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Man on the moon

In Bremen, the team led by Prof. Frank Kirchner is working on robots for missions in space and underwater. Far from earth, they have to find their way and make decisions independently— similarly to autonomous vehicles in road traffic.

So the Bremen-based robotics experts have also built an eight-meter-deep water tank in which they can test the Europa Explorer, among other things: The pipe-shaped drill named Teredo is designed to penetrate the 3 to 15-kilometer-thick ice sheet on the moon's surface and then launch the underwater vehicle Leng to explore the ocean beneath. Because control signals from earth would take 33 to 53 minutes to arrive, the torpedo-shaped submarine would have to be able to operate autonomously.
It's no wonder, then, that the research group in the "space city" of Bremen has been working intensively on topics such as sensor technology, actuator technology, and artificial intelligence. But the results they achieve do not only benefit aerospace applications— Kirchner also places great store by the transfer to other fields, for instance for robots that have to maneuver independently in dangerous environments. He is also following the development of autonomous driving avidly, from his own very particular perspective. "For me an autonomous vehicle is a robot I can drive," says Kirchner.

Sherpa is a rover with an active suspension that can adapt to different terrain and obstacle situations.

In contrast to autonomous vehicles, however, there are no maps of the terrain for their missions. “At one meter, the resolution of satellite images is still too poor,” explains Kirchner. “As such, the robots must build their own maps of their environment and locate themselves within it.” To cope with that reality, the researchers developed the SLAM algorithms (Self Localization and Mapping), probability-based methods for orientation in unknown terrain. “It all started with navigation in sewage canals,” recalls Kirchner. “It was a very simple environment, which allowed us to test the new approach there very effectively.” From the mid-1990s, the SLAM algorithms were also used in open terrain and in buildings. The first applications for the self-localization of autonomous vehicles emerged about 15 years ago.

Autonomous vehicles should continue to learn while in use

The AILA robot system has 32 degrees of freedom, including seven joints per arm. It serves as a platform for research in the field of mobile manipulation.

Based on his own research, he knows how complicated it is to steer a car through road traffic without human intervention. Kirchner himself has ridden in two test vehicles and was “very impressed.” As a highly engaged observer of the development, he naturally has a few ideas of his own on the subject. “Autonomous vehicles should learn during their use phase,” he suggests. “One buys a vehicle with basic experience and it continues to develop itself along with the other vehicles on the road.” It would be a collective learning experience—just as with the collaborative robots that are now gaining a foothold in industrial manufacturing processes: They have to get along with a variety of different people and therefore share their individual experiences with each other, for instance via a cloud. “Today, with autonomous driving we pay too much attention to the individual algorithms—but we’ve known them for a long time

already, in some cases since the 1950s," says Kirchner. "What's more important is the organization of knowledge. They key is to network the individual components of knowledge with each other—for instance through collective learning. The vehicle must be a system that learns throughout its life." And to do so, it should also dream from time to time: Kirchner's team is working on the EU project Dreams4Cars, whose mission is to improve the safety of autonomous vehicles. Like mind's-eye pictures or dreams, the control software continually replays real traffic situations in a simulation environment, testing alternative reactions and thereby preparing itself for exceptional circumstances. It will be interesting to see what ideas from the Bremen-based robotics experts eventually make their way from the moon to Earth.

Info
Prof. Frank Kirchner is one of the world's leading experts for autonomous space and underwater robots. He is the campus spokesman for DFKI Bremen and heads the Robotics Innovation Center with its over 100 employees.

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