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THE BASICS OF DESIGNING CONTROLLERS FOR INDUSTRIAL ROBOTS (EG. ROBOTS ABB IRB 2000)

ABSTRACT:
The paper explains the basic aspects of designing controllers for an industrial robot control. Industrial robots are basically mechanical devices which, to a certain degree, replicate human motions. They are used whenever there is a need to reduce the danger to a human, provide more strength or accuracy than a human, or when continuous operation is required.
Most industrial robots are stationary, but some move throughout the workplace delivering materials and supplies. While we have the technical ability to produce human robots, industrial robots are actually quite simple devices.
Motions that we take for granted—picking up a something from the table, for instance—are considerably more difficult for a robot. Its mains characteristics of operation, degrees of freedom, etc.
They are solved and the calculations developed to obtain the kinematics and dynamics. The accomplished test to each servomotors and the research about its operation.
Basicaly all industrial robot have a similarly control, because have a similarly actions.

KEYWORDS:
industrial robot control, designing controllers, basic aspects

INTRODUCTION

Robotics is a new field of modern technology that crosses traditional engineering boundaries. Understanding the robots and their applications requires knowledge of many areas of engineering, informatics, mechanic and mathematics. We need to know the dynamics, kinematics to control of the robot manipulator. Is the basic to the understanding of the robot operation?
An official definition of such a robot comes the Robot Institute of America (RIA): A robot is a reprogrammable, multifunctional manipulator designed to move material, parts, tools, or specialized devices through variable programmed motions for the performance of a variety of tasks.
In the Laboratory of Intelligent Systems in Faculty of Mechanical Engineering in Banja Luka we have a robot IRB 2000. This robot was starting for this study of design controller.
IRB 2000 is a six-axis robot with a large work volume and is primarily intended for arc welding and glueing/sealing.
The IRB 2000 is also suitable for applications such as assembly, water jet cutting, laser cutting, material handling and stud welding.
The handling capacity is 10 kg and the very quick movements of the wrist axis are other important features for the intended applications. The S3 control system makes use of established features like soft keys, joystick and the robot language ARLA for simple and fast programming. The IRb 2000 is in its basic form equipped with an absolute measuring servo system. Another important factor is the interface capacity. The S3 controller has the ability to perform a communication in several different ways. These are digital or analogue I/Os and the serial computer link.

THE STUDY

A robot is the main component of a flexible production system (FPS). Other components of this system are machine tools, transport machines, control devices, and different auxiliary elements. A flexible production system is an automatically operating production system that can be easily reprogrammed and adapted to manufacture different products.
Robot centered modules of FPS, called robot modules or robot systems are intended for specified technological operations like welding, surface coating, packaging, etc. The robot module includes one or more robots (with manipulators and control devices), pallets for details or products, auxiliary positioning, transport devices, etc.
Therefore, robot control means control of a complete robot module and a certain part of the production

process. The control system has the whole electronic of the system and allows the external communications with peripheral equipment.
Fig. 1 shows main hardware and software components of the IRB2000 robot from ABB.

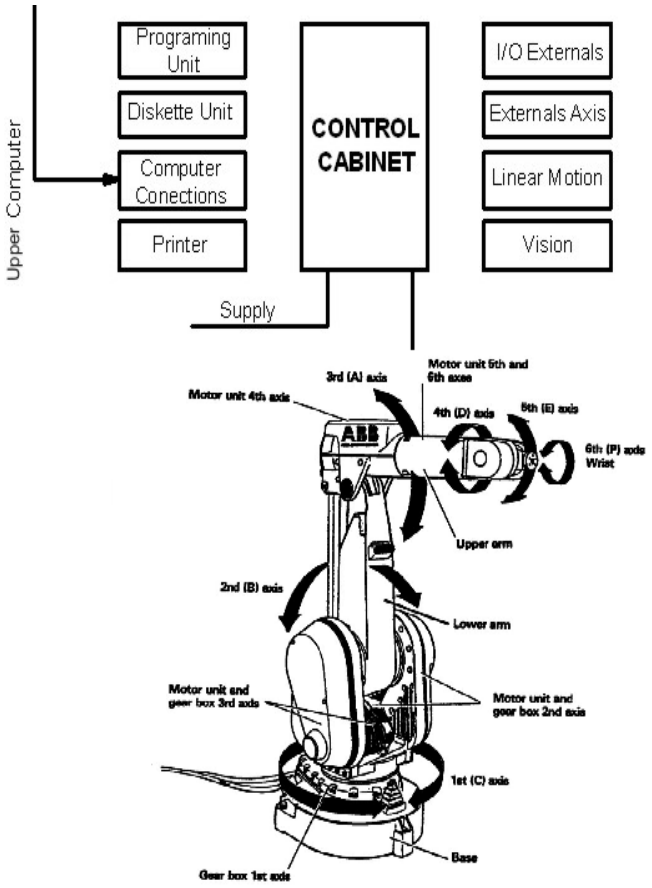

Fig. 1 main ABB IRB 2000 hardware and software components

The mechanical robot is provided with servomotors controlled, in each axes, the servo system have:

- *Speedometer for the speed control.*
- *Resolver for the position control.*
- *Resolver for the absolute measurement system*

The robot is equipped with brakes in each axes, is automatically brake in the emergency stops, power supply fails, or when the motors are disconnected of power supply.
The robot is equipped with brakes in each axes, is automatically brake in the emergency stops, power supply fails, or when the motors are disconnected of power supply. This brakes setting in stand by mode or totally disconnected. While the robot is running and still static the brakes activate automatically after three seconds (automatic operation) or after five seconds. The brakes can turn off manually one by one through of switches in the side of the robot.

ANALISES, DISCUSIONS, APPROACHES AND INTERPRETATIONS

Industrial robots are all-purpose mechanical arms with a number of axes. Regarding movement cycle, route and angle its movements are programmable without mechanical intervention and where required also sensor guided. The mechanical arms are equipped with grippers, other tools and they achieve handling tasks and assembly works.
The path between the positions of robot can be executed in three different coordinate systems: rectangular coordinates, robot coordinates and modified rectangular coordinates.
Each one of the coordinate systems will produce a different path and are used according to the needs of speed, precision and direction. All can be activated through instructions in a robot program.

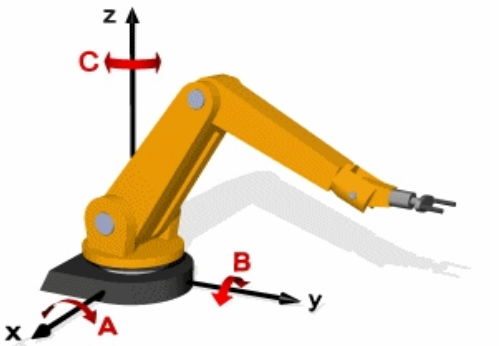

Figure 2. Space coordinates

Figure 3. Joint coordinates

Figure 4. Gripper coordinates

Figure 5. Workpiece coordinates

All the positions of the robot are expressed through the coordinates system that which describe the positions of the robot in the space. This system is setting to the base of the robot with plane X - Y in floor and the axis Z noting upward and concentric to the first rotation shaft.
The point of origin of the space coordinate system usually is located at the first axis of universal robots. In linear robots the point of origin is located at the intersection point of the three linear axes.
The angle and length description of the particular robot axes describe the orientation of the TCP explicitly. A polar insertion of the coordinates is best.
Gripper coordinates describe the orientation and position of the effector in space.
The zero point of the coordinate systems is located at the Tool-Center-Point (TCP) of the effector.
If a workpiece has to be processed in different positions, one can site a workpiece coordinate system into one corner of the workpiece.
IRB 2000 manipulates charges in a wide work area, with great rapidity and precision. This robot is particularly adapted for arc welding, application of adhesives and manipulation of materials, because its speed, wide work area and the inherent flexibility of the design of their 6 shafts. The admissible maximum load is of 10 Kg and depends on the distance to the center on the wrist.
The set of points in the space that they can be reached by the extreme of the wrist of the robot constitute its workspace. Remain limited by the maximum angle or linear displacement that permits the joints and the length of the arms.
The movements and degrees of freedom of the robot IRB 2000 are described in table below:

Table 1: Scopes of the robot's axis IRB 2000

Motion	Workspace	Max. Speed
Axis 1: Rotation	+180° -180°	115°/sec
Axis 2: Arm	+100° -100°	115°/sec
Axis 3: Arm	+60° -60°	115°/sec
Axis 4: Wrist	+200° -200°	280°/sec
Axis 5: Lurching	+120° -120°	300°/sec
Axis 6: Draft	+200° -200°	300°/sec

The robot connections for tools and grippers have been designed as a modular system to achieve the best flexibility when accessories are selected. Component can be selected in various ways without limiting the robot working area. Compressed air as well as electrical signals is supplied to the tools via well integrated cablings. Tool exchange can be performed automatically. The exchanger provides a tool fixing plate free from play which allows supply of compressed air and electrical signals fro the tools. Main components in the system are:

- *Connection unit*
- *Swivel with cabling carrier*
- *Tool exchanger*
- *Slip ring*
- *Tool attachment*
- *Dual grippers*

The modular design enables the unit to be offered in many variants.
Computer board contains four microprocessors.

- *Main computer – for overall control*
- *Servo computer – for control of servo functions and robot movements*
- *Axis computer – for individual control of robot axes*
- *I/O computer – for control of communication with operators unit, peripheral equipment, host computer and floppy or cd disk*

Safety board contains circuits for the personal safety functions

- *Emergency stop*
- *Work hold*
- *Safety hold*

Digital I/O boards have digital process communication up to 128 inputs and 128 outputs
Analogue I/O board has analogue process communication up to 4 inputs and 4 outputs
Combined I/O board has digital and analogue communication up to 16 digital inputs and 16 outputs + 2 analogue outputs
Control Board for external axes also we have communication via RS 232 interface with computer.

CONCLUSIONS

The control panel must to provide full communication with robot system. The emergency stop button and button for resetting the emergency stop function is salient buttons for reasons of safety. The control panel is designed for a demanding industrial environment.
The control panel must include functions for:

- *Selection of operation modes for the robot system, STANDBY (electronics powered, motor de-energized) and RUN (the entire robot system powered)*
- *Synchronization of the robot system*
- *Loading of programs from floppy disk or CD*
- *Start and stop of programmed operation*
- *Emergency stop and re-setting of emergency stop function*
- *Locking by key of the programming unit*
- *Separate LEDs or LCD for indicating emergency stop and fault status*
- *Remote control with joystick*

The robot system can be controlled by sensors mounted on the robot or on the object. The robot system can store signal data from sensors, and used then for program. The robot system can receive digital, analog and asyncronics signal with RS232 or other interfaces from the outside computer.
Programming method is point to point method by:

- *Interactive dialogue*
- *Manual running with joystick*
- *Off-line via terminal*
- *Connected with computer*

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