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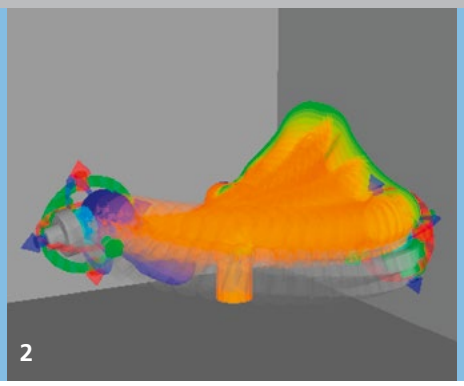
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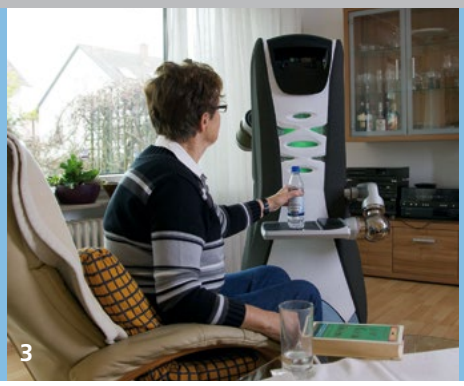
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1 *Intralogistics scenario with rob@work.*
2 *Visualization of a motion trajectory.*
3 *Fetch & carry task with Care-O-bot® 3.*

COLLISION-FREE MANIPULATION FOR MOBILE SERVICE ROBOTS IN DYNAMIC ENVIRONMENTS

Background

The increasing use of service robots systems – in both industrial and everyday settings – is leading to growing demands on those systems. Not only in intralogistics or assembly processes, but also for fetch & carry tasks in private households, the safe and robust execution of complex motion sequences is indispensable. In contrast to industrial robots with their permanent safety installations, the environment of a service robot is significantly more complex. There must be no risk to humans or their surroundings at any time. In particular, moving and unknown objects must be taken into consideration in motion planning and execution. Also, the robot system must be capable of appropriately and, above all, quickly reacting to changes in its environment. Additional challenges result from the combination of mobile platforms with various manipulators, especially with regard to the synchronization and coordination of superimposed motions.

Our solution

Fraunhofer IPA has many years of experience in the field of manipulation with mobile service robots. It provides a flexible software framework uniting the basic algorithms for kinematic calculations and a set of components for collision-free manipulation.

In addition, the software framework includes intelligent control-based methods for the synchronized and coordinated motion of two or more actuators.

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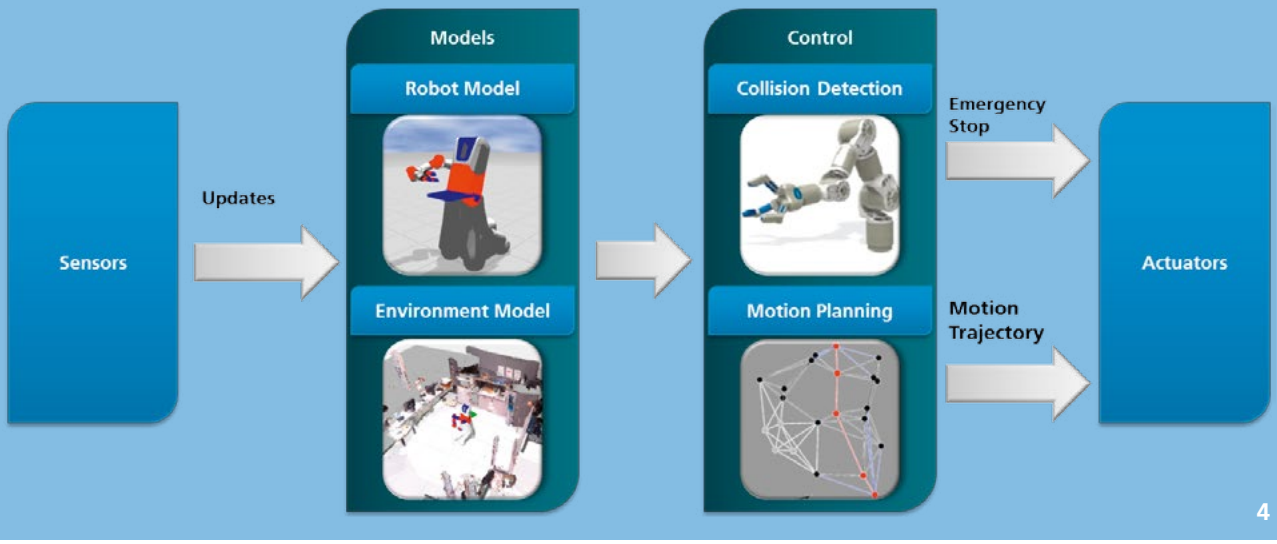

Flexibility

This control software allows the autonomous planning and execution of manipulation operations for robot systems with different kinematic structure. The components can be combined, parameterized and optimized on an application-specific basis. Connection to the Robot Operating System (ROS) enables simple integration with other software modules for easy application development. As part of the ROS Industrial initiative, work is also underway to deliver standardized interfaces to existing hardware components.

Collision monitoring

A multiplicity of sensors, such as stereo or 3D depth-image cameras, can be used for environment sensing. The use of 2D laser scanners is also possible depending on the application. The various sensor information is fused in a consistent representation of the environment, which is used both for online collision prevention and also for motion planning in that are currently out of the robot's field of view.

Grasp planning

The possibility of collision-free motion planning opens the door to complex sequences of operations in combination with appropriate tools or grippers. For example, the picking-up and placing of various objects can be planned in advance and adjusted to the relevant environment.

Fraunhofer IPA offers suitable algorithms and software components with which appropriate grasp configurations can be generated and feasible grasping strategies can be selected for various industrial or domestic objects.

Synchronized motion control

The combination of robotic manipulator and mobile platform not only makes it possible to use the robot system as a manipulator in different locations. In addition, the work space of the manipulator can be significantly extended by continuously repositioning the mobile platform. Where there is such a superimposition of motions, key importance is attached in particular to synchronized motion control.

The control-based solution developed by Fraunhofer IPA supports the conjoint motion planning and control of different actuators. In addition to applications with mobile platforms, this also allows other actuators to be combined with each other. This can be used, for example, to align a sensor to a moving object or to observe the manipulator so that continuous visual monitoring is guaranteed.

Reference projects

Resilient Reasoning Robotic Cooperative Systems (R3 COP)
The purpose of the project was to develop an integrative platform for autonomous robot systems. This included, for example, the development of components to enable a table to be cleared autonomously.

Interactive Mobile Manipulators for Advanced Industrial Diagnostics (InterAID)
The goal of this project was the quality control of washing machines by mobile robots. Collision-free manipulation on the machines was a key focus of the development efforts.

What we offer

Fraunhofer IPA will assist you in all the development phases of your service robot application:

- Advice in connection with the design of mobile service robots, particularly with hardware selection
- Implementation of the control software for your robot system, integration of individual modules into existing controls as well as customized development of new components for your control system
- Advice, design and realization of complex manipulation tasks and application scenarios

4 *System architecture for collision-free manipulation.*