Astroscale Spacecraft Systems Engineer

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Space Engineering MSc at Politecnico di Milano
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This portfolio is designed to showcase my understanding of the various subsystems involved in satellite development. Owing to confidentiality agreements, my contributions as a Payload Team Member and Intern are not featured in this portfolio. Each project page includes a link to its corresponding report housed in a GitHub repository. The concluding section is dedicated to include recommendation letters.

Payload Design:
D.U.S.T.I.N. - Dust Understanding and Storm Tracking Investigator on Mars

Group Project - Space Engineering MSc - 09.2023 to 02.2024

Report Link: D.U.S.T.I.N. - Dust Understanding and Storm Tracking Investigator on Mars

Description

D.U.S.T.I.N. is a mission designed to monitor and analyse Martian dust storms. The project focuses on **developing a payload, using a systems engineering approach**, capable of observing Mars' lower atmosphere to track the evolution of dust storms. The instrument is designed **up to a Phase A/B** level of detail.

Objectives

⇒ Select the scientific mission to be performed.

⇒ Do a **trade-off analysis** to select the **most suitable architecture** to satisfy the mission statement.

⇒ Perform a **preliminary design of the instrument** including Architecture, ConOps, MA, Optics, OBDH, EPS, TCS and Structures.

Contributions

⇒ **Systems engineer role**, assuring the coordination of the team and the correct application of system engineering procedures.

⇒ Head of **requirements definition** according to ESA standards.

⇒ Head of On-Board Data Handling (OBDH) design and **data budget** development.

Development

⇒ Select the scientific objective to be assessed.

⇒ Do a literature review and a **trade-off analysis** to select the best type of instrument: IR spectrometer.

⇒ Define the **high-level requirements** and design **ConOps and operational modes**.

⇒ Retrieve ideal Payload orbit and mission architecture.

⇒ Design **acquisition strategy**.

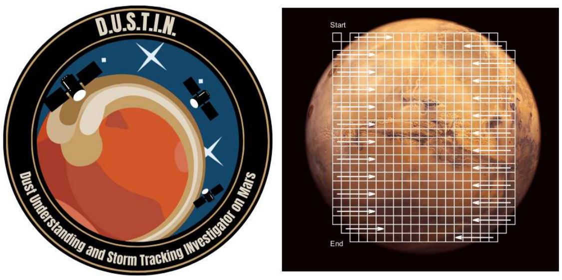

Figure 1. Mission Logo and Acquisition Map

⇒ Define **instrument architecture and interfaces**.

⇒ Derive the **technical requirements** and **iterate** to obtain a design satisfying the mission statement and high-level requirements.

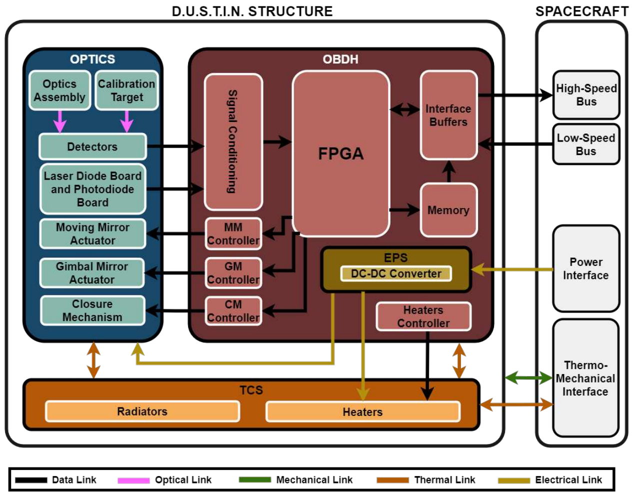

Figure 2. D.U.S.T.I.N. Architecture Diagram

⇒ Design the **optics**, using Zemax, including the mirrors scheme, a Michelson Interferometer, detector selection and SNR (Signal-to-Noise Ratio) assessment.

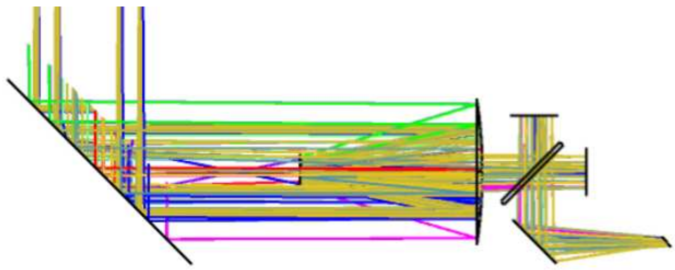

Figure 3. Final Optical Design

⇒ Design the **OBDH subsystem** including preliminary memory and throughput sizing based on **SMAD** (Space Mission Analysis and Design) **book procedures**, deep study of heritage solutions, analysis of **data rates** and selection of **final solution meeting** all the **requirements** and constraints.

⇒ Design the **EPS subsystem**, consisting of a DC-DC Converter, and retrieve the regulated voltages inside the instrument.

⇒ Design the **TCS subsystem** using Mathworks Simscape to assess the **payload thermal behaviour** in cold and hot cases.

⇒ Design the instrument **structure and configuration** and analyse its behaviour under launching loads using Inventor Nastran.

Results

A **general understanding of optical instruments' working principles** and payload design is acquired with this hands-on project. By **applying systems engineering** procedures, a **successful design** is obtained, **meeting the mission statement** and high-level requirements and with **potentially improved capabilities with respect to heritage missions**.

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Space Systems Engineering and Operations: MetOp-A Reverse Engineering Study

Group Project - Space Engineering MSc - 02.2023 to 06.2023

Report Link: MetOp-A Reverse Engineering Study Report

Description

The project aims to study and preliminary **size the main subsystems** of the MetOp-A ESA mission through reverse engineering. After researching information about the mission and applying simple methods, the **functional analysis** and **system budgets**, including system-level margins, are retrieved.

Objectives

⇒ Apply reverse engineering to preliminary size and understand the main subsystems of a MetOp-A mission.

⇒ Subsystems included: **MA** (Mission Analysis), **PS** (Propulsion Subsystem), **TTMTC** (Tracking Telemetry Telecommand), **ADCS** (Attitude Determination and Control Subsystem), **TCS** (Thermal Control Subsystem), **EPS** (Electrical Power Subsystem), **OBDH** (On-Board Data Handling) and **CONF** (Configuration).

⇒ Obtain the **functional analysis, drivers, phases and modes** of the mission.

⇒ Obtain the **subsystems' budgets**.

Contributions

⇒ Understanding and retrieving the orbit maintenance strategy.

⇒ Size ADCS subsystem.

⇒ Size TCS subsystem.

Development

⇒ Perform a literature review to retrieve MetOp-A documentation and **understand the high-level goals of the mission**.

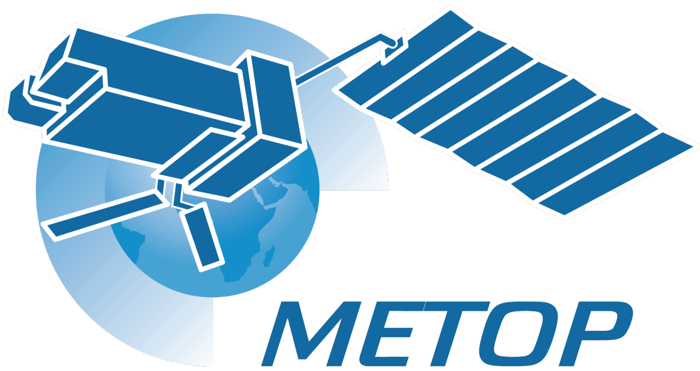

Figure 1. MetOp-A Mission Logo

⇒ Define the **functional analysis, phases, modes and drivers**. A key task that guides the whole project.

⇒ **Retrieve the ΔV budget** including LEOP and Nominal Operations phases.

⇒ Size PS as a blowdown pressurised monopropellant and **estimate the subsystem and propellant mass**.

⇒ Size TTMTC uplink and downlink modes, study its architecture and retrieve the **link budget**.

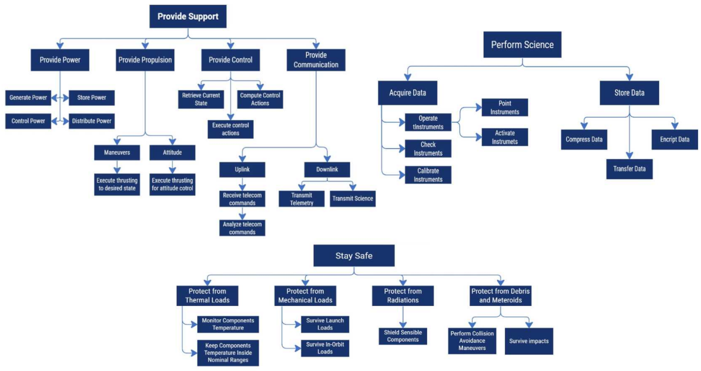

Figure 2. Functional Analysis Breakdown

⇒ Analyse the ADCS control modes and architecture, and estimate the **pointing budget**.

⇒ Perform TCS mono nodal analysis for hot and cold scenarios, **select radiators** properties and area, and **estimate heaters heat generation** in the cold case.

⇒ Size the EPS subsystem by computing solar panels area, sizing the batteries, understanding the architecture and retrieving the **power budget**.

⇒ Understand OBDH architecture and retrieve the **data budget**.

⇒ Understand and justify the satellite configuration.

Subsystem	LEOP			SIOV				Science Day	Science Eclipse	Manoeuvre	Transmission (X and S)	Disposal	Off-Nominal	Safe Mode
	Phase 1	Phase 2	Phase 3	Phase 1	Phase 2	Phase 3	Phase 4							
Instruments	**0**	**110**	**110**	**110**	**110**	**110**	**908**	**908**	**589**	**110**	**908**	**0**	**110**	**0**
A-DCS	0	0	0	0	0	0	72	72	72	0	72	0	0	0
AMSU-A	0	0	0	0	0	0	99	99	0	0	99	0	0	0
ASCAT	0	100	100	100	100	100	215	215	215	100	215	0	100	0
AVHRR/3	0	0	0	0	0	0	27	27	27	0	27	0	0	0
GOME-2	0	0	0	0	0	0	42	42	42	0	42	0	0	0
GRAS	0	10	10	10	10	10	30	30	30	10	30	0	10	0
HIRS/4	0	0	0	0	0	0	24	24	24	0	24	0	0	0
IASI	0	0	0	0	0	0	210	210	0	0	210	0	0	0
MHS	0	0	0	0	0	0	93	93	93	0	93	0	0	0
S&RSA	0	0	0	0	0	0	86	86	86	0	86	0	0	0
SEM-2	0	0	0	0	0	0	10	10	0	0	10	0		0
SVM	**306**	**764.4**	**764.4**	**286**	**389**	**389**	**389**	**389**	**727.4**	**767.4**	**429**	**349**	**867.4**	**687.4**
EPS	6	6	6	6	9	9	9	9	9	9	9	9	9	9
TTMC	20	20	20	20	120	120	120	120	120	20	160	20	120	120
ADCS	50	388.4	388.4	50	50	50	50	50	388.4	388.4	50	150	388.4	388.4
TCS	150	150	150	150	150	150	150	150	150	150	150	150	150	150
OBDH	20	60	60	60	60	60	60	60	60	60	60	20	60	20
PS	60	140	140	0	0	0	0	0	0	140	0	0	140	0
PLM	**10**	**145**	**145**	**145**	**550**	**550**	**550**	**550**	**550**	**145**	**550**	**10**	**550**	**10**
TOTAL	**316**	**1019.4**	**1019.4**	**541**	**1049**	**1049**	**1847**	**1847**	**1866.4**	**1022.4**	**1887**	**359**	**1527.4**	**697.4**

Figure 3. Power Budget

Results

After the project, a general understanding of the MetOp-A architecture and design process is obtained. Besides, the preliminary sizing allows for retrieval of most of the **mission budgets, compliant with real data**. The project works as an introduction to **systems engineering methodology for satellite development**.

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Spacecraft Guidance and Navigation: Guidance Assignment

Individual Project - Space Engineering MSc - 09.2023 to 01.2024

Report Link: Guidance Assignment Report

Description

This project involves the **design and optimisation of spacecraft missions** using advanced computational methods implemented in **Mathworks Matlab and NASA SPICE Toolkit**. It is focused on three exercises: modeling periodic orbits in the Earth-Moon system, designing a planetary protection mission against asteroid Apophis, and optimising a low-thrust Earth-Venus transfer.

Objectives

⇒ **Compute and analyse periodic halo orbits** in the Earth-Moon system using **CRTBP** (Circular Restricted Three-Body Problem) **dynamics**.

⇒ Develop an **impulsive optimal guidance solution** to alter the trajectory of asteroid Apophis using a spacecraft impact, **minimising its impact risk with Earth**.

⇒ Design a **time-optimal low-thrust trajectory** for an Earth-Venus transfer, **using PMP** (Pontryagin Maximum Principle).

Development

Exercise 1: Periodic orbit

⇒ Retrieve the 3D CRTBP for the Earth-Moon system to compute halo orbits.

⇒ Compute the halo orbit derived from the given initial conditions.

⇒ **Implement differential correction and numerical continuation methods** to compute the family of halo orbits.

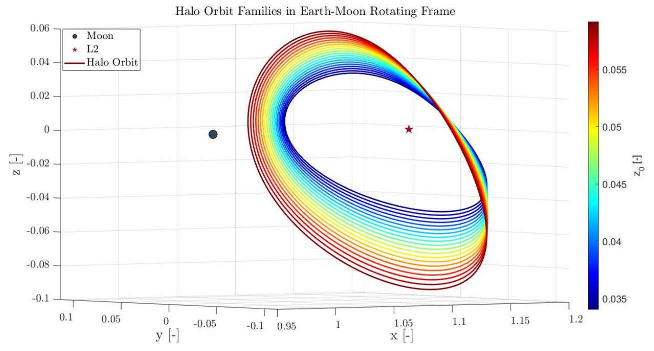

Figure 1. Halo Orbits Family

Exercise 2: Impulsive guidance

⇒ Select the **appropriate optimisation variables**.

⇒ Develop the **optimisation nonlinear problem statement** considering **multiple-shooting impulsive guidance**.

⇒ Translate the mathematical problem statement to Mathworks Matlab.

⇒ Use the **fmincon** function to maximise the final distance between Apophis and Earth at the time of closest approach.

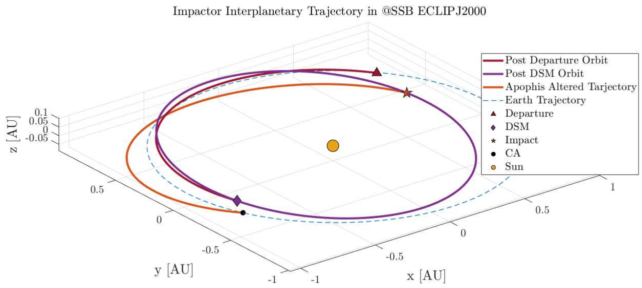

Figure 2. Impact Mission Trajectory

Exercise 3: Continuous guidance

⇒ Retrieve the PMP equations for Keplerian motion.

⇒ Define the **optimisation nonlinear problem statement**.

⇒ Translate the statement into Matlab language.

⇒ Solve the optimisation problem by using **fmincon** and exploring a set of randomly generated initial conditions.

⇒ Solve a reduced thrust case by applying **numerical continuation**.

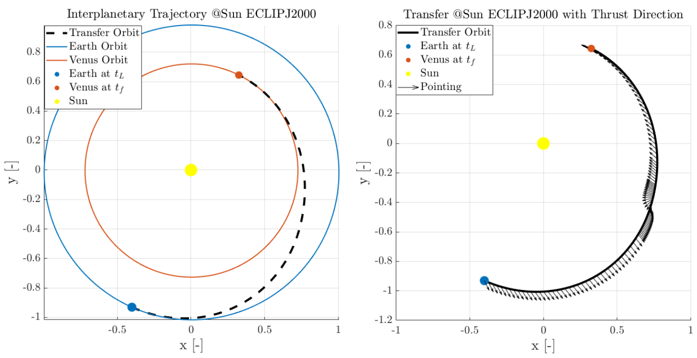

Figure 3. Interplanetary transfer and thrust vector evolution

Results

The project **successfully applies astrodynamics concepts and optimisation methods in spacecraft mission design**. It highlights skills in solving complex space mission scenarios, from Earth-Moon system exploration to planetary defence and interplanetary transfers. Generally, a **good knowledge of optimal impulsive and continuous guidance** is acquired and implemented.

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Spacecraft Guidance and Navigation: Navigation Assignment

Individual Project - Space Engineering MSc - 09.2023 to 01.2024

Report Link: Navigation Assignment Report

Description

This project explores commonly used methods in **satellite orbit determination and navigation** using **Mathworks Matlab, NASA SPICE Toolkit and SGP4** integrator. It focuses on **uncertainty propagation**, **batch filters**, and **sequential filters** applied to the Swedish Prisma mission. The mission is composed of two satellites, Mango and Tango, and is a formation flight technological demonstrator.

Objectives

⇒ **Analyse uncertainty propagation** in the trajectory of Prisma mission satellites using different methods.

⇒ Implement and assess the **least squares batch filter** for state estimation of satellites.

⇒ Use the **UKF**(Unscented Kalman Filter) **sequential filter** for solving the navigation problem of both satellites.

Development

Exercise 1: Uncertainty propagation

⇒ Propagate the state and covariance of both satellites using **LinCov** (linearised approach) and **UT** (Unscented Transform).

⇒ Perform **Monte Carlo simulation to validate** the linear and Gaussian assumptions.

⇒ **Assess the collision risk** using the relative positions and covariance of both satellites.

⇒ Transform the position and position covariance submatrices into LVLH (Local Vertical Local Horizontal) frame to compare the three uncertainty propagation methodologies.

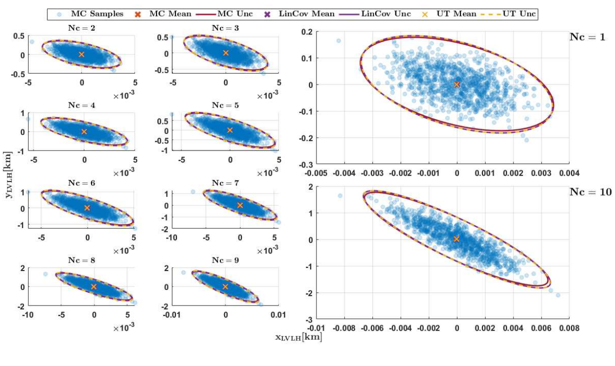

Figure 1. Propagated Position State and Covariance

Exercise 2: Impulsive guidance

⇒ **Compute Mango visibility windows** with respect to two ground stations, Kourou and Svalbard, in the given period using Keplerian motion.

⇒ **Simulate the measurements** taken from the ground stations employing **SGP4** and adding random noise.

⇒ Implement the **least squares batch filter** in Mathworks Matlab to solve the navigation problem.

⇒ **Solve the navigation problem** for different combinations of measurements and spacecraft dynamics models, Keplerian or J2 perturbed motion.

⇒ Repeat the procedure for Tango.

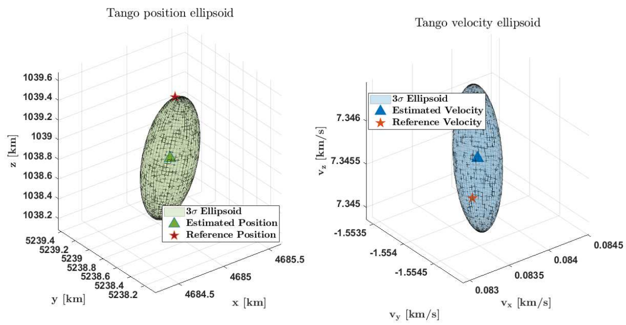

Figure 2. Tango Position and Velocity Uncertainty Ellipsoids

Exercise 3: Continuous guidance

⇒ Simulate Mango measurements acquired from one ground station by using SGP4 and adding random noise.

⇒ **Solve the navigation problem** using the **UKF** implemented in Matlab.

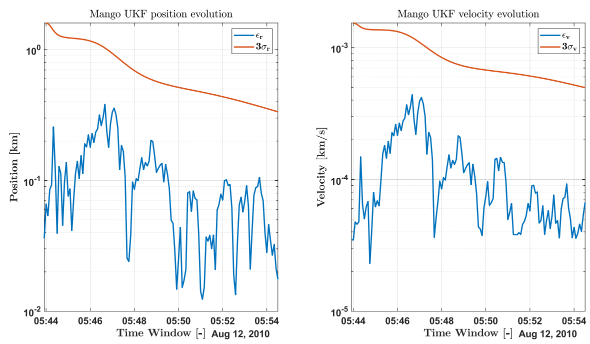

Figure 3. Navigation Problem Solution

⇒ Simulate relative measurements and **solve the relative navigation problem** between both satellites using UKF and CW (Clohessy-Wiltshire) dynamics.

⇒ Estimate Tango absolute state.

⇒ Analyse the error and uncertainty of the state estimates.

Results

The project effectively employs standard methods to address the orbit determination and navigation problem. It demonstrates **proficiency in dealing with complex astrodynamics** problems and in the **analysis of data**. An **overall comprehension of the commonly used filters** for satellite navigation is acquired, and **critical thinking** is adeptly used in evaluating the results obtained.

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Space Propulsion: Preliminary Design, Modeling and Comparison of Green and Toxic Rocket Engines For Kick Stages Applications

Group Project - Space Engineering MSc - 02.2023 to 06.2023

Report Link: Preliminary Design, Modeling and Comparison of Green and Toxic Rocket Engines For Kick Stages Applications Report

Description

The project aims to **design, analyse and compare** two **pressure-fed non-throttlable LRE (Liquid Rocket Engine** propulsion systems for use as orbital transfer stages. **Two propellant couples** are evaluated to provide a ΔV of 2500 m/s with 250 kg of inert mass. The work provides the data needed to **perform a trade-off analysis based on different mission drivers**.

Objectives

⇒ **Design two liquid rocket engines for kick-stage applications**, one using a toxic propellant couple and the other having an innovative green couple.

⇒ Model the **nozzle, combustion chamber, injectors, and pressurisation system**.

⇒ Perform a **preliminary thermal analysis**.

⇒ The design must be focused on **providing enough data to perform a trade-off analysis** based on different selection criteria.

Contributions

⇒ Green propellant trade-off analysis.

⇒ Nozzle and combustion chamber design.

⇒ Thermal analysis.

Development

⇒ Understand the expected performance of a kick-stage engine.

⇒ Perform a **literature review** to do a **trade-off analysis** for selecting the green propellant couple.

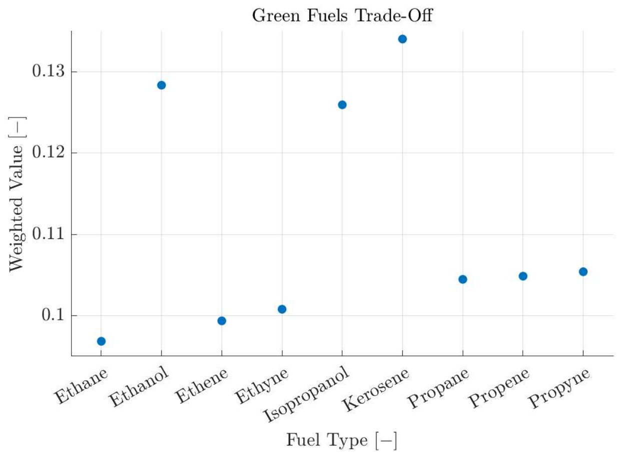

Figure 1. Plot to Perform Trade-Off Analysis for Green Couple Selection. Based on a Weighted Function Created by the Team

⇒ Analyse manufacturing techniques and material compatibility.

⇒ **Iterate to design the nozzle and combustion chamber** by combining Rocket Propulsion RPA (Rocket Propulsion Analysis), NASA CEA (Chemical Equilibrium with Applications), Mathworks Matlab and Autodesk Fusion 360 software.

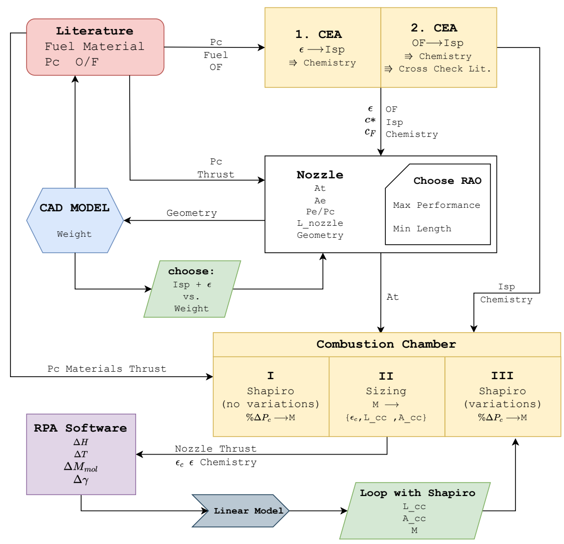

Figure 2. Design Workflow

⇒ Model and design the **injectors and pressurisation system** using Mathworks Matlab.

⇒ Perform **thermal analysis** with Rocket Propulsion RPA and Mathworks Matlab.

⇒ **Design and validate the thermal coating**.

⇒ Extract enough data from both engines to allow a trade-off analysis for the final selection.

Figure 3. Final Design CADs

Results

After the project, **two operational and functional engine units** for kick-stage applications are obtained. **Data** regarding specific impulse, expansion ratio, combustion chamber pressure or total mass is **provided for both engines to allow a deep trade-off analysis** and final selection of one propellant couple.

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Spacecraft Attitude Dynamics:
Control and Architecture Design for a Nadir Pointing 12U CubeSat in LEO

Group Project - Space Engineering MSc - 09.2022 to 01.2023

Report Link: Control and Architecture Design for a Nadir Pointing 12U CubeSat in LEO Report

Description

The project aims to **design and model the ADCS subsystem** for a 12U CubeSat in LEO orbit. The **control logic is also designed** and both controlled and non-controlled behaviours are compared. The **implemented control logic considerably improves the satellite's performance**.

Objectives

⇒ **Model the ADCS subsystem** based on given sensors, actuators and requirements using Mathworks Simulink.

⇒ **Design and implement a control logic** to improve the satellite's performance.

⇒ Analyse the **pointing performance**.

Contributions

⇒ I am involved in all the tasks, focusing more on the **environment, sensors and actuators modeling and the control logic design**.

Development

⇒ **Understand** the given **components and requirements**.

⇒ Perform a **literature review on existing ADCS solutions** for the given mission.

	Assigned Specification
Platform	12U CubeSat
Attitude Parameters	Quaternions
Mandatory Sensors	3 axis Magnetometer
Actuators	3 Magnetorquers 1 Inertia Wheel

Figure 1. Given Mission Architecture and Requirements

⇒ **Implement quaternions-based dynamics and kinematics** model tailored for reaction wheels and magnetotorquers.

⇒ Model and validate the environmental disturbances with orbit propagation: **Solar Radiation Pressure, Aerodynamic Drag, Magnetic Field Interaction and Gravity Gradient**.

⇒ **Model sensors and attitude determination** with the algebraic method, including sensors' noise and errors.

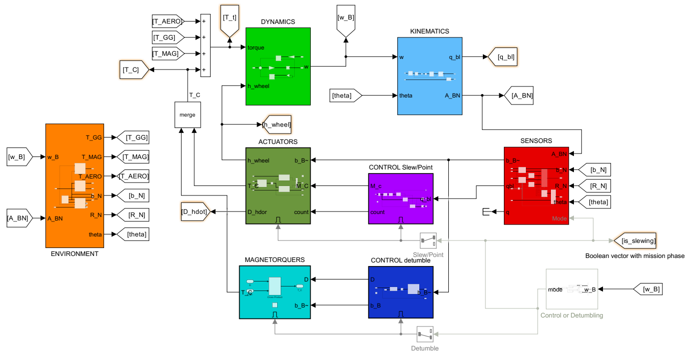

Figure 2. Simulink Model

⇒ **Model actuators** including noise and errors.

⇒ Design and implement the control logic: **B-Dot for detumbling and LQR and LQE** (Linear Quadratic Regulator and Estimator) **for slew manoeuvre and nadir pointing**.

⇒ Analyse pointing performance by comparing **pointing error and drift error**.

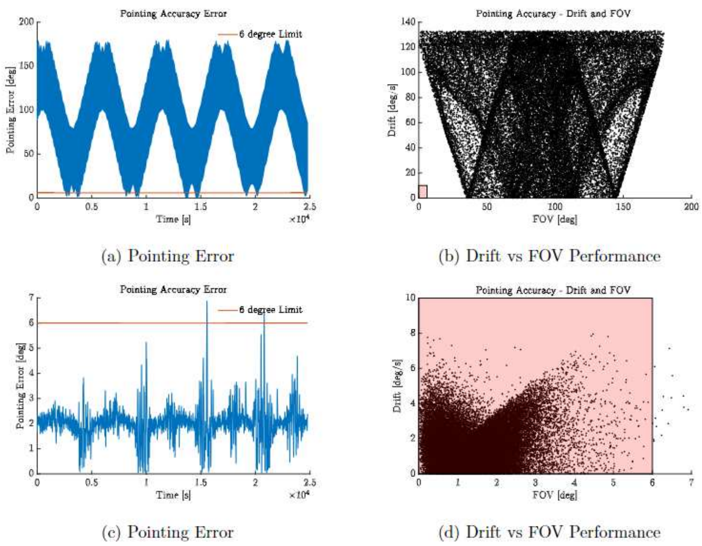

Figure 3. Pointing Performance Analysis Comparing Controlled and Non-Controlled Systems

Results

After the project, the **ADCS subsystem is modeled in its totality**, tailored for the given components and requirements. A **cost-effective control** is designed and applied, **achieving the required performances** and **improving the non-controlled system**.

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Orbital Mechanics:
Interplanetary Optimisation and Planetary Perturbances Modeling

Group Project - Space Engineering MSc - 09.2022 to 01.2023

Report Link: Interplanetary Optimisation and Planetary Perturbances Modeling Report

Description

The project is divided into two main segments. The initial phase involves optimising the interplanetary trajectory for a journey from Earth to an asteroid performing a flyby on Saturn. The second phase focuses on propagating the orbit of a planetary explorer mission, taking into account the J2 effect and Lunar perturbation.

Objectives

⇒ **Optimise** the **interplanetary trajectory** between Earth and a Near-Earth Object (NEO) performing a flyby.

⇒ **Propagate an Earth explorer mission** including J2 and Lunar perturbations.

⇒ **Validate the orbit propagator** model with real ephemeris.

Contributions

⇒ I actively participate in every task of the project.

Development

⇒ **Understand** the given **requirements and missions**.

Departure Planet	Earth
Flyby Planet	Saturn
Arrival NEO	90
Earliest Departure	30-08-28
Latest Arrival	26-02-63

$a[km]$	$e[-]$	$i[deg]$	$\Omega[deg]$	$\omega[deg]$	$\theta[deg]$	$T[s]$	$RGTR$
$2.6566 \cdot 10^4$	0.6369	17.8904	0	0	0	$4.8322 \cdot 10^4$	2 : 1

Figure 1. Given Missions

⇒ **Model**, using Mathworks Matlab, **the interplanetary trajectory** including an intermediate flyby on Saturn.

⇒ Create a **coarse grid search** to be applied in the interplanetary model.

⇒ Refine the grid search and **use gradient-based optimisation methods** to retrieve the optimal trajectory.

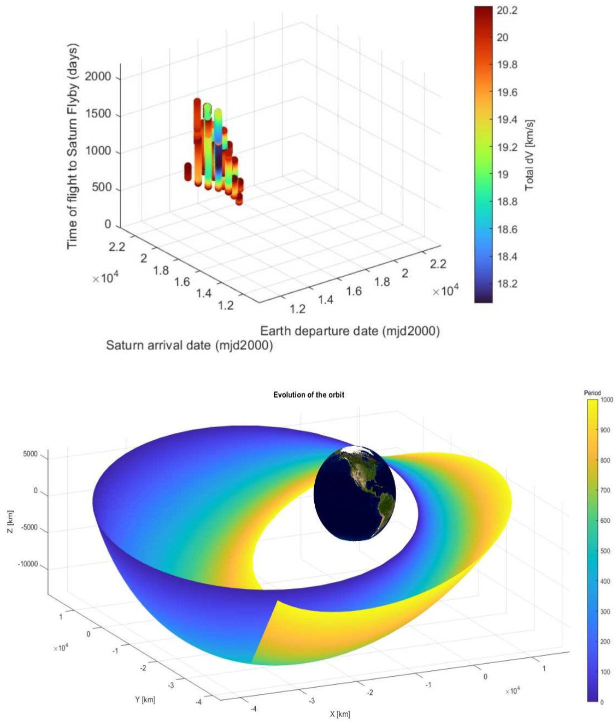

Figure 2. Interplanetary Coarse Search and Planetary Orbit Propagation

⇒ **Model J2 and Lunar perturbations** tailored for Gaussian planetary equations.

⇒ **Develop an orbital propagator** based on Gaussian planetary equations.

⇒ **Validate** the model using the **ephemeris of an Atlas 5 Centaur debris** from Space-Track.

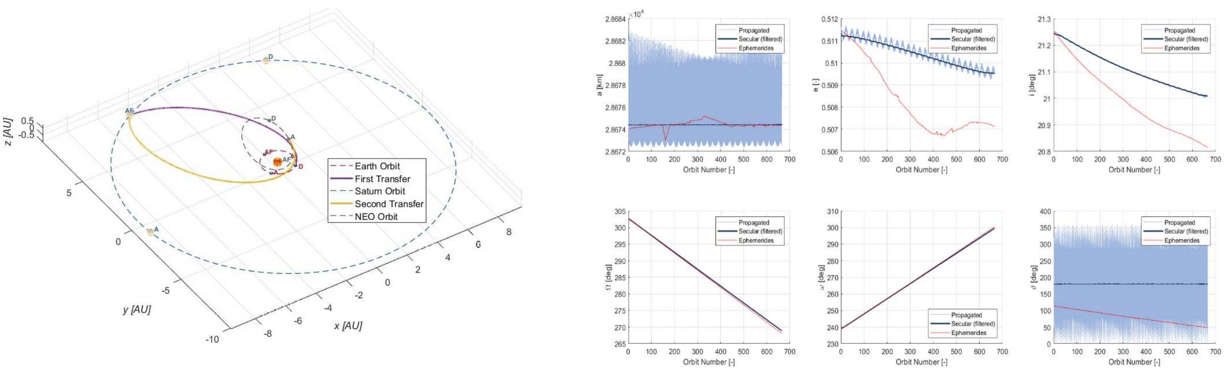

Figure 3. Final Interplanetary Trajectory and Ephemeris Comparison Between Orbit Propagator and Real Data

Results

After the project, an **optimal interplanetary trajectory is obtained** with a total ΔV of 17.67 m/s. For the second part, the comparison between propagated and real data highlights that **the orbit propagator has small errors** considering that not all the relevant perturbances are modeled. General knowledge of interplanetary optimisation and perturbations modeling is acquired.

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Modeling and Simulation of Aerospace Systems: Modeling Assignment

Individual Project - Space Engineering MSc - 09.2023 to 01.2024

Report Link: Modeling Assignment Report

Description

This project focuses on the **modeling and simulation** of two different **aerospace systems**: a rocket engine nozzle for thermal analysis and an electric propeller engine for general performance evaluation. The project aims to compare and apply causal and acausal modeling techniques to practical scenarios using **Mathworks Matlab, Mathworks Simscape and Dassault Systèmes Dymola**.

Objectives

⇒ **Model a rocket engine nozzle** for thermal analysis using **Mathworks Matlab and Simscape**.

⇒ Compare both causal and acausal methodologies.

⇒ Learn and use the **MBSE software Dassault Systèmes Dymola**.

⇒ **Model an electric propeller engine**, including its cooling system, and **perform simulations for general performance** evaluations.

Development

Exercise 1: Rocket Engine Nozzle

⇒ Perform a literature review to select the nozzle materials and layer lengths.

⇒ Derive the nozzle physical model.

⇒ Implement the **thermal causal model** of the nozzle in Mathworks Matlab.

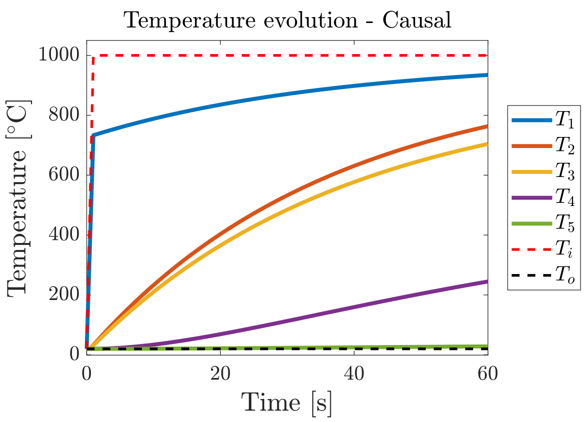

Figure 1. Causal temperature profiles

⇒ Create the **acausal model** for simulations in Mathworks **Simscape**.

⇒ Perform a **comparative analysis** of the temperature profiles and nozzle behaviour under different conditions.

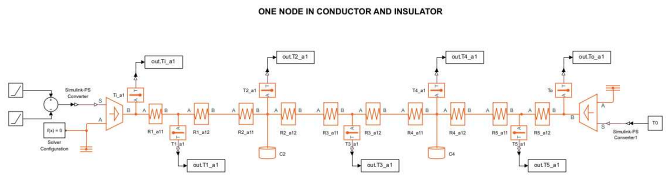

Figure 2. Simscape Model

Exercise 2: Electric Propeller Engine

⇒ Develop **the engine's physical model**, including a gear box.

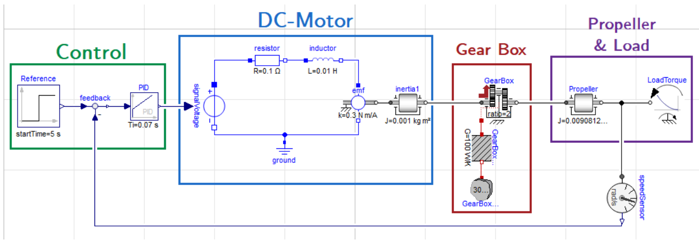

Figure 3. Electric Propeller Engine Model

⇒ **Design the control logic** to achieve system stability.

⇒ Simulate in Dassault Systèmes **Dymola to evaluate the performance** of the engine.

⇒ Develop the **physical model for the cooling system** of the engine.

⇒ Simulate in Dassault Systèmes **Dymola to evaluate the performance** of the cooling system.

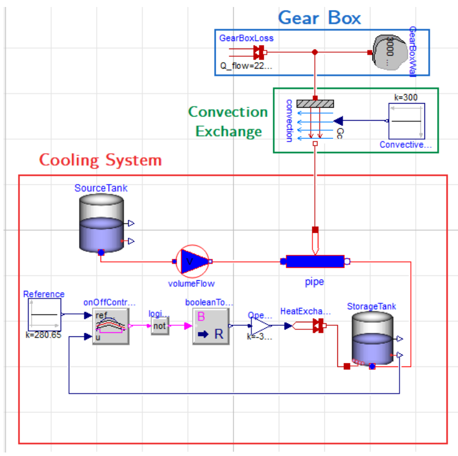

Figure 4. Cooling System Model

Results

After the project, a **good understanding of** the acausal modeling tools **Mathworks Simscape and Dassault Systèmes Dymola** is acquired. In the first exercise, both approaches are successfully compared and studied. In the second exercise, the **MBSE tool is applied** to design a control logic and a cooling system that **satisfy the requirements imposed** by the exercise statement.

fernando.aranda@mail.polimi.it Fernando Aranda Romero www.linkedin.com/in/fernandoaranda35

polispace

February 4, 2024

Dario Scimone PoliSpace President
PoliMi - Student Asssociation
Via Antonio Oroboni N. 11
20161, Milan - Italy
Email: info@polispace.it

Human Resources department
Astroscale Toulouse
Toulouse, France.

Dear Astroscale Recruiting Team,

I am pleased to recommend Fernando Aranda Romero for any position related to the space sector, requiring strong leadership, technical skills, and dedication. As the President of PoliSpace, I've seen him excel as a member of the Payload Subsystem of the 6S - CubeSat Team.

Fernando jumped into the role of team member and quickly adapted, handling responsibilities well. He maintained a solid work ethic throughout his one-year involvement, even while completing exams and a master's thesis.

In team discussions, Fernando was proactive, sharp, and precise at handling tough questions from external parties. He fosters a positive team environment, appreciating interpersonal activities.

One notable achievement was managing subsystem design and interface control for different operation phases. Fernando ensured accurate documentation while adhering to strict requirements, budgets, and ECSS standards. He effectively defined the data rate coming from the satellite's payload during scientific phases while also designing the nominal operations and writing requirements. The outcome of his work can be appreciated in the paper he co-authored at the 72nd International Astronautical Congress.

Fernando has also demonstrated outstanding collaboration with external partners and suppliers such as Cambridge and Potsdam universities and experts from ESA Fly Your Satellite Design Booster. His ability to communicate effectively with these stakeholders has significantly contributed to the improvement of the system design.

In summary, Fernando is an exceptional individual who exceeds expectations in dedication, technical skills, and teamwork. He brings valuable qualities to any team or project. I am confident he will continue to thrive in future endeavors.

If you have any questions or need further information, feel free to contact me. Thank you for considering Fernando.

Sincerely,

Dario Scimone

motores térmicos

UNIVERSITAT POLITÈCNICA DE VALÈNCIA

Valencia, Spain, 2024.01.23

To whom it may concern:

This letter is to serve as my formal recommendation for Mr. Fernando Aranda Romero. He has been my student in the subject of "Flight Mechanics" and I bear witness that he is a qualified person and hard-working person. He is very interested in working for the company ASTROSCALE, based in Toulouse, dedicated to space debris removal and on-orbit services.

I feel confident that he will succeed in ASTROSCALE. I have noticed that in addition to an excellent academic preparation, he also has outstanding personal qualities, as his people skills, and the ability to work with others in a team. He develops an optimal contagious motivational environment with all his colleagues, especially in an international environment due to his language skills. He also has a high spirit of improvement and a willingness to perform extra tasks entrusted to him.

I am sure that Mr. Fernando Aranda Romero will work with you in the same manner and with the same dedication as he did with us during his university period. For this reason, I am eager to widely recommend him.

I am at your disposal for any clarification or additional information needed.

Sincerely,

Ph. Doc. José Pedro Magraner Rullán

Flight Dynamics Lecturer (Ret.)

UPV_ SPAIN

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