Intuitive Human-Robot Interaction

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Introduction

In robot design, the constructive process and control tasks are not the only challenge mechatronics engineers are facing. Another important area of work is the development of a communications interface that provides great usability in interacting with a robot system in the most intuitive way, by means of human language via speech or text or by processing a user's body movement, the so-called gestures. The main goal in this bachelor thesis is to create such a system that is generic enough to be easily ported to many types of robots on the one hand, but that can also be tightly integrated with any robot in order to fulfill application-specific requirements on the other hand.

Speech Recognition

The most intuitive way of communication is human speech. This system uses advanced speech recognition technology for translating spoken words into text which is then checked for previously defined commands. Since the implemented technology is not speaker-dependent, it can be used by multiple speakers without requiring any kind of training. The set of possible commands is freely extensible to achieve reactions like voice output and any type of movement the robot is able to provide.

Voice Output

The implementation used in this interaction system uses the highly sophisticated speech synthesis technology of Google Text-to-Speech (2) providing another essential component for a very natural way of communicating with the robot system.

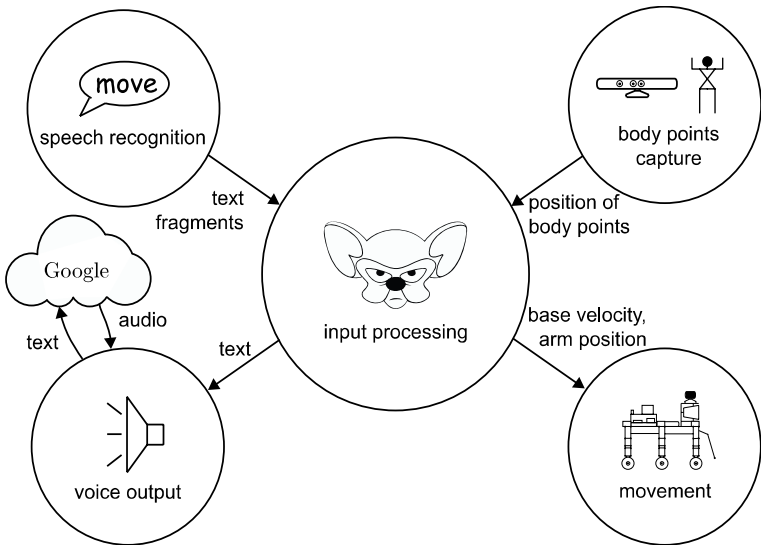

Fig 1. Information flow diagram.

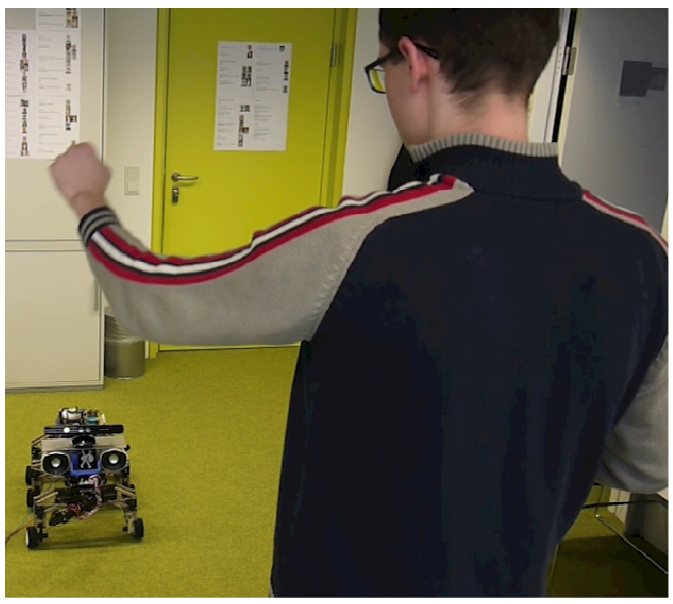

Fig 2. The robot's arm is following the user's left hand.

Gesture Recognition

In order to control the robot by gestures, this system is using Microsoft Kinect to acquire position data of specific body points of persons in front of the robot. This information can be used either to command the robot by specific body postures, so-called static gestures, or by controlling the velocity of the robot and the position of the robot arm's tool center point directly by means of the user's hand positions, as depicted in Fig. 2.

Experimental Setup

For demonstration purposes this interaction system is installed on a robot with six legs which is able to move by either walking or driving. The robot features the Microsoft Kinect sensing device providing most of the required interfaces for intuitive interaction with users. While the movement control system itself is operated under hard real-time using RTAI, the user communication software is running under Ubuntu Linux and the Robot Operating System (ROS) (3).
A diagram of the information flow of the system is depicted in Fig. 1.

References

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(2) "The Unofficial Google Text-To-Speech API", *http://techcrunch.com/2009/12/14/the-unofficial-google-text-to-speech-api, December 14th, 2009*.
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