Case Study

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VisSim

Universal Instruments Shortens GSM1™ Design Cycle with VisSim

▲ *Universal Instruments' General Surface Mount Application Machine (GSM1).*

Universal Instruments, a leading manufacturer of electronic circuit assembly equipment, turned to VisSim, a Windows®-based modeling and simulation package, 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.

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

Jim York, Motion Control Engineer: Universal Instruments

The 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 10 ms was required. To attain this time, we specified a high bandwidth for the servo motor governing the axis (20 to 40 Hz for positioning, and 100 to 200 Hz 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.

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Modeling The Future

Application: *Precision Motion Control*

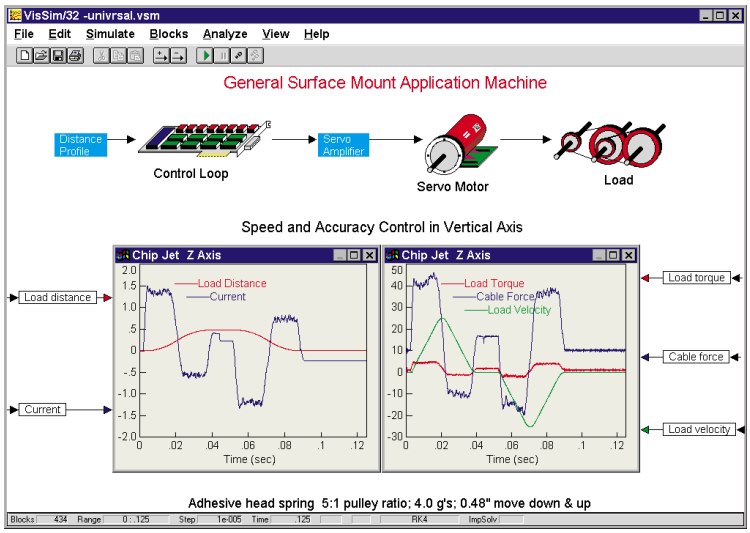
The Solution: VisSim

Our initial evaluation of VisSim 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. We 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, we also included the proper gains and bandwidths. Component operating parameters were entered directly to the appropriate blocks through pop-up dialog boxes.

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

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

Universal Instruments' General Surface Mount Machine simulation in VisSim. Current, load distance, load torque, load velocity and cable profiles are shown.



The Benefits

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

Because we could view the entire dynamic picture of the mechanical load, we 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, we could identify the correct components before building the prototype, shortening the design cycle significantly.

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

Download a Motion Control tutorial/VisSim models from our web site: www.vissim.com

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