

Project and Diploma Thesis Topics in DAAS

Intermediate Project (P)

Engineering Diploma Thesis (E)

Master Diploma Thesis (M)

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The navigation area

1. Algorithms for sensor data fusion (E,M)
2. Statistical and spectral analysis of sensor signals (P,E)

Dynamics and control

1. Digital automatic flight control system for manned and unmanned aircraft. (M)
2. Automatic flight control system based on optimal control approach (M)
3. Flight control algorithm for rotorcraft (P,E,M)
4. Influence of attitude measurement system performance on autopilot efficiency. (E,M)

Dynamics modelling and simulation

1. UAV dynamics modelling and simulation for automatic flight control system design. (E,M)
2. Sailplane dynamic modelling and simulation. (E,M)
3. Quadrocopter dynamic stability analysis. (M)

Navigation

1. Integrated navigation systems using various sensors: INS/GPS/magnetometers/others (P, I, M)
2. Application of satellite navigation system to measure attitude of a mobile platform (P, I, M)
3. Algorithms in inertial navigation systems (P, I, M)
4. Alignment methods for inertial navigation systems (P, I, M)

Dynamics and control of mobile platforms (ground, surface, underwater, space and air)

1. Modeling of mobile platforms dynamics (P, I, M)
2. Control methods and algorithms (P, I, M)
3. Performance and control of rotorcraft (P, I, M).

On-board systems

1. Models and algorithms for on-board navigation and control systems (P, I, M).

The area of dynamics and control

1. Implementation of tracking and stabilization control algorithms at the kinematic level to a mobile robot Pioneer 3-DX. (work with ARIA software – the original robot software). (P,E)
2. Dynamics modeling and motion control of a wheeled mobile robot including wheel slipping. (M)
3. Dynamics modeling and motion control of a multi-link manipulator model with flexible links. The manipulator model selection is up to a student (M)
4. Dynamics modeling and motion control of a formation of objects (objects are due to a student, e.g. wheeled mobile robots (WMR), unmanned aerial vehicles (UAVs), underwater autonomous vehicles (UAV's), satellites formation, manipulators in duets, e.t.c). (E,M)
5. Implementation of “model-based” tracking control algorithms to a mobile robot Pioneer 3-DX. (M)
6. Dynamics modeling and motion control of underactuated system models, e.g. acrobot, pendubot, snake-like manipulator, space vehicles and manipulators, biomechanical system models and others (object selection is due to a student). (E,M)
7. Dynamics modeling and maneuver control for underwater vehicles (gliders, ROVs, hybrid propelled vehicles. (E,M)
8. Optimization of control maneuvers for underwater gliders (a glider propulsion way selection is due to a student). (M)
9. Control design for servicing satellites and space robots (E,M)
10. Tracking controller designs for servicing space missions (E,M).
11. Control design for space missions for servicing satellites and space robots (E,M)
12. Control design for servicing and docking maneuvers of satellites and space robots (E,M)

The area of dynamics modeling and simulation

1. Modeling complex dynamical systems – constrained dynamics models including environmental constraints, friction, joint and motor dynamics. A system is due to a student. (P)
2. Dynamics modeling and simulation tests for motion of complex systems: (P)
 - multi-link ground, space and underwater manipulators,
 - wheeled mobile vehicles, mobile manipulators, car-like vehicles,
 - autonomous systems like UAV's.
3. Dynamics modeling and simulation tests for motion of systems with flexible parts and links: (P)
 - multi-link ground, space and underwater manipulators with flexible arms,
 - wheeled mobile vehicles and platforms with flexible parts and chassis.
4. Dynamics modeling and simulation tests for motion of a mobile robot including tire models and motor dynamics. (E)

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5. Dynamics modeling and simulation tests for motion of a mobile robot including wheel slip models. (E)
6. Dynamics modeling and simulation tests for formation of ground autonomous vehicles motion and regrouping in surveillance and patrol missions (vehicles due to a student). (E)
7. Dynamics modeling and simulation tests for formation of UAV's. (E)
8. Dynamics, motion analysis of a car-like vehicle including wheel slip models. (M)
9. Dynamics, motion analysis of a multi-link manipulator model with flexible arms – simulation studies of flexibility and compliance models. (M)
10. Dynamics, motion analysis of a space robot model with flexible arms – simulation studies of flexibility and compliance models. (M)
11. Dynamics, motion analysis of a space robot model with flexible appendages – simulation studies of flexibility and compliance models. (M)
12. Dynamics analysis of space missions and docking for spacecraft (M)

The area of navigation

1. Simulation of selected navigation algorithm (ex. GPS) (P,E)

The area of aeronautical systems

1. Simulation of control systems operation, selected channel (E,M)
2. Simulation of the selected aeronautical system operation (eg GPWS, TCAS, VOR, etc.) (P)

The area of dynamics modeling and simulation

1. Concept and software development for dynamics module for flight simulator (E,M)
2. Concept and software development for selected aeronautical system for flight simulator (E,M)
3. Concept and software development for autopilot in the selected channel for flight simulator (E,M)
4. Implementation of open-source graphics engine to DAAS simulator (E,M)
5. Concept and software development for objects interactions (collisions) for flight simulator (E,M)
6. Topics regarding pilot training in simulators with VR/AR equipment (E,M)

The area of unmanned aerial vehicles

1. Topics regarding unmanned aerial vehicles/systems (P,E,M)
2. Sense and avoid system development for UAV/UGV (E,M)

Other student-proposed topics within the field of simulators and unmanned systems.

Control and navigation

1. System identification
2. Control of unmanned systems (aircraft, mobile robots)

The area of modeling and simulation

1. Modeling the dynamics of flying objects and implementation in a virtual environment
2. Modeling and parameter identification of the human operator (pilot, driver, operator)
3. Modeling human-machine systems
4. Application of fuzzy logic to model personal characteristics within a human dynamics model
5. Modeling of sensors and flight control
6. UAV simulation in virtual environment
7. Modeling Urban Air Mobility environment
8. Air Traffic Management
9. Augmented Reality with UAV

The Unmanned Aerial Systems

1. Commercial use of UAVs
2. Trajectory Optimization and analysis
3. Systems of systems (multiple UAV in one environment)
4. Data acquisition and analysis from various sensors (daylight IR, thermal Lidar)
5. Urban Air Mobility Concept
6. Use of Augmented Reality in UAV operator's training

The area of Aeronautical System

1. Design of a system for evaluating handling qualities
2. Design of a flight analysis system

The area of Human Factors

1. Psycho and physio of the pilot during flight operation (flight simulator)
2. Analysis of biofeedback in human training
3. Human factors in aviation

The area of navigation

1. Design and simulation of a navigation system using sensor data fusion for spacecraft (E, M)
2. Orbit determination using nonlinear Kalman filters (UKF and related methods) (E, M)
3. Navigation for missions in the inner Solar System (E, M)

Dynamics and control

1. Automatic flight control and stabilization system for a helicopter (E, M)
2. Optimal control (LQR/LQG) of an unmanned helicopter and controller tuning by optimization (E, M)
3. Nonlinear control of an unmanned compound helicopter (M)
4. Automatic helicopter control during precision landing (E, M)
5. Control augmentation system based on fractional-order controllers (E, M)
6. Reinforcement learning for thruster-based satellite attitude control (M)

The area of space technology

1. Attitude guidance and control system for a nanosatellite (E, M)
2. On-board computer for a sounding rocket (E, M)
3. Mitigation of Single Event Upset effects in on-board software using error correction codes (E, M)
4. Assessment of Single Event Latch-up susceptibility of CMOS devices (E, M)

The area of aeronautical systems

1. Avionics data transmission and reception via CAN Aerospace (P, E)
2. Flight management system — simulation application (E, M)

The area of unmanned and mobile platforms

1. Automatic control system for an unmanned helicopter (E, M)

Themes of intermediate projects

1. Orbital mechanics
2. Modelling and simulation of spacecraft flights
3. Orbital maneuvers
4. Space mission analysis and design
5. Spacecraft navigation in near-Earth, interplanetary and interstellar space
6. Spacecraft subsystems modelling
7. Modelling of the loads acting on a spacecraft
8. Optimization
9. Paragliding

Examples of intermediate projects

1. Simulation of spacecraft launch
2. Simulation of spacecraft landing/deorbitation
3. Simulation of atmospheric re-entry/aerocapture with dynamic pressure/temperature limit constraints
4. Simulation of satellite constellations, visibility determination of GNSS satellites (GPS, Galileo, GLONASS, Beidou)
5. Spacecraft launch/landing trajectory optimization, Goddard problem
6. Spacecraft aerodynamic coefficients determination (free molecular flow)
7. Spacecraft reflectivity characteristics coefficients determination (solar radiation pressure)
8. Analysis of distribution of objects in near-Earth space based on TLE data
9. Spacecraft orbit determination based on ground-based observations
10. International Space Station (ISS) orbit determination based on the photo of its flyover
11. Modelling of nonuniform objects' gravity field (spherical harmonics model, mascons model, polyhedral model)
12. Earth's shadow modelling
13. Modelling of a star tracker device - camera attitude determination based on an image of the stars
14. Multistage rocket optimization
15. Development of a numerical model of a crater covered surface for the simulation of visual navigation during landing
16. Interplanetary trajectory optimization, gravity assists
17. Comparison of interplanetary spaceflight simulation with the patched-conics method
18. Comparison of low and high thrust maneuvers (orbit radius change, plane change)

19. Simulation of an interplanetary mission propelled by a solar sail
20. Simulation of motion of many (~1000) objects under the influence of mutual gravitational interaction
21. Simulation of debris dispersion during spacecraft collision
22. Simulation of the dispersion of an object's impact site during deorbiting
23. Development of a tool for rapid/preliminary optimization of generic functions based on a finite list of query points
24. Development of an algorithm for generating a random attitude with uniform distribution
25. Optimization of flight path through an area with a specified wind vector field
26. Paraglider/glider winch/tow launch simulation
27. Development of an application for data recording on the Android platform with remote support via SMS
28. Development of an application for displaying the location of geographical points using augmented reality techniques on the Android platform

The area of navigation

1. Basic navigation systems and methods
2. Simulation of selected navigation methods

The area of aeronautical systems

1. Simulation of basic aircraft systems
2. Simulation of selected aircraft control systems

The area of dynamics modeling and simulation

1. Modeling and simulation of aircraft motion
2. Modeling and simulation of selected flight dynamics problems
3. Development of a simple flight simulation model

The area of unmanned aerial vehicles

1. Modeling and simulation of unmanned aerial vehicles
2. Basic navigation and control of unmanned aerial vehicles
3. Simulation of UAV flight

Topics of intermediate projects

1. Automatic control system design
2. System identification
3. Dynamics modeling of mechanical systems
4. State estimation of mechanical systems
5. Numerical optimization
6. Measurement data filtering
7. Application of soft computing methods in the control of flying vehicles

Examples of intermediate projects

1. Control of an uncrewed helicopter in hover using PID / LQR / LQG / MPC
2. Synthesis of a predictive controller for a selected flying vehicle
3. Tuning of an automatic control system using global optimization methods (PSO / GA)
4. Synthesis of a fuzzy controller for a selected flying vehicle
5. Synthesis of a stability augmentation system for an uncrewed helicopter
6. Simulation of turboshaft engine dynamics
7. Simulation of electric motorcycle dynamics
8. Calculation of helicopter trim conditions as a function of flight speed
9. Determination of helicopter performance using the power method
10. Determination of electric motorcycle performance
11. State estimation of a selected dynamical system using Kalman filtering
12. Tracking of moving objects in angle-range measurement systems (radar / sonar / lidar)
13. INS/GPS integration
14. Outlier detection in navigation systems
15. Comparison of bio-inspired algorithms in solving global optimization problems
16. System identification of an uncrewed helicopter
17. System identification of a selected mechanical system
18. Programming projects (proposed by students) using Matlab/Simulink/C++