Motion Control

Universal Instruments General Surface Mount Application Machine (GSM1)

Universal Instruments Uses Embed for Pick-and-Place Assembly System

Universal Instruments, a leading manufacturer of electronic circuit assembly equipment, turned to Embed, to design their new pick-and-place assembly system, the General Surface Mount Application Machine (GSM1).

The GSM1 automatically picks surface mount components and places them on printed circuit boards at speeds in excess of several thousand components per hour. It achieves precise component placement through a fine pitch, closed-loop vision recognition system. Accuracy is critical in lining up a component's leads over the board's solder pads, as the distance between leads may be only 8 to 15 mils.

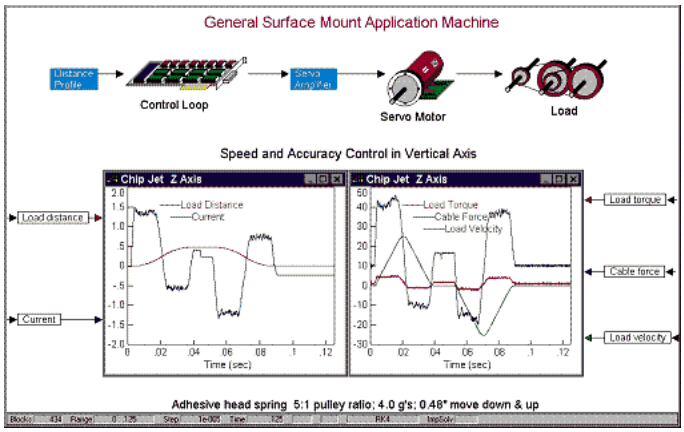
Challenge: Designing Speed and Accuracy in the Z-Axis

Critical to the design was enhancing the head and Z-axis of the GSM1 to optimize the time it took to pick and place a component, without causing the head to move so rapidly that it would sacrifice accuracy.

To ensure the head descended stably into position, a short settling time of 10ms was required. To attain this time, we specified a high bandwidth for the servo motor governing the axis (20 to 40Hz for positioning, and 100 to 200Hz for velocity). However, as accurate as these motors are, the performance of the GSM1 would be limited mainly by its mechanical components.

The servo motor for the Z-axis drives a shaft via a timing belt, which allows a reduction ratio. To move the Z-axis, a solenoid clutch couples a pulley and cable to the shaft. The other end of the cable is connected to the Z-axis, along with a spring to keep the cable taut. When the clutch is released, the Z-axis springs up to a hard stop. If the spring does not have enough tension when the shaft accelerates, the cable becomes slack and uncontrollable.

Our challenge was to design the mechanical elements so they would support the head's acceleration and deceleration rates, while maintaining tight control of the load as it was moved.



Embed GSM1 model. Current, Load Distance, Torque, Velocity and Cable Profiles

Solution

Universal Instruments' initial evaluation of Embed proved that it was not only easy to use but also powerful enough to model and simulate a complex, nonlinear system, like the GSM1. Building the model was simply a matter of dragging predefined function blocks off the Blocks menu and into the work area and wiring them together with the mouse. UI engineers modeled the properties specific to the servo drive, such as its position, velocity, and current control, as well as all the parameters affecting the cable tension, including acceleration and deceleration rates, load mass, spring rate, and friction. To achieve the settling time characteristics of the servo mechanism, engineers also included the proper gains and bandwidths. Component operating parameters were entered directly to the appropriate blocks through pop-up dialog boxes.

During simulation, they viewed the dynamics of the cable's tension in plots and real-time graphs. As they entered known values for acceleration, deceleration, and mass, their effect on the tension could be immediately monitored. This allowed them to adjust the spring rate so the tension was positive at all times.

Based on the simulation results, they built a hardware prototype of the GSM1 Z-axis. After further testing, released the unit for production.

Benefits

Using Embed, Universal Instruments designed the GSM1 much faster than if they had assembled a breadboard and performed physical testing. In addition, the GSM1 model provided a high degree of accuracy, allowing them to examine signals that would have been too difficult to monitor in a breadboard.

Because they could view the entire dynamic picture of the mechanical load, they designed the components to properly support the acceleration and deceleration rates of the vertical axis, ensuring tight control of the load while it moved up and down.

And, by validating the design through simulation, they could identify the correct components before building the prototype, shortening the design cycle significantly.

In the broader realm, Embed will be used to design and test improvements to Universal Instruments' existing products. As machines undergo changes to their mechanical and servo systems, they can test the proposed changes by opening the corresponding Embed model, making the modifications, and running a quick simulation.

Based on the success of the GSM1 Z-axis application, we use Embed on every new servo system design. In fact, modeling the system in Embed is a required point on our development checklist.

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