

Department of Industrial Engineering

Second Cycle Degree in
AEROSPACE ENGINEERING

REPORT TITLE

Final report of the curricular internship in
Unmanned Systems

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Acronyms

ASI	Italian Space Agency
DART	Double Asteroid Redirection Test
DCO	Data Cut-Off
DSN	Deep Space Network
EME2000	Earth Mean Equator at J2000
EMO2000	Earth Mean Orbit at J2000
ESA	European Space Agency
FOV	Field of View
FPC	Flight Path Control
GNC	Guidance, Navigation and Control
G/S	Ground Station
INAF	Istituto Nazionale di Astrofisica
I/O	Input and Output
ISL	Inter-Satellite Link
JPL	Jet Propulsion Laboratory
LICIACube	Light Italian Cubesat for Imaging of Asteroids
LIDAR	LIght Detection And Ranging
MA	Mission Analysis
MCC	Mission Control Center
MOC	Mission Operations Center
MONTE	Mission-analysis and Operations Navigation Toolkit Environment
NASA	National Aeronautics and Space Administration
NAV	Navigation

NEA	Near Earth Asteroid
NEO	Near Earth Object
OD	Orbit Determination
OM	Orbital Maneuver
OPNAV	Optical Navigation
PHA	Potentially Hazardous Asteroid
PL	Payload
PS	Propulsion System
RCS	Reaction Control System
RMS	Root Mean Square
RW	Reaction Wheel
S/C	spacecraft
SEP	Sun-Earth-Probe
SOC	Science Operations Center
SPA	Sun Phase Angle
SRP	Solar Radiation Pressure
SSB	Solar System Barycenter
SSDC	Space Science Data Center
STM	State Transition Matrix
TCA	Time of Closest Approach
UNIBO	University of Bologna
USO	Ultra Stable Oscillator
WVR	Water Vapour Radiometer

Introduction

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$$(a + b)^2 = a^2 + 2ab + b^2 \quad (1)$$

Sed ut perspiciatis unde omnis iste natus error sit voluptatem accusantium doloremque laudantium, totam rem aperiam, eaque ipsa quae ab illo inventore veritatis et quasi architecto beatae vitae dicta sunt explicabo [4–7]. Nemo enim ipsam volup-

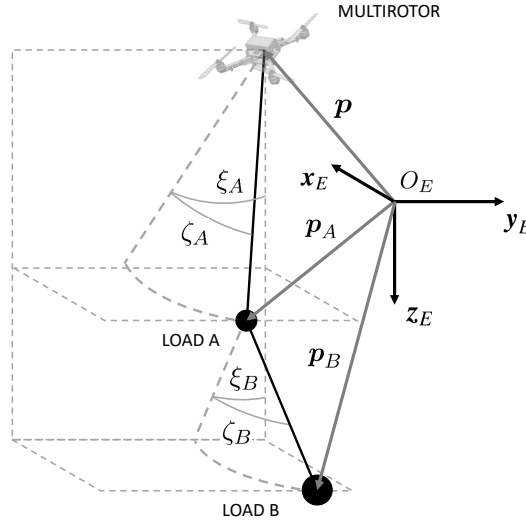


Figure 1: Sample figure caption (note: numerical data must be characterized with their respective units of measurement)

tatem quia voluptas sit aspernatur aut odit aut fugit, sed quia consequuntur magni dolores eos qui ratione voluptatem sequi nesciunt (Fig. 1). Neque porro quisquam est, qui dolorem ipsum quia dolor sit amet, consectetur, adipisci velit, sed quia non numquam eius modi tempora incidunt ut labore et dolore magnam aliquam quaerat voluptatem (Tab. 1).

$$\mathbf{F} = m \mathbf{a} \quad (2)$$

Ut enim ad minima veniam, quis nostrum exercitationem ullam corporis suscipit laboriosam, nisi ut aliquid ex ea commodi consequatur [8, 9]? Quis autem vel eum iure reprehenderit qui in ea voluptate velit esse quam nihil molestiae consequatur, vel illum qui dolorem eum fugiat quo voluptas nulla pariatur [10]?

Table 1: Sample table (note: numerical data must be characterized with their respective units of measurement)

Parameter	Symbol	Value	Unit
Multirotor			
Mass	m	70	kg
CG position	$STA_{CG} = BL_{CG}$	0	m
	WL_{CG}	-0.15	m
Moments of inertia	J_{11}	10.61	kg m ²
	J_{22}	10.31	kg m ²
	J_{33}	19.74	kg m ²
	J_{12}	0.037	kg m ²
	J_{13}	-0.043	kg m ²
	J_{23}	-0.003	kg m ²
Propeller			
Number of blades	n_b	2	
Radius	R	0.5	m
Mean aerod. chord	\bar{c}	0.086	m
Payload			
Mass	m_l	100	kg
Reference area	A_l	0.785	m ²
Drag coefficient (sphere)	C_{dl}	0.5	

Conclusions

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Appendix A

Matlab code

Example of Appendix section with code report.

```
1  clc,clear
2
3  A = 1; % Max. amplitude
4  omega = 5; % Angular frequency (rad/s)
5  phi_o = 10; % Initial phase (rad)
6  delta = 1/sqrt(2); % Damping coefficient (1/s)
7
8  t = linspace(0,10,1000);
9  y = A*exp(-delta*t).*cos(omega*t + phi_o);
10
11 plot(t,y,'LineWidth',1.5)
12 grid on
13 xlabel('time (s)')
14 ylabel('system response')
```

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