Urban Cargo Transport UAV
NRT Aerospace

By: Niko Giannakakos, Rafael Barreto, Tejas Bhavsar

Department of Systems & Industrial Engineering

KENNESAW STATE UNIVERSITY

Mission Statement

Design a short range Unmanned Aerial System capable of receiving and delivering packages autonomously.

Design shall have a focus on:

- Reliability
- Profitability
- Fully automated
- Low-noise

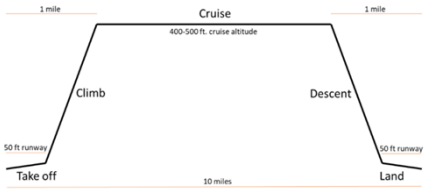

Figure 1: Mission profile of UAS system

Design Requirements

- As a design competition for NASA, the goal of this project is to design an unmanned aircraft system (UAS) to deliver packages to urban environments with the aid of an unmanned aerial vehicle (UAV).
- Design requirements include (but not limited to):
  1. Must traverse distance of takeoff-to-landing minimum of 10 miles
  2. 10-mile travel should be time < 10 minutes
  3. Must ascend and descend an altitude of 400 ft with 1 mile of takeoff and landing
  4. Cruise at altitudes of 400 – 500 ft
  5. Fly in rain (not snow)
  6. UAS deliver 2 packages without human intervention

Verification Approach

Conceptual design verification used initial design estimations to calculate approximations of aircraft characteristics.

Preliminary design verification utilized iterative process to refine data. Creation of initial CAD model (figure 4) was used for FEA and CFD simulations to back up calculations.

Aircraft design and performance underwent quantitative analysis to backup all design choices.

Figure 2: CAD render of NRT UAV made in SolidWorks

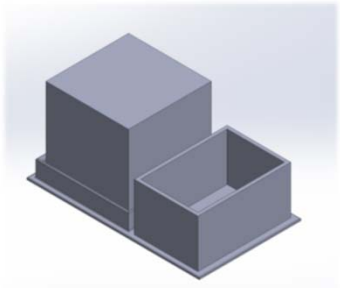

Figure 3: UAV Avionics plus Package compartment

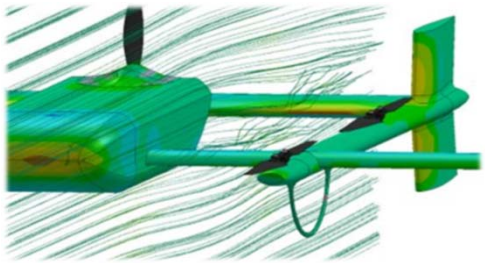

Figure 4: CFD simulations for UAV

Control Systems

System	Function	Cost (USD)
Adafruit Ultimate GPS	GPS	$39.95
Adafruit HTSs221	Thermal/Humidity	$6.95
Carbon Fiber	Housing/Shell/Body	$500.00
Collision Avoidance	Avoid Obstacles	$17.46
360 Camera	Full Maneuverability	$99.00
Pusher Motor	Thrust	$207.95
VTOL Motor X 4	Lift	$60.95
Battery (1600 mAh)	Power	$325.00-579.00

Table 1: Control systems function and cost

Figure 5

Figure 6

Motors

Forward Flight - KDE600XF-1100, Figure 5

VTOL - KDE2315XF-2050, Figure 6

Design Process

Initial TOPSIS compared historical UAV design and help select which one is best suited for our mission profile. A hybrid fixed wing-VTOL style UAV was developed. Aircraft configuration was based on a decision matrix of key components. Factors with highest priority were weight, cost, mission influence,

- **Wing position: Mid-wing** – enabled storage of payload below fuselage
- **Propulsion: Pusher-propeller** – increase wing lift efficiency and provide space in front for payload storage and drop-off
- **Empennage type: Boom tail** – added surface area for VTOL motors. Protective shroud for propeller
- **Preprogramed Avionics/Payload -** Flight trajectory and payload tray shown in figure 3, will be loaded into craft to reduce loading time.
- **Safety -** Folding props reduce strike damage and a parachute reduces the damage in the case of entire failure

UAV Calculated Performance

Approximate W_0 : 35 lb	$(W/S)_{cruise}$: 0.019 lb/ft^2
Aspect ratio: 6	$(W/S)_{stall}$:0.334 lb/ft^2
Approximate Wingspan: 4.18 ft	V_{stall} : 12.47 ft/s
Main Airfoil: MH-83-iL	V_{cruise}: 45.6 ft/s
Root cord: 1.4 ft	V_{climb}: 33.7 ft/s
$(L/D)_{cruise}$: 0.866	$(T/W)_{prop}$: 0.011
Tail moment arm: 2.2 ft	$(T/W)_{cruise}$: 0.82
$S_{vertical\ tail}$: 0.222 ft^2	$(T/W)_{takeoff}$: 0.33
$S_{horizontal\ tail}$: 0.616 ft^2	$(P/W)_{cruise}$: 0.127 hp/lb

CONCLUSION

Our concept UAV addresses all major project requirements. The fixed-wing hybrid VTOL configuration allows for the UAV to navigate close urban environments. Using quantitative and qualitative analyses we can verify that our UAV meeting design requirements.