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Matteo Rossetti

EDUCATION AND TRAINING

MSC in Space and Astronautical Engineering

Sapienza Università di Roma [01/09/2020 – 24/01/2024]

Address: 00185 Rome (Italy) | **Field(s) of study:** Engineering, manufacturing and construction | **Final grade:** 107/110 | **Level in EQF:** EQF level 7 | **Type of credits:** ECTS | **Number of credits:** 120 | **Thesis:** Real-time optical detection and tracking of resident space objects via Kalman filter

Thesis abstract: The persistent congestion of Earth's orbital space due to man-made satellites raises the likelihood of catastrophic events such as collisions and explosions, resulting in the creation of additional space debris in orbit. The issue of space debris within the limited region around Earth has garnered increasing attention from space agencies, with a particular focus on Space Surveillance and Tracking (SST) services. The primary objective of SST is to monitor these objects and continually update their orbital data through ground tracking stations. Optical observations have emerged as a promising and cost-effective method to gather information about artificial orbital objects. Within this complex framework, this thesis work aims to present a real-time optical detection and tracking method for monitoring Resident Space Objects (RSO). The method enables satellite tracking even when no prior information, such as ephemeris or Two Line Element sets (TLE), is available. So, the aim is to develop an efficient software capable of real-time space object detection and tracking based on the Stare and Chase strategy using a Kalman filter, while providing the necessary angular rates for telescope mount control. This strategy is designed to acquire an initial measurement during the Stare phase and initialize the subsequent Chase phase, where measurements extracted from images are integrated into an orbit determination method to enhance the state and estimate more accurate commands, in a closed loop logic. To implement the strategy software, various routines need to be developed, tested, and integrated. The software must include a telescope control routine to physically track the target object, which has been achieved by integrating a controller that considers the current telescope position. The performance of the telescope control has been analyzed as a preliminary result of the project, providing a useful tool for object tracking from TLE. Furthermore, routines for camera control and image analysis have been developed to manage and analyze the acquired data, i.e., the images. The developed Kalman filter will be presented, designed to execute the orbit determination procedure for updating the state, including position and velocity. From the update state the rates are estimated. The thesis will provide insights into the software's architecture, procedures, and algorithms employed. It will explain the recursive method's implementation for detecting and tracking objects over time using acquired video frames. Also, the required hardware setup to perform the real-time tracking is illustrated. Towards the end, a series of tests will be conducted to assess the system's actual operability and performance. In the concluding remarks, the software's capability to detect and track objects with varying behaviors will be discussed, along with its potential for achieving accurate tracking, considering the obtained results.

BSC in Aerospace Engineering

Sapienza Università di Roma [01/09/2017 – 23/10/2020]

Address: 00185 Rome (Italy) | **Field(s) of study:** Engineering, manufacturing and construction | **Final grade:** 99/110 | **Level in EQF:** EQF level 6 | **Type of credits:** ECTS | **Number of credits:** 180 | **Thesis:** Optical Observations of Orbital Debris Caused by an Explosion in Low Earth Orbit

Thesis abstract: The aim of this thesis is to track and identify space debris resulting from an explosion in low Earth orbit through optical observations conducted at the Collepardo observatory site belonging to the Sapienza Space Systems and Space Surveillance Laboratory (S5lab). After acquiring the images, they were analyzed and objects were identified using various software tools. The ultimate goal is to develop a method and strategy for identifying fragments likely to be debris from the exploded object by cross-referencing the results with those cataloged and identified by the North American Aerospace Defense Command (NORAD). Additionally, through appropriate analysis, it was possible to associate an impulse (ΔV) with the measurements obtained, thus

characterizing the fragments in terms of energy and their angular distribution over time relative to the original body from which they detached.

Diploma Liceo Scientifico

Istituto istruzione superiore scientifico e tecnico di Orvieto (TR) [01/09/2012 – 30/06/2017]

Address: 05018 Orvieto (Italy) | **Final grade:** hundred out of one hundred | **Level in EQF:** EQF level 4

WORK EXPERIENCE

Collaboration Grant

Dipartimento di Ingegneria Astronautica, Elettrica ed Energetica University of Rome La Sapienza [17/01/2024 – 16/02/2024]

City: Rome | **Country:** Italy

Topic: Attività di supporto alle operazioni degli osservatori EQUO-AD e all'analisi dati per caratterizzazione, identificazione e determinazione orbitale per detriti spaziali e oggetti in orbita

Activities: Testing of the EQUO observatory system, installed in November, to evaluate its performance in acquiring data in both sidereal tracking and object tracking modes. Development and testing of software to achieve precise object tracking using the installed system. Organization of the observatory calibration campaign and subsequent data analysis.

Visiting Research Student

University of Michigan - Department of Astronomy [05/08/2022 – 20/08/2022]

City: Ann Arbor | **Country:** United States

Research fields activities:

- Daytime optical observations
- Optical observations for studying the impact of the newmega constellations on the night sky
- Joint Sapienza Michigan Satellite Observations

Collaboration Grant

Department of Mechanical and Aerospace Engineering University of Rome La Sapienza [27/06/2022 – 27/07/2022]

City: Rome | **Country:** Italy

Topic: Supporto alle attività di sorveglianza spaziale in ambito IADC

Activities: Fragmentation analisys and observations, observativesnights organizations and optimizations, partecipations to the observatives nights, database structure implementation

Collaboration Grant

Department of Mechanical and Aerospace Engineering University of Rome La Sapienza [01/06/2021 – 30/06/2021]

City: Rome | **Country:** Italy

Topic: Dispiegamento e test network sorveglianza spaziale Sapienza

Activities: Fragmentation analisys and observations, observatives nights organizations and partecipations

PROJECTS

[09/10/2023 – Current]

RESEARCH PROJECT - BEXUS 34/35 Partecipation in the Swedish-German BEXUS 34/35 programme, with RETINA (Real-time Experiment for Thermal management, Inertial Navigation and Attitude) experiment.

Role: Electrical Engineer and Software Engineer

Link: https://www.linkedin.com/company/retinabx15s5lab/posts/?feedView=all

[2023 – Current]

RESEARCH PROJECT - Space debris and the long-term sustainability of space activities Participation in the activities related to the agreement ASI-INAF: "Detriti spaziali e sostenibilità delle attività spaziali a lungo-termine 2023-2025, Accordo di collaborazione tra ASI e INAF N. 2023-50-HH.0, WP5 – Osservazioni ottiche, data fusion, studio sensori ottici a largo campo e attività WG1 dello IADC"

Acitivities:

- Participation of AIs and ITs of WG1.
- Participation in re-entry campaigns and fragmentation characterization campaigns.
- Support for the preparation of campaigns within WG1 through exploratory campaigns, software, and definition of strategies.
- Preparation of photometric calibration data from laboratory data.

[28/04/2022 – Current]

REASEARCH PROJECT - GEA (Analog Explorations Group) Participation in the programme GEA (Analog Explorations Group) in collaboration with the Italian Alpine Club (CAI).

Role: Member of the logistic group with resposabilities in materials transportations, organization and assembly. Responsabilities in the power supply system and assembly.

Link: https://it.linkedin.com/company/gea-gruppo-esplorazioni-analoghe

[2020 – 2023]

RESEARCH PROJECT - SUPPORT FOR IADC AND SST ACTIVITIES Participation in the activities related to the agreement ASI-INAF: "SUPPORTO ALLE ATTIVITÀ IADC E SST 2019-2022, Accordo di collaborazione tra ASI e INAF N. 2020-6-HH.0, WP 2200 – Osservazioni Sapienza"

Activities:

- IADC Internal Task 39.2 for Fragmentation Events
- IADC Internal Task 34.1 for Molniyapopulation study
- Optical observation scheduling and management
- Telescope and sensors installation

[2021 – 2022]

REASEARCH PROJECT - ESA'S FLY YOUR SATELLITE Partecipation in the ESA Accademy program Fly Your Satellite with the LEDSAT cubesat Mission

Role: Member of the ground segment team for the optical observationsof the LED-based payload and immages analysis.

[2019 – 2020]
Sapienza Space Team (SST) Participation in the Sapienza Space Team project, part of SASA – Sapienza Aerospace Student Association, taking part in the CanSat Competition.

Role: Team Leader

DIGITAL SKILLS

Programming

MATLAB / Python / MATLAB App Designer / C, C ++ / WSL (Windows Subsystem for Linux) / Arduino language program

Office Automation

Microsoft Word / Google Drive / Microsoft Excel / Internet user / Gmail / Microsoft Powerpoint

CAD Software

3D Cad Modelling / Autodesk Fusion 360 / EAGLE PCB desing / SIEMENS Solid Edge

Soft Skill

Critical thinking / Creativity / Analytical skills / Organizational and planning skills / Reliability / Team-work oriented / Flexibility / Responsibility / Good listener and communicator / Motivated

Optical observatory system managment

Telescope control center operations / MaximDL / TheSkyX Software / Astrometry.net

LANGUAGE SKILLS

Mother tongue(s): Italian

Other language(s):

English

LISTENING B1 **READING** B1 **WRITING** B1

SPOKEN PRODUCTION B1 **SPOKEN INTERACTION** B1

Levels: A1 and A2: Basic user; B1 and B2: Independent user; C1 and C2: Proficient user

CONFERENCES AND SEMINARS

[03/03/2015 – 07/03/2015] Riva del Garda
34th National Selection Conference of the Association Parlamento Europeo Giovani (European Youth Parliament - EYP Italy) I took on the role of delegate at the 34th National Selection Conference of the European Youth Parliament (EYP Italy).

[01/02/2022 – 03/02/2022]
Workshop Una Roadmap per la Luna: Scienza e tecnologia Participation to the Workwshop, which was held in Rome by ASI agency.

[18/09/2022 – 22/09/2022] Paris, France

73rd International Astronautical Congress Participation to the 73rd IAC (International Astronautical Congress),which was held in Paris.

PUBLICATIONS

[2021]

OPTICAL OBSERVATIONS FOR ENERGETIC CHARACTERIZATION OF IN-ORBIT EXPLOSION: THE FREGAT-SB CASE **Authors:** G. Zarcone, L. Mariani, M. Rossetti, L. Cimino, S.H. Hossein, F. Curianò, F. Piergentili, F. Santoni

Proc. 8th European Conference on Space Debris, Darmstaldt, Germany, 20-23 April 2021, SDC8

[2021]

Overview of optical observation strategies and systems: LEO and GEO measurements acquisition for position and attitude determination **Authors:** L. Mariani, L. Cimino, M. Rossetti, P. Celesti, L. di Palo, M. Bucciarelli, F. Curianò, S.H. Hossein, G. Zarcone

IEEE 8th International Workshop MetroAeroSpace, 23 June 2021, Article number 9511712, Pages 305-310

[2021]

Satellite early identification through LED observations: First in-orbit results from WildTrackCube-SIMBA **Authors:** F. Piergentili, P. Marzioli, L. Frezza, F. Curianò, G. Zarcone, L. Mariani, D. Amadio, A. Gianfermo, N. Picci, E. Bedetti, S. H. Hossein, D. K. Kabutha, P. Celesti, M. Rossetti, L. Cimino, M. Bucciarelli, P. Seitzer, J. Cutler, C. Mwaniki, M. Toninelli, M. Jahjah, F. Santoni

Acta Astronautica, Volume 193, 2022, Pages 163-172, ISSN 0094-5765

[2022]

A graphical method for the analysis of a satellite's in-orbit breakup through optical observations **Authors:** G. Zarcone, M. Rossetti, S. H. Hossein, F. Piergentili

Advances in Space Research, Volume 70, Issue 4, 2022, Pages 1048-1061, ISSN 0273-1177

[2022]

Photometric characterization of Starlink satellite tracklets using RGB filters **Authors:** Hadji Hossein S., Cimino L., Rossetti, M., Zarcone G., Mariani L., Curianò F., Bucciarelli M., Seitzer P., Santoni F., Di Cecco A., Piergentili F.

Advances in Space Research (2022), ISSN 0273-1177

[2023]

Genetic algorithm for space debris and space objects attitude motion reconstruction through optical measurements **Authors:** L. Cimino, L. Mariani, S. Varanese, G. Zarcone, M. Bucciarelli, M. Cerci, S. H. Hossein, M. Rossetti, F. Piergentili

Proc. 2nd NEO and Debris Detection Conference, 24-26 January 2023

[2024]

Multiband photometric observations of GEO objects through Sloan filters **Authors:** L. Cimino, L. Mariani, M. Rossetti, F. Piergentili

Advances in Space Research, 2024, ISSN 0273-1177

[2023]

A Dual Perspective on Geostationary Satellite Monitoring Using DSLR RGB and sCMOS Sloan Filters **Authors:** Mariani L., Cimino L., Rossetti M., Bucciarelli M., Hossein S.H., Varanese S., Zarcone G., Castronuovo M., Di Cecco A., Marzioli P., Fabrizio P.

Aerospace 2023, 10(12), 1026

[2021]

Innovative observation systems for LEO and GEO orbiting objects state determination Authors: G. Zarcone, L. Mariani, F. Curianò, S. H. Hossein, L. Cimino, M. Rossetti, M. Bucciarelli, L. Di Palo, P. Celesti, L. Frezza

Proceedings of the International Astronautical Congress, IAC, IAF, 2021, IAC- 21,A6,1,x64929

[2022]

Large data collection through innovative optical systems for angles-only orbit determination Authors: Zar cone G., Rossetti M., Varanese S., Bucciarelli M., Cimino L., Hossein S.H., Mariani L., Santoni F., Piergentili F

Proceedings of the International Astronautical Congress, IAC, IAF, 2022, IAC- 22,A6,IP,35,x73839

Early identification and attitude reconstruction of LED-equipped satellites for Space Traffic Management and improved trackability Authors: P. Marzioli, L. Frezza, N. Picci, A. Gianfermo, E. Bedetti, D. Amadio, L. Mariani, G.Zarcone, L. Cimino, M. Rossetti, S. H. Hossein, M. Bucciarelli, C. Ghini, M. C.Fiorella, L. Chiavari, A. Fabbrizi, M. Boscia, S. Kumar, F. Santoni, P. Seitzer, F. Piergentili

Proceedings of the International Astronautical Congress, IAC, IAF, 2022, IAC-22,A6,4,7,x73755

[2022]

Lessons learned from the first student-led Sapienza GEA cave exploration analog mission Authors: P. Marzioli, A. Fabbrizi, L. Chiavari, A. Di Giacomo, C. Ghini, A. Binni, E. Gramillano, S. di Bartolo, F. Curianò, L. Gugliermetti, G. Catesini, F. Rizzi, L. Cavalieri, L. Cimino, M. Colantoni, G. Gardini, L. Misercola, M. Solfaroli, F. Toso, E. Valant, M. Viviano, M. Rossetti, M. Bucciarelli,F. Piergentili, F. Santoni

Proceedings of the International Astronautical Congress, IAC, IAF ,2022, IAC-22,E1,4,14,x73748

[2022]

Photometric analysis for testing Starlink solutions to light reflection mitigation Authors: L. Cimino, S. H. Hossein, L. Mariani, G. Zarcone, M. Rossetti, M. Bucciarelli, F. Santoni, A. Di Cecco, P. Seitzer, F. Piergentili

Proceedings of the International Astronautical Congress, IAC, IAF, 2022, IAC- 22,D1,IPB,2,x73606

[2023]

CubeSat Confusion: CubeSat ID via ground-based observations of a pulsed LED beacon Authors: A. M. Goodyear, D. A. Hinkley, P. Marzioli, F. Piergentili, G. Zarcone, L. Cimino, M. Rossetti, L. Frezza, S. Varanese, L. Mariani

Proceedings 74th International Astronautical Congress, IAC, Baku October 2023, IAC-23-A6.IPB.1

[2023]

Satellite reflectance and brightness testing facility for reducing spacecraft constellations light pollution A uthors: G. Lorenzia, C. Ghinia, M. Rossetti, L. Cimino, L. Mariani, P. Marzioli

Proceedings 74th International Astronautical Congress, Baku 2023, IAC-23,B4,9-GTS.5,6,x79814

[2023]

Advances in spaceborne LED payloads attitude determination and autonomous units design for Space Traffic Management Authors: L. Frezza, N. Picci, A. Gianfermo, E. Bedetti, D. Amadio, L. Mariani, G. Zarcone, L. Cimino, M. Rossetti, S. H. Hossein, M. Bucciarelli, C. Ghini, M. C. Fiorella, L. Chiavari, A. Fabbrizi, M. Boscia, S. Kumar, F. Santoni, P. Seitzer, F. Piergentili

Proceedings 74th International Astronautical Congress, Baku 2023, IAC-23,A6,4,1,x79847

[2023]

Observation Strategy to Cataloguing, Monitoring and Classifying Objects in Molniya Orbit through Optical Observations Authors: Rossetti M., Cormani F., Mariani L., Varanese S., Zarcone G., Cimino L.

Proceedings 74th International Astronautical Congress, Baku 2023, IAC-23,A6,1,5,x79348

[2023]

Lunar lava tube infrastructure and innovative technologies testing through speleology analog mission: the Sapienza GEA project Authors: A. Fabbrizi, A. Binnia, L. Misercola, A. Di Giacomo, C. Ghini, M. Bucciarelli, F. Rizzi , E.Valant, L. Chiavari, M. Rossetti, L. Cimino, L. Mazzetti, E. Gramillano, G. Catesini, M. Viviano, L. Cavalieri, M. Solfaroli, L.Gugliermetti, P. Marzioli

Proceedings 74th International Astronautical Congress, Baku 2023, IAC-23-A5.1.10

[2023]

GEO Optical Measurements Correlation and Angles-Only Orbit Determination Authors: Varanese S., Mariani L., Zarcone G., Bucciarelli M., Cimino L., Rossetti M., Kelecy T.

Proceedings 74th International Astronautical Congress, Baku 2023, IAC-23,A6,9,4,x79853