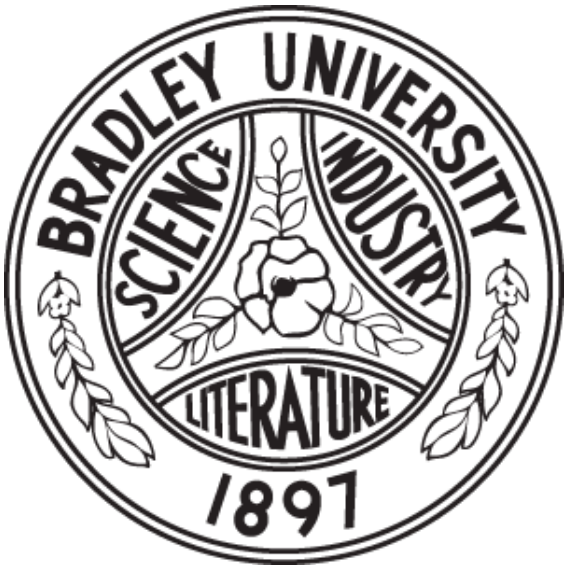
Multiple UAV Coordination



By: Ethan Hoerr, Dakota Mahan, Alex Vallejo

Team Advisor: Dr. Driscoll

Department: Bradley ECE

Purpose

- To create an overhead image map of a defined land plot using autonomous Unmanned Aerial Vehicles (UAVs)

Background

- Advantage of using multiple UAVs
- How to coordinate multiple UAVs
  - Individual flight plans
  - Wandering until region is cleared
  - Leader-follower configuration

Background

- Use of “swarming” or “flocking” coordination scheme
- Distribution of task responsibilities based on vehicle capabilities
  - Leader-follower configuration

Previous Work

- Research: *Coordinated Mapping and Exploration for Autonomous Soaring*
  - Depenbusch and Langelaan, 2011
  - Uses multiple UAVs to estimate vertical wind speed of discrete regions in an air space

Previous Work

- Patent: *Multi-UAV dynamic formation control method*
  - Hall, et. al, 2012 for Beijing University of Aeronautics and Astronautics
  - Establishes method for maintaining multiple UAV formation
  - Establishes method for obstacle avoidance

Previous Work

- Research: *Flocking with Fixed-Wing UAVs for Distributed Sensing*
  - Quintero et. al, 2013
  - Leader-follower configuration for visual ground target tracking
  - Distributes task responsibilities based on UAV privileges

Previous Work

- Patent: *Controlling unmanned aerial vehicles as a flock to synchronize flight in aerial displays*
  - Stark et. al, 2013 for Disney Enterprises, Inc.
  - Choreographed air shows
  - Ground control system uploads flight plan to individual UAVs
  - Each UAV executes its specific, choreographed flight pattern
  - Non-swarming

Possible Applications

- Commercial
  - Agriculture, civil engineering, professional photography, mapping
- Research
  - Environmental science, tracking natural disasters
- Government
  - Security, defense, intelligence
- Search and Rescue

Design Constraints & Specifications

- Battery power
  - UAVs must have enough power to complete task
- UAV payload
  - UAVs must fly while carrying any additional equipment
- Collision avoidance
  - People, trees, buildings
- Altitude
  - Advisor Spec: Between 7-20 feet
- FAA Limitations
  - Cannot exceed 400 ft altitude
  - Must have manual control override

Detailed Budget

- Four Quad Copters
- Four Emitters
- Four Receivers

The Purchasing Decisions Process

- Defining the Problem (Current vs Ideal situation)
- Information Search (Internal and External)
- Alternative Evaluation (Evaluation Criteria vs. Consideration Set)
- Purchase Decision (When & Where)
- Post-purchase Behavior (Cognitive Dissonance)

Cost-Benefit Analysis(CBA)

- Two purposes
  - To determine if this is a sound investment
  - To provide a basis for comparing project investments(total expected costs vs total benefits)

Economic Analysis

- How will this effect the market?
- Scarce Resources
- Opportunity Costs, Social Costs, and Benefits

Gantt Chart

- Order Parts (Research)
- Interfacing Software
- Interfacing Hardware
- Complete Assembly
- Debugging
- Prepare Presentations

Progress Presentations

- November
- February
- April

Division of Labor

Ethan Hoerr	Dakota Mahan	Alex Vallejo
ADC	Image Processing	Hardware
Skywalker Interface with Microcontroller	Ardrone setup	Logic Analyzing

Societal and Environmental Impacts

- Who is affected?
- What is the affect of our project on natural resources?
- Is development of our product safe?
- Is the development of our product ethical?
- What is the effect of the project on human welfare and on human rights?

Societal and Environmental Impacts cont.

- What could go wrong?
- What is the potential that the outcome of our project will contribute to accidents and harm?
- Is our product safe?
- How can it be made safer?
- Is it safe for children and disabled persons?
- Is it easy or likely to be used in an unsafe way?

Societal and Environmental Impacts cont.

- Can this product be used unlawfully and unethically?
- What is the risk to the consumer?
- What is our potential liability?
- How could customers be made aware of the risks?
- How does the risk compare to the present situation in the market?

Conclusion

- Background
- Design Approach & Methods of Solution
- Economic Analysis
- Division of Labor
- Societal & Environmental Impacts

Flowchart (Mothership)

- Initialize Sensors (IMU & Front Camera)
- Manual vs Automatic (Autopilot)
- Collision Detection
- GPS Waypoints

Flowchart (Drones)

- Initialize ADC MUX & Sensors (Emitters/Receiver)
- Manual vs Automatic (Autopilot)
- Sensors
- PID Control Loop

References

- http://en.wikipedia.org/wiki/Mass_production
- http://forum.arduino.cc/index.php?topic=122014.0

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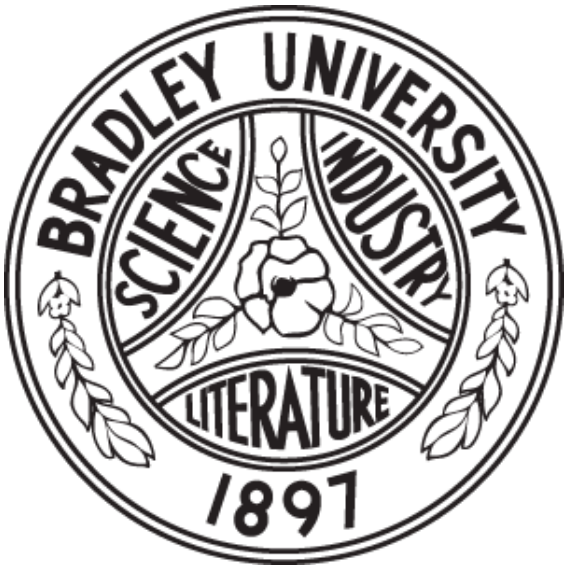

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