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MARS EXPLORATION SYSTEM BASED ON FLAPPING WING DRONES

Abstract

To address the challenges of complex terrain and thin atmospheric conditions in Martian exploration, this study proposes an innovative air-ground collaborative detection system employing bio-inspired flapping-wing drone. This coordinated system overcomes the spatial constraints of conventional exploration paradigms through dynamic collaboration between aerial ornithopters and surface rovers. The flapping-wing aircraft features an X-shaped modular detachable wing configuration with tailless design, achieving multi-modal flight capabilities including hovering, rapid horizontal flight, and sharp-angled turns through a novel actuation mechanism that enables independent vector control of two wing pairs. During launch, the integrated system is housed in the lander's upper payload compartment, protected against launch acceleration and extreme temperatures through damping structures and composite thermal insulation. Deployment employs an intelligent release strategy, utilizing robotic arm assistance for rapid wing-body assembly via snap-fit connectors. A hybrid power system combining flexible solar films with high-density battery arrays supports multiple short-duration daily flight missions. The collaborative navigation architecture utilizes aerial imaging from flapping-wing aircraft to enhance surface rover path planning, while the rover serves as both spatiotemporal reference for autonomous navigation and mobile landing platform. Advanced collaborative mission planning enables joint decision-making for complex exploration tasks. Ground simulation results demonstrate over 200