Experimental Platform For Visuo-Motor Control Of A Robot Hand Using Neural Networks

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Abstract

Visually and haptically guided dextrous manipulation of objects is one of the key issues for intelligent robots. Attempting to develop robot systems with such capabilities poses the challenge to integrate

advanced robot and sensor technology with novel approaches for

the utilization of tactile and visual information for the coordination of arm and multi-finger movements.

In this poster we want to report on the development of an experimental robot vision platform

the design of which was motivated by the wish to explore biologically inspired, neural network-based strategies for visuo-motor control.

Currently, the platform is arranged around a PUMA 562 robot arm with 6 DOF and an image processing facility consisting of two ANDROX ICS400 Boards, each based on four digital signal processors.

These boards provide the computing power for fast image preprocessing and feature extraction from image data acquired with two color CCD cameras.

To allow flexible experimentation, a very important consideration was to overcome the limitations of the commercially available robot controllers. These limitations are a lack of computational power, lack of expandability or compatibility to other systems, and little transparency of their programming languages or operating systems.

In our implementation we chose to replace large parts of the original Puma controller software (VAL II) and employed a UNIX workstation to *directly* control the robot via a high speed communication link.

To achieve a tight realtime control directly by the SUN SparcStation we installed the powerful software package RCCL/RCI. This package allows the user to issue robot motion requests from a high level control program ("planning task" which is written and executed as an ordinary C program) to the trajectory control level ("control task") via shared memory communication.

The control task is executed periodically at a high priority (kernel mode) and is responsible for reading feedback data, generating intermediate joint setpoints, and carrying out a "watchdog" function (collision avoidance).

The system is currently being expanded in several directions:

(i) installation of a hydraulic three-fingered 9 DOF hand

developed by a research group at Technical University Munich within an interdisciplinary, BMFT-funded research collaboration aiming at synthesizing neural network robot control algorithms. The hand design is modular (additional fingers can be mounted) and each finger is actuated by three spring-loaded oil cylinders allowing a gyring of $+/-15°$ and full adduction in three joints (two of them coupled). The oil cylinders are driven by a "base station" with electrical motors and feedback information is provided by position and semiconductor oil pressure sensors.

(ii) integration of a 6D force-torque wrist sensor for the robot arm to allow integral contact force perception and compliant movements with the hand.

(iii) installation of an auxiliary VME CPU board (68040), running the real-time operating system PSOS+, and various interface electronic (ADC, DAC, servo electronic etc.). The CPU will run the real-time operating system PSOS+ and will execute e. g. fast low level control loops and communication tasks with the host via shared memory (VME) or via remote procedure calls over ethernet.

(iv) In a later stage, the addition of a remote controlable stereo camera head to enable active vision is planned.