Wrapping-up a Nasty Packaging Problem

by
Gregory C. Cala, Ph.D.
Partner, Vice President, Operations & Training
Data Science Automation, Inc.
USA

and

Ryan W. Vallieu
Consultant, Measurement & Automation
Data Science Automation, Inc.
USA

Category:
Mechatronics

Products Used:
NI Panel PC PPC-2015
Compact FieldPoint cFP-1808 8-Slot Ethernet/Serial Module
Four NI cFP-DO-401 16- Channel Sourcing Digital Output Modules
Three NI cFP-DI-304 32-Channel 24VDC Sinking Digital Input Modules
Eight cFP-CB-1
LabVIEW 8.2.1

The Challenge
Injection molded parts for the pharmaceutical industry were created on two independent injection molding systems. Star Automation robots remove the parts from the mold machines and place them in bins for manual packaging. The customer needed an automated system to collect and package parts from these systems.

The Solution
Data Science Automation designed a single automated system that interacted with two independently running production lines. The system utilized a Compact FieldPoint Ethernet module from National Instruments to control a central receiving and packaging system, the core of which was a two-axis motion system.

Abstract
In order to increase production line throughput, a manufacturer of injection molded pharmaceutical parts wanted to develop an automated packaging system that could service two independent production lines. Data Science Automation developed a robust automated packaging system that collected the finished parts from Star Automation robots four parts at a time. The parts were collected until thirty-two parts were waiting in a marshalling area, at that time the new automation system guided the parts to a pick-up area serviced by a two-axis picking system that grabbed the parts and placed them in a box.

Getting to the problem
To meet their production requirements, the customer had two injection molding machines that are situated side-by-side on the shop floor. These machines operated independent of each other and produced parts at an aggregate rate of 16 parts per minute. At the end of each injection molder's 30-second production cycle, the Star Automation robots would remove from the injection molding machines the four new parts that had been formed and drop them into a collection bin. In the past, human operators would come by periodically and box the accumulated parts by hand. This manual process – besides being mind numbingly tedious –also formed a significant bottleneck in the production process.

Mechatronics Solution
The main challenge in the mechatronics solution was the desire of the customer to have only one packaging machine servicing two separate asynchronous lines of production. DSA selected the PPC-2015 industrial panel PC (with touch screen) to hosts the application controlling the new packaging machine. The PPC-2015 communicates with the cFP-1808 through an Ethernet cross-over cable.

In terms of software architecture, the code broke the mechatronics solution to the packaging problem into nine main sub-systems:

- Pick and Place servo robot moving in the X and Z axes
- Two accumulator stations that interact and collect parts from the Star Automation robots
- E-Stop system that monitors for guard door openings or E-Stop button presses
- Two conveyor systems that move the boxes into place under the Pick and Place robot station and eject full boxes
- Alarm system that notifies operators of any system problems or I/O failures
- Foam level and Air Supply monitoring system that keeps track of air pressure for the sub-system pneumatics and packaging foam supply levels
- Manual Commands response system that reacts to system commands when it is in manual maintenance mode

The code for managing these sub-systems is encapsulated in subVIs that independently and in parallel with one another (Figure 1). The internal structure of the subVIs is based on the State Machine architecture, and communications between the various state machines is handled using Queues and Functional Globals.

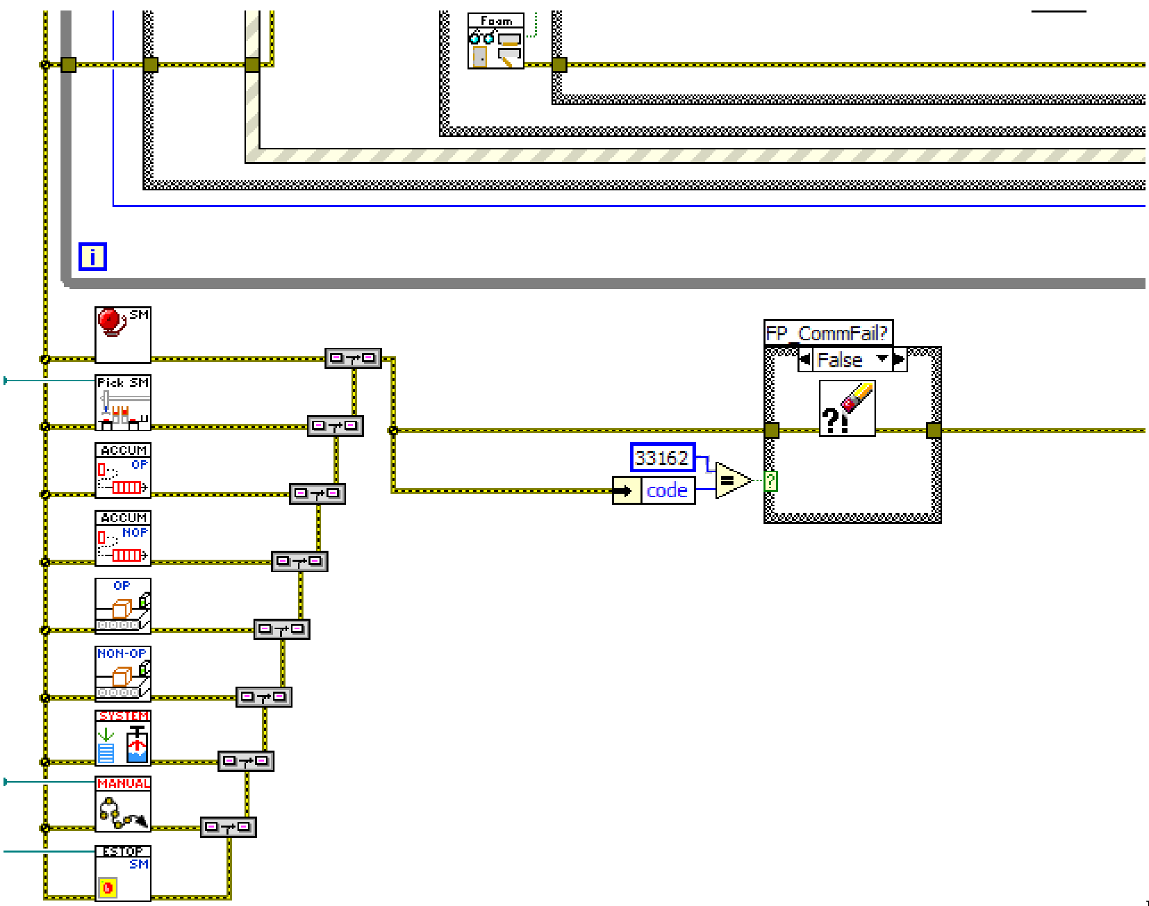

Figure 1 – Main Block Diagram shows the nine separate subsystem state machines that all run in parallel to make the packaging machine work.

Physically, the packaging system is split into mirror sides consisting of an Accumulator and Conveyor that service one Star Robot drop-off. The Accumulator stations collect parts until two rows of sixteen parts are in place. It then pushes these parts into the Pick and Place staging area. The packaging system is shown in Figure 2.

Figure 2 – The main packaging machine communicates with and receives parts from two asynchronously running Star Automation robots which remove parts from the injection molding machines.

The Pick and Place robot receives pick requests via a named queue from either Accumulator station. Once it receives the pick request it moves over to the pick area and clamps the parts and places them into a box that the Conveyor system has moved into place. After the Pick and Place robot has puts the parts into the box, it retrieves a piece of foam sheet from the foam magazine and places it over the packaged layer. These steps are repeated seven times until there are 224 parts in the box.

When the Conveyor state machine detects the current package is full, it sets a functional global to let the Pick and Place know to not service any more pick requests. The full box is then ejected and an empty box is brought into place below the Pick and Place robot. When the new box is correctly positioned, the functional global flag set earlier is reset to reenable pick and place operations.

The I/O Behind it All

All of the packaging subsystems communicate via industrial level (24VDC) digital input/output, and with the main application through the cFP-1808. The I/O density of the cFP-1808 combined with the Panel PC allowed the creation of a powerful control system handling 90+ channels of digital input and almost 80 channels of digital output.

An example of the way this digital I/O was utilized in this system is the control of the servo axes on the Pick and Place robot. The intelligent controllers used in this system were programmed to accept four bit binary recipe requests. Additionally each axis controller was sent commands for drive enable, start motion, and halt motion. Feedback from the drives was also provided by digital signals. Examples of this feedback included motion complete, and drive fault.

Summary

The combination of the PPC-2015 Panel PC running NI LabVIEW with the cFP-1808 sub-system allowed DSA to deliver a robust mechatronic solution to a production throughput problem presented by our customer. This system runs 24 hours a day, 7 days a week, with a throughput of 28 boxes per side in a 24-hour period. This is a yield of 12,554 parts packaged in a single day.

375 Valley Brook Road • Suite 106 • McMurray, PA 15317 • T 724-942-6330 • F 724-942-8390 • DSAutomation.com