무인이동체 설계해석 소프트웨어 개발 및 성능시험

Unmanned Vehicle Design Software

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한국항공우주연구원

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01

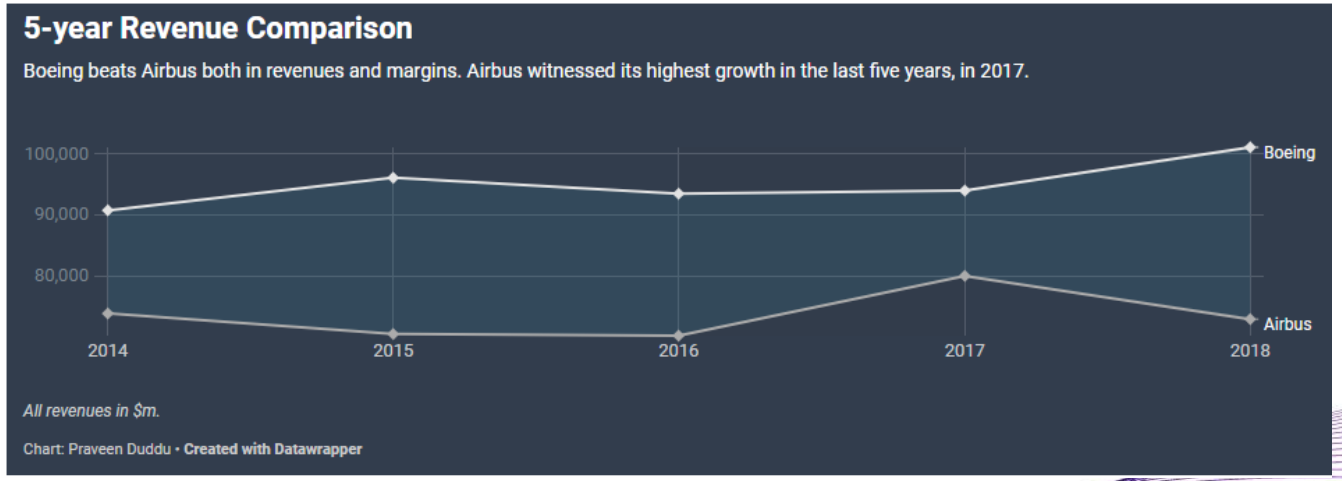
무인항공기 시장

01 항공기 시장

- Airbus A320 family deliveries[39][40]
- Boeing 737 series deliveries[41][42]

(출처: Wikipedia)

에어버스 A320(좌) 보잉 737(우)

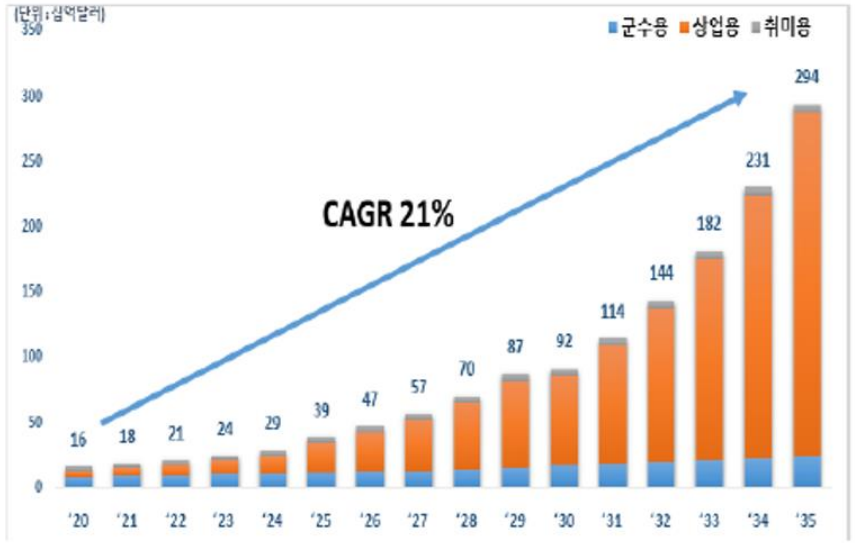


- 전통적인 민항기 시장

⇒ 소품종 소량 생산

01 무인기(드론) 시장

(공중) '20년 159억불 → '25년 385억불 → '30년 915억불



(출처: 무인이동체로드맵 공청회)

미국 드론 등록 대수 (2022, FAA)

- 865,505 drones registered
  - 314,689 commercial drones registered
  - 538,172 recreational drones registered

DJI 2021년 매출 US$ 3.83B

- 무인기(드론) 시장

  ⇒ 다품종 대량 생산

01 드론 오픈소스 생태계

PX4 Autopilot

The PX4 Autopilot provides guidance, navigation, and control algorithms for autonomous fixed wing, multirotor, and VTOL airframes, along with estimators for attitude and position.

MAVLink

Feature complete and fully customizable control station for MAVLink based UAVs. It can be used to update, configure, and tune an airframe. The control station has a mighty mission planner and tracks missions.

MAVSDK

Feature complete and fully customizable control station for MAVLink based UAVs. It can be used to update, configure, and tune an airframe. The control station has a mighty mission planner and tracks missions.

QGroundControl

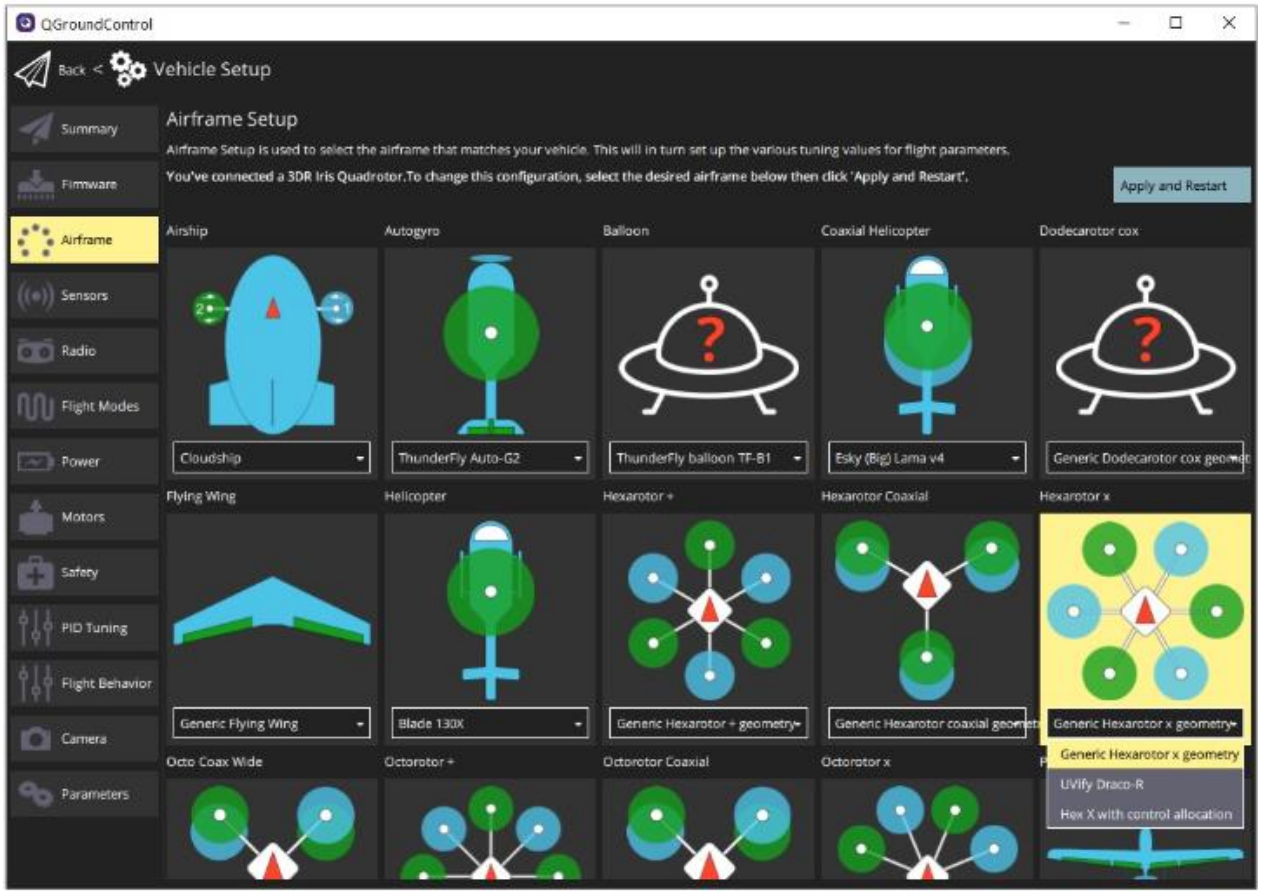
Feature complete and fully customizable control station for MAVLink based UAVs. It can be used to update, configure, and tune an airframe. The control station has a mighty mission planner and tracks missions.

pixhawk

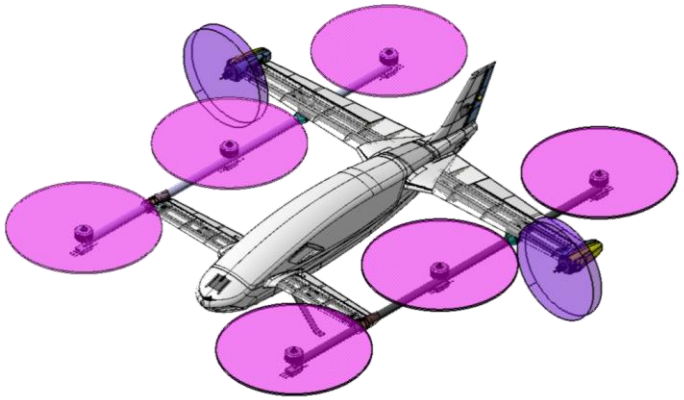
02

PX4 비행제어

02 PX4 비행제어 알고리즘 개선



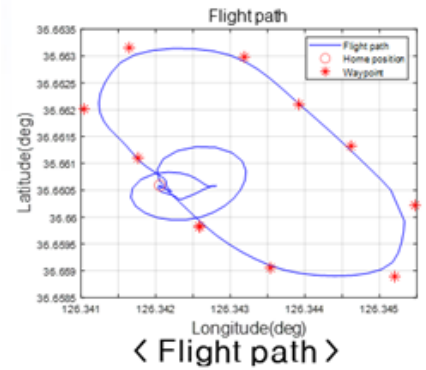
드론 기체 형상 설정 (QGC)



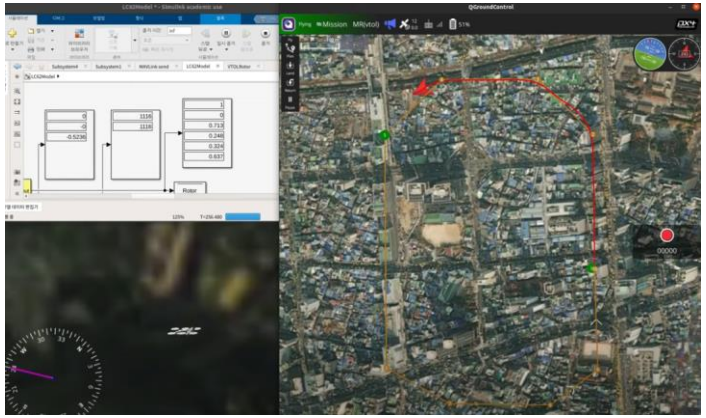
LC62-50B (항우연)

02 PX4 비행제어 알고리즘 개선

- 천이 비행을 위한 비행제어 알고리즘 개선
  - 천이 중 선회 비행이 가능하도록 비행제어 알고리즘 개선
  - 회전익+고정익 모드 혼합 시 비행제어 안정화



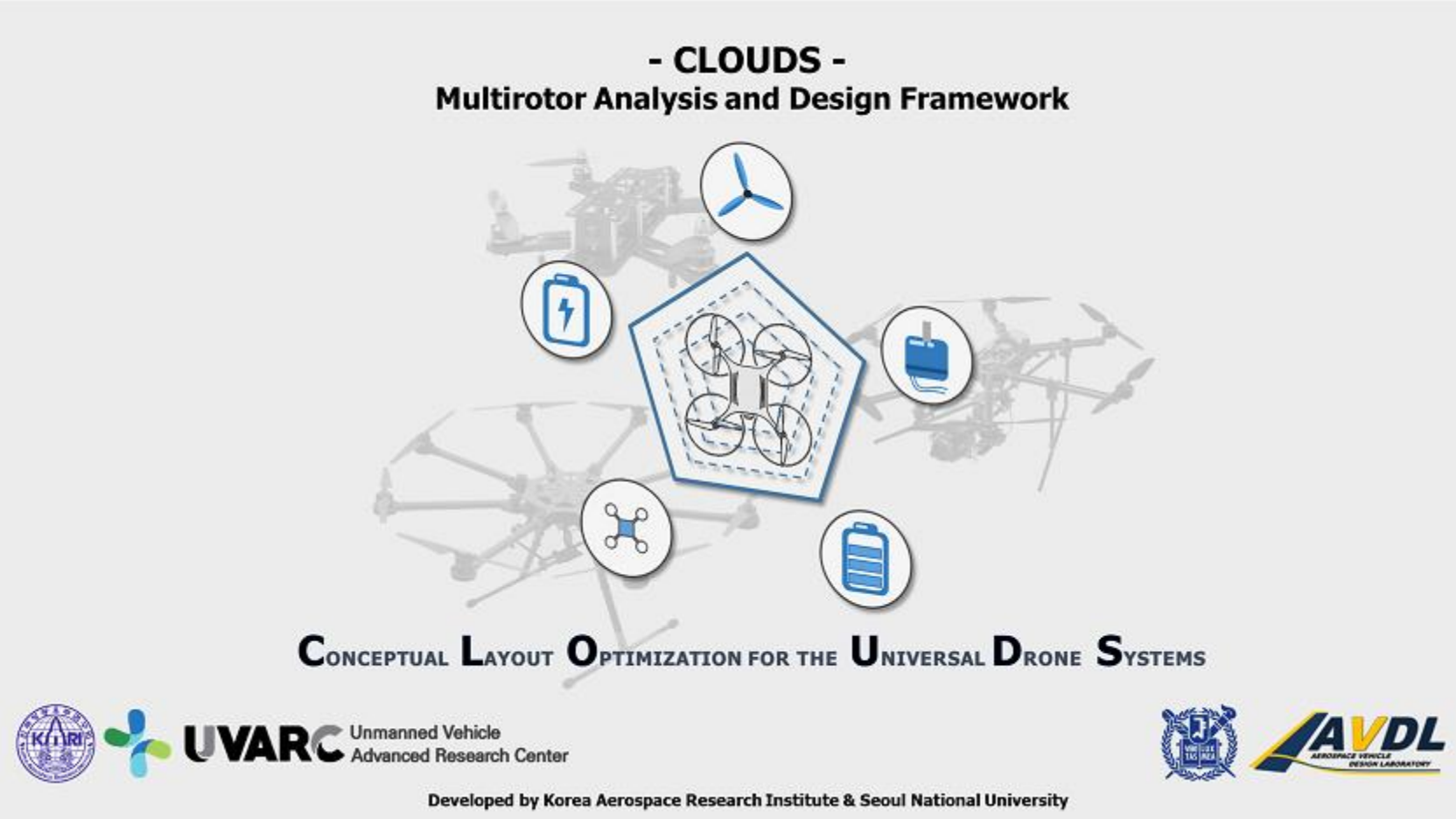
〈 Flight path 〉



03

소형 드론 설계 SW

03 소형 드론 초기설계 SW



25kg 이하 소형드론 초기설계용 소프트웨어

03

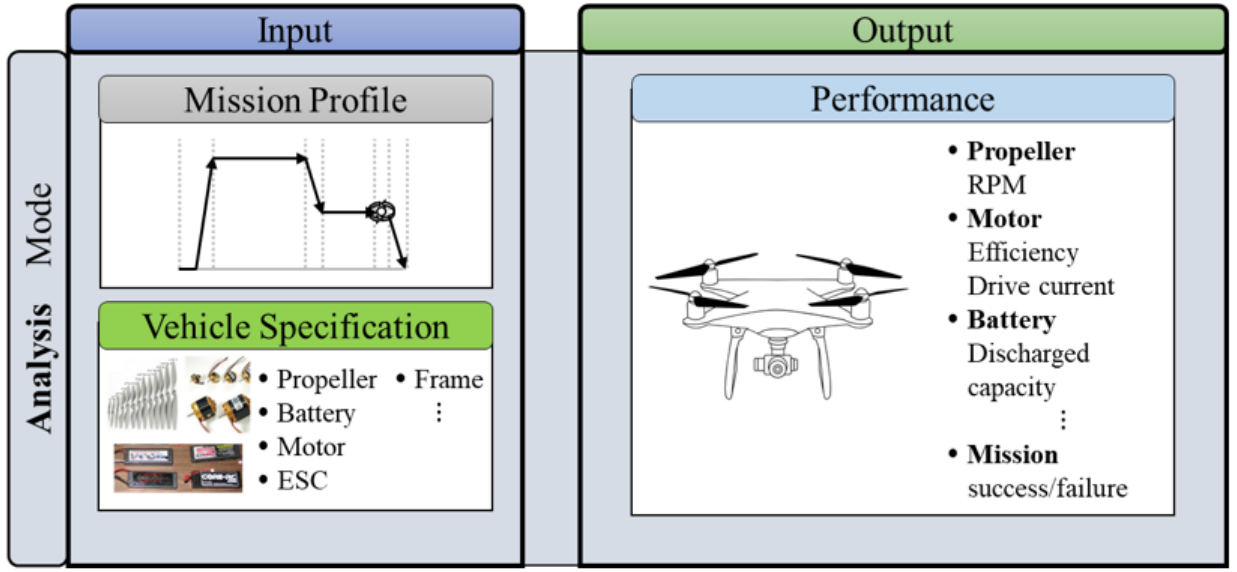
해석 모드

▶ 입력

- 사용자 요구 임무 형상
- 멀티콥터 구성품 제원

▶ 결과

- 멀티콥터 성능
- 임무 달성 가능 여부



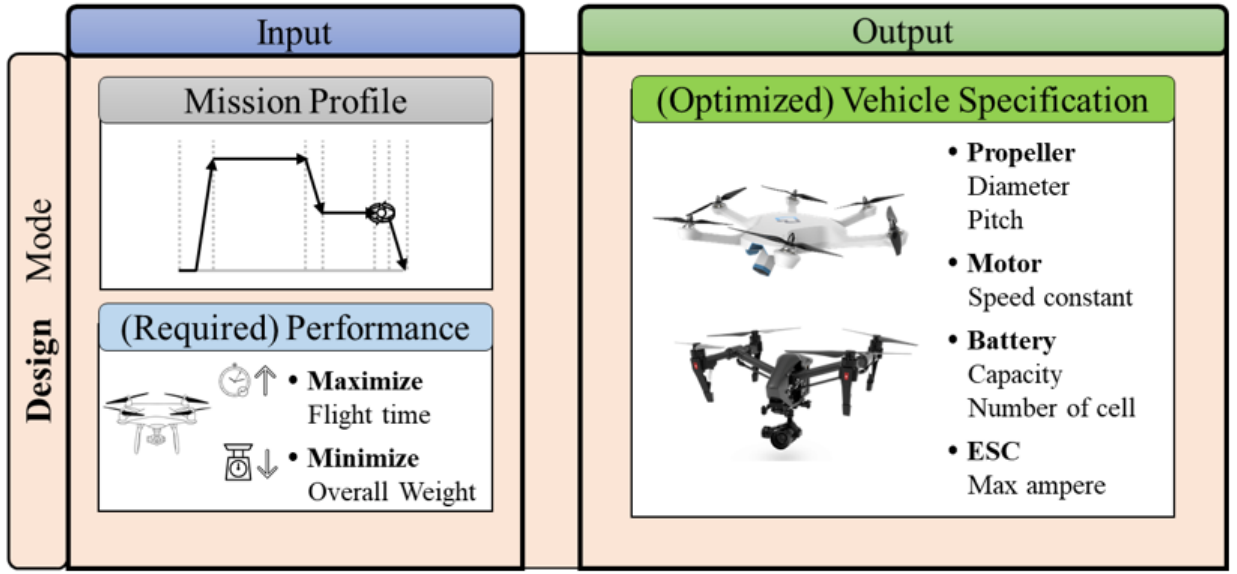
설계 모드

▶ 입력

- 사용자 요구 임무 형상
- 멀티콥터 요구 성능

▶ 결과

- 최적설계된 멀티콥터의 구성품 제원



03 드론 기술시연기 개발 및 성능검증

목적함수 | **비행시간 최대화**

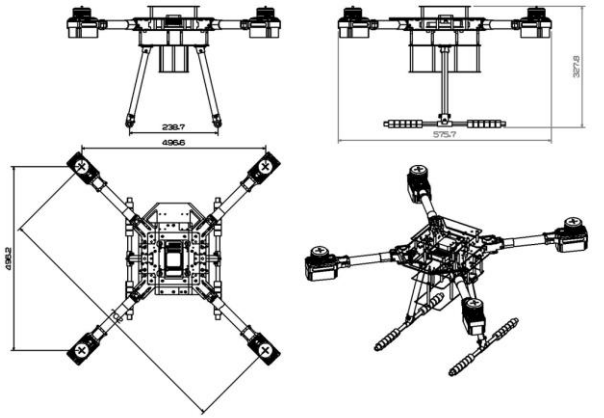
설계변수	단위	최소	최대
모터상수	RPM/V	200	600
프로펠러 지름	In	15	17
배터리 전압	V	4S	6S
배터리 용량	mAh	5,000	15,000
ESC 최대전류량	A	30	70
이륙중량*	g		5000

* 계측장비중량 1250g 포함

설계결과 및 기술시연기 개발

	CLOUDS	기술시연기 적용*
모터	390	KDE 4014XF-380
프로펠러	15.2x5.0	Tmotor 16.0x5.4
배터리	6S x 12,000	Dinogy 11,000
ESC	30	Hobbywing Xrotor 50A
이륙중량	4923	4910
축간거리	800	700

* 프로펠러 크기에 따른 축간거리 선정후 재계산



비행시험 결과

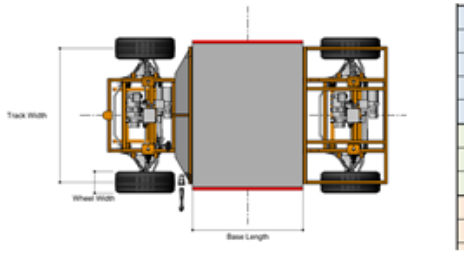
임무중량 (g)	CLOUDS	비행시험
0	15분 49초	16분 22초
500	12분 41초	12분 19초
1000	11분 10초	11분 19초

04

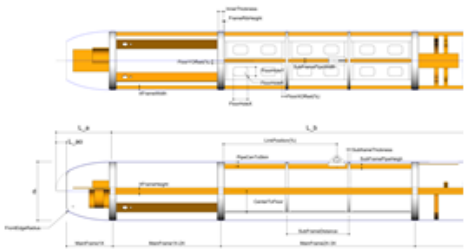
무인이동체 매개변수 모델링 & 해석

04 무인이동체 매개변수 형상 모델링

Unmanned Vehicle Parameters (Excel)



LandingPadLength(%)	101
LandingPadWidth(%)	105
LandingPadHeight	170
LandingPadLift	400
LifterLength(%)	90
BatteryLength	1200
BatteryWidth	600
BatteryHeight	200
BaseLength	1450
GroundClearance	330



Main Shape Parameters				
L_a	425	MainFrame1X	355	XFrameHa
L_b	3075	MainFrame1X-2X	830	XFrameTh
L_c	1005	MainFrame2X-3X	1490	SubFramel
L_ao	80	MainFrame3X-Plate	1190	PipeCenTo
L_co	350	MainFrameWidth	32	SubFramel
d	450	FrameInnerHeight/2	166	SubFramel
theta	25	InnerThickness	40	SubFramel
n	2.5	FrameRibThickness	2	Subframe1
FrameWeight	75	FrameRibOffset	4	SubframeE
FairingWeight	38	FrameRibHeight	8	Subframe1

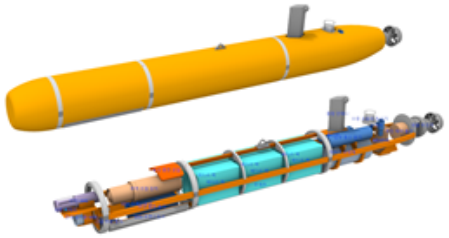
AFT Wing Parameters									
Position	X	2109	Z	164	Attack Angle	0			
	Airfoil	Chord	Thickness	Twist angle	Span	Sweepback	Dihedral	Buffer zone	Twist ref. chord
Root	sd7032	991	149	0	0				25%
Mid	sd7032	486	75	0	453	29	0	5	25%
Tip	sd7032	311	30	0	1300	0.3	0		25%

Buffer Zone Shape	
	W2-3
Num Sections	10
Blend Bulge	0.5
Continuity	Tangent

AFT Control Surface		Use	TRUE
Span Start(%)	Span End(%)	Width(%)	Clearance
5	45	23	1.5

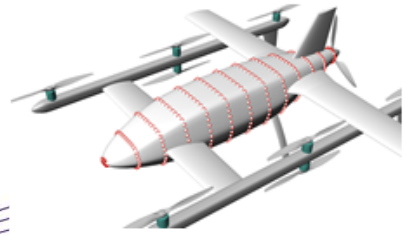
Front Wing Parameters									
Position	X	776	Z	50	Attack Angle	0			
	Airfoil	Chord	Thickness	Twist angle	Span	Sweepback	Dihedral	Buffer zone	Twist ref. chord
Root	sd7032	348	79	0	0				25%
Tip	sd7032	256	35	0	1120	0.35	0		25%
						FWD Control Surface		Use	TRUE

Vehicle 3D CAD



Model Data

Surface Volume
Weight Area
Volume Center (3D)
Center of gravity (3D)



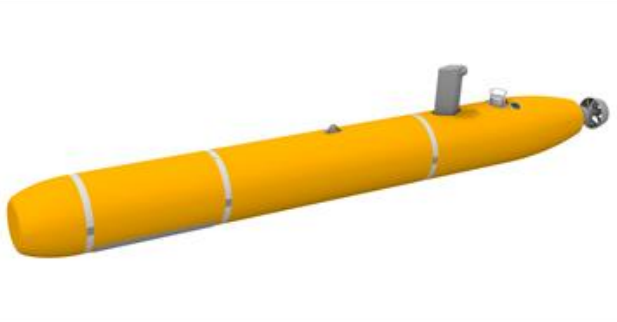
Fuselage XSection

04 무인이동체 매개변수 유동해석

3D CAD Model

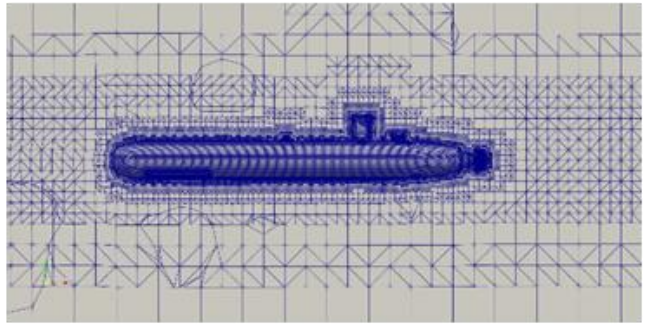
CFD Mesh

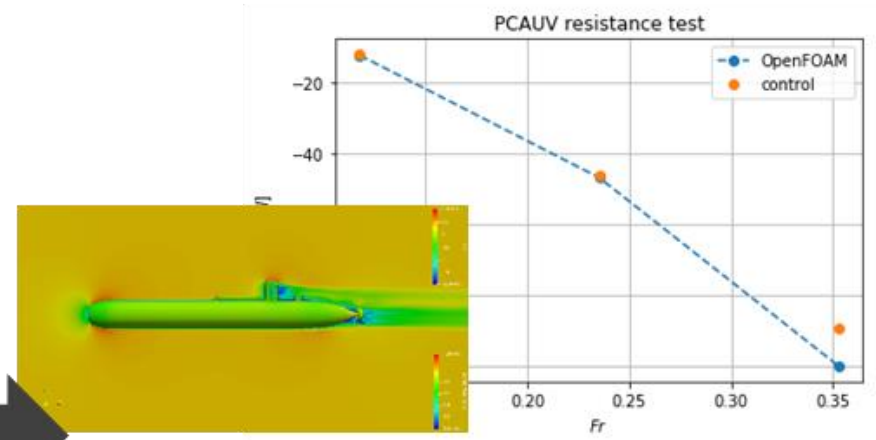
CFD Analysis

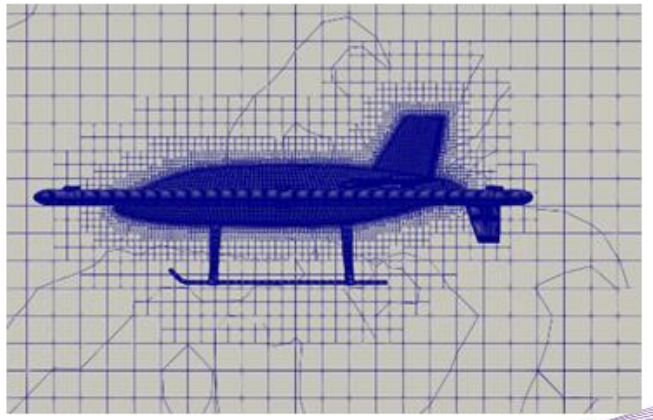


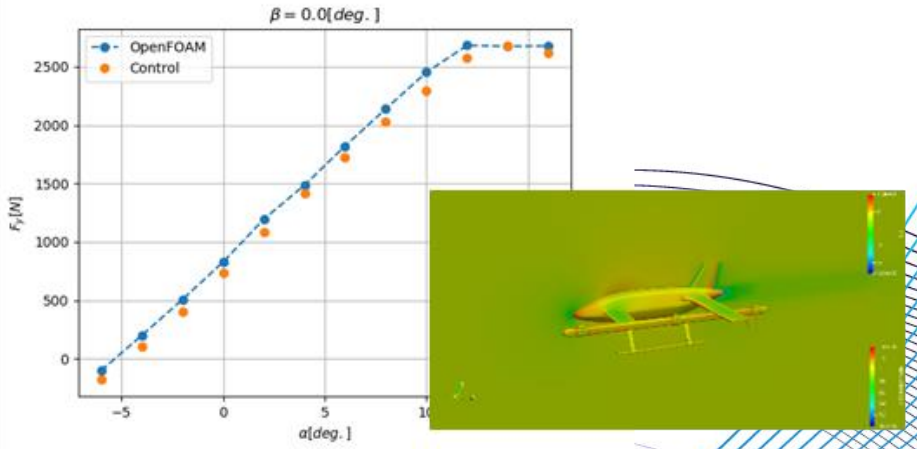
3D STL Files

openFOAM SHM



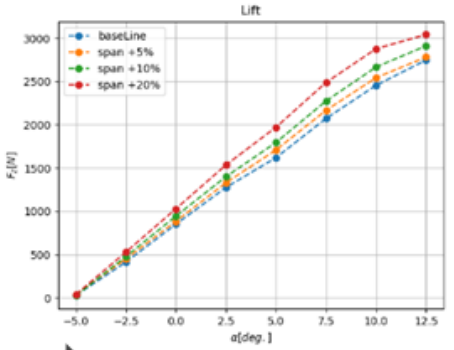


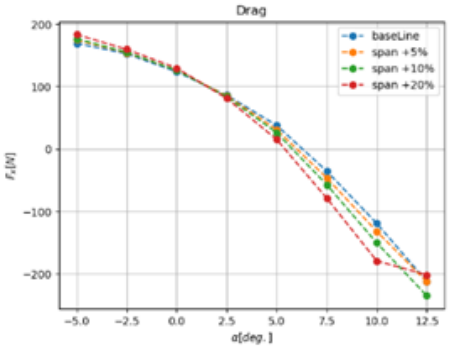


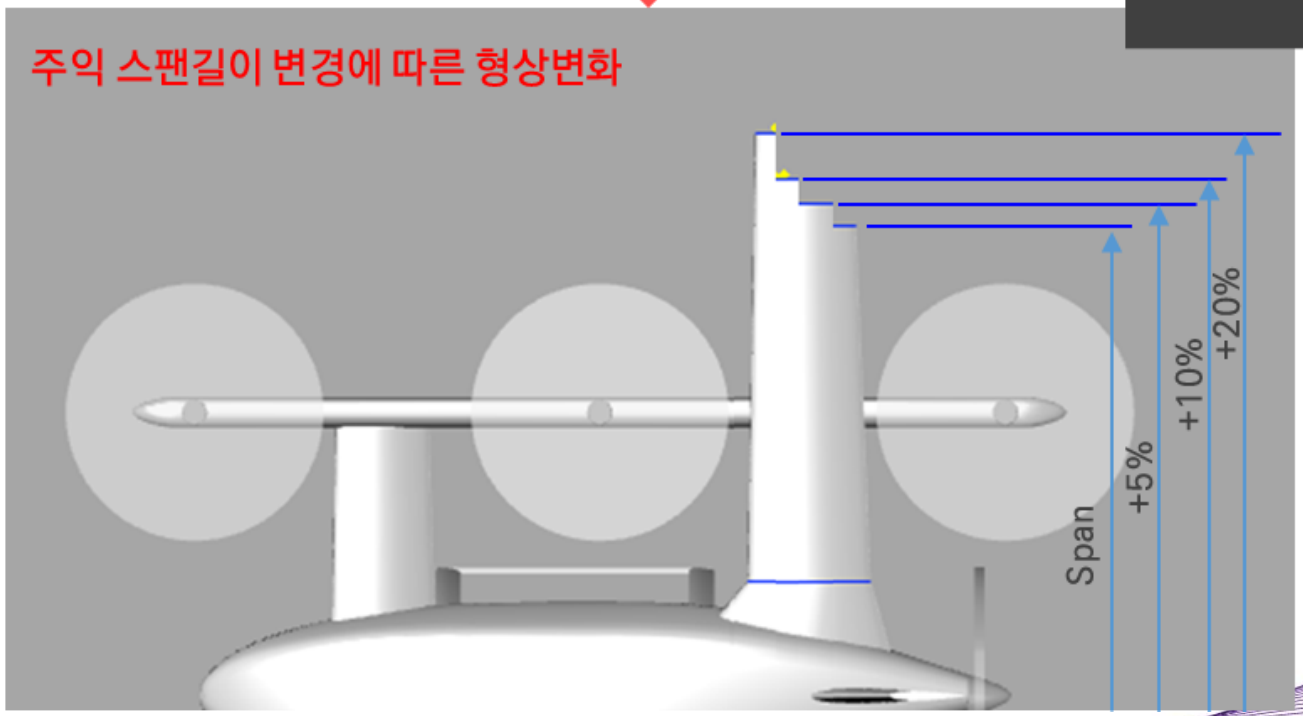


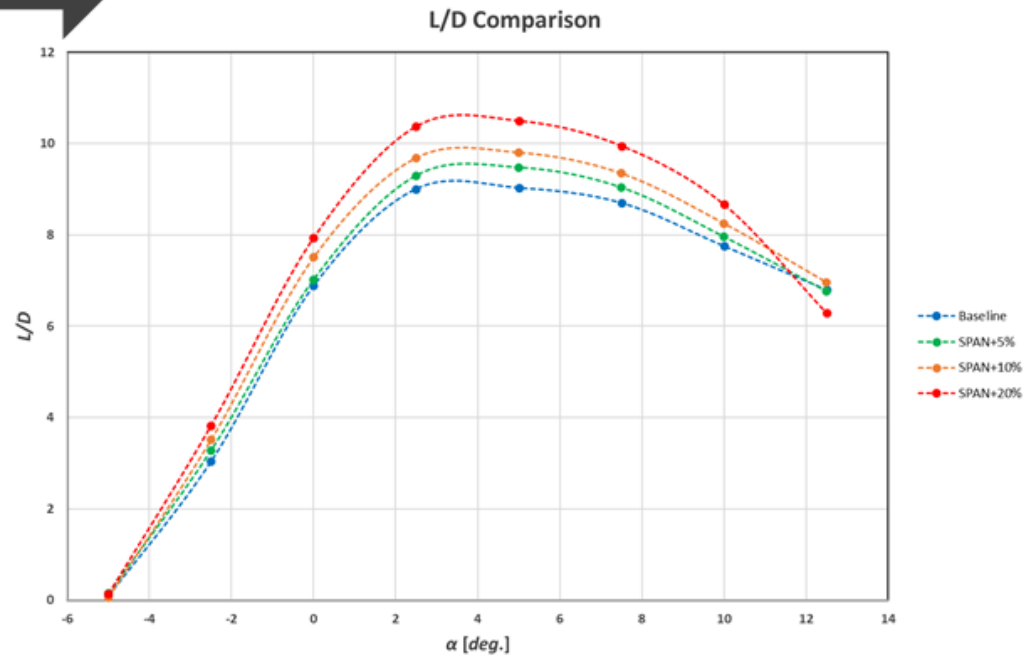
04 무인이동체 매개변수 최적설계 자동화

AFT Wing Parameters									
Position	X	2109	Z	164	Attack Angle	0			
	Airfoil	Chord	Thickness	Twist angle	Span	Sweepback	Dihedral	Buffer zone	Twist ref. chord
Root	sg6043	991	99	0	0				25%
Mid	sg6043	486	58	0	453	29	0	5	25%
Tip	sg6043	399	48	0	1400	0.3	0		25%
Buffer Zone Shape		Chord_210811				AFT Control Surface		Use	FALSE
	W2-3	991	149			Span Start(%)	Span End(%)	Width(%)	Clearance
Num Sections	10	486	75			10	90	30	1.5
Blend Bulge	0.5	311	30						
Continuity	Tangent								









감사합니다