Meet the Development Team

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Battery Switching & Latching

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Controls & Electronics

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Controls & 3D Modeling

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System Integration

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Embedded Systems
BACKGROUND
Overview
Applications of UAVs
Overview
Applications of UAVs
Overview

Applications of UAVs
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Applications of UAVs
Introduction

Problem

Drones have extremely limited battery life (typical maximum of 20 mins)

- Limited range due to battery shortcoming
- Current approach: drones must land to recharge or switch battery
- Drones are needed in remote areas without infrastructure
- Setting up remote infrastructure is expensive

Environmental Monitoring  Offshore Monitoring  Border Security / Patrol  Precision Agriculture
Introduction

Solution

Switch drone battery in flight to allow “eternal flight”
Introduction

Solution

Switch drone battery in flight to allow “eternal flight”

Receiver navigates to Tanker using GPS coordinates
Introduction

Switch drone battery in flight to allow “eternal flight”

Solution

- Receiver navigates to Tanker using GPS coordinates
- Receiver lands on Tanker using computer vision and controls algorithm
Introduction

Switch drone battery in flight to allow “eternal flight”

Solution

Receiver navigates to Tanker using GPS coordinates

Receiver lands on Tanker using computer vision and controls algorithm

Tanker hot swaps battery from Receiver using custom battery switching mechanism
### Introduction

Switch drone battery in flight to allow “eternal flight”

<table>
<thead>
<tr>
<th>Receiver navigates to Tanker using GPS coordinates</th>
<th>Receiver lands on Tanker using computer vision and controls algorithm</th>
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<tr>
<td>Tanker hot swaps battery from Receiver using custom battery switching mechanism</td>
<td>Receiver undocks and takes off once battery is replaced</td>
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HARDWARE
Receiver and Tanker Model
Receiver
Parts Overview

1. Pixracer Flight Controller
2. Raspberry Pi Zero W
3. u-blox NEO-M8P GPS
4. Raspberry Pi Camera v2.1
5. Battery Holder Compartment

Weight: 1068 grams
Tanker
Parts Overview

1. DJI N3 Flight Controller
2. Raspberry Pi Zero W
3. u-blox NEO-M8P GPS
4. Actuonix Linear Actuator
5. Switching Base & Landing Alignments
6. AprilTag Platform

Weight: 3679 grams
Tanker
Schematic
Power Distribution
## Power Distribution

**Receiver Requirements**
- 4S 14.8V LiPo Battery

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<td>5V (2A)</td>
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<td>Raspberry Pi Zero W - 250mA</td>
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<td>Raspberry Pi Cam v2.1 - 150mA</td>
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<td>u-blox NEO-M8P Module</td>
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<td>Pixracer Flight Controller</td>
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**Tanker Requirements**
- 6S 24V LiPo Battery

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<td>Linear Actuator - 400mA</td>
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<td>2</td>
<td>5V (1A)</td>
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<td>Raspberry Pi Zero W - 250mA</td>
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<td>u-blox NEO-M8P Module</td>
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Power PCB
Power PCB

- Two layer PCB – 47 mm x 84 mm
- Receiver and Tanker circuitry on a single PCB
- Components include voltage level-shifting and backup battery IC
FUNCTIONALITY
Waypoint Navigation
Waypoint Navigation
Centimeter-Level GPS Accuracy

- Tanker determines own GPS coordinates with centimeter-level accuracy using RTK
- Tanker communicates GPS coordinates to Receiver over WiFi
- Receiver navigates above Tanker using GPS
Landing Control System
Precision Landing using Computer Vision

- AprilTag fiducial marker provides x, y, z (linear) and roll, pitch, yaw (rotational) coordinates
- Receiver uses Pi Cam to collect AprilTag inputs and runs a controls algorithm to land stably on Tanker
Controls Algorithm
Precision Landing Controls

- Hovers over AprilTag using PID controls algorithm
- Velocity, Position, and the Integral of Position are independently scaled and input into the system
- Algorithm works on XYZ directions independently
- Controller inputs emulate an RC system
Battery Hot Swap
Mechanical Battery Switching System
Battery Hot Swap
Individual Battery Case

Parts Overview

1. Neodymium Magnet
2. Copper Plate Connectors
3. Power/Ground Lines
Receiver Battery Holder
Parts Overview

1. Neodymium Magnet
2. Spring Compression Contacts
3. Power Lines
Tanker Switching Base
Parts Overview

1. Replacement Battery
2. Actuonix Linear Actuator
3. Linear Sliding Rail
4. Drained Battery Holder
DEMO
Thank you!

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