision



SmartFeeder



SmartVision



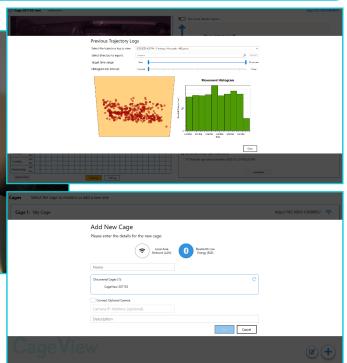


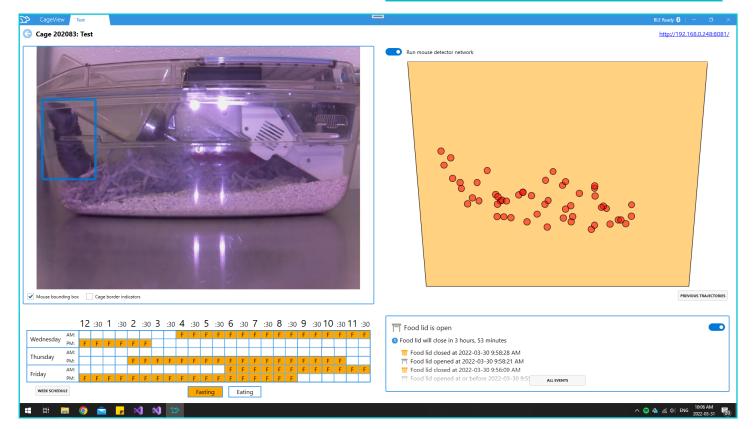
SmartCage-App™

- 🔼 Easy-to-use programmable interface
- Consolidates information from SmartVisionTM and SmartFeederTM units
- Records and exports data in .csv formats
- Export a mouse's activities over any time interval in the form of histograms
- Remote access to all functions of CageView
- Ability to use multiple units simultaneously



24/7 remote access to multiple cages

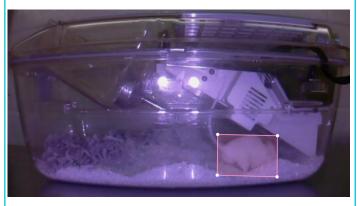


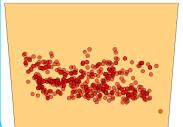


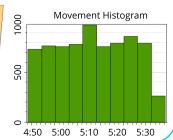


CV-SmartVision™

- Real-time video monitoring platform using infrared cameras and sensors
- Tracks mouse movement using advanced proprietary AI and video processing software
- History of mouse movements tracked, stored, and reported using graphical tools and metrics
- WiFi compatible for remote access







CV-SmartFeeder™

- Automated feeding/fasting control via programmable scheduler
- Customizable scheduler allows on/off control of feeder in 30-minute increments
- Recorded data files provides a mouse's feeding/fasting history
- WiFi compatible for remote "anywhere" access

		12	:30	1	:30	2	:30	3	:30	4	:30	5	:30	6	:30	7	:30	8	:30	9	:30	10	:30	11
Sunday AM: PM:	AM:		F		F		F		F		F		F		F		F		F		F		F	
	PM:		F		F		F		F		F		F		F		F		F		F		F	
Monday	AM:		F		F		F		F		F		F		F		F		F		F		F	
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Torredore	AM:		F		F		F		F		F		F		F		F		F		F		F	
Tuesday	PM:		F		F		F		F		F		F		F		F		F		F		F	
W-JJ	AM:		F		F		F		F		F		F		F		F		F		F		F	
Wednesday	PM:		F		F		F		F		F		F		F		F		F		F		F	
Thomas	AM:		F		F		F		F		F		F		F		F		F		F		F	
Thursday PM:	PM:		F		F		F		F		F		F		F		F		F		F		F	
Fatalan.	AM:		F		F		F		F		F		F		F		F		F		F		F	
Friday PM:	PM:		F		F		F		F		F		F		F		F		F		F		F	
Catalana	AM:		F		F		F		F		F		F		F		F		F		F		F	
Saturday	PM:		F		F		F		F		F		F		F		F		F		F		F	









Benefits

Animal Health

Ensures mouse health and safety *via* activity monitoring and food control

Staff Convenience

Remote access eliminates the need to travel to cage location multiple times per day

Staff Safety

Conduct daily tasks remotely without exposure to contaminated or radioactive environments

Remote Control of Multiple Cages

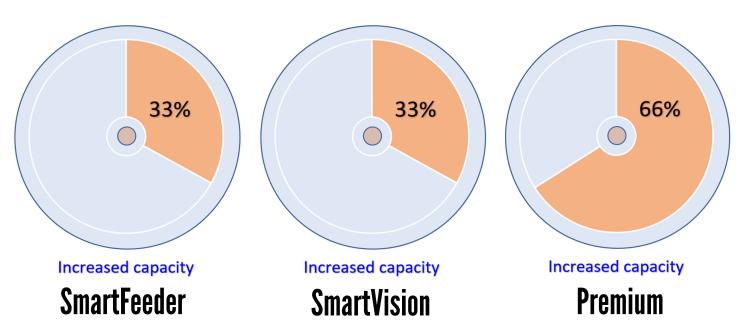
Access and control multiple CageView units wherever you can access the SmartCage App

Easy-to-Use

An interactive graphical user interface allows the user to perform any task with only a few clicks

Activity and Food History

Allows researchers to track the history of mouse movements and feeding routine



Applications

- Musculoskeletal Disorders
- Behavioural Disorders
- Systemic and Multi-Organ Disorders
- History of Activity and Food Access
- Peripartum Monitoring

- Peri-Surgery Monitoring
- Mice Condition Post Lethal Treatments
- Intermittent Fasting & Diet Control
- PET-FDG Scan
- Neurological Disorders



Call to action

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