Autonomous Pathfinding in Boid-Inspired Swarm Networks

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Abstract

➤ Multi-agent swarm movement has been implemented using scripted flight planning (Reynolds, 1987) in past work but lacks autonomous movement functionality.
➤ This project aims to implement the LRTA* algorithm (Korf, 1990) to facilitate pathfinding in partially-observable environments (Fig.2).
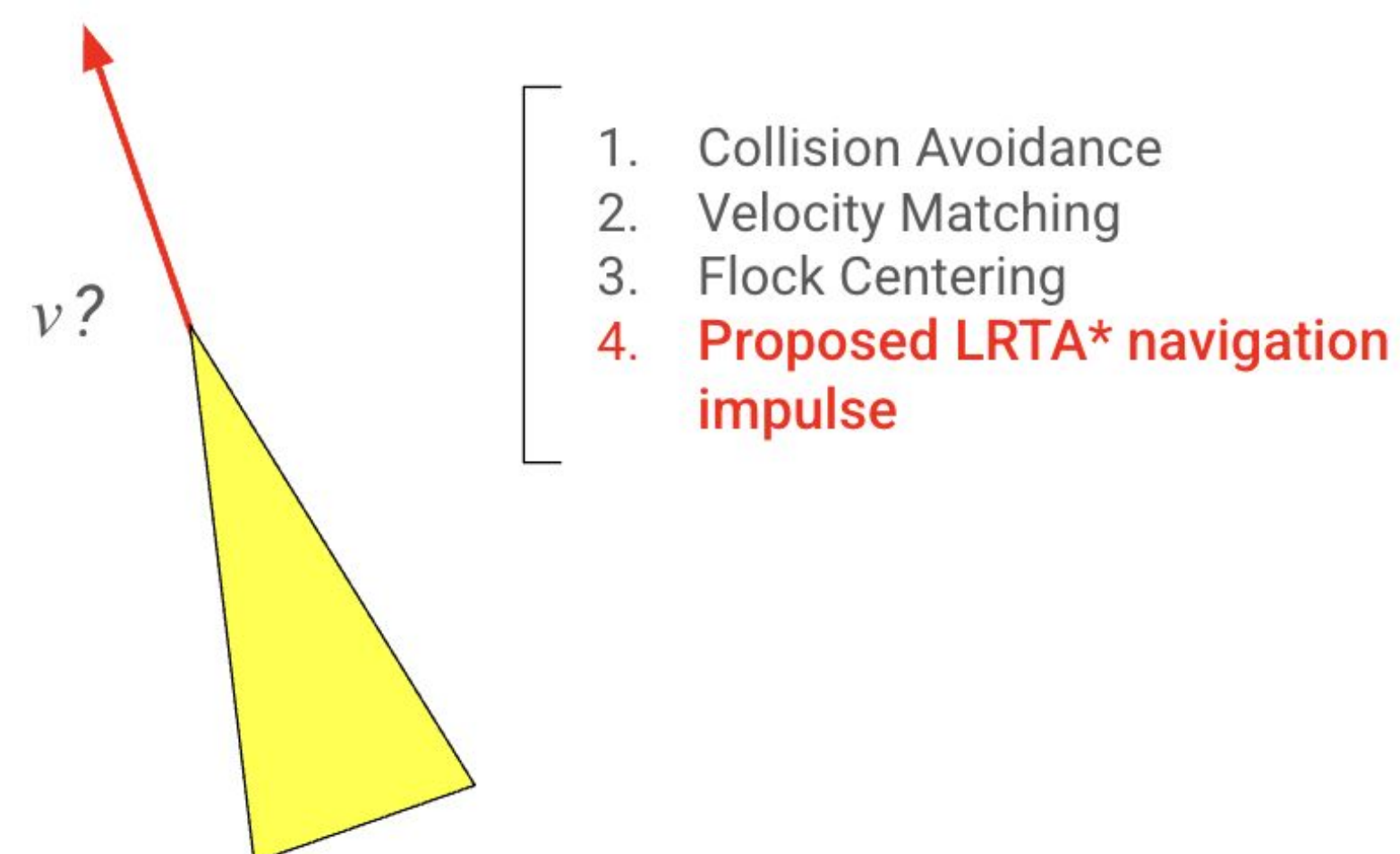
v?

1. Collision Avoidance
2. Velocity Matching
3. Flock Centering
4. **Proposed LRTA* navigation impulse**

Fig.1 Diagram of boid behaviors

Performance

➤ Average computational time to complete [one] swarm movement step and
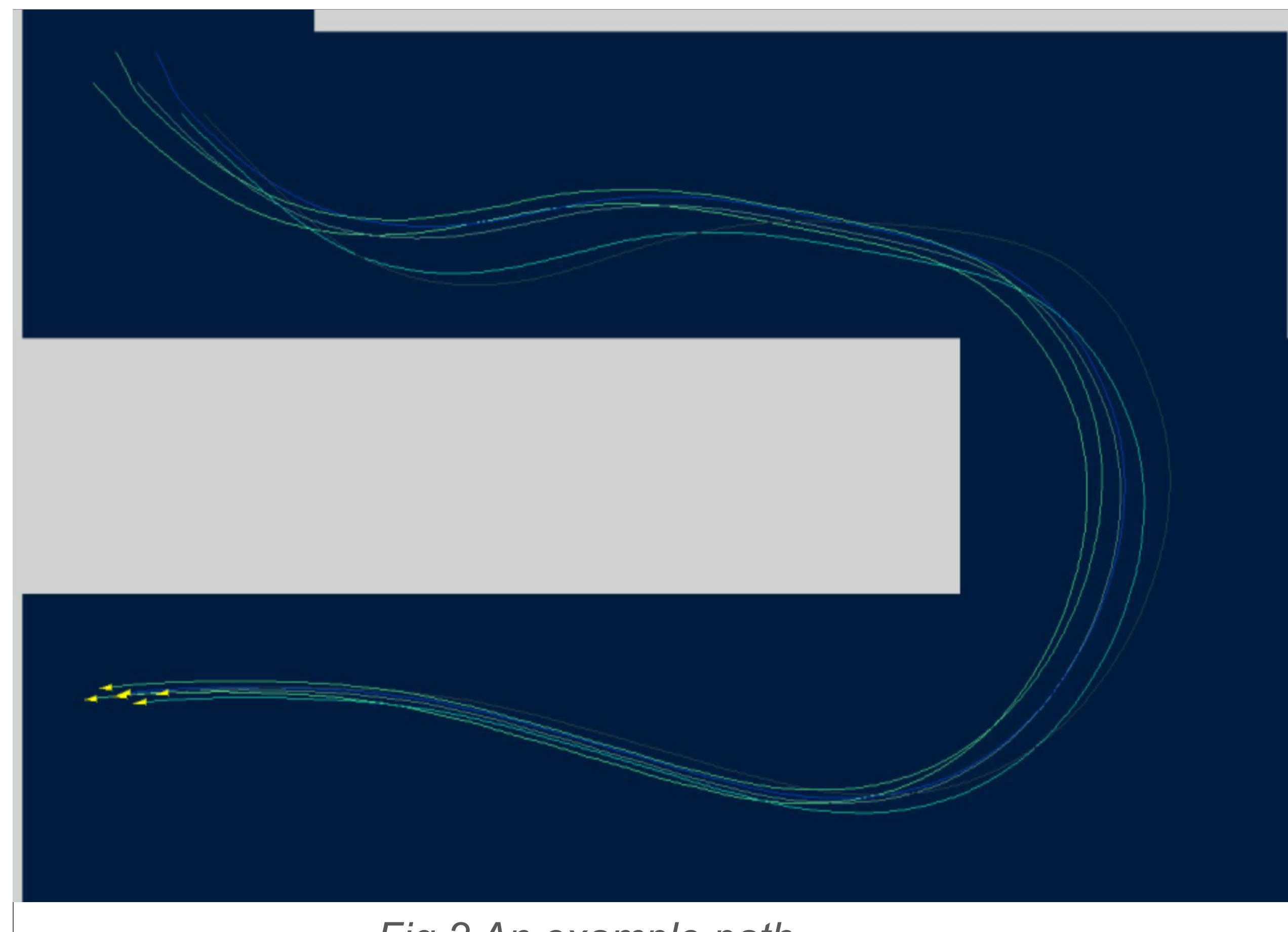➤ time-to-complete (TTC) a given map are plotted against swarm size graphically

Fig.2 An example path

Boid Logic

➤ Innate behaviors in each individual boid provide *impulses* that urge heading and speed changes for the boid.
➤ An accumulator combines and weighs behavioral velocity *impulses* to decide what the *actual* velocity change should be (Fig.1 & Eq.1) for the boid
➤ LRTA* provides a supplementary impulse that nudges the boid towards an objective while still obeying other behaviors
➤ Independent movements towards an objective ripple through the swarm leading to organic-looking pathfinding and cohesive motion.

$$\Delta \vec{v} = w_0\vec{b}_{\text{centering}} + w_1\vec{b}_{\text{velocity\_matching}} + w_2\vec{b}_{\text{collision\_avoidance}} + w_3\vec{b}_{\text{LRTA*}}$$

Eq.1 Behavior weighing equation

Future Work

➤ Future work includes (1) improving robustness through control theory and (2) developing implementation-specific variations of this project
➤ Plans are in place to implement LRTA*-infused swarm navigation on Autonomous Underwater Vehicles (AUVs) built by the multidisciplinary Marine and Naval Technological Advancements for Robotic Autonomy (MANTARAY) team

Acknowledgments

References

[1] Reynolds, C. (1987). Flocks, herds and schools: A distributed behavioral model. SIGGRAPH Comput. Graph., 21(4), 25–34
[2] Richard E. Korf (1990). Real-time heuristic search. Artificial Intelligence, 42(2), 189-211.