ETERNAL FLIGHT
Winter 2019 Final Design Review
DEVELOPMENT TEAM

Aditya Wadaskar (Lead)  Latching and Battery Switching
Kyle Douglas         Controls & Electronics
Richard Boone        Embedded Systems
Sang Min Oh           Design & Construction
Sayali Kakade        Embedded Systems
Applications of Unmanned Aerial Vehicles (UAVs) expanding in various industries:

- Agriculture
- Defense
- Surveillance
- Emergency Response
- Urban Planning
- Weather Forecasting
- Entertainment

and many more!
Problem: Drones have extremely limited battery life (typically up to 20 min)

- Limited range
- Current Approach: Drones must land and then recharge or switch battery
- Certain applications of drones are needed in remote areas -- applications include surveillance, wildlife monitoring, emergency response, etc.
- Setting up infrastructure in remote places for recharging and switching batteries is expensive.
- Need a more flexible solution, without rigid drone bases, to handle battery switching problem
Goal: Switch drone’s battery in flight to allow “eternal flight”

System will use a large drone (parent) to replace the battery of a smaller drone (child)

- Parent locates child using Real-Time Kinematic
- Child calibrates and lands on Parent using computer vision
- Drones latch using electromagnets
- Parent switches drained battery from Child drone
- After battery is replaced, Child drone undocks and takes off
DESIGN APPROACH

Physical Assembly:
1. Chassis, motors and flight controller -- Purchased and assembled.
2. Latching and battery switching mechanisms -- Rapidly prototyped in SolidWorks and 3D-printed components
3. Interfaced Raspberry Pi with OpenMV camera, RTK module, linear actuator, and electromagnets
4. Electronics and power management -- Designed PCB for both drones

Software:
1. Program communication of GPS coordinates between drones
2. Program DJI N3 Flight controller using DJI Onboard SDK on Pi
3. Program Pixracer flight controller using Dronekit on Pi
PARENT DRONE SCHEMATIC
PARTS OVERVIEW - PARENT

- **Tarot 680 Pro Frame**
  - **Tarot 4108 High-Power Brushless Motor**
  - **HobbyWing XRotor 40A-OPTO-ESC**
- **DJI N3 Flight Controller**
- **Raspberry Pi 3 B+**
- **Turnigy 6S 20C LiPo Battery**
- **Actuonix L16 Linear Actuator**
- **ublox Neo M8P-2 DGPS**
CHILD DRONE SCHEMATIC
PARTS OVERVIEW - CHILD

- ReadyToSky FPV Drone Frame
- CrazePony Motors
- Raspberry Pi Zero W
- OpenMV M7 Camera
- Pixracer Flight Controller
- HolyBro Radio Controller
- ublox Neo-M8P-02 DGPS
POWER DISTRIBUTION

Parent Drone Requirements (24V Battery)

- 7V (600mA)
  - Electromagnets (400mA)
- 5V (1A)
  - Linear Actuator (400mA)
  - Raspberry Pi 3 B+ (350mA)

Child Drone Requirements (14V Battery)

- 5V (2A)
  - PixRacer
  - Raspberry Pi Zero W (250mA)
- 3.3V (500mA)
  - OpenMV Camera (150mA)
Power Schematic: 24V → 5V

[Diagram of power schematic]
Power Schematic: 24V → 7V
Power Schematic: 14V → 5V
POWER PCB

● **Description:**
  ○ 2 layer PCB -- 47mm x 84mm
  ○ Combine parent and child circuitry on single PCB
    Components include voltage level-shifting and backup battery charging IC

● **Finished Soldering 2nd Respin**
  ○ Parent PCB load-tested and finished
  ○ Testing left for PCB on child drone
CURRENT STATUS - PARENT DRONE

- Drone stable and in-flight testing complete
- Latching mechanism using electromagnets complete
- PCB operates correctly

Next Steps:
- Complete battery switching mechanism
- Assemble battery switching on drone -- drone will be complete!
CURRENT STATUS - CHILD DRONE

- Drone stable and in-flight testing complete
- Interfaced with OpenMV camera

Next Steps:
- Load-test PCB
- Complete battery switching mechanism
- Program control system on Pixracer for landing with AprilTag
- Set up autonomous system for landing and take-off
FUTURE GOALS

Accomplished this Quarter:
● Have both drones flying stably
● Completed inflight testing for both drones
● Finished assembling parent drone
● Finished majority of battery switching mechanism
● Finished interfacing child drone with peripherals

Spring Quarter:
● Finalize hardware assembly and test battery switching
● Finish PID control to land on AprilTag
● Perform combined system-level tests on both drones
DEMO
ACKNOWLEDGEMENTS

Special thanks to:

- Yoga
- Brandon
- Carrie

Eric (Toyon)
Questions?