

# PHD PROJECT OVERVIEW

SPACE SITUATIONAL AWARENESS AND CHARACTERISATION  
OF RESIDENT SPACE OBJECTS USING OPTICAL TECHNIQUES

Submitted by

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# INTRODUCTION

The growing congestion of the orbital environment makes it necessary to develop advanced Space Situational Awareness tools capable not only of monitoring, but also of characterising and predicting the behaviour of space objects, integrating optical observations, physical models and artificial intelligence techniques.

# OBJECTIVES



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## **Realistic simulations**

Satellite orbit & attitude and optical response of different materials

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## **Data comparison**

Simulated vs real for model validation

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## **AI algorithms**

For reconstruction, classification and anomaly detection of resident space objects

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## **Operational SSA**

Real data integration and unified platform to support scientific and operational SSA

# METHODOLOGY OVERVIEW - 1

## Dynamic Module

Orbital propagation  
and attitude

## Radiometric Module

Optical chain simulation,  
atmosphere, PSF, MTF,  
noise

## Synthetic Data Generation

Light curves, images,  
multi-object scenarios

# METHODOLOGY OVERVIEW - 2

**AI  
algorithms**

Parameter  
reconstruction,  
classification, anomaly  
detection

**Validation  
with OGS**

Photometry, polarimetry

**Integrated  
SSA Platform**

Scientific and  
operational support

# FIRST-YEAR ACTIVITIES

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## FROM SATELLITE OBSERVATION TO OPTICAL RESPONSE

- **Classification of known satellites observed by the team**
  - Study of the platform's main materials, orbit and attitude dynamics
- **Laboratory measurements on materials**
  - Polarimetric response of typical satellite materials (solar cells, MLI, etc.) at different illumination and observation angles
- **Optical and polarimetric model of satellite**
  - Derivation of an optical-polarimetric model of the satellite from laboratory measurements, used to simulate responses observable from the ground.
- **Comparison with real data**
  - Analysis of optical and polarimetric observations: search for correlations between physical characteristics of the satellite peculiarities in the observed data



### **Incomplete and confidential data**

Detailed information on satellites is not available in the literature or disclosed by manufacturers, making it difficult to correlate optical observations with actual characteristics.

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### **Geometric variability**

Relative position of the observer–satellite–Sun is constantly changing; lighting conditions are not repeatable between observations taken at different times, complicating data comparison.

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### **Choice of spectral band**

Different satellite surfaces respond differently; identifying the optimal band (blue, infrared, etc.) for reliable observations is complex.

# CRITICALITIES

# CONCLUSION



In summary, the work proposes an innovative approach to Space Situational Awareness that integrates optical observations, physical modelling and artificial intelligence to interpret and predict the behaviour of space objects in a more comprehensive and reliable manner.

THANK YOU