

# Faculty Project Information

<b>Automated Algorithm Design Framework for Mission-Specific UAV Design</b>	
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Research Field:	Automated Algorithm Design, Machine Learning, Optimization
<b>Brief Description</b>	
<p>This project develops an automated algorithm design (AAD) framework that generates unmanned aerial vehicle (UAV) designs tailored to specific mission requirements. The framework automatically synthesizes and adapts optimization strategies that search over airframe geometries, sizing, and key subsystem parameters for designated tasks such as long endurance surveillance, cargo delivery, or low noise operation in urban environments. The work will be conducted primarily at the software level using computational models of aerodynamics, performance, and mission profiles together with AAD methods. The initial focus will be on virtual conceptual design, optimization, and benchmarking in simulation, while keeping the geometry representation compatible with downstream manufacturing workflows so that selected designs could be exported as three dimensional models for later fabrication by additive manufacturing or conventional methods when opportunities arise.</p>	
<p>The project will begin with a prototype phase using established UAV conceptual design test cases from the literature. In this phase we will define standardized parametric configuration spaces covering wing planform, tail configuration, fuselage layout, and propulsion sizing.</p>	
<p>We will integrate existing aerodynamic and mission performance analysis tools to create an evaluation pipeline that automatically computes mission performance metrics from any given configuration. This establishes a solid foundation for AAD experiments where the system automatically synthesizes optimization strategies rather than using manually selected algorithms. Building on this prototype we will introduce the core research innovation which is an AAD framework that configures optimization strategies for UAV configuration problems.</p>	

Instead of choosing one fixed optimization algorithm, the system will automatically design and adapt algorithmic strategies by composing and tuning components such as representation schemes, variation operators, selection mechanisms, hybrid local search steps, and evaluation schedules based on performance feedback on standardized UAV design benchmarks. The framework will orchestrate a portfolio of automatically designed algorithms over a shared benchmark suite of mission oriented design tasks and will support rigorous comparative experimental analysis across many algorithm configurations on identical UAV design problems. This architecture is intended to deliver several advances for automated UAV design and for empirical research in optimization. It will reduce design cycle time by discovering algorithmic strategies that exploit structure in the UAV configuration space, improve design quality by enabling multi objective search over performance, robustness, and manufacturability guided by automatically tailored algorithms, and provide a systematic empirical basis for comparing families of algorithm designs on well defined UAV benchmarks.

In the longer term, the use of explicit three dimensional geometric representations will allow selected virtual designs to be transferred to computer aided design tools and then fabricated as physical prototypes through three dimensional printing or other manufacturing processes, enabling physical validation when resources permit.

#### **Expected Outcome(s)**

- At least one peer reviewed publication and a potential patent on the automated algorithm design framework for UAV configuration and benchmarking
- A functional software prototype that can generate and evaluate UAV concepts for specific missions using automatically designed optimization algorithms
- A documented benchmark suite and experimental protocol for comparing multiple algorithm designs on UAV configuration tasks.

#### **Requirements for Student Applicants**

- Strong programming skills in Python and familiarity with numerical computing and scientific libraries
- Knowledge on machine learning and optimization
- Basic knowledge of aerodynamics, flight mechanics, or aircraft and UAV design principles, or strong motivation to acquire this knowledge quickly
- Experience with data processing, experimental design, and reproducible research including version control and experiment tracking

**Additional Requirements for the Project**

- Access to compute resources including central processing units and graphics processing units for large scale algorithm design experiments and simulation runs
- Optional access in later stages to manufacturing and prototyping facilities that can import three dimensional models from the software framework for fabrication and physical testing of selected configurations