Fly-Inspired Ultra-selective Looming Perception and Avoidance on Resource-Constrained Micro-Robots

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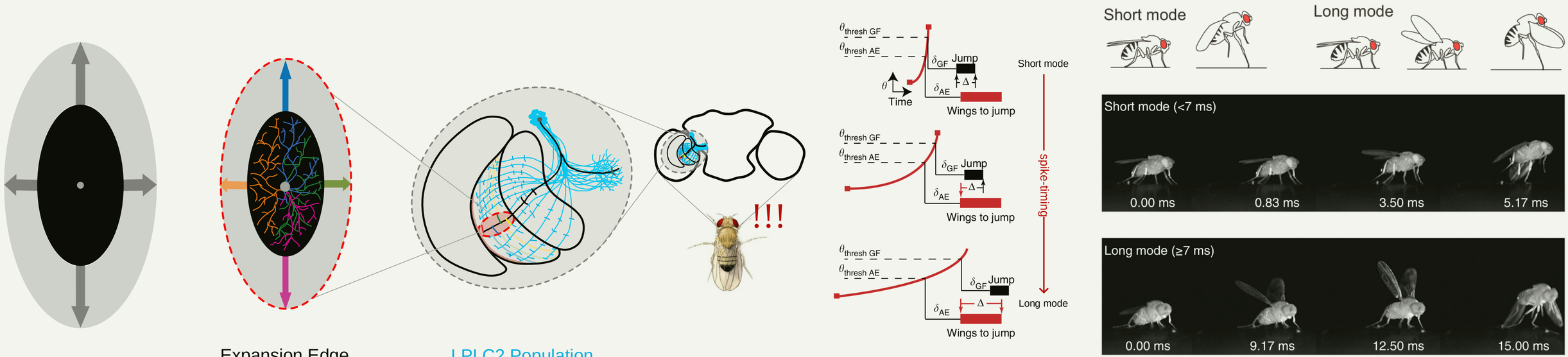
Abstract

- **Flying insects** such as *Drosophila* can swiftly transform sensory cues into **evasive actions** to avoid predators.
- Among their **visuomotor pathways**, the **LPLC2** visual projection neurons are **ultra-selective to looming stimuli**; their population densely tiles the entire visual field and activates premotor circuits to trigger **escape takeoff**.
- Inspired by this, we designed a concise closed-loop **visual-perception and motion-control system** for the *Colias* micro-robot, mimicking the fly's looming-sensitive circuit for real-time threat evasion.
- To our knowledge, this is the first **real-world implementation** of a fly-inspired collision perception system on a vision-based micro-robot.

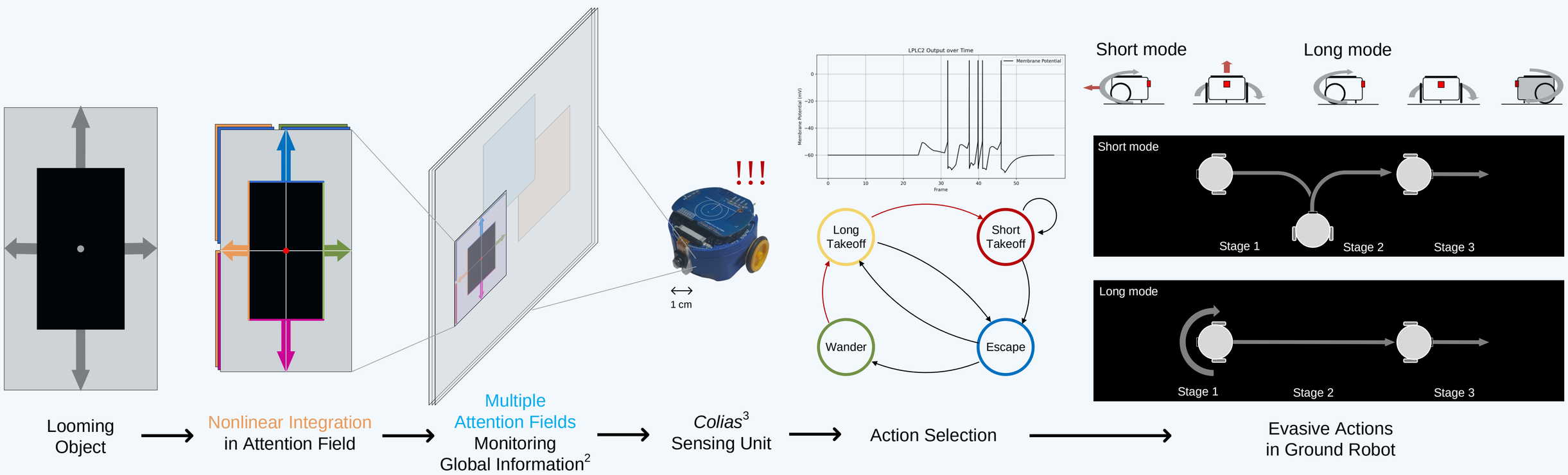
Evasive Intelligence in *Drosophila*

- In flies, looming-related visual features are linearly integrated by the escape circuit, with downstream giant fiber neurons modulating the selection between long and short takeoff evasive responses.



Biomimetic Micro-Robotics

- Inspired by insect vision, our goal is to enable vision-based micro-robots to detect and evade approaching threats by mimicking the ultra-selective response of the LPLC2 neural ensemble.



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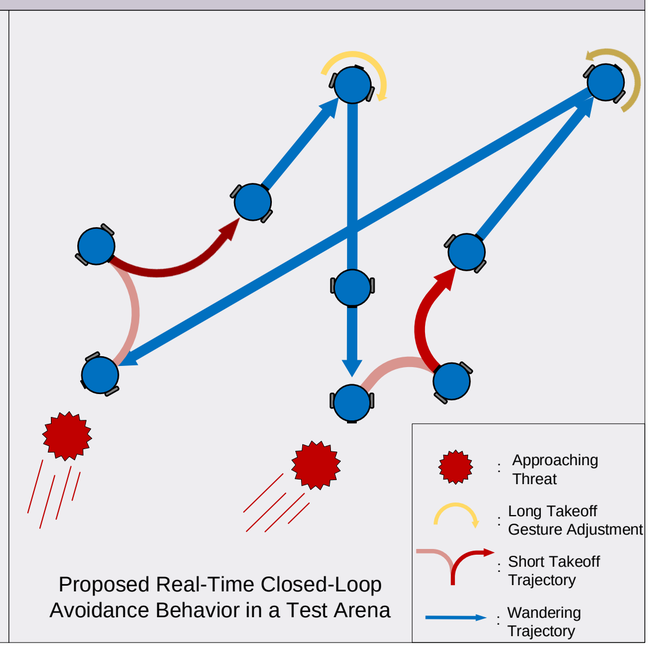
Future Work

- Currently, we have developed a closed-loop control system for *Colias* inspired by the fruit fly visual system.
- In the next stage, we plan to conduct **more comprehensive experiments**, including comparative studies with existing bio-inspired models such as the locust-inspired LGMD collision detection system
- These experiments will be performed on micro-robots in **real-world physical environments**, which are significantly more challenging and interesting than computer simulations.
- Our goal is to enable *Colias* to **agilely dodge approaching threats** from its entire visual field.



Proposed Real-Time Closed-Loop Avoidance Behavior in a Test Arena

Reference

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