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REMOTE CONTROL OF INDUSTRIAL ROBOT

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ABSTRACT: The aim of this article is basic overview of actual situation in principles of industrial robot programming and introduction of simple extended remote control principle. Remote control is realized by serial communication port and software in C# programming language. It is used for positioning articulated robot with 5 DOF Mitsubishi RV-2AJ. These industrial robots are usually used for student education to teach robot programming languages. Introduced software provides simple interface to robot program only by mouse control or import trajectory of movement from external position list file. We can set two movements types PTP and CP interpolated linear movement. Remote control software of robot can be used for many special task; we tested reliability by drawing equipment.
KEYWORDS: Industrial robot, remote control, robotics

INTRODUCTION

Continuous advancements and rapid developments of electronics, computing, network and web technologies have been much concerned in recent period of time. The emerging technologies including teleoperation, communication and control via web, visual servo control and so forth, have induced high motivation and demand towards the researchers who belong to conventional control and robotics [1]. Standardized industrial robots are usually limited to control by robotics programming languages. This is an area where can started some research in alternative control by another principles or remote control.

INDUSTRIAL ROBOT PROGRAMMING PRINCIPLE

Due to the highly proprietary nature of robot software, most manufacturers of robot hardware provide their own software. While this is not unusual in other automated control systems, the lack of standardization of programming methods for robots does pose certain challenges. For example, there are over 30 different manufacturers of industrial robots, so there are also 30 different robot programming languages required. Fortunately, there are enough similarities between the different robots that it is possible to gain a broad-based understanding of robot programming without having to learn each manufacturer's proprietary language. The most used industrial robot programming languages are MOVEMASTER, MELFA BASIC 3, 4 (MITSUBISHI), V+, KUKA-KRL, RAPID (ABB), VAL (Staubli), KAREL (Fanuc). New standardized robotic language is "Industrial Robot Language" - IRL (DIN 66312), but there is a lack support from robot producer support [3].

MISTSUBISHI RV-2AJ INDUSTRIAL ROBOT DESCRIPTION

There are described basic features of used industrial robot in our research. The RV-2AJ is 5-axis compact arm design coupled with its enhanced motion controller and servo amplifiers, rated at 2 kg with a 3 kg maximum payload, 410 mm reach, 2100 mm/sec Speed, +/- 0.020 mm repeatability. A main body weight of less than 20 kg and AC servomotor reduces all axis outputs to less than 50 W. Control unit is based on 64 bit CPU RISC/DSP. Used industrial robot with control system and teach pendant is shown in the Figure 1.

Figure 1. Mitsubishi RV-2AJ, CR1 control unit, teach pendant

DESCRIPTION OF REMOTE CONTROL PRINCIPLE

This remote control design of the industrial robot was applied because its ability to be easily modified and used in other application. Another reason, why we decided to use Assembly Industrial Robot Mitsubishi RV-2AJ [6] was that the robot has been accessible in our department and is available on many universities in education system. In addition, the industrial robot is enough precise for different special task, measuring, drawing manipulating with small parts. Next advantage is auxiliary DOF in effector which can be used to setup angle, position or load during special operation in comparing to standard linear manipulator. The system consists of industrial robot RV-2AJ, control system CR1, extended device and external control application in programming language C#. Figure 2 shows block communication scheme of device.

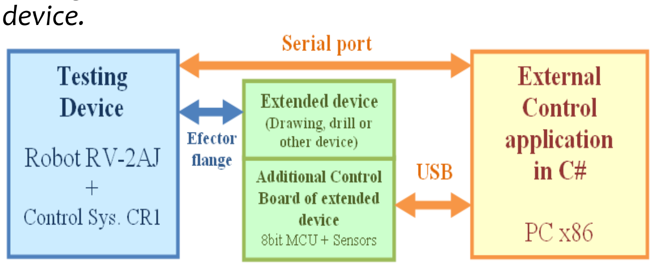

Figure 2. Communication scheme of Remote industrial Robot control system

Control Unit CR1 [7] provides serial port for communication with external application. Addition Control board can send extra information about extended device status from many sensors by

USB/UART interface. Figure 3 left shows simulated trajectories of testing device for 1 or 2 joint together, Figure 3 right shows first testing of generated trajectories on real device with drawing holder in scale 5:1 to real device. The speed of industrial robot is possible to modify before the program was executed for CP and PTP separately. Testing of final position robot movement is tested by loop. Precision of whole system is derived from industrial robot, repeatable precision is ± 0.02 mm.

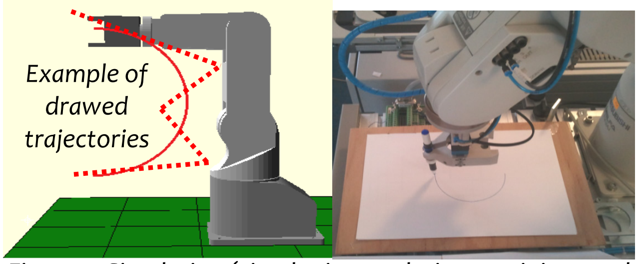

Figure 3. Simulation (circular interpolation one joint – red line, linear interpolation two joints together – dotted line), testing of remote control by drawing accessories

SOFTWARE PART OF SOLUTION

Principle of trajectory programming for standard industrial robot is primarily based on before known number of Points (Positions). These points are stored to robot memory through teach pendant console. Program is created offline and is loaded to control system by serial port. We need faster and dynamic method for create Robot program and Points definition. That was a main reason for development of new external Robot control application. Our program provides dynamic robot programming. This possibility is defined trajectory by selecting Point in graphic area adapted to Robot workspace. There is possible dynamically change number of cycles. Principle of remote control Robot is using internal system command for control system and command for Robot.

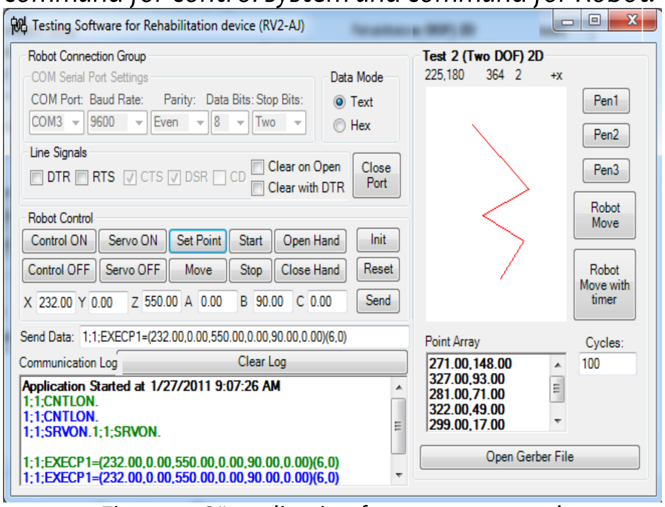

Figure 4. C# application for remote control of industrial robot

There is described minimal sequence for testing device: robot control system activation "1;1;CNTLON." and servomotor enable command "1;1;SRVON.". After the initial activation is done, we can use classical commands for robot programming MelfaBasic4, but with command prefix "EXEC", for example. "1;1;EXECMOV P1". The control program is working remote, that is reason why we must get periodically information about control and robot state, "1;1;STATE". Request for actual control system state is sent every 100 ms. The Figure 4 shows control application for remote robot control.

CONCLUSIONS

The main task of this article was to introduce simplified system of remote programming for industrial robot. Introduced remote control doesn't need any additional modification in current hardware of industrial robot only addition of serial port connected computer and grip pen for testing. Solution can be used as first step in industrial robot programming education because many of these industrial robots are established on the different universities. Reliability check of testing system was done with simulation program and trajectories were checked with drawing jig scaled in XY plane. The Current solution only log robot state to text file during movement in fixed interval. Next works on the solution will be implementation database to store complex data (robot state, sensor data) from testing process for next result processing. Next works on the project can be extending remote control by camera vision system.

Acknowledgments

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