A control layer for multi-vendor industrial robot interaction providing integration of supervisory process control and multifunctional control units

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Abstract

I. Introduction

Modern demands to smaller lot sizes and more flexibility on automated robot based production processes claim supervisory process control layers enabling adaptive behaviour in terms of process and motion planning. Out of the trends for decentralized or distributed control of industrial robots arises a need for highly-flexible robot control tasks, e.g. modular path and motion planning such as automated programming. Using industrial robots of different manufactures in a conjunct production process motivates the need for an integrative and flexible interface to establish a data exchange between a supervisory robot control and various robot control systems.

Further trends in industrial robotics aim for a novel type of manual control units, used for online-programming and intuitive movement control. In regard to the standard manual control units or standard robot control terminals there is a lack of intuitive movement control methods, flexibility and versatility in favour of advantages in physical robustness and usability. Enabling access to control industrial robots via a commonly used arbitrary electronic device, e.g. a Table-PC or a smartphone would make contact between human and industrial robot more comfortable and intuitive. Thus, there is a general requirement of a flexible, vendor independent interface which provides access to various robot control systems and allows data exchange with control units via Wi-fi, Ethernet and other forms of industrial communication.

II. The objective of the work

Based on recent industrial needs for a flexible integration of supervisory control system and novel intuitive manual control units, a new control layer is introduced. The control layer is located between external systems, e.g. novel control units or supervisory process control systems, and various industrial robot control systems. For this purpose a manufacturer independent, generalized programming language for input commands, including all basic robot commands, is constituted. An inherent capability of the control layer is the transformation of the generalized robot commands to manufacturer specific robot languages, e.g. KUKA ROBOT LANGUAGE. To support the high flexibility of the control layer and to cover a broad range of robotic application fields, different communication standards of industrial automation are implemented.

III. The results and their significance

The control layer is implemented as an independent module, which operates internally with a manufacturer neutral robot programming language. Translating these neutral, generalized commands to a manufacturer specific robot language is achieved by specific postprocessors. The communication interface for input data is a generic TCP/IP-Socket, independent of the underlying physical network, supporting Wi-fi and Ethernet. For the use in insecure network environments the connection is SSL-encrypted and password protected. Output data is a manufacturer specific language, which is transmitted via serial port or Ethernet to the particular robot control systems. Hence, a flexible interaction between external control units and arbitrary robot control systems is enabled. Currently there are two practical applications recently realized using the presented control layer. At first a decentralized wireless sensor network, employing Sun SPOTS, adapts and executes robot programs in tasks. The innovative approach is inspired by the idea of self organizing production by the use of “intelligent” parts. This is achieved by self-sustaining wireless nodes to transfer the production control and logic from a centralised approach to a distributed logic [1].

Secondly an ADEPT SCARA and a KUKA KR16 are motion controlled by a smartphone, adopting the functionality of a manual control unit. For demonstration an App for Apple’s iPhone is presented for motion control of industrial robots via the proposed interface. In addition to motion control of single axis or specific motions of the end-effector, the smartphone application offers the possibility to carry out simple teach-in or programming tasks.

Due to the implementation of a smartphone as a special kind of manual robot control unit, there is an increase of intuitive motion control and flexibility in programming the robot, using a commonly used device instead of a normative manufacturer specific manual control unit. In the near future novel input units, such as Tablet-PCs will be put into practice as further examples of application.

IV. How the Paper Fits the Conference Theme

The presented control layer is an essential basis for flexible multi-vendor industrial robot interaction providing the integration of supervisory process control and novel multifunctional robot control units. Two novel applications are examined, the use of smartphones or Tablet-PCs for robot control and a decentralized supervisory control system for the control of various robots. By means of the presented control layer further innovations in the field of industrial automation can be implemented with less effort, supported by a unified programming interface. For these reasons the aspired paper fits well the theme of 2011 IEEE TePRA in the tracks of “Robot Applications - Consumer & industrial” and “Robot Technologies - Power & Communication”.

References

[1] M. Chemnitz, J. Krüger, M. Patzlaff, and E.-U. Tuguldur, “SOPRO – Advancements in the Self-organising Production(Submitted and accepted for publication),” , ETFA 2010 – IEEE International Conference on Emerging Technologies and Factory Automation, Bilbao, 2010, Work in Progress Paper.