Abstract

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Have you ever wondered about nature's precision and adaptability? Millions of years of evolution have sculpted creatures perfectly for survival, even without understanding the universe's physics. Similarly, in the realm of machine learning, particularly Reinforcement Learning, we witness a parallel process of exploration, learning, and evolution.

The research begins with the construction of an ornithopter(robotic bird) using techniques like 3D printing and pultrusion. The focus is on designing aerodynamic wings that generate both lift and thrust. By incorporating the perforation feature observed in real bird wings, a 12% improvement in efficiency is achieved. Furthermore, a novel bio-inspired mechanism is developed to generate diverse wing tip motion, enhancing the ornithopter's agility to replicate the agile flight of a bird.

The study then integrates intelligence into the ornithopter. A Recurrent Neural Network (RNN) based controller is designed using post-processed flight data, enabling the ornithopter to learn from past experiences and make better future decisions. Then we discuss the integration of a Reinforcement Learning (RL) strategy that allows the ornithopter to handle novel scenarios. Training is conducted using a digital model in a simulated environment like OpenAI Gymnasium, preparing the ornithopter for real-world challenges.