TrackAiR: Optimal Tracking of Moving Aerial Targets With Online Reinforcement Learning

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Over the past decade, deterring aerial threats such as enemy missile, rocket, and drone technology have become critical in the defense industry. New threats are resistant to the physics-based models of the past, and are performing more complex and unpredictable maneuvers. We formulate the elimination of an enemy aircraft as a game-theory problem between a pursuer and an evader. Online Reinforcement Learning (RL) methods employing an actor-critic structure are designed to solve the optimal tracking problem through the use of approximate dynamic programming (ADP). This is done by approximating the solution to the Hamilton-Jacobi-Bellman Equation. The tracking problem is designed to minimize the error between the agent state and the desired trajectory, as well as the energy (fuel), expended. Instead of converging to a stable value like traditional control methods, optimal tracking instead tracks a desired trajectory or signal provided, which is more applicable to real-world use. This learning is done online, and without any prior knowledge of the dynamics of the evader, leading to the pursuing aircraft adapting to the state of the evader in real time. The applicability of these methods are demonstrated through simulation of a 2D Dubins Car: a constant velocity swiveling robot model that is commonly used to represent the projection of moving fixed-wing aircraft. The simulation showed the TrackAiR algorithm is able to perform a traditional search and destroy mission by successfully intercepting a representation of an enemy aircraft.

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