A Novel Autonomous Vertical Take-Off and Landing (VTOL) Aircraft Using a Variable Thrust Control Vector and Morphing Wing Configuration System

Pokkunuri, Samhita (School: Old Bridge High School)

Vertical takeoff and landing (VTOL) of unmanned aerial vehicles (UAV) have many real-world aircraft applications, including intelligence, surveillance, reconnaissance, search, and rescue, while extending its fly range, speed, and endurance capabilities. This study aims to build a novel intelligent autonomous UAV that can perform VTOL with low weight and high payload without heavy launching and recovery infrastructure, factors typically needed for the current aerial systems. A four-propeller variable thrust vector control aircraft was modeled and developed for improved aerodynamic efficiency to reach desirable hover height before transitioning into level flight mode. The nonlinear dynamic flaps on the counter-rotating propellers control the vehicle's angular velocity during the transition between hover and fly modes to minimize external disturbances and achieve attitude stabilization. A machine learning guidance control system expands the folded wings during hover mode to achieve the most significant power reduction and a stable transition between fly modes. Extensive experiments showed a 20% flight endurance improvement and 33.5% payload improvement between with-variable-thrust-vector control and without-variable-thrust-vector control. The morphing wing structure and smart guidance system achieved a 30% better power consumption from hover to forward flight mode, with a maximum wing span of 48.5 cm. The results from this study provide strong evidence that such advanced VTOL UAV systems can be deployed and retrieved with substantial power reduction and increased flight time without relying on infrastructure in remote areas or disaster zones.