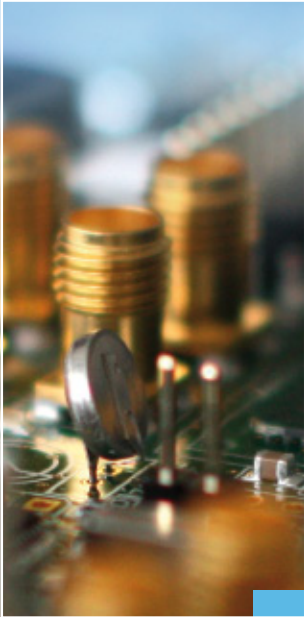


# SyDe



**Graduate School  
System Design**

 **Universität Bremen**

 **Deutsches  
Forschungszentrum  
für Künstliche  
Intelligenz GmbH**

 **Deutsches Zentrum  
DLR für Luft- und Raumfahrt**

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## Editorial



In summer 2012, the winners of the Excellence Initiative of the German Federal Government were announced. Among them was the University of Bremen, who scored this success with a concept

for a sustainable future entitled “Ambitious and Agile”. Two of the cornerstones of the University of Bremen’s institutional strategy are the successful collaboration with its surrounding research institutes, and the support of young talents.

One project that came into life in the course of the Excellence Initiative is the Graduate School System Design (SyDe). As a joint project of the University of Bremen, the German Research Center for Artificial Intelligence (DFKI), and the German Aerospace Center (DLR), it combines the education of young scientists and the continuation of a successful research collaboration.

We are excited about the opportunity to build up a structured PhD program at the crossroad of hardware design, verification, advanced robotics, and aerospace systems. Within SyDe, we want to bring together a new generation of computer scientists and electrical engineers and introduce them to a fast moving and innovative field of research.

With this booklet, we would like to present the Graduate School System Design, its partners, advisors and research topics. Enjoy reading!

Prof. Dr. Rolf Drechsler  
Spokesman of SyDe



**\*AMBITIOUS  
AND AGILE**

University of Bremen  
An Excellence Initiative  
Success Story

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## Graduate School System Design

The Graduate School System Design (SyDe) has been established in 2012, starting with the funding by the German Excellence Initiative. It is part of the University of Bremen's institutional strategy "Ambitious and Agile". One of the success stories of the University of Bremen is its close cooperation with surrounding research institutes, two of which are the German Research Center for Artificial Intelligence (DFKI) and the German Aerospace Center (DLR). Together with the Faculty for Computer Science and Mathematics, they are the co-founders of SyDe.

The partners of SyDe cover a wide range of exciting research topics – ranging from robotics over space systems to the design of energy efficient electronics and natural language processing. The goal of SyDe is the modeling and the design of complex electronic systems, as they can be found in almost all technical devices today: in cars, planes and satellites, but also in cell phones and medical equipment. Building correct and reliable systems for safety-critical applications is a major challenge.

In SyDe, we bring together PhD students of several working groups and institutes in Bremen. The graduate school provides a structured program for the formation of young researchers. In a regular research seminar, new ideas are exchanged and external speakers present their work. A yearly summer school and additional courses give further insights into advanced topics. Regular discussions with a thesis committee guarantee for a timely and well-founded feedback for the PhD students.

With this booklet, we would like to give applicants and partners an insight into the research and education within SyDe.



# SyDe

## SyDe Partner Institutions

### University of Bremen



The University of Bremen is a mid-sized university with 250 professorships and 19,000 students. It offers a broad range of disciplines with twelve faculties, ranging from physics, chemistry and computer science to law, linguistics, and health sciences. Within these faculties, there are six high-profile areas, one of which is computer, cognition and communication sciences. This is where SyDe is located. Within the Faculty of Computer Science and Mathematics, there are five working groups involved in the graduate school: the Operating Systems Group (AGBS), the Multi-Sensorial Interactive Systems Group (AGMSIS), the Group of Computer Architecture (AGRA), the Robotics Group and the Group for Reliable Embedded Systems (ZESY).

**Operating Systems Group (AGBS):** The fields of interest of the Operating Systems Group are safety-relevant systems, which have an emphasis on distributed and reactive real-time applications. For this to accomplish, methods and tools are investigated, which support the creation-process of security-relevant systems in all phases. A special focus is on model-based testing of real-time systems with applications in automotive, railway and aerospace domains.

**Multi-Sensorial Interactive Systems Group (AGMSIS):** The Multi-Sensorial Interactive Systems Group investigates algorithms for sensor fusion and the design of reactive real-time systems. A common problem with sensor data is noise, meaning that a sensor never exactly measures the real world. In order to interpret sensor data despite disturbances, a combination of intuition and formalism is needed: judge, which effects are relevant for the application; model these effects in a probabilistic framework and conceive algorithms that find the most likely interpretation of the sensor data.



**\*EXZELLENT.**

Gewinnerin in der  
Exzellenzinitiative



**Group of Computer Architecture (AGRA):** The research focus of the Group of Computer Architecture is on circuit and system design. Especially, the team is looking into the design methodology that is enriched by the use of formal methods. Meanwhile electronic circuits and systems are part of everyday life and are used more and more in safety-critical areas. The main research areas of the group are formal verification and test pattern generation. Other topics include emerging technologies such as quantum computing and reversible logic, and the use of natural language processing techniques in system design.

**Robotics Group:** The research of the Robotics Group at the University of Bremen deals with the design of intelligent agents, which can learn by interacting with their environment. These agents should be able to collect knowledge about their surroundings and to autonomously identify potential courses of action. Another important research focus is the development of innovative concepts for robot-human interaction, which is driven by finding and developing common ways of communication between robots and humans.

**Group of Reliable Embedded Systems (ZESY):** The Group of Reliable Embedded Systems investigates advanced automation for circuit and system design. Powerful reasoning engines known from verification together with scalable techniques for abstraction and simulation are the backbone for analyzing safety aspects or simply ensuring correct functionality of a design. Using this infrastructure, designer's every-day-tasks like debugging, understanding details of a poorly documented design or Intellectual Property (IP) block, and analyzing reliability are supported.

## German Research Center for Artificial Intelligence



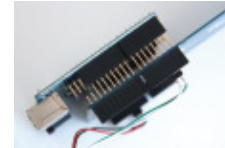
Deutsches  
Forschungszentrum  
für Künstliche  
Intelligenz GmbH

The German Research Center for Artificial Intelligence (DFKI) is the leading research center in Artificial Intelligence and innovative software technologies, with around 750 employees from over 60 countries. Bremen is one of three sites of the DFKI. In its Robotics Innovation Center (RIC), robotic systems are developed for complex missions on land, under water, in the air and in space. The Cyber Physical Systems group (CPS) focuses on formal methods and quality-driven design of cyber-physical systems.

**RIC:** The Robotics Innovation Center focuses on the topic “Long Term Autonomy” of mobile robots. The research goal is to answer the elemental question how intelligent behavior of technical systems in complex and dynamical environments can be achieved sustainably for long periods of time, i.e. for months and years. Starting point for this approach is the assumption that only systems which feature a minimum of structural complexity even possess a disposition for a sustainable interaction with natural environments and thus represent appropriate platforms for control and feedback control systems. The different teams of the RIC conduct research on autonomy, system design, interaction, intelligent kinematics, sustained learning, hardware architectures and simulation. Underwater and space robotics are the focal application fields.

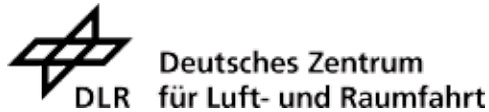


**CPS:** The Cyber-Physical Systems Group focuses on formal methods and quality-driven design of cyber-physical systems; it covers the entire range from basic research to application-oriented development. Projects are application-oriented, and are carried out in close collaboration with industrial partners. The applied methods include hardware and software verification, formal modeling, and the management of documents throughout the entire development process. The research areas include circuit and system design, software development and dedicated applications of cyber-physical systems. Important application areas are transportation in general, where quality-driven design on all stages is a key to success, and ambient assisted living, as exhibited in the Bremen Ambient Assisted Living Lab (BAALL).





## German Aerospace Center



The German Aerospace Center (DLR) is Germany's national research center for aeronautics and space. It employs around 7,700 people at 16 different locations all over Germany. Researchers at DLR develop concepts for innovative space missions, but also analyze safety critical systems in general with respect to their dependability. At the Bremen site of DLR, the Institute of Space Systems opened its doors in 2007. Its Avionics Systems Department is part of the Graduate School System Design.

**Avionics Department:** The avionics system is at the core of each space system. All control tasks, any processing of mission data and the full communication stack are handled by the avionics system. Consequently, the reliability of the avionics system is essential for any mission. At the same time the requirements for enhanced processing capabilities increases while keeping parameters like energy consumption or size of the system stable. Only by achieving such an improved performance future missions can be supported that demand for advanced processing of video data or a high degree of autonomy. The research of the department focuses on the design of new avionics concepts as well as design methodology and tools.



## Advisors



### **Prof. Dr. Rolf Drechsler**

Head of the Group of Computer Architecture, University of Bremen and of the Cyber Physical Systems group, DFKI. Spokesman of SyDe.



### **Prof. Dr. Görschwin Fey**

Head of the Avionics Systems Department at the Institute for Space Systems, DLR and of the Group for Reliable Embedded Systems, University of Bremen.



### **Prof. Dr. Udo Frese**

Head of the Multi-Sensorial Interactive Systems Group, University of Bremen.



### **Prof. Dr. Frank Kirchner**

Head of the Robotics Group, University of Bremen and of the Robotics Innovation Center, DFKI.



### **Prof. Dr. Jan Peleska**

Head of the Operating Systems Group, University of Bremen.

## Research Topics

Today, electronic systems form an integral part of most technical devices. They are used in mobile phones and tablet computers, but also – less obvious – embedded in cars, planes, medical equipment and satellites. In automobile and aerospace applications, such systems already perform safety critical tasks. With the development of driving assistance systems or robots in ambient assisted living scenarios, safety and robustness of the underlying systems will become more and more important. Already today, quality assurance by verification and testing constitutes a major challenge in the design process.

In SyDe, we investigate the design of complex electronic systems, including hardware and software. A special focus is on correctness and reliability of the designed systems. The PhD students learn about a consistent view over the different levels of abstraction, starting with first abstract models in graphical description languages (like UML or SysML) and ranging down to the actual implementation. We are also interested in non-functional properties like timing and power consumption. Research projects in SyDe target the creation of methods and tools for system design, but also innovative solutions and implementations in the domains of robotics and space systems.



## Goals

1. Correct design of technical systems including hardware and software – an integrated view over different levels of abstraction
2. Methods and tools for system design – from natural language specification to complex realizations in hardware and software
3. Modeling of systems – considering non-functional properties like power, robustness and testability
4. Technical implementation of systems with a special focus on correctness, reliability and control paradigms – applications in robotics, space systems and mobility



Source: DFKI GmbH,  
Robotics Innovation Center

**“Bring me a glass of water” – How do I teach a robot to recognize its environment?**

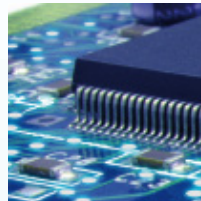
Semantic object recognition for mobile robots



Source: Universität Bremen,  
AG Computer Architektur

**How can I turn natural language into a correct computer program?**

Model based design



Source: DFKI GmbH,  
Cyber-Physical Systems

**How can I make systems more energy efficient?**

The green revolution on the micro chip

## Qualification Program



SyDe is aiming at a research oriented education program for the PhD students. The PhD students are working in one of the research groups or partner institutes. Additional seminars

and courses complement the scientific work. A thesis committee accompanies the graduation process of each student and provides valuable feedback in regular milestone meetings. With this strong support, we want to allow for a successful graduation within three years.

### Thesis Committee

In the first six months of the thesis, each PhD student and his or her advisor agree on a thesis committee. Besides the first advisor, who is heading the committee, another professor and a post-doc are invited. The committee will guide and advise the PhD student. Meetings with the PhD student and the thesis committee take place at least twice a year. In these milestone meetings, the PhD students present their recent work and explain their future plans. The members of the committee have the opportunity to discuss the current research. At the end of the meeting, milestones will be agreed on that should be cleared until the next meeting.

### Research Seminar

Regularly, the whole graduate school meets for the research seminar. This is the place where the PhD students can present and discuss their own work, give a talk on the state of the art in their field, show a tool demonstration, or give a tutorial they have attended during their last conference trip. External guests or members of the associated research institutions are also invited.

### Summer School

Once a year, the graduate school goes on a retreat for the SyDe summer school. Here, speakers from the partner institutions as well as external guests from industry and academia give talks and tutorial courses during three days. While overview lectures introduce new and exciting research fields, specialized sessions offer a deeper insight into the focus topics of SyDe.



## Key Competences

Besides the scientific qualification program of SyDe, the University of Bremen offers a variety of workshops and seminars for languages and complementary key competences. Here, we give a short overview of three of the most important institutions and their offers.

### Graduate Center ProUB

The Graduate Center of the University of Bremen ProUB is the central institution for networking, personality development and coaching of PhD students. It offers a diverse qualification program with many courses and seminars in English, including formations like “advanced academic writing” or “conflict management”, but also occasions to meet other PhD students and to form groups and networks.

### Foreign Language Center and Goethe Institute

Directly on campus of the University of Bremen, the Foreign Language Center and the Goethe Institute offer a variety of language courses on different levels. Advanced English for academics or German courses for foreign students are offered both as a weekly course or as intensive workshops.

### International Office

With its Welcome Centre, the International Office of the University of Bremen offers services especially to international students and researchers coming to Bremen. Besides courses and seminars on intercultural competences, the International Office can also help to find an accommodation in Bremen or give advice on opportunities for research stays in other countries.



## University Campus

Most of the faculties and institutes of the University of Bremen are located on the campus in the north of the city. They can easily be reached by a 15 minutes tram ride from the city center. Encircled by student residences, the main canteen (Mensa) with its adjacent lake, and the central Glass Hall with numerous shops and service facilities, lies the Campus Park, which opened in 2010. This park forms the “green heart” of the campus, providing surroundings where you can relax and chat with your friends.

The University of Bremen campus is an important science center in Germany’s North West. Few universities have such a high density of leading research institutions in their immediate surroundings. Several independent institutes and research establishments run by national research organizations are located on campus, and many of them are linked to the University of Bremen via joint professorships. Besides DFKI and DLR, there are also institutes of the Max Planck and the Fraunhofer societies, as well as the Leibniz scientific community.



On campus, the Mensa serves lunch to thousands of students and employees per day, offering a reward-winning quality and variety of dishes, soups, salads and pasta. Besides, there are several cafés and some smaller restaurants. Sports facilities and the offerings of the University Sports Association are open to all citizens. The local green areas of “Blockland”, the Stadtwald and Bürgerpark, as well as the recreational lake “Unisee”, are all in the close surroundings of the university.



## Bremen

Bremen is a lively city of around 550,000 inhabitants in the north of Germany. It offers various cultural activities with its theaters and its museums on art, history, science and more. Bremen also has a very active night live, with many bars, clubs, and discotheques in the center and its surrounding quarters. Here, you can also find restaurants offering food from all over the world.

In the summer months, you can sit down on the banks of the Weser river or take a bath in the Werdersee, the central recreation site of Bremen. If you like sports, Bremen offers good opportunities for running, swimming, cycling, tennis, football, or ice skating. Or you can just go and watch a match of the famous “Werder Bremen” football club in the Weserstadion.

The public transports – mainly based on trams and buses – are excellent. If you prefer cycling, most of the places in Bremen can easily be reached by bike.



## Admission

To apply for a PhD position in SyDe, you should hold a master degree (or equivalent) in computer science or a related field, with above-average grades. Please make yourself familiar with the research focus of SyDe and tell us why you think you are the perfect match for our Graduate School. We require a good knowledge of the English language (level C1 “advanced” of CEFR or comparable). We strongly encourage women to apply.

Here is a list of documents to be included in your application:

- Cover letter
- Curriculum vitae
- List of publications (if available)
- Copy of master certificate
- Transcript of records (of highest degree)

Please compile the above documents into a single pdf file and send it to [syde-apply@cs.uni-bremen.de](mailto:syde-apply@cs.uni-bremen.de).

Feel free to contact us, if you have any questions regarding your application. Also visit our website at [www.syde.uni-bremen.de](http://www.syde.uni-bremen.de) to learn about current open positions or special scholarship programs.



## Contact

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