Implementation of Adaptive Compliant Mechanism Networks for Force Management and Enhanced Structural Longevity in Morphing Wings

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Morphing wing technology promises improved aircraft efficiency by optimizing aerodynamics across flight regimes. However, widespread adoption faces a fundamental challenge: excessive stress concentrations at shape-changing interfaces cause structural fatigue and premature failure. This creates a "morphing paradox" where structures must simultaneously allow shape change while bearing aerodynamic loads. This research introduces an innovative force distribution system that redirects internal forces away from critical stress regions through a specialized lattice architecture. This project utilizes SLA printing to fabricate variable-thickness compliant mechanisms that integrate with a morphing wing platform. Strain gauges monitor force distribution under various conditions, comparing baseline performance with the adaptive system. Mathematical modeling and finite element simulations provide theoretical benchmarks for experimental validation. The experimentation focuses on reducing peak strains and enhancing distribution uniformity throughout the structure. Analysis methods include comparative strain assessment, distribution mapping, response time measurement, and parameter optimization studies. The results show that strategic force redistribution extends component lifespan without compromising morphing functionality. This approach functions independently alongside primary morphing systems, enabling separate optimization of shape adaptation and structural integrity. By addressing this critical limitation, this research contributes to advancing more efficient and sustainable aircraft technologies.

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