

Aerospace Information Technology

International Summer School

20 - 31 July 2015 in Würzburg (Germany)
for Advanced Students

Julius-Maximilians-
**UNIVERSITÄT
WÜRZBURG**



DAAD
Deutscher Akademischer Austausch Dienst
German Academic Exchange Service

Information Brochure

The department of computer science and the chair of Aerospace Information Technology of the University of Würzburg are pleased to announce that the summer school of aerospace information technology will be offered again this summer.

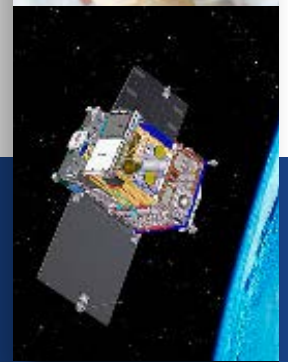
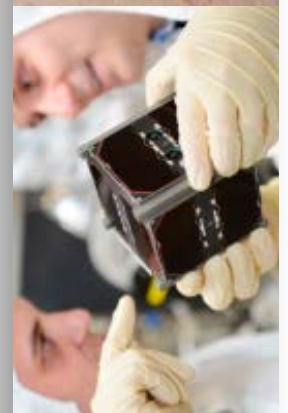
The summer school is primarily directed at students of computer science and aerospace technology or related study paths. We address advanced students, Master's degree and PhD-students but very good bachelor's students may also apply.

The summer school is directed at students from Latin America and Eastern Europe in particular. If you are from one of the following countries you can apply for scholarship: Guatemala, Mexico, Poland and the Czech Republic. For further details see the section "Application".

This summer school is designed for students studying subjects related to information technology and aerospace technology. While at German universities typically aerospace technology is taught from a mechanical engineering perspective you can learn about this subject at the University of Würzburg from the mathematics and computer science perspective.

Course Description

The participants will learn about avionics, the related hardware and software and much more. The lectures will include an introduction to aerospace information technology, devices in satellites, real time control systems, power supply in aeroplanes and satellites, theories of secondary batteries, control of quadrocopters, space systems, space environment, orbital mechanics and attitude control, satellite communication and mission operations. The course offers lectures and practical exercises.





Course Subjects

Introduction to Aerospace Information Technology: Electronic components in Aerospace are called avionic components or in short avionics. Today each aircraft is equipped with an electronic position sensor, a radar system or a navigation system. These subsystems are interconnected through a wired network today and probably interconnected wirelessly in the future. Students will learn about avionics and its function and how to interconnect those component.

Information Technology and Devices in Satellites: Satellites always consist of a typical set of subsystems. These are e.g. reaction wheels for attitude control, solar cells and batteries that ensure continuous operation and much more. With respect to dimensioning and interconnecting such subsystems there are classic and future-oriented approaches. Students will learn about the building blocks of satellites such as sensors, actuators, communication modules and the software protocols used to exchange information between ground station, busses or payload. We will also discuss typical onboard computer systems and their software.

Real Time Control Systems: Following the schedule and reacting on time is crucial to mission success. A descending lander far away on a celestial body has to interpret its sensor data within a guaranteed time window. A time delay here could cause an immediate loss of control and the consequence would be a crash.

Power supply in Aeroplanes and Satellites: In aerospace technology weight saving is one of the top priorities so there is a need for energy sources with a very high density. Therefore aerospace industry developed a variety of technologies over the past decades. So as the nuclear batteries of the voyager probes will have ensured their continuous operation for more than fifty years. Nevertheless nuclear batteries involve a high risk since during a launch failure radioactive material could fall back down on earth and cause substantial damage to the environment. Students will learn about the diversity of alternative energy sources and how energy is distributed inside an aerospace vehicle during a mission.

Theories of secondary Batteries: Just like every functional element a battery can also fail and therefore there as a need for corresponding backup systems. Batteries can be regarded as che-





mical plants with a certain functional principle. These functional principles contain certain failure mechanism. Knowing about the chemistry of batteries and the chemical reactions will help to understand the mechanism of failure and provides the possibility to reduce the risk in the future by adjusting the design. Students learn about the details of charging and discharging batteries, possible failure mechanism and accident hazards.

Control of Quadcopters: An aircraft needs it for the autopilot, a helicopter and a Quadcopter needs it as well: position controlling. There is a need for systems that can autonomously control the position of an aircraft without the need for human intervention. In case of an autopilot such a system may be used to reduce the stress of a pilot. In case of quadcopters or multicopters it is necessary for realizing the ability to fly at all. Here a human being is not able anymore to set the numerous control signals and the proper parameter values within the limited timeframe. The students will learn about the architecture of Quadcopters with the help of a corresponding development kit for hardware and software as well. During multiple sessions the students will learn about the specific system platform and they will learn how to program a closed loop control in C++ (PID-controller) for that specific setup. The problem will be divided into several steps so that in the end the developed Algorithm will be able to control all 3 axis of the Quadcopter which will allow stable hovering of the quadcopter.

Introduction to Space Systems: Satellite missions do not consist of the satellite only. The satellite as payload is only a portion of a much more complex mission. This lecture teaches the basic concepts of rocket engineering and especially drives, launchers, components of a satellite mission and a strategy for designing a satellite mission.

Space Environment: spacecraft operate in an extreme environment. Besides fluctuating temperatures over a wide range the aircraft is always exposed to high-energy radiation (x-ray and particle radiation). Students will learn about the basics of the massive natural influence on the spacecraft. The subject of space debris will also be explained and the fact, that a satellite can become itself a dangerous environmental influence.





Basic Principles of Orbital Mechanics and Attitude Control: Satellites don't move on random orbits. They will be put into position according to the desired purpose. Sometimes it is necessary to lift a satellite from a lower orbit near earth into a more distant geostationary orbit. And sometimes it is necessary to perform a swing-by maneuver in order to initiate a long voyage. The students will learn about the basic concepts of satellite orbits and the referring mathematical methods. This lecture deals with the "Hohmann-Transfer" and its analytical description of a satellite transfer from a low earth orbit into a geostationary orbit. Another subject will be the "Vis-Viva" equation with which we determine the local speed of bodies moving on Keplerian orbits around celestial bodies.



Satellite Communication: Terrestrial communication and satellite communication differ in certain aspects. In particular we have to consider signal runtime, disturbances due to atmospheric phenomena and simply the temporary visibility of the communication partners. This lecture will deal with frequency domains, modulation schemes and estimations of the expected performance of a certain sender-receiver-combination. The students will learn about "link budgets" and how it will be calculated from parameters specific of the sender and receiver.



Power Subsystem: Besides the previously discussed topic of battery chemistry and suitable energy cells the students will learn in this section about the problems arising due to energy demand in aircraft systems and how to choose and dimension energy cells and solar panels. This lecture will focus on near-earth satellites.



Mission Operations I: As already mentioned in the introduction to space systems a satellite is only a single component of a more complex overall mission that aims the dependable and failure-free operation over a long period of time. The students learn about the elements of a satellite control center and the activities and procedures being accomplished. The keywords in this context are ground segment, mission planning, telecommand and telemetry.

Mission Operations II: In this section mission operation will be discussed in detail. This lecture focusses on flights, the flight operation manuals, the different mission phases and the consideration of (partial) autonomy during mission execution.





Course Schedule

The course duration is two weeks and it will take place from 20 – 31 July 2015.

Week 1	Mon - 20. July	Tue - 21. July	Wed - 22. July	Thu - 23. July	Fri - 24. July
9:00 - 10:30		Excursion 1 (AeroSpace- Exhibition Speyer)	Space environ- ment	Excursion2 (AeroSpace- Exhibition Sinsheim)	Avionics for Space
Break					
11:00 - 12:30			Introduction Aerospace Infor- mation techno- logy		Communications
Lunch					
13:30 - 15:00	Introduction space systems		Space environ- ment		Power (Aircraft and Spacecraft) and Charge Control
Break					
15:30 - 17:00	Introduction Aerospace Infor- mation techno- logy	Orbital mecha- nics and attitude control	Power, thermal and mechanical design		

Week 2	Mon - 27. July	Tue - 28. July	Wed - 29. July	Thu - 30. July	Fri - 31. July
9:00 - 10:30	Avionics for Aeroplanes	Control of Quadrocopters (Hardware)	Excursion 3 (ESOC - Europe- an Space Opera- tions Center)	Control of Quadrocopters (Programming)	Avionics for Launchers
Break					
11:00 - 12:30	Real Time Sys- tems and Control	Control of Quadrocopters (Development Environment)		Control of Quadrocopters (Programming)	Real Time Sys- tems and Control
Lunch					
13:30 - 15:00	Real Time Sys- tems and Control	Control of Quadrocopters (Software)		Control of Quadrocopters (Programming)	Mission opera- tions I
Break					
15:30 - 17:00	Real Time Sys- tems and Control	Control of Quadrocopters (Software)	Control of Quadrocopters (Test-Flight)	Mission opera- tions II	

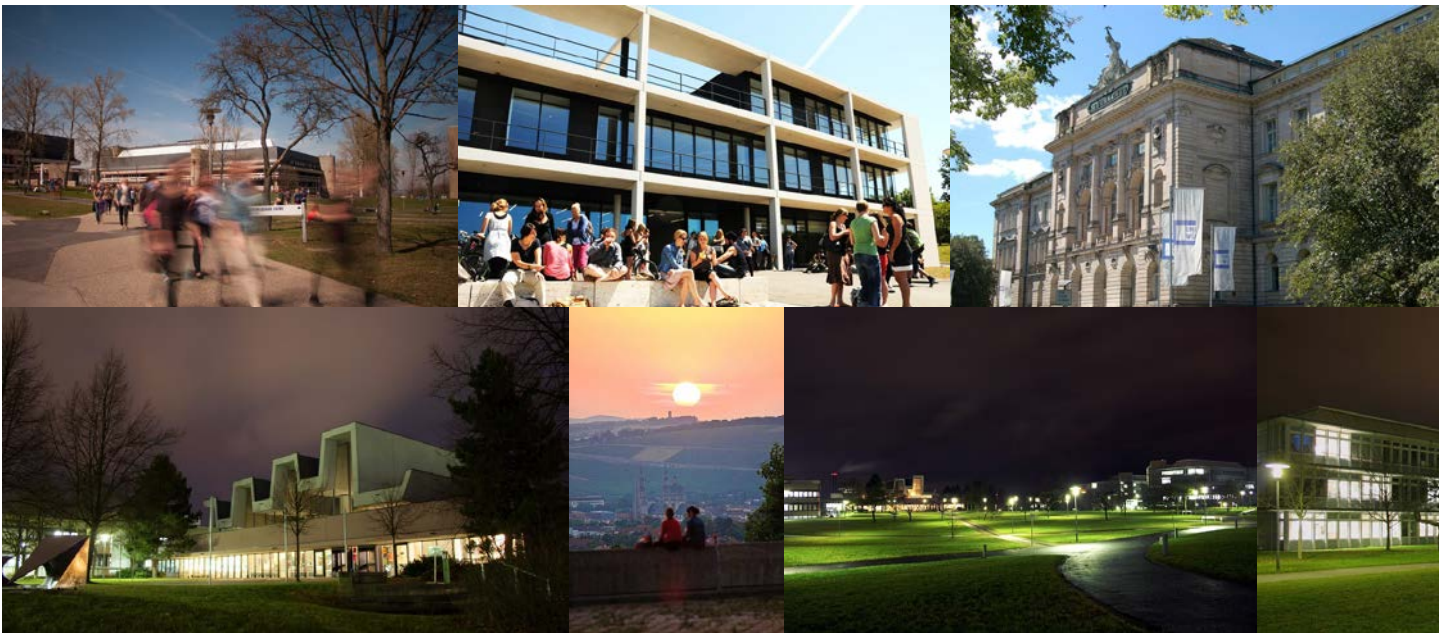


Course Location Würzburg (Germany)

The southern German city of Würzburg is a student's city rich in culture and lifestyle. It is located in the state of Bavaria. Since Würzburg is a wine growing area and because almost a quarter of the residents are students the city provides a pleasant and entertaining atmosphere.



The University of Würzburg is one of the oldest institutions of higher learning in Germany having been founded in 1402. Beside Wilhelm Conrad Röntgen who discovered the x-rays there in 1895 there are 14 Nobel laureates affiliated with the university. About 30.000 students are enrolled today.



During their stay the students will get the opportunity to go on 3 full day excursions. The students will visit the „Technic Museum Speyer“ and the „Car & Technology Museum Sinsheim“ whose exhibitions include pieces like the Russian space shuttle Buran, the Concorde and it's Russian counterpart TU-144 and much more. The third excursion will go to Darmstadt and the European Space Operations Centre (ESOC).

The students granted a scholarship will stay at the hostel „Babelfish“. For further information please visit www.babelfish-hostel.de



Requirements

The participants have to be enrolled at a university in study paths related to aerospace technology, computer science or engineering. The participants should be experienced in C/C++ and should have a good mathematical understanding. Part of the courses will be implementing a PID-control in C++.

Application

1. Send us your complete application form (Deadline: 30 April 2015)

Please fill in the required form and send it to alexander.hilgarth@uni-wuerzburg.de by 30 April of 2015 at the latest. With this application form you apply for the summer school and a scholarship at the same time. If you are from one of the following countries you can apply for scholarship: Guatemala, Mexico, Poland and the Czech Republic. All others can also apply but in case the scholarship will not be granted the students will assume all accumulated costs for accommodation, meals and travelling. You can download the application form at:

http://www8.informatik.uni-wuerzburg.de/lehre/summer_school/

2. Receive the result of the evaluation of your application

Your application will be discussed internally at the University of Würzburg and will be evaluated according to the requirements of the summer school. You will be informed by 15. May 2015 latest whether your application was successful or not.

3. Send us your complete register form

With this register form you supply all necessary information to the administration so your stay here in Würzburg can be organized. You can download the register form at

http://www8.informatik.uni-wuerzburg.de/lehre/summer_school/

4. Receive further information

Once your registration is completed you will receive some useful information concerning your travel and stay.

Important Information about the Summer School and Your Application

There is no participation fee. Due to the generous financial support of the DAAD (German Academic Exchange Service) scholarships can be given to students from Poland, the Czech Republic, Mexico and Guatemala. The scholarships cover the following travel costs:

- 1.875 EUR (for participants who come from Mexico)
- 1.850 EUR (for participants who come from Guatemala)
- 200 EUR (for participants who come from Poland or the Czech Republic)

Additionally, the scholarship covers full accommodation, courses, breakfast and lunch. Students who unfortunately cannot be granted a scholarship or students from other countries than listed above will have to pay all expenses themselves (accommodation/living costs minimum 900 EUR). The number of scholarships is limited.