ROBOT CONTROL MADE EASIER

LOGIX KINEMATICS FOR ROBOT CONTROL DELIVERS SIGNIFICANT PERFORMANCE AND COST SAVING BENEFITS TO PACKAGING INDUSTRY OEMS AND USERS.
Overview

Constantly shifting consumer preferences are putting increased pressure on manufacturers to offer a greater variety of product styles, shapes, sizes and colors. This is forcing manufacturers to demand greater speed and accuracy from their packaging operations. Packaging cannot be the bottleneck that delays product delivery.

The market is demanding more flexible product packaging performed by flexible machines that can package a wider variety of products with simple, fast, automatic changeover. Increasingly, robots are being used to facilitate flexible packaging machine designs and have become a critical element in the modern, flexible, high-performance packaging machine.

Recent advances in robot technology have resulted in availability of a broad range of standard, off-the-shelf robot types with very high reliability and low cost. The advent of Programmable Automation Controllers (PACs) with advanced motion capability helps provide high performance, integrated control of the robot by the line or cell controller. Advances in robot technology, combined with the robot control capabilities of the PAC, have resulted in rapid growth in the use of robotics in packaging.

In the past, robots required a dedicated, special-purpose robot controller. The dedicated robot controller was connected to the main cell or line supervisory control using a network or discrete interface. The dedicated robot control architecture results in a number of issues, including:

- Separate control cabinets that consume valuable floor space are required for the robot controller
- Use of servo drives, motors and cables that are different than those used for the rest of the line
- Requires separate programming and configuration software than what is used for the line controller
- Increased complexity and reduced performance due to line/cell controller and robot controller interlocking
- Requires a separate, dedicated operator interface; cannot use the line operator interface
- Limited and/or inconsistent safety solution exists
- Limited or no ability to select best of breed components such as the vision system
- Makes validation more difficult
With the advent of advanced motion capabilities in modern PACs, the same PAC controller that provides control of the packaging line or cell also can control the robots, reducing the need for a dedicated robot controller. The ControlLogix® PAC using the Logix Control Platform from Rockwell Automation® is an example of a PAC that can provide high-performance robot control using advanced kinematics capability.

The Logix line or cell control can provide complete control of the robot, reducing the need for the dedicated robot controller and associated control cabinets and equipment. Rockwell Software® RSLogix® 5000 from Rockwell Automation helps provide complete programming and configuration support for the robot. The robot is programmed using familiar ladder logic, structured text or sequential function chart. The robot can be directly controlled by the line or cell operator interface; the same Allen-Bradley® Kinetix® servo drives and motors used for the rest of the line are used to power the robot. When a vision system is required, customers are free to choose a vision system that best fits their needs with simple connectivity using EtherNet/IP. Also, the same safety solution deployed on the cell or line level can be deployed on the robot.
The benefits of the Logix integrated robot control approach are:

- Open architecture solution allows best-in-class devices to be used.
- System costs are reduced by eliminating the stand-alone robot controller and associated control cabinets.
- Line or cell control Electronic Operator Interface (EOI) can be used to program/configure the robot motion, reducing the need for a dedicated EOI for the robot.
- Floor space is optimized by a reduction of dedicated robot controls and power cabinets.
- Common components such as I/O, Kinetix servo drives, Kinetix servo motors and common safety functionality can be used across the entire cell or line.
- RSLogix 5000 is the only software package required for complete line, cell and robot control programming, commissioning and maintenance.
- The robot operation can be programmed in familiar, easy-to-understand ladder logic, structured text or sequential function chart; no need to call the robot vendor for programming changes.
- Simplified integration and higher performance are achieved by reducing the performance-robbing network interface and complex cell/line control to robot control handshaking logic.
- Extensive robotic Add-On Instructions (AOI) library supports a range of robotic control functions for easy integration.
This typical packaging end of line, pick and place operation uses a four-axis Delta (spider) robot fitted with Allen Bradley MP-Series™ gear motors from Rockwell Automation. It is integrated using a GuardLogix® controller, CompactBlock™ I/O, GuardMotion™ Kinetix servo drives, VersaView® HMI and EtherNet/IP safety.

**Kinematics in Packaging Applications**

The Logix kinematics feature allows robot motion to be commanded in Cartesian coordinates using familiar standard Logix motion commands such as linear/circular interpolation and PCAMing. The kinematics feature automatically transforms the Cartesian coordinate motion into world coordinate system motion of the robot. All robot motion programming is done with RSLinx 5000 using Ladder, Structured Text, or Sequential Function Chart, and the standard library of motion commands.
Using the kinematics feature in Logix is a simple three-step process:

1. Using RSLogix 5000, define the robot type and associated axes using the geographical robotic configuration template.
2. Using RSLogix 5000, include the MCT and MCTP motion instructions in the application program to allow the kinematics transforms that link the Cartesian coordinate system to the world coordinate system of the robot defined in step 1.
3. Using RSLogix 5000 and the standard instruction set, develop the necessary application program logic to control the robot motion in Ladder, Structured Text and/or Sequential Functional Chart.

Figure 3

RSLogix 5000 Kinematics

To further simplify application program development, an extensive Logix robotic application Add-On-Instruction (AOI) library is available for a range of robot applications.
The library includes support for common robotic functions such as pick-and-place path programming, ancillary axis control, conveyor tracking algorithms and vision system part location. The library also supports identification information access, operator interface, teach-and-learn, path position and time-based output control. Users can reduce application development and commissioning time by using the standard AOI library.

The kinematics feature facilitates support of a range of robots using ControlLogix or GuardLogix® controls. SCARA (Selective Compliant Assembly Robot Arm), Delta, H-Bot, and articulated arm robots are supported. In addition to the control capability, a range of Kinetix drives, motors and gear boxes are available for power and actuation of the robots.

A kinematics solution based on the Logix Control Platform from Rockwell Automation offers the following attributes:

- Support for a broad range of robot geometries including H-Bot, SCARA, Delta, Dependent and Independent articulated.
- Kinematics provides enhanced coordinate configuration for handling of non-Cartesian systems via easy-to-use configuration dialogs
- Two new coordinated motion instructions allow users to superimpose multiple moves/instructions as needed
- Kinematics allows dynamic path profile translation and rotation (orientation), and translational and orientation offsets between the two systems. By using the dynamic rotation feature, H-Bot gantry robots can be easily controlled

Rapid Growth in the Adoption of Delta Robots
Delta Robots, also known as spider robots, in particular are rapidly gaining in popularity for use in pick-and-place and packing operations in Consumer Goods Packaging. A number of factors are driving the growing popularity:

- A surge of new Delta robot offerings is available, resulting in lower costs and a wider range of configurations and sizes
- Fast cycle times, exceeding 180 ppm for single pick or 2,000 ppm for multiple gang pick, help provide high throughput
- Advancements in vision technology support high-speed, random product identification and location required in many pick-and-place applications
- Simple mechanical design results in lower cost, high reliability and easy maintenance
- Highly flexible with quick product changeover times make them well suited to the growing trend of highly configurable packaging machines that can handle a range of product configurations
- Overhead mounting design allows for compact machine designs and minimal floor space requirements
Multi-disciplined Control Capabilities

By using integrated robot control, users can more easily support packaging lines by using one common hardware and software architecture. Shared development tools allow engineering resources to be reused. If a manufacturer needs to scale from one line to three, for example, it’s as easy as adding the necessary processors and copying code from one to the next. Having a scalable architecture can allow OEMs to minimize design efforts by eliminating retraining and repeat work.

The Rockwell Automation Integrated Architecture™ provides one common hardware and software architecture supporting multiple control disciplines and application types. The Logix family of controllers and RSLogix 5000 programming software from Rockwell Automation leverage the Integrated Architecture to support multiple disciplines — with the addition of kinematics, this now includes high performance robot control.

The integrated Logix solution also supplies the NetLinx™ open networking strategy for Integrated Architecture. NetLinx networks provide a common set of services, allowing users to mix multiple processors, networks and I/O without adding complexity. For example, from a PC on EtherNet/IP, ControlNet™ or DeviceNet™, a user can exchange data for fast and precise control, and collect data for trending and analysis. System designers also can route and bridge between networks with no additional logic programming for communication required.

Safety Control

To address safety concerns in packaging applications, Rockwell Automation added safety control to the Logix Control Platform and Kinetix drive platform, with the addition of the Allen-Bradley GuardLogix controller and Kinetix safety drives. The design commonality of the Logix platform, including the same control engine, motion, networking and I/O, allows for better sharing of information, reduced training costs, and faster programming and commissioning.

With GuardLogix, safety control is managed the same way as standard control. In addition, RSLogix 5000 software helps manage safety memory, so users don’t have to manually manage the separation of standard and safety memory, or worry about partitioning logic to isolate safety-related data. Safety memory can be read by standard logic and external devices such as human-machine interfaces (HMIs) and other controllers. This helps reduce the need to set up or condition safety data from a dedicated safety device.

With Kinetix safety servo drives, machine builders and manufacturers can implement machine solutions that help increase safety while maximizing machine availability. A safe-off function that is integral in the Kinetix 6000 and Kinetix 7000 servo drives allows typical maintenance work that previously required power-down conditions to be accomplished without removing power from the entire machine. The result is faster machine restart and shorter machine downtime.
Integrated control and the ability to use one common hardware and software architecture also solve another big challenge in the packaging industry: improving machine flexibility and reducing changeover time. It also lowers long-term costs associated with training, configuration and maintenance. The primary benefit, however, is a synchronized and efficient production line that allows companies to manufacture, package and ship more goods at a lower cost and with better accuracy.