Talk 1: "Heterogeneous Robotic Teams for Future Space Exploration and Beyond"

(Marcus G Müller)

Exploring extraterrestrial bodies with robots is a challenging task. For instance, the robot must operate in an unknown environment without having a global positing system to tell it exactly where it is. Teleoperating the robot is, in most cases, not an option due to the low bandwidth and high latency of the communication channel. As a result, the robot must perform a large number of different tasks autonomously. Robotic teams can help to break down the challenging task in smaller ones, which can then be distributed to a designated robotic team member specialized for that task.

At the German Aerospace Center (DLR), we are building such a robotic team for future planetary exploration missions. This talk will introduce the robotic team containing two rovers and a flying robot. Furthermore, it will give an overview of a selection of current projects in the planetary robotic domain at DLR. We will have a closer look at our ongoing project ARCHES, which will have a large field campaign coming up next month on Mt. Etna. Here, we will have a closer look at the flying team member, ARDEA. Furthermore, we will explore how this technology we developed in the planetary robotic exploration domain can also be used to help us directly here on Earth and how we can use the knowledge for future space missions. *Image credits: DLR.*

German Aerospace Center
Robotics and Mechatronics Center (RMC)

Deutsches Zentrum für Luft- und Raumfahrt

Marcus G. Müller is a researcher in the department of Perception and Cognition (PEK) at the German Aerospace Center (DLR) as well as Ph.D. student in the Autonomous Systems Lab (ASL) at the Swiss Federal Institute of Technology Zürich (ETH Zürich). At DLR, he leads the MAV Exploration Team at the Institute of Robotics and Mechatronics (RM), which conducts research on autonomous navigation and exploration for Micro Aerial Vehicles (MAV) in unknown challenging environments. The team is also responsible for the development of the ARDEA system. Marcus is interested in autonomous navigation algorithms for MAVs, like state estimation and terrain classification and segmentation. Before joining DLR, he conducted research at the Jet Propulsion Laboratory (JPL) of NASA in Pasadena, USA, where he worked on visual inertial navigation for MAVs and on radar signal processing. Marcus received his Master's and Bachelor's degree in Electrical Engineering from the University of Siegen, Germany.

Talk 2: "Ultra-wideband ranging for a team of autonomous robots" (Robin Pape)

Instead of sending only one robot to space, NASA's CADRE project (Cooperative Autonomous Distributed Robotic Exploration) aims at using an entire team of shoe-box-sized robots to complement larger rovers in their effort to explore the Moon, Mars and other planets in the future. These autonomously acting robots can help with tasks like mapping or collecting data without the need to be controlled by a ground station. In order to work together as a team, the robots need to be able to communicate with each other and get accurate updates on the position of themselves and the other robots. Ultra-wideband (UWB) ranging helps with this by providing measurements of the distances between the robots to be used together with other localization techniques like Simultaneous Localization and Mapping (SLAM). However, to perform range measurements and successfully distribute them in the network, the robots need to agree on a communication protocol that enables reliable communication. In this talk, we will learn about how UWB ranging is done, the challenges that a distributed communication protocol designed for UWB ranging faces and how these can be overcome.

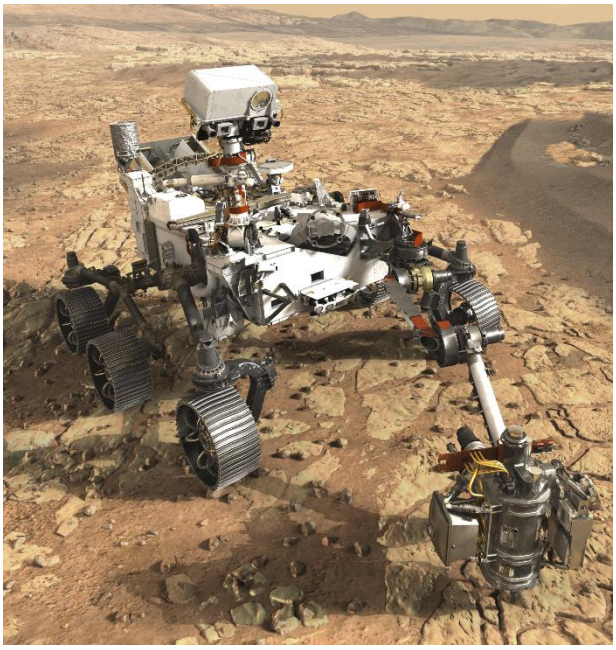
Image credits: NASA/JPL – Caltech.

Jet Propulsion Laboratory
Mobility and Robotic Systems Section
California Institute of Technology

Robin Pape is a master's student in information technology and electrical engineering at UAS Dortmund. He is currently working on his master's thesis as a Visiting Student Researcher at NASA's Jet Propulsion Laboratory, where he designs and implements a communication protocol for ultra-wideband ranging for NASA's CADRE project.

Talk 3: "Exploring Mars: From rovers and helicopters" (Prof. Dr. Roland Brockers)

NASA's newest rover *Perseverance* arrived on Mars in February 2021 carrying a small companion on-board who hitched a ride to demonstrate that controlled flight is feasible on another planet: the NASA *Ingenuity* Mars Helicopter.



While *Perseverance* is the most sophisticated rover we send to Mars so far, *Ingenuity* has stunned us with exceptional performance since its maiden flight on April 19th 2021, giving us a new perspective of the red planet: a view from the air.

In this talk, we will examine the history of Mars exploration that led to the Mars 2020 mission and have a close look at *Perseverance* and *Ingenuity* and what they are up to on the surface of the red planet.

Image credits: NASA/JPL – Caltech.

Roland Brockers
Jet Propulsion Laboratory / California Institute of Technology
University of Klagenfurt, Austria

Roland Brockers is a Research Technologist at NASA's Jet Propulsion Laboratory/California Institute of Technology with more than 20 years of R&TD experience in vision-based autonomous navigation of unmanned systems. He received his Ph.D. in Electrical Engineering from the University of Paderborn, Germany, in 2005. He was part of the Mars Helicopter *Ingenuity* Guidance Navigation and Control (GNC) team and wrote the image-processing software that *Ingenuity* uses for navigation.

Roland is also a Professor for Modular Robotics Systems at the University of Klagenfurt, Austria.

More information on
https://www.fh-dortmund.de/termine/space-robotics-forum.php
For data protection reasons, video and audio recordings are prohibited !!