

TECH NOTE 120-6: Packaging Machine Motion Control System

In a typical packaging application, there are three axes of servo motion control:

Axis 1 is the master axis which moves the web used for packaging wrap.

Axis 2 is the Slave 1 axis and moves a chain conveyor which has the product to be packaged. It uses a registration sensor in addition to electronic gearing to properly position the product in the packaging film relative to a registration mark (Registration Sensor 1).

Axis 3 moves the quick-action cutter. Axis 3 uses another registration mark sensor (Registration Sensor 2) to cut the packaged product at the right spot. Because this cutter is a rather quick action cutter, the cutter axis does not have to move along the translational motion of the web.

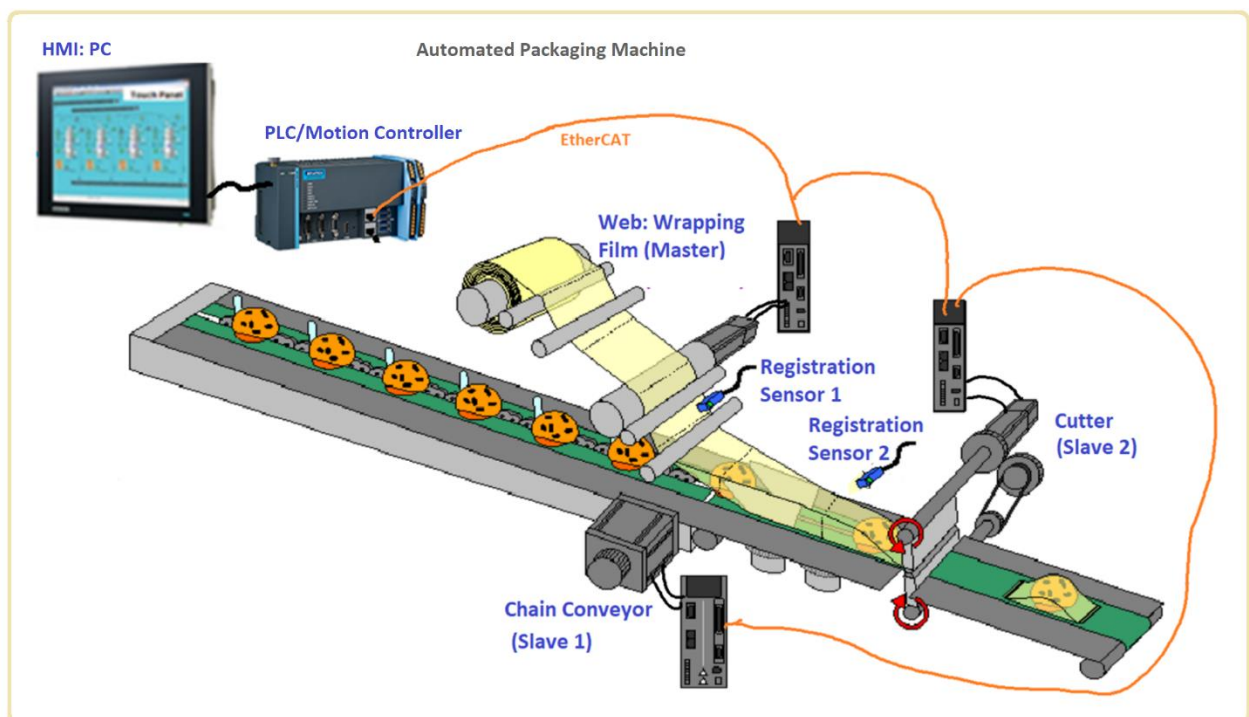


Fig. 1 – Packaging machine motion control application.

Depending on the accuracy requirements for positioning of Axis 2 and Axis 3, we may use a standard ON/OFF sensors interfaced to the standard digital I/O channels of the controller to make positioning corrections for these axes. In other words, if the positioning accuracy requirements for these axes are not very stringent, use of “registration sensor” and “position capture” interface may not be needed.

Components of the controls system are

1. HMI - Flat Panel PC, touch screen
2. PLC/Motion Controller
3. Three axes servo motors with EtherCAT drives or two axes servo motors with EtherCAT drives plus a Master Encoder with EtherCAT interface to the controller.
4. Two registration mark sensors if the product has registration mark.
5. Homing sensors for each axis:
 - a. Registration Mark Sensor also used as HOME Sensor for Axis 1 if registration is used. If not, separate HOME sensor is used.
 - b. HOME Proximity Sensors for Axis 2 and 3.

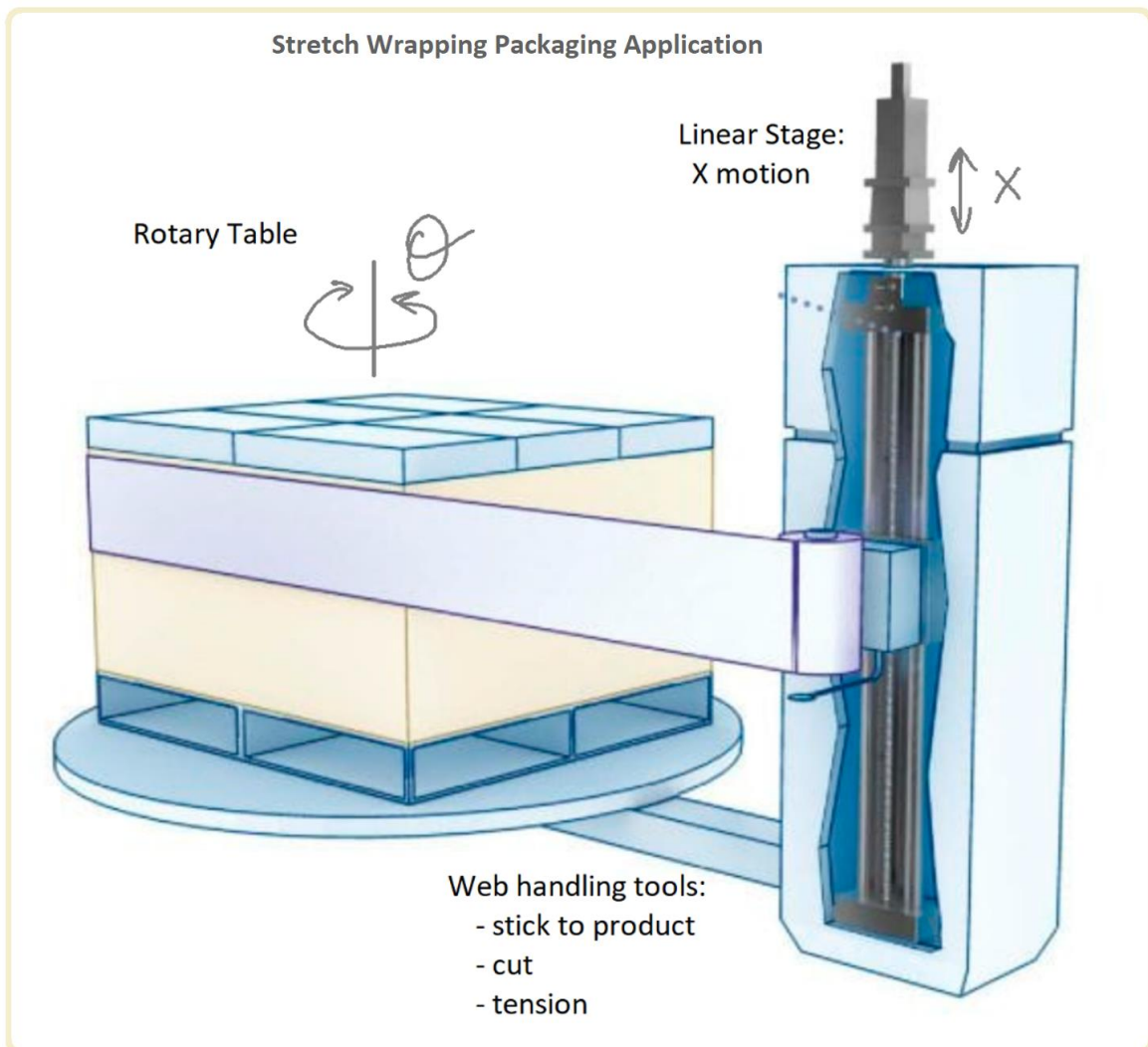
Parameters of the Coordinated Motion Control Algorithm

1. Product length per cycle
2. Length of the product during which tool engages the web
3. Length of the product during which tool does not engage the web
4. Length of the web during which tool starts from start and matched the translational speed of the web
5. Length of the product during which the tool disengages and returns to the start position
6. Registration Mark Sensor used or not
7. If Registration Mark Sensor is used, what is the desired position at Registration Signal
8. If Registration Mark Sensor is used, what is the maximum allowed position correction motion distance per cycle
9. Maximum travel distances for tool carriage in Axis 2 and 3.
10. Maximum travel speed in Axis 1 ,2, 3.
11. Maximum acceleration and deceleration for Axis 1, 2, 3.

Each one of the above parameters may also be limited to a certain range that the machine operator is allowed to change.

In a related packing machine application, the Stretch Wrapping Packaging Machine, there are at least two servo motion control axes: one to rotate the box to be wrapped, and one axis to move the web up and down. Other controlled motions may be controlled by ON/OFF type actuators, or may also be controlled by servos:

- web tension control, to maintain a constant tension during packaging
- a mechanism to start the web wrap around the box of product
- a mechanism to cut the web when each cycle is done



Controller Inputs:

Controller Outputs:

Control Algorithm Parameters:

CODESYS Application Software in PLC/Motion Controller using Function Blocks:

CODESYS Implementation: for Helical Coil Winding

CODESYS Implementation: Slotted Coil Winding

Demo Video:

References:

Cetinkunt, S., Mechatronics with Experiments, John Wiley and Sons, 2012, Second Edition, pp. 717-748.

Conveyor tracking by Yaskawa: <https://www.youtube.com/watch?v=cWa8evbwSkI>