Gary Stevens
5/24/17

Sustained Flight Power Requirements, Minimum Weight Configuration

Filename: Sustained_Flight_Power_Requirements_Min_Wt_052417

Assumptions:

- Flying weight is 8.944 lb. No telemetry system. One 2S3.3AH LiPO battery installed.
- Airspeed is 24.59MPH = 36.07ft/s = 10.99m/s = 39.57Kilometers/hr
- L/D of wing is 20.76*, so wing drag is 8.944/20.76= .4308 pound (*Clark-YH & aspect ratio of 9.68)
- Drag Force= 1/2 * mass density * Velocity^2 * Cd * Area, mass density is 1.225Kg/m^3
- Fuselage drag, worst case, 4”x4”square, thin flat plate (Cd=1.28 at 10.99m/s: 0.740Newton = 0.166 pounds force
- Empennage drag, area: 10.5sq-in, Cdrag~0.2, at 10.99m/s, Drag=0.096Newton = 0.022 pounds force
- Total drag: .431 + .166 + .022 = .619 pounds force
- Outrunner motor and ESC efficiency is 77%
- Propeller efficiency is 72%
- Solar-electric power production = 8.0V @ 9.45A = 75.6W (for zenith-Sun angle of 20°)

Sustaining Thrust = Drag= 0.619 pound

Sustaining Power = (0.619lb)(36.07ft/s)/(550ft-lb/s/HP) = 0.0406HP

Sustaining Power = (0.0406HP)(746W/HP) = 30.28W (thrust power)

Available power into ESC/ motor: 75.6W

Available shaft power out of 77% efficiency motor: 58.21W

Available thrust power out of 72% efficiency prop: 41.91W

Required Electrical Power = (30.28W mechanical) / (0.554 combined efficiency) = 54.7W (electrical power)

Surplus Electrical Power = 75.6W – 54.7W = 20.9W

Power Margin: 20.9 / 75.6 = 27.6% (in minimum weight configuration)

Climb Rate Using Surplus Power = (20.9W)(0.554 efficiency)(1HP/746W)(550ft-lb/HP-s)(1/8.944 lb)

Climb Rate Using Surplus Power = 0.937ft/s (or 56.2 ft/minute)

Conclusion - Looking Ahead

Lighter construction techniques and materials, plus better solar cell layout could substantially improve the power margin. A 20% increase in wingspan (from 10' to 12') would allow 50% more solar cells in the wing. The higher aspect ratio would improve the finite-wingspan L/D ratio by 11%. Utilizing cut solar cells would allow a high-coverage tapered-wingtip design that would further reduce the wing's induced drag by 7-10%.