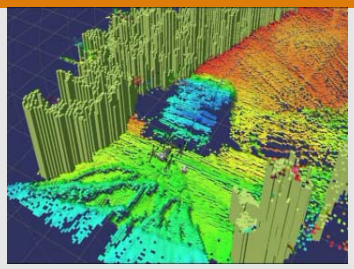
German Research Center for Artificial Intelligence GmbH

Intelligent Mobility

Robust autonomous navigation in unknown, unstructured environments

(Fig.1) The Asguard robot climbs a loose sandwall with 40 degree incline

(Fig. 2) The Asguard v3 system uses its on board sensors and computing capabilities to autonomously navigate through difficult terrains



(Fig. 3) Map-building on the DFKI Outdoor Test Track

Navigation algorithms for unknown terrrain: using the robot‘s own body as a sensor for navigation

In the “Intelligent Mobility“ project, the DFKI Robotics Innovation Center focussed on the four core areas essential to autonomous navigation: vehicle control, mapping, localisation and decision-making. The project developed Asguard v3, a new version of the highly mobile Asguard platform. Asguard is a mobility concept that has been completely developed at DFKI RIC. Asguard v3 has been equiped with standard navigation sensors: cameras, laser scanners and an inertial measurement unit. In addition, more specialized sensors have been added (torque measurement, contact sensors, vibration sensors) to allow to the robot to be aware of its own body.

The first goal of this project is to achieve „mechanical intelligence“. That is, improving a robot‘s navigation capabilities through clever mechatronic design. The robot‘s mechanics can adapt passively to a changing environment, allowing to seamlessly go over difficult obstacles. The robot is also designed to sense the structure and nature of its environment through its body, such as the fact that it is on loose sand (Fig. 1) or hard terrain, low or high slopes, rough or flat, … Thus allowing to adapt itself to its surroundings.

The project’s second goal is to utilize this embodied information in the localisation and mapping processes. On the one hand, in order to build a map, a robot must first have an idea of where it is (localise). However, on the other hand, to localise itself, it needs a map in which it can recognize its surroundings. When working in a completely unknown environment, the system must therefore both build a map and localise into it at the same time. This is known as Simultaneous Localisation and Mapping (SLAM). The Intelligent Mobility project significantly improved a SLAM process by adding information coming from the robot’s body, in the embodied SLAM (eSLAM) algorithm (Fig.3).

Finally, the project dealt with the ability for the robot to recognize and deal with error situations such as finding blocked paths or having problems with the quality of the localisation solution. This ability adds the necessary robustness for Asguard to be used in critical situations, where the optional use of its locomotion capabilities (such as the ability to swim in water) would make it a one-of-a-kind.

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