Design of a Jet-Powered Remote Control Aircraft for use at an Intercollegiate Competition

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Recommended Citation
"Design of a Jet-Powered Remote Control Aircraft for use at an Intercollegiate Competition" (2019).
Standar Symposium Posters. 1584.
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Design and Construction of a Jet-Powered Remote Control Aircraft
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University of Dayton

Mission
- Launch from 6 x 6 ft area
- Create less than 72 dBA of sound during flight
- Launch, identify target, and land in under 5 minutes
- Top speed of 200 mph
- 15nm range and followed by a 10 min loiter
- Build for under $5000

**Initial Sizing**
- Max Take Off Weight determined by T/W of 1.5 and engine max thrust of 19 lbs
- Wing area determined from historical average wing loading of 3.2 lbs/ft^2
- Fuel payload determined from engine tests
- Tail sizing done using historical tail volume coefficients
- Modeled Using OpenVSP design software
- Designed to be capable of hand launched takeoff
- Symmetrical NACA 0018 airfoil used for tail
  - Thick enough to house servos
- Cambered NACA 2412 used for wing to produce necessary lift

**Weight Buildup**

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payload</td>
<td>1.12</td>
</tr>
<tr>
<td>Structure</td>
<td>3.58</td>
</tr>
<tr>
<td>Propulsion</td>
<td>23.2%</td>
</tr>
<tr>
<td>Powerplant</td>
<td>7.3%</td>
</tr>
<tr>
<td>Avionics/Electronics</td>
<td>7.1%</td>
</tr>
<tr>
<td>Camera and Gimbal</td>
<td>0.44</td>
</tr>
<tr>
<td>Fuel System Components</td>
<td>0.8%</td>
</tr>
<tr>
<td>Fuselage</td>
<td>2.68</td>
</tr>
<tr>
<td>Engine/mount</td>
<td>2.97</td>
</tr>
<tr>
<td>Camera/Gimbal</td>
<td>0.44</td>
</tr>
<tr>
<td>Thrust Tube</td>
<td>0.73</td>
</tr>
<tr>
<td>Servos (ailerons)</td>
<td>0.31</td>
</tr>
<tr>
<td>Servo H-Tail</td>
<td>0.16</td>
</tr>
<tr>
<td>Servo V-Tail</td>
<td>0.16</td>
</tr>
<tr>
<td>Electronics</td>
<td>0.25</td>
</tr>
<tr>
<td>Avionics Battery</td>
<td>0.22</td>
</tr>
<tr>
<td>Engine Battery</td>
<td>0.25</td>
</tr>
<tr>
<td>Fuel Tank</td>
<td>0.47</td>
</tr>
<tr>
<td>Fuel System Comp.</td>
<td>0.10</td>
</tr>
<tr>
<td>Total Weight (lbs)</td>
<td>14.57</td>
</tr>
</tbody>
</table>

**Structural Design**
- Carbon Fiber Fuselage Skin
- Flame Tube
- Rudder
- Elevator
- Engine
- Control Surface Servos
- Camera and Gimbal
- Leading Edge Caps
- Ribs
- Spars
- Aileron
- Fuel Tank
- Bulkheads
- Carbon fiber rods (spars) and balsa wood (ribs, leading edge caps, trailing edge devices)
- Skin of wings are made of fiberglass composites with carbon fiber strips
- Designed and sized using Autodesk Fusion 360

**CG Location/Static Margin**
- Full Fuel CG: 25.69%
- Zero Fuel CG: 12.08%
- Neutral Point
- Total Weight w/ Fuel (lbs): 14.57
- T/W Ratio w/ Full Fuel: 1.33

**Jet Engine Testing**
- Experimented tested the engine to determine thrust specific fuel consumption curve and choose high efficiency operating points of the engine for the flight
- Used data to calculate fuel needed for duration of the endurance mission
- Led to sizing of fuel tank

**Manufacturing Process**
- Fuselage mold was constructed with 3D printed material
  - 4 layers of carbon fiber were laid up in mold to create skin
  - Aircraft plywood used for bulkheads and internal support in fuselage
- Wings were built with carbon fiber rods (spars) and balsa wood (ribs, leading edge caps, trailing edge devices)
- Skin of wings are made of fiberglass composites with carbon fiber strips
- Detailed component design done in Autodesk Fusion 360

**Future Work**
- Tests for endurance and range
- Implement autopilot for extending applications and functionality
- Construct a better fuel system (layout) to shrink Static Margin Range
- Use knowledge of jet engine propulsion for future projects
- Build upon knowledge of experimenting in future designs and studies by the team