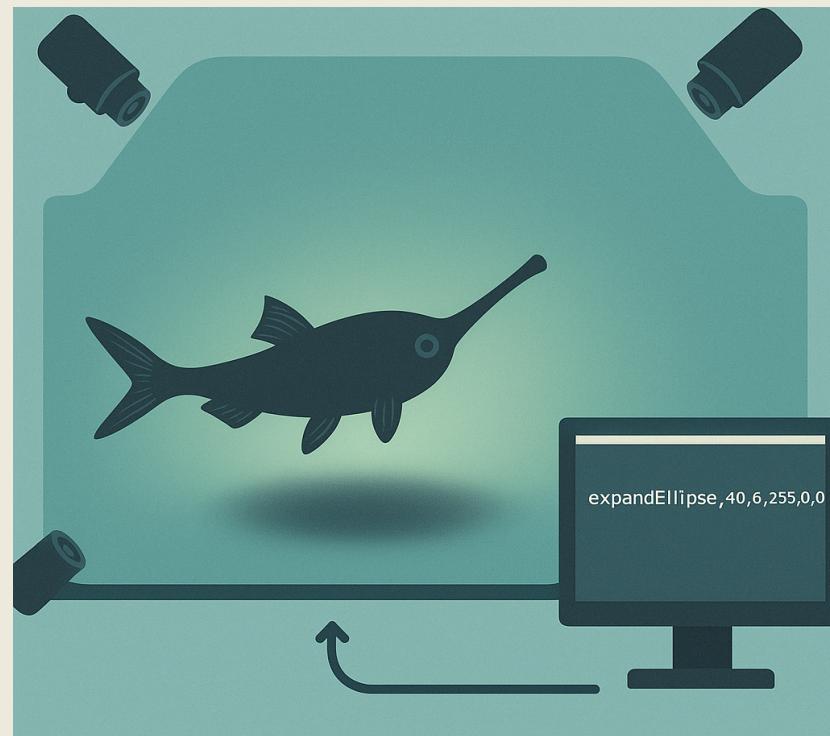




PROJECT BY:

Michal Shani



01. Motivation

Understanding escape mechanisms in weakly electric fish offers insights into fundamental neural and cognitive processes underlying survival behavior.

While electroreception plays a key role in these responses, it remains underexplored in real-time experimental contexts.

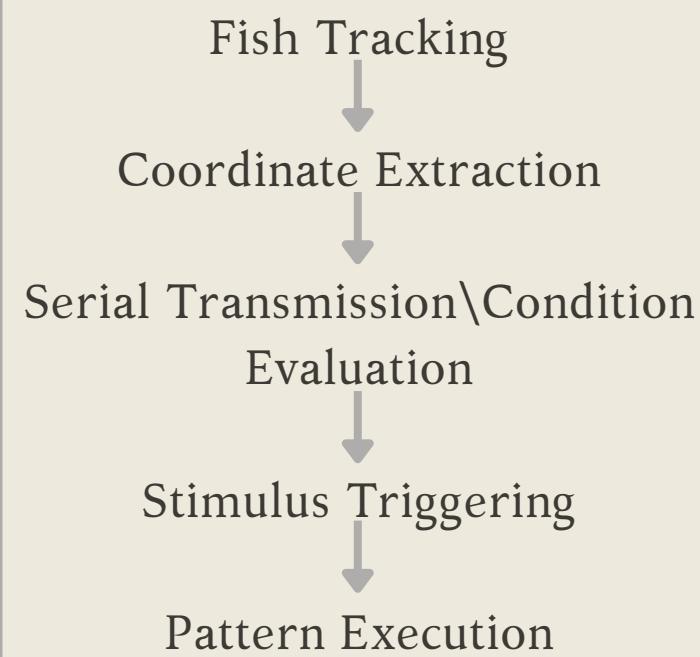
Most existing systems rely on passive observation or manual stimulus delivery, limiting research potential.

This project aims to address that gap by enabling precise control, real-time behavioral tracking, and laying groundwork for future neuroethology studies.

02. Objective

Design and implement a system for synchronized real-time video analysis and visual stimulus presentation targeting escape behavior.

03. System Workflow



04. Experimental Setup

The experimental setup included:

- A custom-built aquarium designed to house *Gnathonemus petersii* (elephantnose fish)
- A five-camera array: four positioned at the corners and one at the center
- A control station with a central computer and a user interface for manual or automatic operation

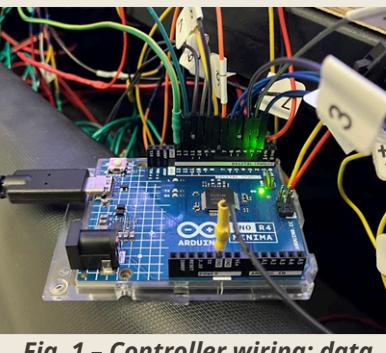


Fig. 1 – Controller wiring: data lines (pins 2-13) at top, GND connection to LED strips at bottom

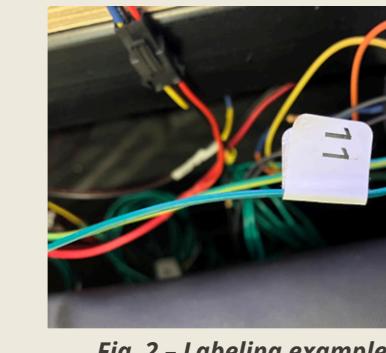


Fig. 2 – Labeling example for data line to LED strip 11

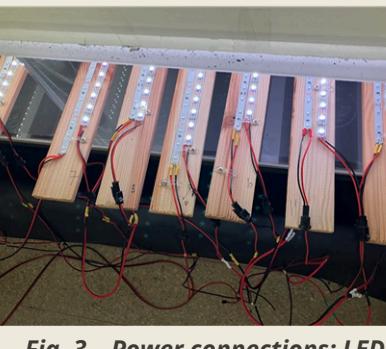


Fig. 3 – Power connections: LEDs (right side) and IR strips (left side), both via red & black wires

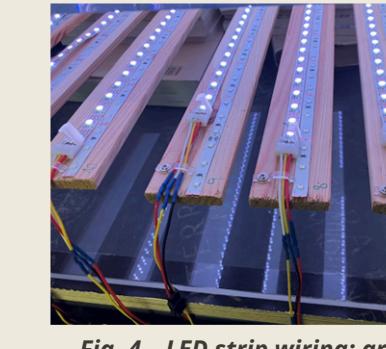


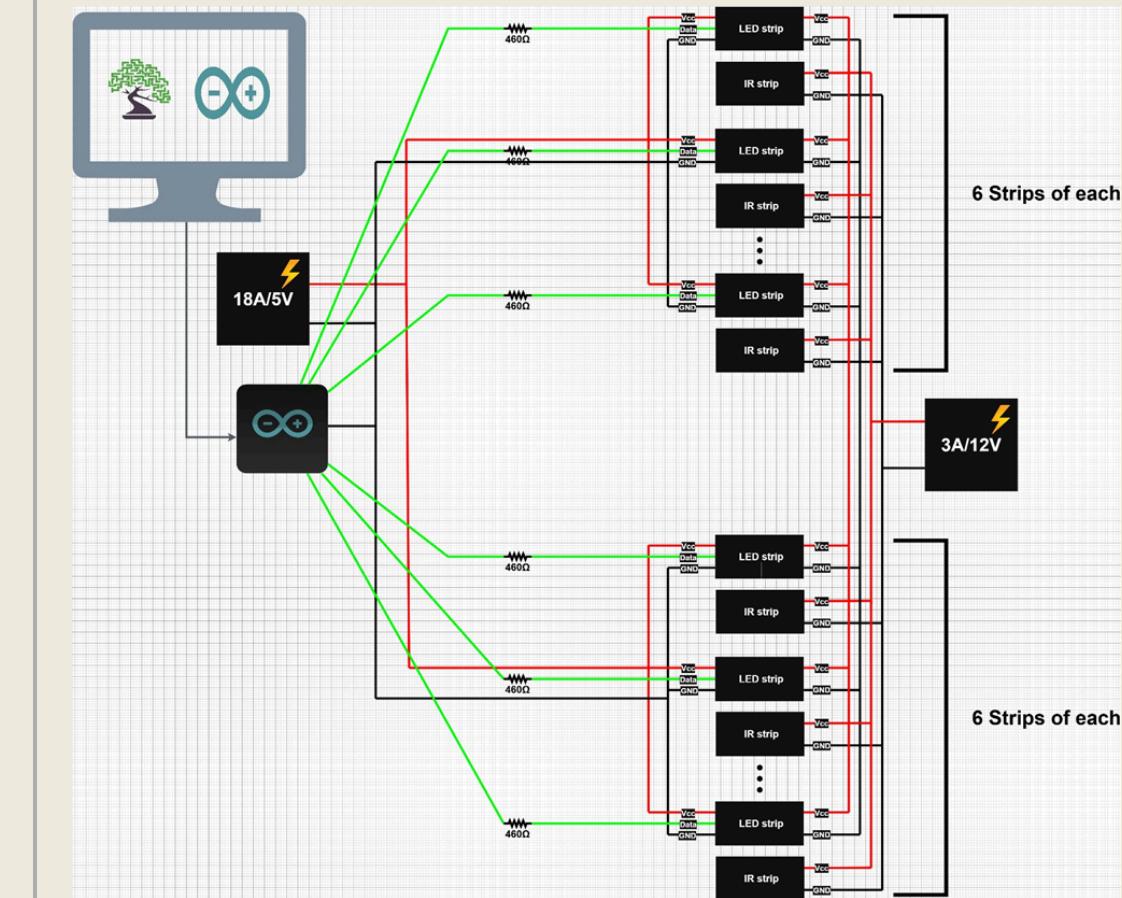
Fig. 4 – LED strip wiring: ground (black), power (red), data (yellow)



Fig. 5 – LED strips power supply



Fig. 6 – IR strips power supply



The main hardware challenge was stable power delivery to 12 high-current LED strips.

To ensure reliability:

- 5V/18A power supply powers all LED strips
- Each data line includes a 460Ω resistor for signal stabilization
- Power was supplied to both ends of each strip to minimize voltage sag
- A separate 12V/3A supply powers the IR strips
- All components share a common ground (GND)

This setup provides consistent brightness and prevents flickering or signal loss.

05. System Overview

- Real-time, closed-loop behavior tracking
- Arduino-controlled 12×118 LED grid
- Custom lighting patterns triggered via serial commands
- Integration with Bonsai platform for live tracking
- Fish coordinates are mapped to LED positions dynamically

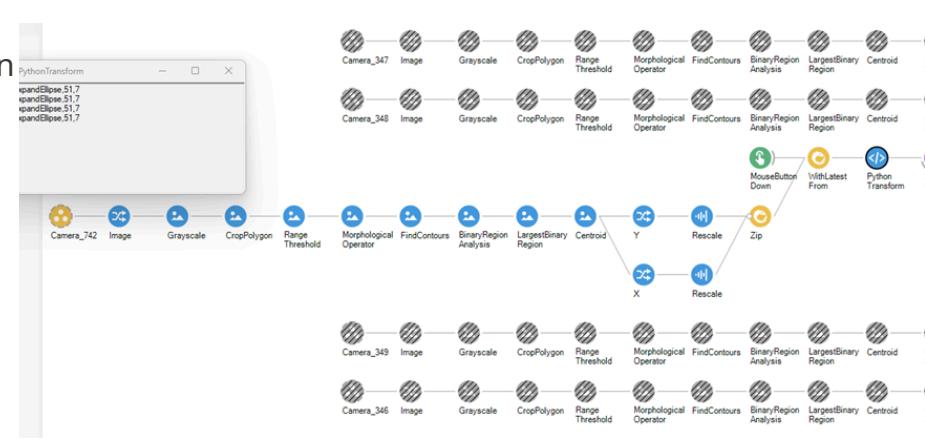
06. Real-Time Integration with Bonsai



Bonsai Processing Pipeline (Simplified):

- Video Input & Preprocessing:
 - Grayscale → Crop → Threshold
- Object Detection:
 - Morphology → Contours → Largest Region
- Position Extraction:
 - Centroid → Rescale → Zip
- Command Generation & Trigger:
 - PythonTransform → SerialWrite

This setup enables responsive, position-based stimulation for dynamic behavioral experiments.



Bonsai Workflow: From Live Video to Real-Time Serial Command

07. Project Achievements

- Developed a fully functional, modular LED stimulation system.
- Controlled and validated a 12×118 LED matrix (1,416 LEDs).
- Conducted power, timing, and stability tests.
- Built and tested Arduino firmware with flexible, text-based command parsing.
- Integrated a 5-camera infrared tracking system with Bonsai for spatial detection.
- Implemented a real-time trigger pipeline from fish location to LED activation
- Established a clear scalable hardware-software architecture ready for behavioral integration.

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