Improving Operational Effectiveness of Tactical Long Endurance Unmanned Air System (TaLEUAS) by Utilizing Solar and Thermals Energy

**MS candidate:** LT Nahum Camacho (MX NAVY)

August 20th, 2013
**Objective:**
Develop a system of multiple cooperating autonomous gliders that harvest thermal and solar energy to achieve extended endurance that will be used to provide long duration network and communication coverage in a typical ISR mission.

**Scenario:**
Optimal energy management result can be achieved only when accounting for total energy that is comprised of the mechanical and electrical components.

**Goal** - optimize energy expenditures for the purpose of maximizing the mission objectives.
**Total mechanical energy** – utilize all available onboard instrumentation to estimate each component:

\[
E_{\text{tot}} = E_{\text{potential}} + E_{\text{kinetic}} = mgh + \frac{mV^2}{2}
\]

\[
E = \frac{E_{\text{tot}}}{mg} = h + \frac{V^2}{2g}
\]

\[
\dot{E} = \dot{h} + V\ddot{V} / g
\]

\[
\ddot{E} = \ddot{h} + (V\dot{\ddot{V}} + \dot{V}^2) / g
\]
Solar Array Integration

**Concept:**
- Embed flexible solar panels without adversely affecting the aerodynamics of wing
- Develop and integrate onboard the power management system {batteries, MPT, lightweight protected wiring}

**Original system**

**Placement of solar panels**

**Impregnation process**
Sink Polar

- Measure of inherent descend rate in still air
- Velocity dependent
- Comparison when thermal (+ energy)

**Camp Roberts experimentation**
Photovoltaic energy

- Running systems onboard only with solar panel
- No propeller
- Energy gained stored in battery
- Charging system configuration works.
HIL setup based on Piccolo AP
- Based on real AP and onboard instrumentation
- Rapid code development and in-flight V&V

High Fidelity Soaring Simulator - Condor
- High fidelity glider model (6 DOF model).
- High fidelity simulation of unsteady atmosphere and thermal’s generation.
  - Strength, and location of thermals.
  - Motion with wind.
  - Decaying over time.

Developed and Implemented algorithms
- Sink polar online estimation
- Orbital polar online estimation
- Total energy estimation and thermal detection
- Thermalling guidance
- Autonomous soaring
- Probabilistic thermals mapping
Contributed to ME4822 Class Project

- **Search for a thermal**
- **Cooperate**
- **Stay in thermal**
- **Compete**

- Design energy harvesting control
- Thermal
- Design a long endurance ISR mission

- TALEUAS - Tactical Long Endurance UAS
- CRUSER, ARL and USMC sponsored project

- ME4822=>Design your intelligent controller in MatLab/Simulink

- Compete against human pilots online
Next status update - November 2013

Questions?