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Can chess-style strategic planning revolutionize high-speed engagement?

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Background & Challenges

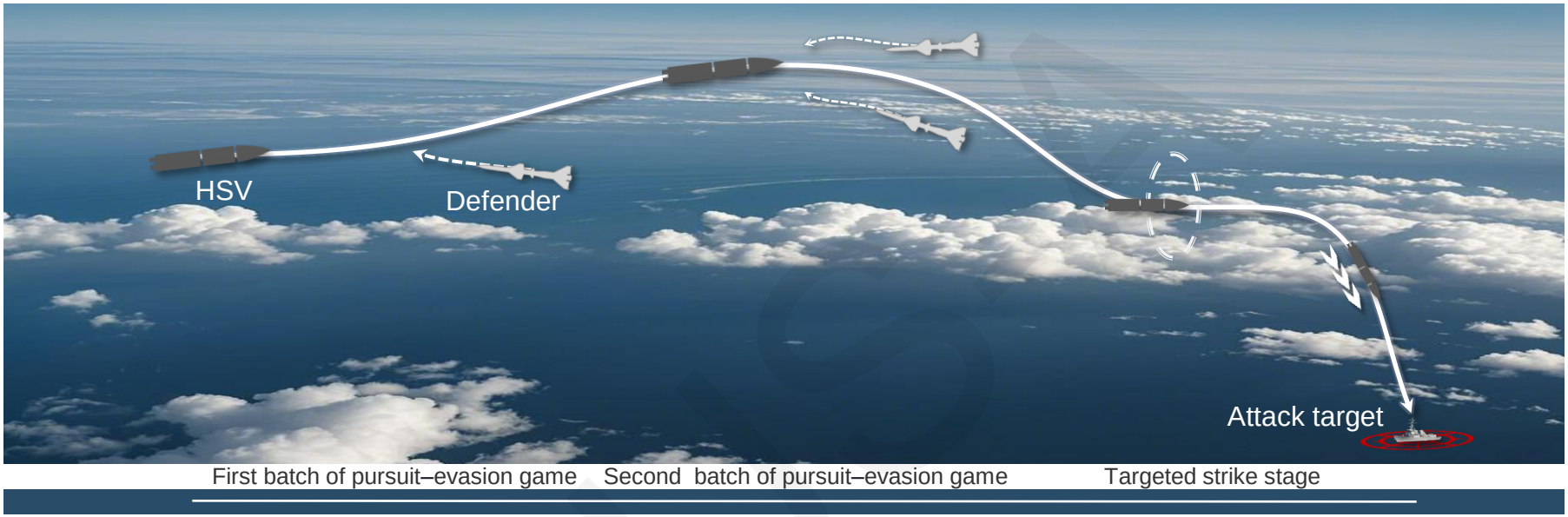

Fig. 1 Pursuit–evasion game scenario

Core characteristics of HSV

High-speed vehicles (HSVs) feature extremely high flight speeds and a wide maneuvering range, with significant strategic penetration value.

Realistic defense threats

With the continuous evolution of anti-missile defense systems, target detection, tracking, and interception technologies have become increasingly precise.

Essence of game confrontation

HSV confrontation is essentially a life-or-death pursuit–evasion game under extreme dynamics, compressed decision windows, and partial observability.

Limitations of Current Methods

Traditional solutions

- Reliance on precise modeling, enormous computational costs in high-dimensional state space.
- Incapable of handling uncertain strategies, poor adaptability to opponents' moves.

Deep reinforcement learning

- Black-box issue: no decision transparency and difficult safety assessment.
- Poor generalizability: environmental deviations and easy strategy invalidation.

Core pain point: Failure to balance computational efficiency and strategic adaptability in either method, falling short of the requirements for HSV pursuit–evasion games.

Core Method: MCTS Strategy

Drawing inspiration from game AI: Monte Carlo tree search

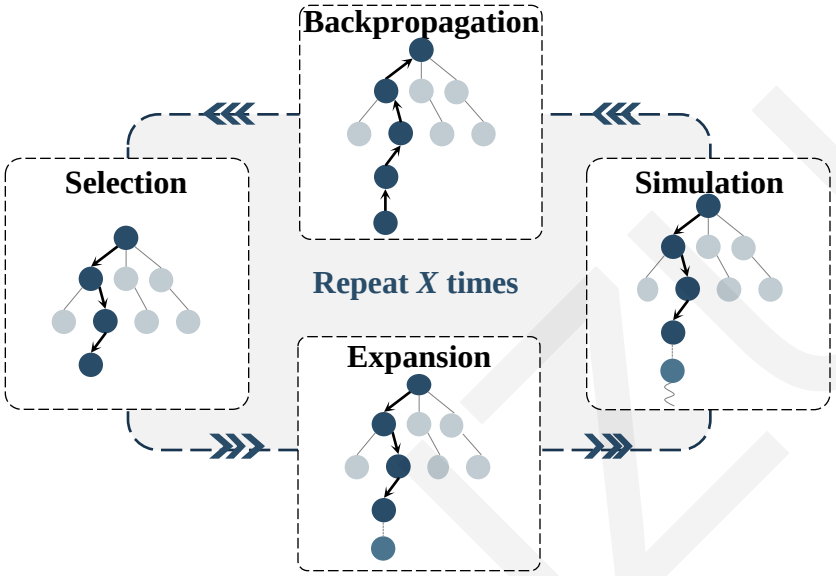

Fig. 2 Process of the MCTS algorithm

- **AI-driven strategy**: Bringing AlphaGo's logic to high-speed aerial combat.
- **MCTS closed-loop**: Continuous strategy refinement via four-step iterative search.
- **Optimal approximation**: Stochastic simulation for robust decisions in dynamic environments.

Online Pursuit–Evasion Architecture

Algorithmic adaptation

- **Continuous-domain extension**: Adapting MCTS from discrete grids to handle continuous action spaces.
- **Heuristic Guidance**: Leveraging expert experience via physics-informed heuristics to guide the search.

Operational workflow

- **Integrated decision loop:** Autonomous detection → Online search → Optimal execution.

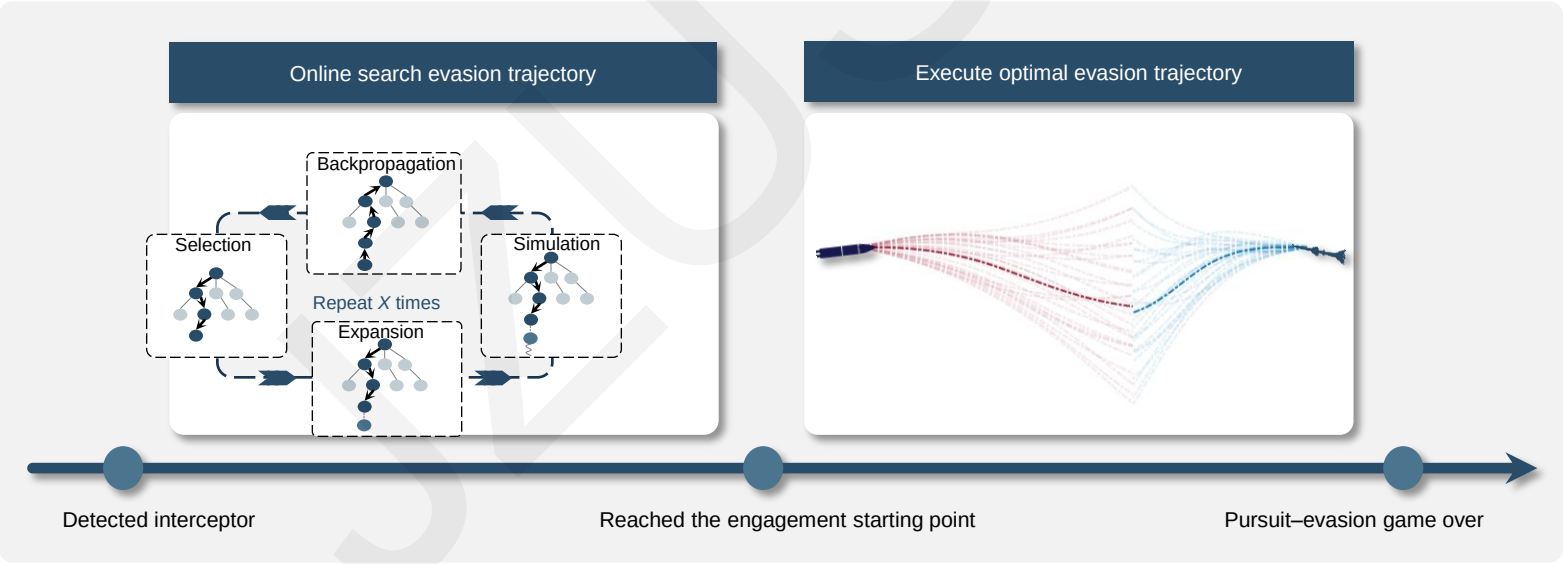

Fig. 3 MCTS-based HSV evasion strategy process

Conclusion: A New Paradigm

High interpretability: Providing transparent decision trails through tree-structured search, overcoming "black-box" limitations, and enhancing decision credibility.

High real-time performance: Achieving millisecond-level response and decision-making through algorithm light weighting and parallel acceleration.

High robustness: Effectively handling interceptor strategy uncertainties and complex environmental disturbances to ensure decision stability.

Chess-style strategies: Beyond board domination—reshaping the future of high-speed adversarial engagement.