Flight Performance of Small Scale Porous Wings

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Background and Objective
• Next generation of small unmanned flying vehicles (about 30 cm wingspans)
• Civilian and military operations
• Tiny disturbances to airflow can cause dramatic instabilities in flight
• Dr. Geoffrey Spedding’s current research studies the aerodynamic effects on small wings of about 30 cm at Reynold’s numbers of $5 \times 10^{-4}$
• Objective is to investigate the effects of porosity on small wings with goal of improved gliding flight

Skills Learned
• MATLAB
  • Plotted Distance, L, D, and L/D
  • Assisted PhD student Michael Kruger perform calculations to determine numerical models based on input values
• Statistics
  • Calculated standard deviation and propagation of error for all collected data (gliding flight distance)
• Hands-on construction
  • Designed and constructed a launcher to consistently launch glider in a straight path
• Electrical Circuit
  • Assisted PhD student Joe Tank to amplify the signal from a pressure transducer by 100x
• Force Balance Calibration
  • Assisted PhD student Yohanna Hanna to calibrate force balance for Dryden Wind Tunnel experiments

Experimental Setup

Birds’ porous wings are the inspiration behind the project

Wingspan: 55 cm

$$D = W \sin \theta$$
$$L = W \cos \theta$$
$$\tan \theta = \frac{1}{(L/D)}$$

Relation to my Stem Coursework
• Real-World usage of equations and concepts learned in physics and calculus classes
• Use of extensive mathematical and programming knowledge

Results

<table>
<thead>
<tr>
<th>Plane Number</th>
<th>Hole Size (mm)</th>
<th>Number of Holes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>34</td>
</tr>
<tr>
<td>2</td>
<td>1.5</td>
<td>34</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>34</td>
</tr>
<tr>
<td>4</td>
<td>1.5</td>
<td>16</td>
</tr>
<tr>
<td>5</td>
<td>1.5</td>
<td>34</td>
</tr>
<tr>
<td>6</td>
<td>1.5</td>
<td>70</td>
</tr>
</tbody>
</table>

Conclusions
• No statistically significant result was achieved
• More tests are needed with more precise equipment to determine whether porosity has an effect on gliding flight

Acknowledgements
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