Air Surveillance Drones

ENSC 305/440
Capstone Project
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Group Members:

- Armin Samadanian
  - Chief Executive Officer
- Juan Carlos Diaz
  - Lead Technician and Test Pilot
- Afshin Nikzat
  - Lead Financial Planner and Lead Builder

Introduction

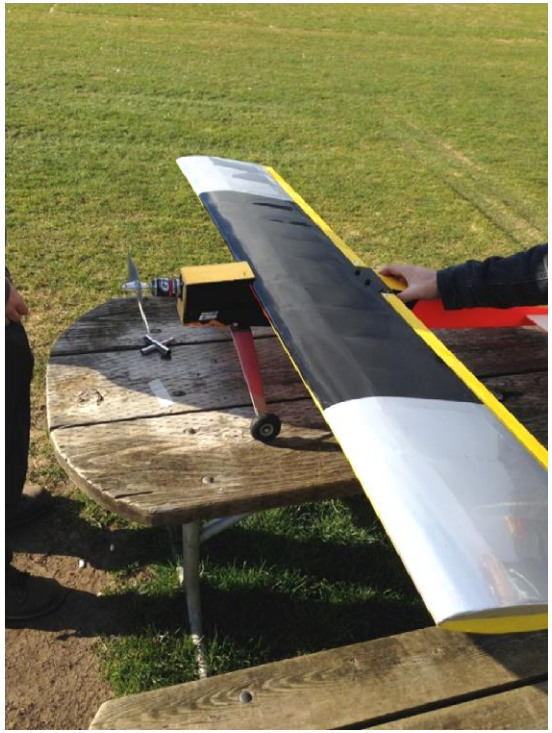
- Drones are mostly used for military applications
- They can be used in many other areas such as search and rescue, fire watch, maritime surveillance, security, aerial photography and most other air surveillance applications

Motivation

- Market
  - Need to expand drone's functionality
- Every year people are lost in places such as mountains and forests
  - The cost of using regular helicopters for search and rescue is around $1800 per hour
  - Mission stops at sunset
  - Solution?

Solution

- Using inexpensive and efficient drones



Competitors

- Mostly consist of quad-copters
- Much more expensive than our product
- More risk involved since quad-copters are very dependent on power and loss of power causes loss of device

Competitors

Name	Type of Product	Cost	Special Features	Flight time
Phantom 2	Quadrocopter	$1,300	-Controllable camera through Android and iOS -Display of footage on smartphone -GPS/ Autopilot -14 Megapixel HD Camera -Internal recording 32GB -Return home fail/safe -Telemetry	25 min
md4-200	Quadrocopter	$40,000	-GPS waypoint navigation -video goggles -Resistant to rain -Telemetry	35 min
md4-1000	Quadrocopter	$92,000	-GPS waypoint navigation -Resistant to rain -Telemetry	88 min
Dragon Flyer X4_ES	Quadrocopter	$9,000	-Internal recording of 32 GB -Gyro stabilizing for camera gimbal -HD camera -Thermo Imaging	15-20 min

Airplane design

- Ribs are Symmetrical for to have some aerobatic due to capabilities sudden change of direction
- Total area on wing: 4920 cm^2, Total weight: 3kg
- Wing loading ratio is 0.61 grams/cm^2
- Aspect ratio is 16:3
- Aileron ration to wing area is at minimum 10%
- Fuselage is mainly made by ply wood to increase strength
- Wings and other control surfaces are made out of balsa wood

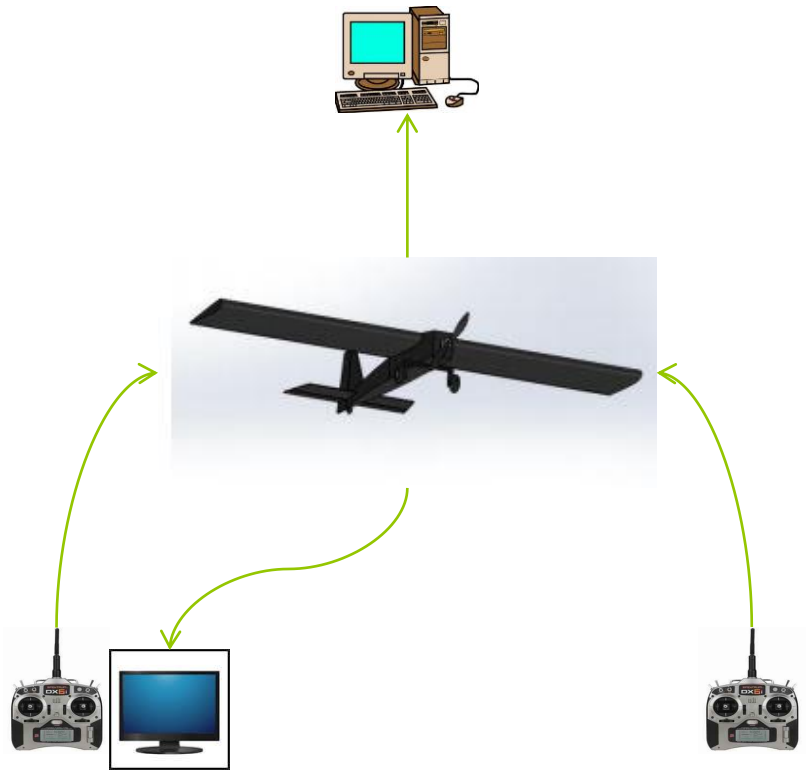
Original design

Plane Adjustments

- Wing span
- Reinforcement of wing
- Stabilizer
- Ailerons
- Landing gear

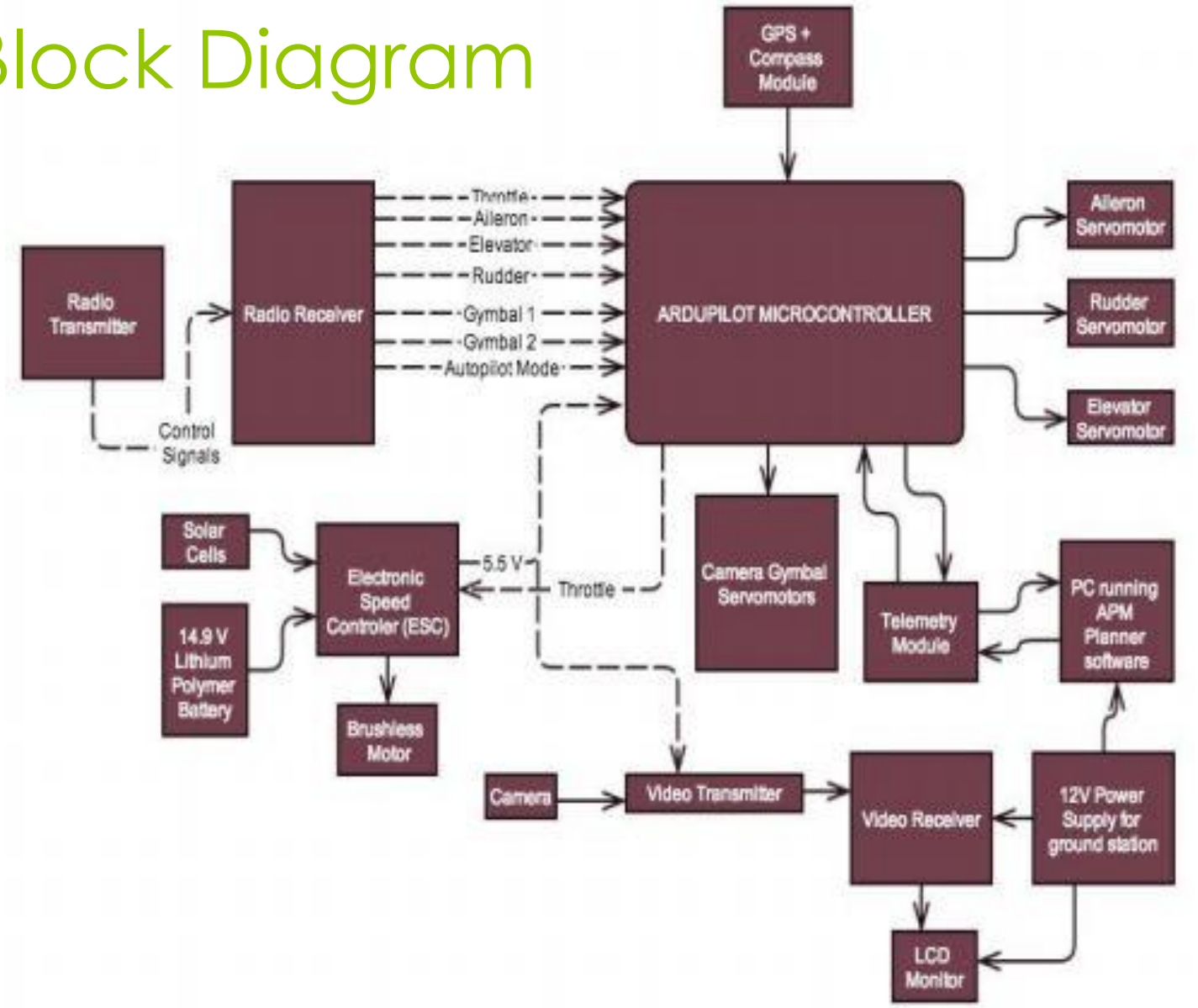
After Adjustments

System Overview



- Two modes:
  1) Auto
  2) Manual
  3) Return to launch
  4) Stabilize
- Autopilot is activated by transmitter or computer
- Another transmitter is used to control the camera movements
- Video transmitter sends video to LCD mounted on transmitter
- All location information is sent from airplane to ground station

Block Diagram



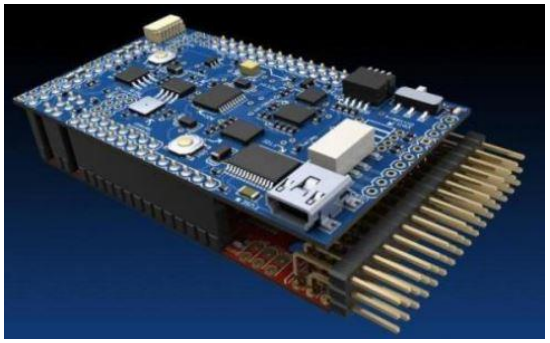
System Breakdown

- Composed of 4 subsystems:
  1) Radio System
  2) Autopilot System
  3) Video System
  4) Power System

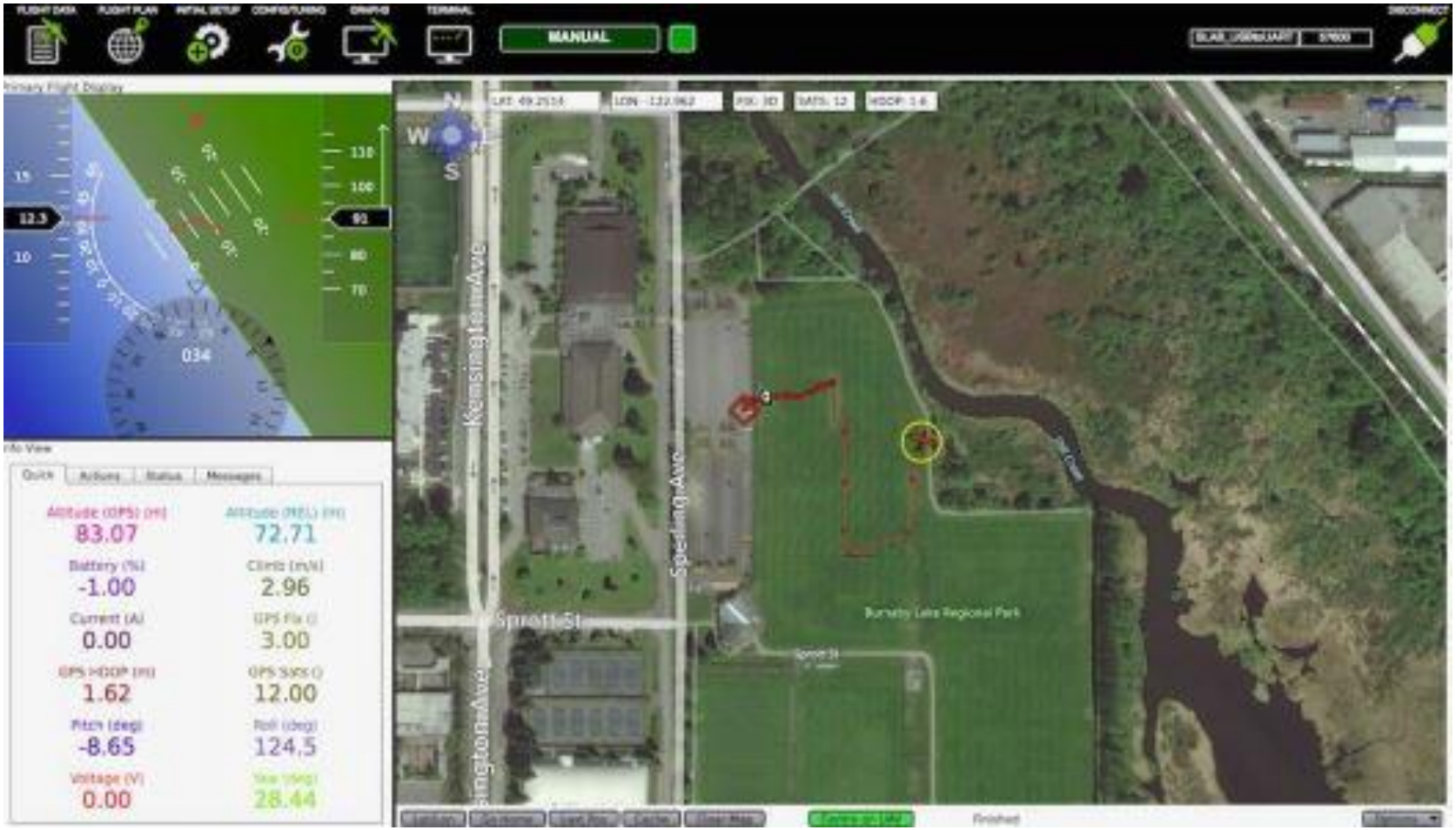
Radio System

- Ideal situation using a 9 channel 72MHz FM radio
- Due to shortage of budget, used 2 6-channel 2.4GHz FM (DX6i Spektrum) transmitter and receiver

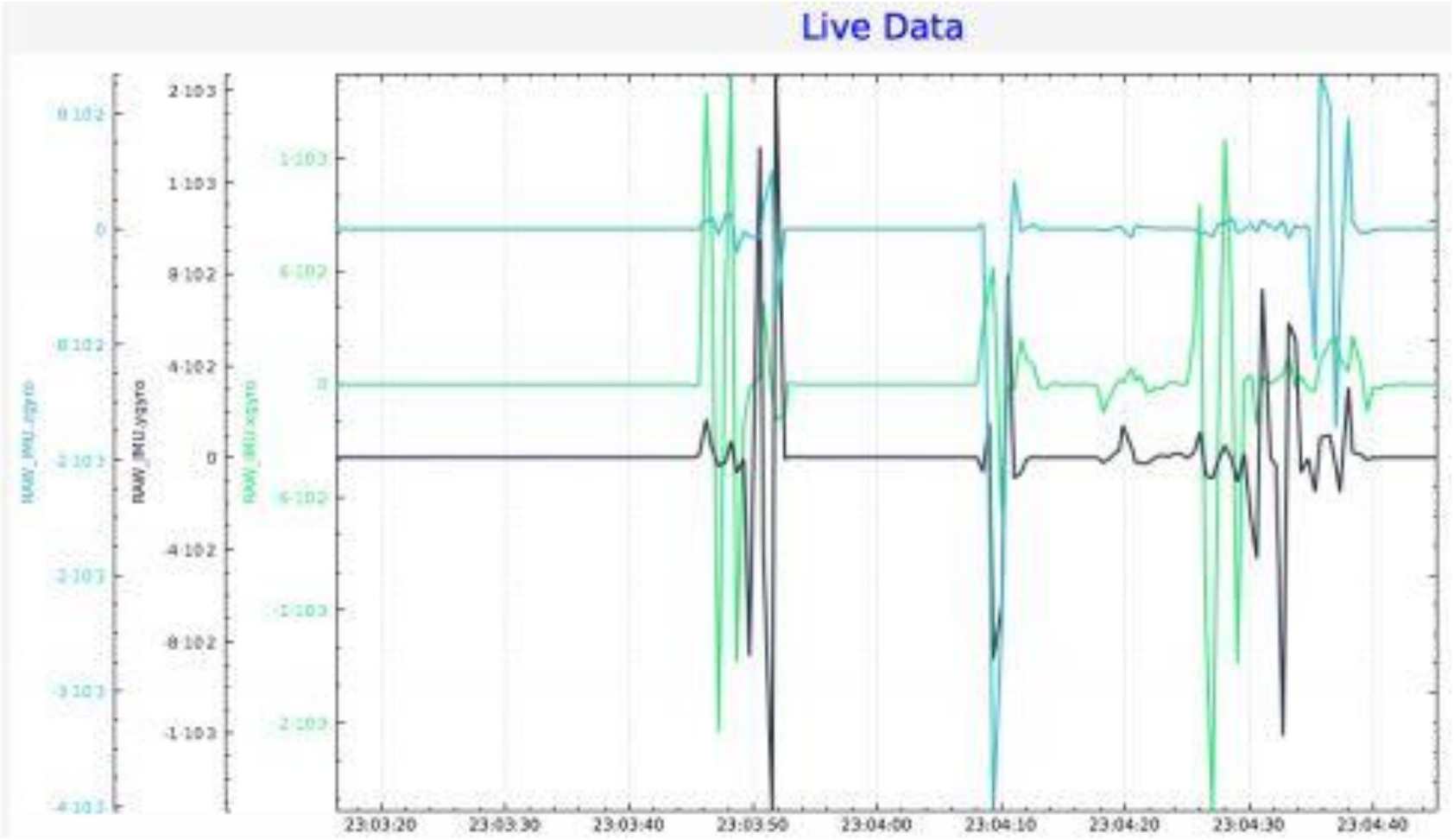
Autopilot



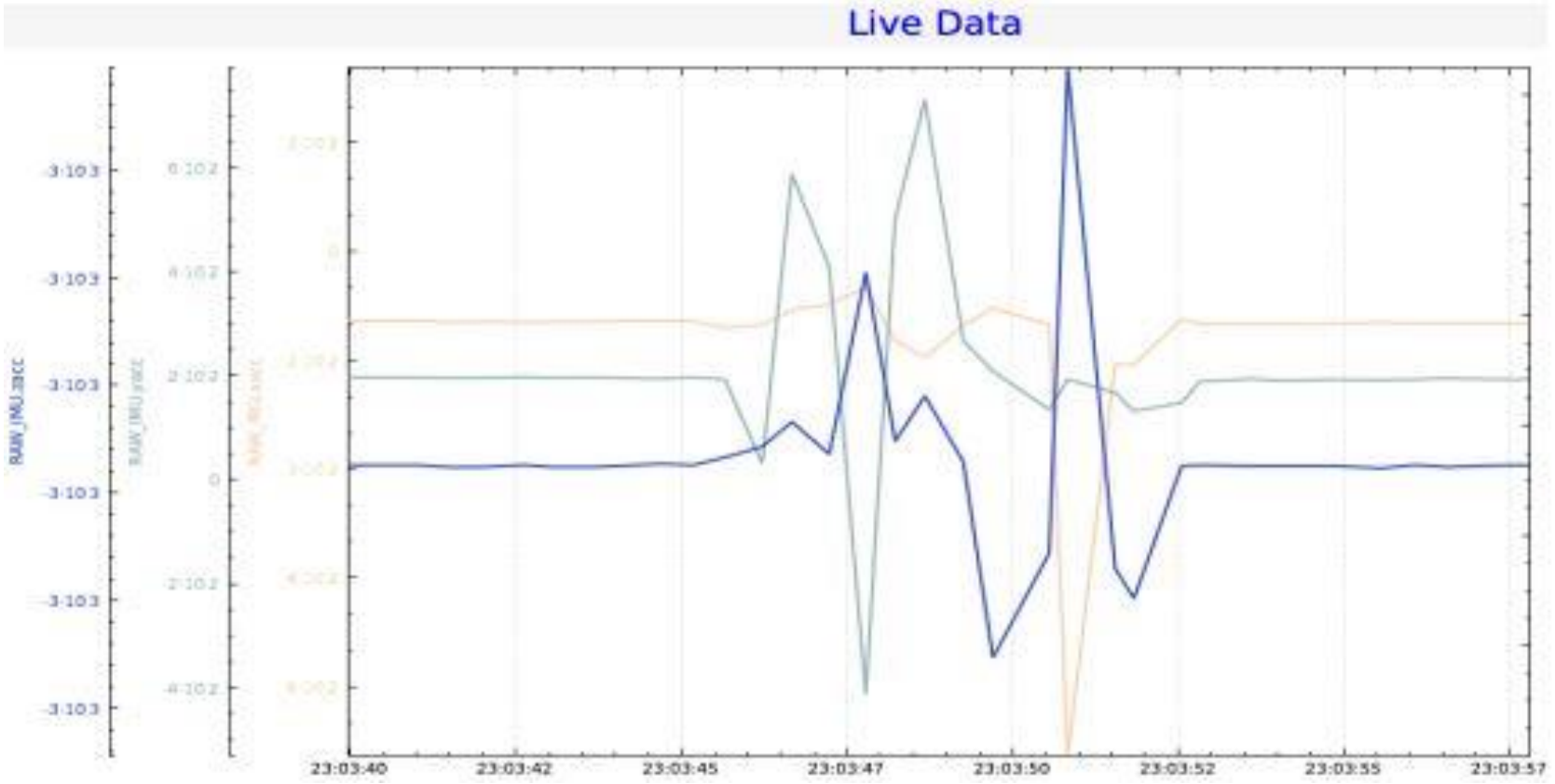
- Using ArduPilot platform
- Includes 3-axis gyroscope, accelerometer and magnetometer
- External addition of GPS and telemetry
- Altitude is approximated by detecting change in atmospheric pressure
- GPS needs to be mounted on the plane so it has direct line of sight to satellites


MANUAL
Kensington Ave
Sprott St
Burnaby Lake Regional Park
Altitude (GPS) (m)
83.07
Altitude (REL) (m)
72.71
Battery (%)
-1.00
Climb (m/s)
2.96
Current (A)
0.00
GPS Fix ()
3.00
GPS HDOP (m)
1.62
GPS Sats ()
12.00
Pitch (deg)
-8.65
Roll (deg)
124.5
Voltage (V)
0.00
Yaw (deg)
28.44

Gyroscope data



Accelerometer

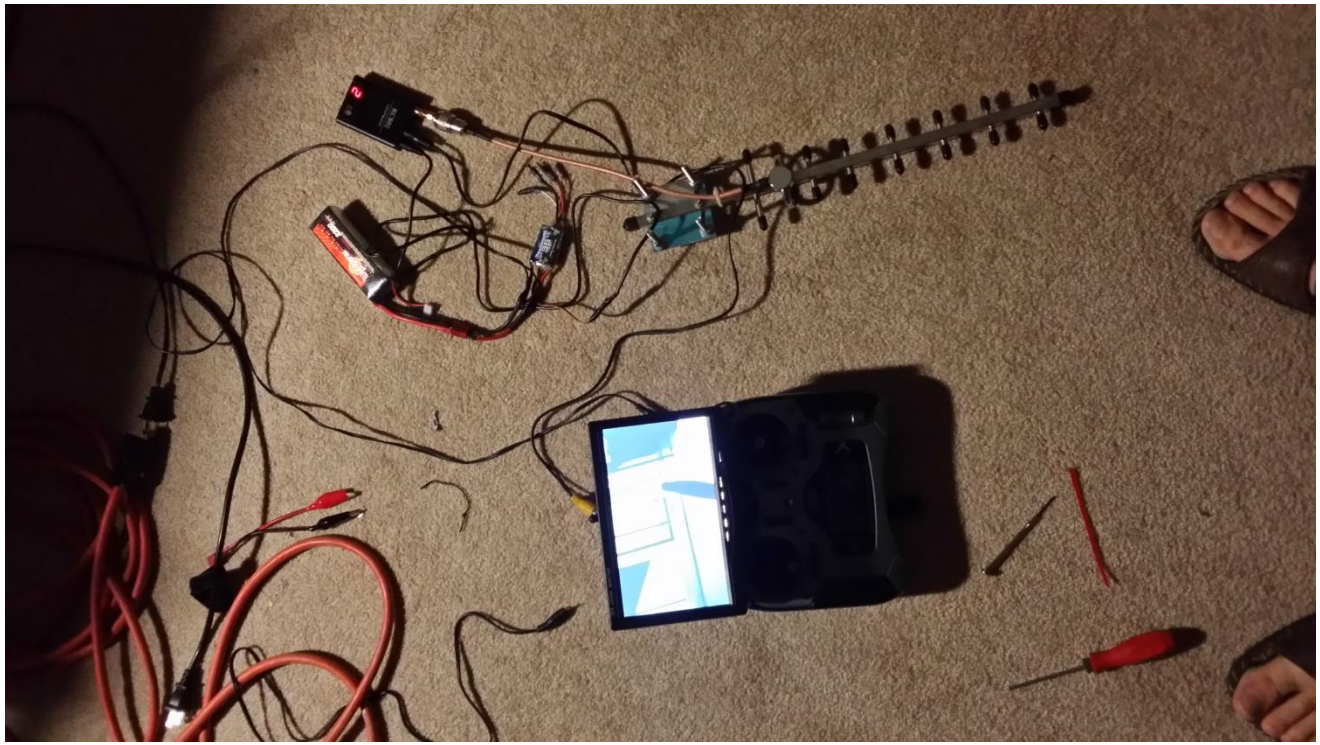


Magnetometer

Video System

- Comprised of video transmitter, receiver, LCD and camera
- Transmitter and receiver were changed from 2.4 GHz to 5.8 GHz to reduce interference
- LCD is connected to the receiver and both are mounted on the transmitter (DX6i)
- Compatible with thermo imaging camera

Implementing Video System



Complete video system

Power System

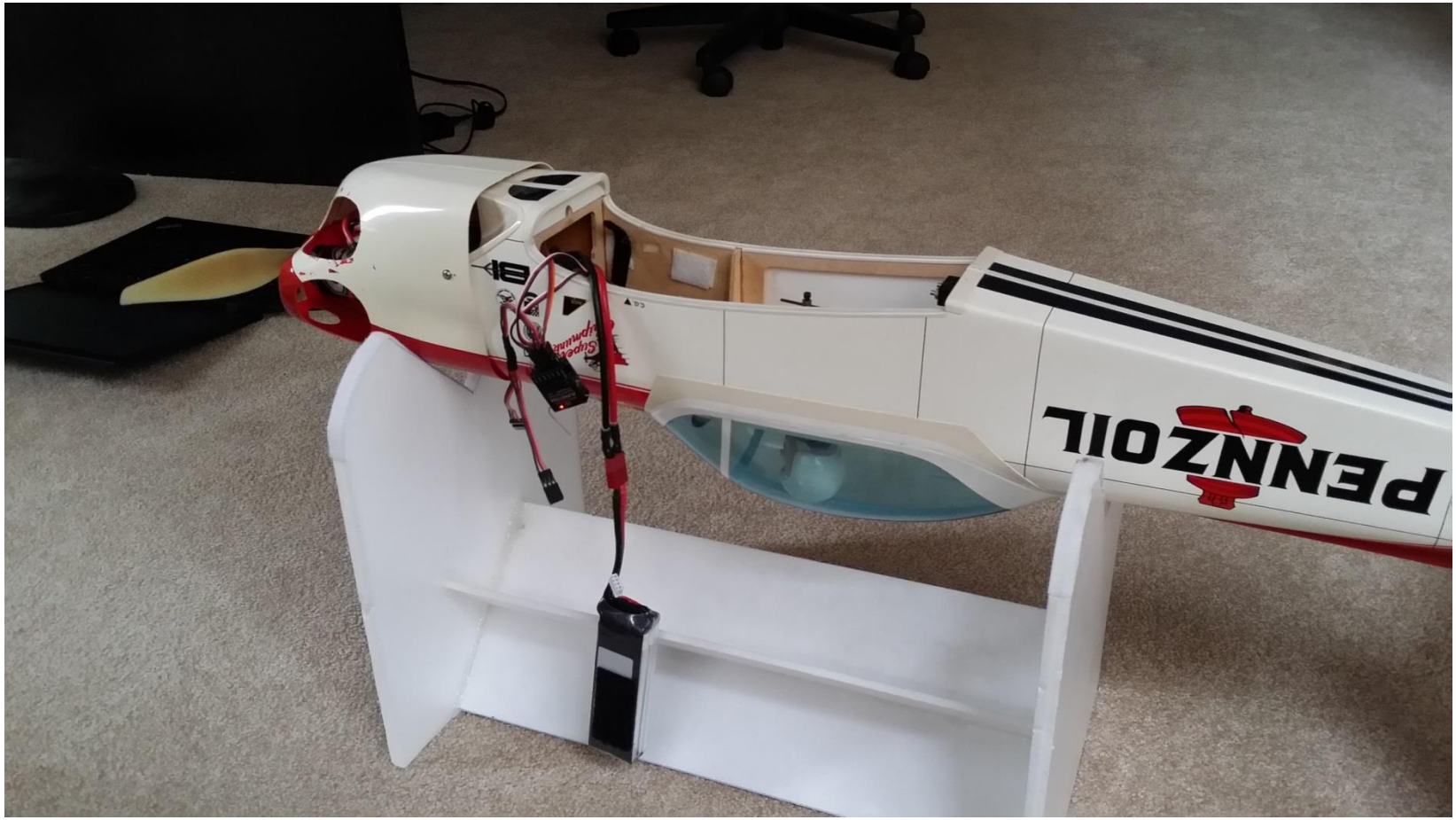
- Consists of a 4 cell Li-Po(Lithium Polymer) battery, a 3 cell Li-Po for the video transmitter and camera, and solar cells on the plane
- The ground station has an 11.1 V battery to power our video receiver and LCD screen

Solar Cells

- First set was too fragile and was damaged during test and mount on the plane plus the manufacturers specifications did not match the output of the panel
- Second set was successful
- Aerodynamics of plane are not affected
- Due to shortage of budget, could not buy enough solar cells
  - Need at least 3 times more solar cells that we have
  - Potentially could make it up to 15.5 volts

Testing:

First test plane



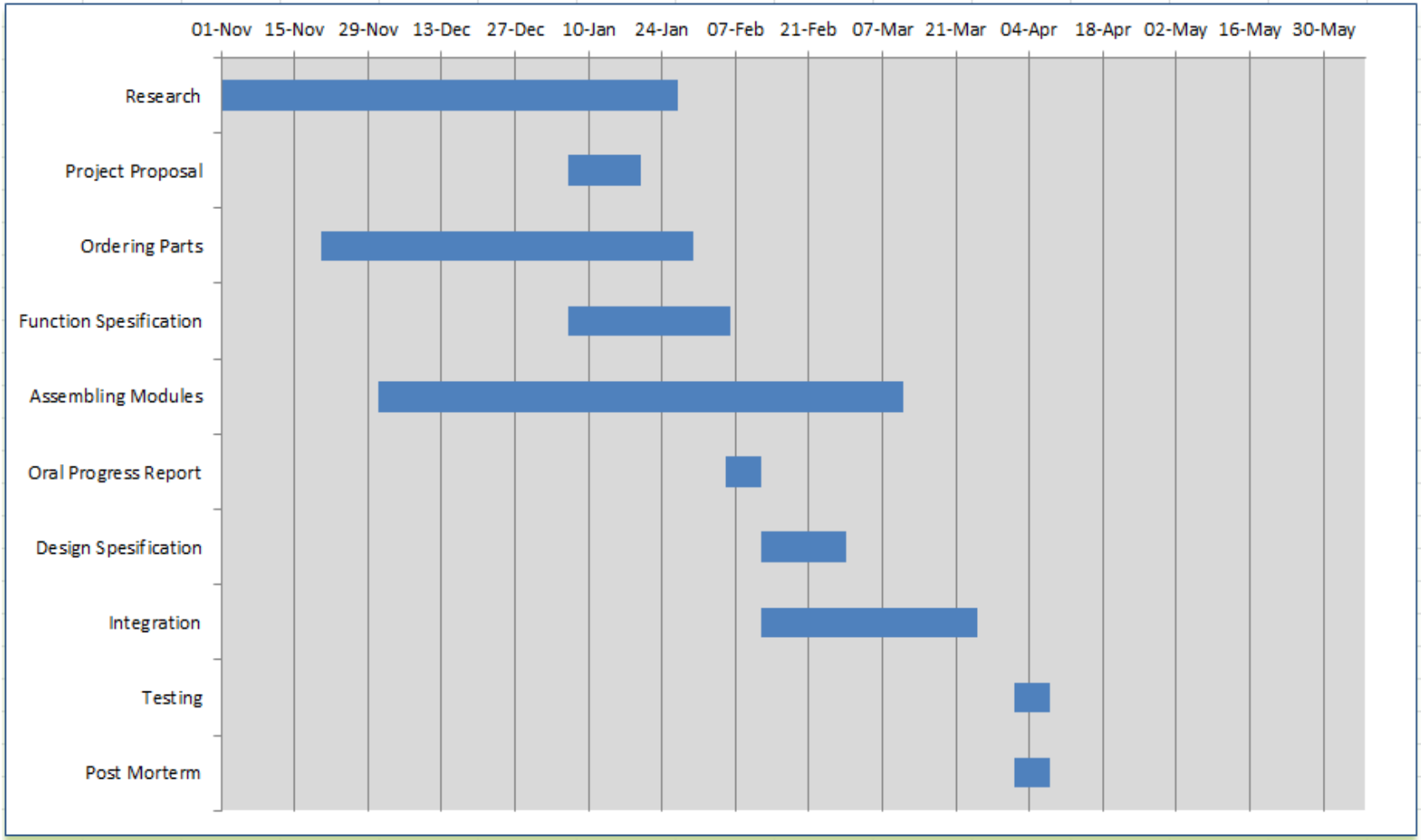
End of first test plane

Second Test Plane

End of second test plane

Successful Test

Timeline estimation



Timeline

Milestone	Projected Milestone Date	Realized Milestone Date
Project Planning/Proposal	January 19	January 19
Design	March 1	March 1
Development, and Unit Test	April 3	March 23
Integration and Assembly Test	April 10	March 29
Project Closure	April 15	March 29

Budget Estimation

Equipment List	Estimated Cost
Model Plane Building Materials	$350
1 x Boscam Video Receiver (RC 305 5.8 GHZ)	$50
1 x Boscam Video Transmitter (TS 353 5.8 GHZ 400mW)	$60
1 x Fat Shark FPV goggles	$200
1 x HD night vision FPV camera	$75
1 x 9CH FM Radio/Receiver	$275
2 x Batteries	$100
1 x Solar Cells	$130
1 x Engine (Turnigy G46 brushless outrunner 550kv)	$50
1 x Autopilot (F-TEK 31AP)	$140
1 x UBEK	$30
5 x Servos	$100
1 x Antennas	$40
1 x Cam mount (RC 5.8 GHZ FPV anti-vibration PTZ)	$50
Total Cost	$1650

Cost breakdown

Equipment List	Estimated Cost
Model Plane Building Materials	$450
1 x Boscam Video Receiver (RC 305 5.8 GHZ)	$50
1 x Boscam Video Transmitter (TS 353 5.8 GHZ 400mW)	$60
1 x 7" LCD Monitor	$60
1 x HD night vision FPV camera	$75
2 x 6CH Radio/Receiver(Borrowed)	$0
2 x Batteries	$35
1 x Solar Cells	$130
1 x Engine (Turnigy G46 brushless outrunner 550kv)	$50
1 x Autopilot (F-TEK 31AP)	$96
1 x UBEK	$30
5 x Servos	$50
1 x Antennas	$40
1 x Cam mount (RC 5.8 GHZ FPV anti-vibration PTZ)	$50
Total Cost	$1176

What we learned

- Acute awareness of the importance of planning and time management.
- How to better communicate our thought processes and ideas in a group Dynamic
- Be persistent and never give up no matter how many times you fail
- Expand our ability to interconnect different systems

Future Work

- Adding a thermo-imaging camera for easier missions
- Integrate camera control for one person operation
- An increased range of signals and flight time
- Making an android application

Conclusion

- Drones can be used in other applications other than military
- They are a solution to expensive air surveillance
- Require less personnel to operate

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THANK YOU FOR YOUR TIME

QUESTIONS?