2017

Vertical Take-Off and Landing Aircraft

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MULTI-DEPARTMENTAL

Vertical Take-Off and Landing Aircraft

CAPSTONE DESIGN EXPO 2017

MULT 605 | **Team members:** Sophie Baldwin, Michael Pennie, Alex Roberts, Dov Szego | **Faculty advisers:** Dr. Klenke & Dr. Atulasimha

Sponsor: Night Vision Laboratories (Department of Defense) | **Sponsor adviser:** Miguel Snyder & Tyler Anderson

Objective

To fabricate a fixed-wing, vertical take off and landing aircraft that has the ability to carry a camera payload for simple surveillance missions and hover for 5 minutes or fly in forward flight for up to 20 minutes.

Calculations

Thrust to Weight Ratio

- Affected by propeller and motor choice
- 37.25 lb ready to fly weight with 61.73 lb of thrust
- Needed to be a 1.3 ratio at 85% efficiency (Got 1.41)

Thrust Factors	
Thrust Factor, N	Thrust Required (g)
1	16860.6
1.1	18546.66
1.2	20232.72
1.3	21918.78
1.4	23604.84
1.5	25290.9
1.6	26976.96
1.7	28663.02
1.8	30349.08
1.9	32035.14
2.0	33721.2

Horizontal Motor

- Gives 18.74 lb of thrust

Ready-For-Flight Weight Estimations		
Component	Weight (g)	Comments
Airframe	7972	Measured
Camera & Gimbal	1179	Measured
Video data link	124	Measured
Motors & Props	1665.6	Input
Drive Batteries	4920	Input
Misc Electronics	1000	Assumed
Total RFW	16860.6	calculated

Battery Life

- 8 minutes of vertical flight
- 30 minutes of forward flight

VTOL Out-of-Box Weight			
Component	Part Weight (g)	Quantity	Weight (g)
Fuselage	4090	1	4090
Wing/Spars	1403	1	1403
Rear Wheel Assembly	374	1	374
Tail Assembly	1717	1	1717
Front Wheel Gear	96	1	96
Servo/Hardware	130	1	130
Rear prop	162	1	162
			0
Total Out-of-Box Weight			7972

Standard Motor Configuration (Four Motors)										
#	Motor			Propeller			Battery	Thrust (g)	Total Weight (g)	Total Thrust (g)	Factor of Safety
	Model/kV	Weight (g)	Cost	Model/Size	**Weight (g)	Cost	Cell	1 Motor	Motors+Props	4 Motors	At 85% Power
7	KDE Direct KDE6215XF-185	360	$255.95	21.5 x 7.3 double	77.4		10s	6890	1749.6	27560	1.481
8		360	$255.95	21.5 x 7.3 triple	77.4		10s	7850	1749.6	31400	1.687
		360	$255.95	18.5 x 6.3 double	56.4		12s	5890	1665.6	23560	1.272
		360	$255.95	18.5 x 6.3 triple	56.4		12s	6990	1665.6	27960	1.509
9		360	$255.95	21.5 x 7.3 double	77.4		12s	9110	1749.6	36440	1.958
10		360	$255.95	21.5 x 7.3 triple	77.4		12s	9960	1749.6	39840	2.141

Design

Naja 2.6 H-Tail Airframe

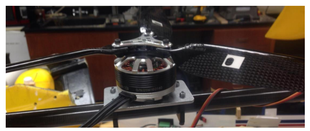
- Fiberglass fuselage
- Balsa wood and pine with Monokote covering wings
- Carbon fiber rods

Boom Extensions and Wing Mounts

- 20mm outer diameter carbon fiber rods used for booms that extend from the H-Tail to the nose assembly
- Vertical motors mounted on booms for vertical take off
- Custom 3D printed wing mounts were inadequate for the project's purpose therefore original aluminum mounts were altered to work with our design

Vertical Motor Mounts

- Laser cut custom made 1/8 in. aluminum plate mounts mounted to the plane's vertical booms using CNC milled aluminum circle brackets



Pusher Prop

- Mounted using shortened stock mounts to the fuselage
  - Adds stability to the center of gravity

Surveillance

Gimbal

HighCee BMMCC pro Gimbal

- 360° view
- Roll 45° to -45°
- Pitch 45° to -115°
- S.Bus control
- Carbon fiber and 3D printed ABS

Camera/Lens

Blackmagic Micro Cinema Camera

- 1080p video
- 60 PFS
- S.Bus control

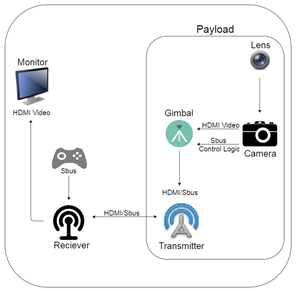
Panasonic Lumix G X Vario

- 3x optical zoom
- Remote zoom and focus

Video Link

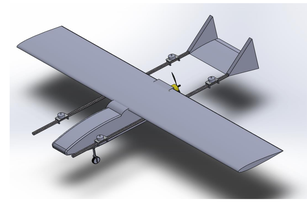
Connex by Amimon

- 1080p raw video
- 60 PFS
- Up to 1 km
- Real-time (less than 1ms delay)
- S.Bus control
- Encrypted
- HDMI input/output



Testing and Demo

- 3D model was made to test prop area



- Wing mounts were subjected to destructive testing using gym weights for deflection and strength.
- VTOL motors and props were tested for vertical thrust
- Mockup of the gimbal and dome were created for clearance and interference evaluation

Business

- ***Target Customers***
  - Target
  - Amazon
- ***Growth Markets***
  - Emergency Services
  - Agriculture
  - Surveillance
- ***Marketing and Advertising***
  - Trading Shows
  - Online Advertising
  - Exhibitions

VCU School of Engineering