

MULTIMODAL USER INTERFACES FOR INTERACTIVE SERVICE ROBOTS

Fraunhofer Institute for Manufacturing Engineering and Automation IPA

Nobelstrasse 12
70569 Stuttgart | Germany

Contact
Dipl.-Ing. Georg Arbeiter
Phone +49 711 970-1299
georg.arbeiter@ipa.fraunhofer.de

Dr.-Ing. Dipl.-Inf. Birgit Graf
Phone +49 711 970-1910
birgit.graf@ipa.fraunhofer.de

www.ipa.fraunhofer.de

Starting Point

Interactive service robots used in everyday environments must be extremely simple to operate, because the users are normally not technical experts. In order to make communication as close as possible to that between humans, it is essential to integrate traditional interfaces, such as graphical inputs and outputs, with new interfaces, such as voice, visual interaction and interfaces using tactile and force-/torque-measuring sensors. The fusion of these different information channels includes, in particular, an appropriate treatment of redundancy and incomplete information.

Graphical User Interfaces

Graphical user interfaces are used in service robotics both for direct interaction on the robot, e.g. for the control and supply

of information for entertainment and information robots, and also for remote control of the robot. Such interfaces inform the user about the robot's current operating state and allow the interruption and adaptation of the actions that are currently being executed.

Mobile Devices

Mobile devices such as cell phones or PDAs increase the flexibility and convenience of the interaction with a service robot. The data transfer between the robot and the mobile device is accomplished by a wireless connection (e.g. Bluetooth). Graphical user interfaces are designed according to the special demands of small displays and allow both the display of status information and the input of user commands.



Voice Control and Voice Output

Compared with conventional forms of control, natural-language communication with interactive service robots offers the great advantage that users can keep their eyes and hands free and are not tied to one place while interacting with the robot.

To provide voice output, Fraunhofer IPA has implemented both a tailor-made text-to-speech process and also a grammar that enables dynamic sentence generation. The processes work independently of each other and can therefore also be substituted by other components.

Gesture Recognition and Interpretation

Recognition algorithms capable of extracting information on a human's current position and movements from sensor data provide the basis for the extended control of mobile service robots. For this purpose, Fraunhofer IPA has realized a recognition process based on a depth-image camera that detects humans in 3D and computes relevant joint positions.

On the basis of these data, it is possible, in conjunction with additional communication channels, to recognize and execute ambiguous instructions, such as »go there« – where »there« is indicated by means of a suitable pointing gesture.



Direct Interaction

Direct interaction between a human and a robot allows the robot to be taught new tasks easily. For this purpose, the forces applied to the robotic arm are converted by means of a model into appropriate movements of the robotic arm.

In addition to the teaching of new tasks, direct interaction is especially useful in cases where objects need to be exchanged between robot and human. Use is made for this purpose of force-reflecting input devices, such as force/torque sensors, in combination with optical sensors, which are normally positioned close to the end effector or directly in the robotic gripper.

Haptic Feedback

The use of haptics allows the user to sense the contours and surfaces of an object by touch through the generation of force values equivalent to the robot motion in the haptic device. Additionally, the user interaction can be supported for example by »mag-netic effects« that focus the attention of the user to specific objects on the screen.

In the teleoperation of service robots, haptic feedback enables the robot to be controlled in a more accurate and more intuitive manner. For example, the tele-



operated gripping and manipulation of objects can be made easier through haptic feedback. The basis for implementing the forces and for haptic rendering is a three-dimensional model of the environment

What we offer

Fraunhofer IPA will help you to design and implement the user interfaces for your specific service robot application. Our technical know-how and experience will guarantee the success and transparency of your product development. Our available services include in particular:

- Joint development of an application-specific, multimodal interaction concept
- Selection of suitable interaction technologies, realization of new interaction components
- Integration, testing and optimization of the entire interaction concept

1 Automatic detection of head, arm, and leg position as a basis for gesture control

2 Commanding via touch screen on the home assistant »Care-O-bot® 3«

3 Direct interaction with a mobile robot for maintenance support