The SnackerTracker: An Autonomous, Integrated, and User-Friendly Home-Cage Monitoring Device

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Background

Challenges with Home-Cage Monitoring

A study involving the intersection of sleep and food intake motivated SnackerTracker development. It relied on manual daily food-measurement, which proved problematic as:

- Mice hide food and break pellets into crumbs
- Reaching into a cage awakens animals and interferes with EEG/EMG recordings during sleep
- Physical disturbances can cause animal distress

An automated home-cage monitor would address such issues, however these and other challenges persist[1]:

- Existing systems are expensive, have limited multi-output recording options, and interfere with EEG/EMG monitoring
- Required animal training may present learning confounds

1. Ali MA, Kravitz AV (2018) Challenges in Quantifying Food Intake in Rodents. Brain Res 1693:188-191.

Mission to Improve Animal Research

Refining animal monitoring systems aligns with operational and international agendas which govern, promote, and/or fund ethical research conduct. Such bodies include:

The National Centre for the Replacement Refinement & Reduction of Animals in Research (NC3Rs) - The 3Rs provide a framework for performing more humane animal research

NC3Rs e-COST TEATIME

The European Cooperation in Science & Technology (e-COST) - Its TEATIME Action aims to improve biomedical research by automated behaviour monitoring in the animal home-cage

Goals

1 Autonomous

- Accurate and continuous food-intake measurement
- Self-contained data acquisition and storage
- Control and monitor via Wi-Fi/Bluetooth connection

2 Integrated

- Advance research capabilities through additional peripheral integrations
- Meets standard home-cage regulations
- Cost-effective

3 User-Friendly (Animals and Researchers)

- Minimise disruptions to animals while enriching the home-cage environment
- Reduce the number of animals required by enabling simultaneous measurements
- Create an intuitive interface through the Arduino Internet of Things (IoT) platform

Methods

3D Chassis Modelling
3D models were developed using TinkerCAD (AutoDesk) and additionally rendered in Babylon JS

Software Development
Device software was written using the Arduino Editor, GitHub, and MATLAB

3D Chassis Printing
Models were transferred to Ultimaker Cura for printing using the Ultimaker S3

Electronic Prototyping
Electronic circuits were manually tested via breadboard-Arduino Editor connections

Device Construction
Software was loaded onto the Arduino microprocessor, and the completed electronics were affixed to the device chassis

Animal Interaction
The assembled SnackerTracker was introduced into mouse cages, in line with ethical approvals/licences, to evaluate animal-device interactions

Practical Application
After further development, the SnackerTracker can be used across research applications…

Solution

The SnackerTracker: An automated home-cage monitoring device to refine – and ultimately reduce – animal research

Figure 1. The above QR code links to a one-minute video featuring SnackerTracker chassis development to date

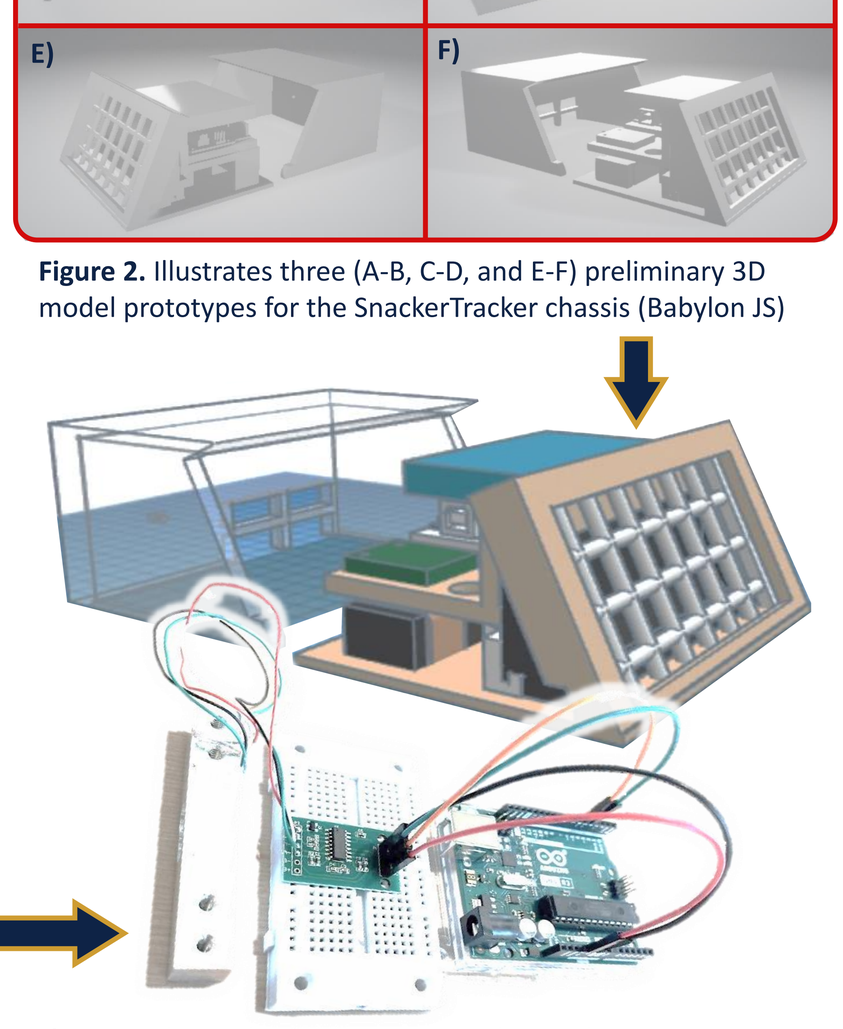


Figure 2. Illustrates three (A-B, C-D, and E-F) preliminary 3D model prototypes for the SnackerTracker chassis (Babylon JS)

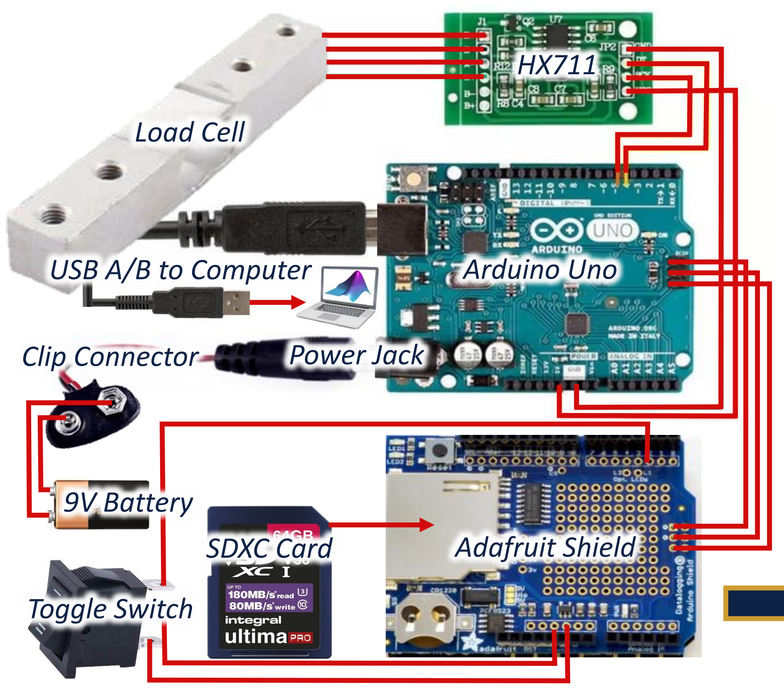


Figure 3. Depicts hardware components for the current SnackerTracker electronics circuit design (key elements labelled)

Figure 4. Shows the most recent SnackerTracker prototype with corresponding electronic circuitry

Deliverables

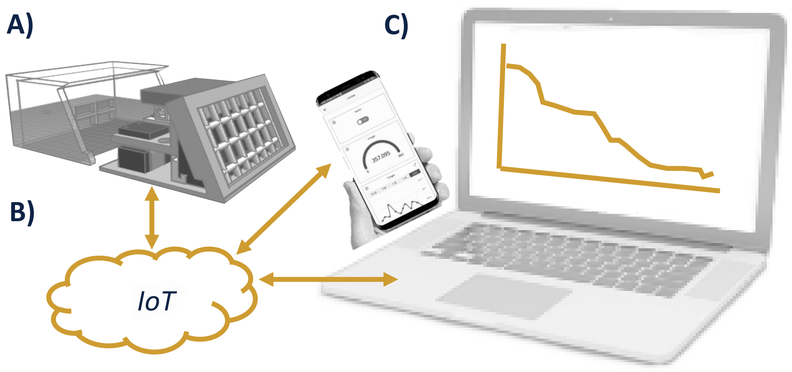


Figure 5. Illustrates the future output pipeline involving A) device data acquisition and the B-C) IoT cloud-based interface

1 Data Collection

- ✓ Continuously record the mass of food pellets within the device as a proxy for animal consumption
- ✓ Local SD-card data storage, including time and date
- ✗ Limited additional peripheral integrations

2 Arduino Internet of Things (IoT)

- ✓ Wi-Fi/Bluetooth integrations allow collected data to be transmitted to–and visualized by–connected devices
- ✓ Enables remote SnackerTracker initiation and operation
- ✗ Risks data loss if signals/connections are unreliable

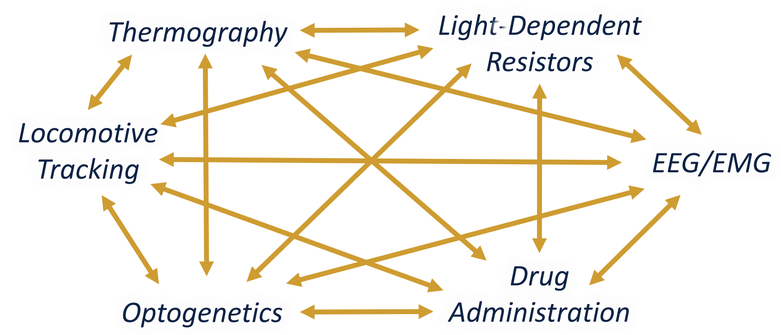
3 Collaboration and Open-Access Provision

- Interdisciplinary team for continued development
- Open-source publication
- Bi-directional consultations (e.g., TEATIME)

Arduino Project Hub | Open Access | GitHub Repositories

Future Directions

Additional Peripheral Integrations



Funding and Partnerships

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