Laser Scanner Speeds Surface Modeling at DaimlerChrysler

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The use of a laser scanner speeds the creation of surface models at DaimlerChrysler by providing a highly dense, highly accurate point cloud from which to construct digital surfaces.

The automaker's Vehicle Measurement Lab scans car bodies, interiors, and clay prototypes to support the design process. The resulting coordinate data is imported into a CAD system and converted into surfaces. Previous scanning devices-a coordinate measuring machine (CMM) and a mechanical digitizer-captured relatively few coordinate locations, making the construction of surfaces very labor-intensive. By switching to a laser scanner, the lab now captures millions of x, y, z coordinates quickly, giving designers a thorough definition of an object's shape and making the job of constructing surfaces go much faster. Another advantage of the laser scanner is that it captures coordinate locations without touching the object. This makes it possible to scan clay models without marking them, and to scan soft objects such as leather seats more accurately.

DaimlerChrysler's Vehicle Measurement Lab supports the company's design efforts in several ways. Its main role is to provide thorough, quantitative descriptions of competitors' vehicles. This information is used by designers when they are creating cars for new markets. The lab provides measurements such as width, height, wheelbase, and so on as well as the layout of the interior space so DaimlerChrysler designers can see how other automakers addressed certain market needs. "We're always benchmarking against competitors," explains Donald Misson, supervisor of the Vehicle Measurement Lab. "We're able to get some design data from the organizations we belong to, but we've found that but the most accurate way to evaluate competitors' vehicles is to measure them ourselves."

The Vehicle Measurement Lab also measures the clay models used by designers during the conceptual stage of vehicle development. While DaimlerChrysler uses electronic CATIA models as the masters for development of new vehicle designs, clay models are still used extensively, especially early in the design process. Conceptual designs are modeled in Alias/Wavefront's industrial design software, Studio. Clay models are then sculpted from the Studio models. Designers physically fine-tune the clay models until they have the precise shape they want. That shape must then be captured digitally for import into CATIA. Although DaimlerChrysler's design office has its own measurement lab that handles most of this digitizing work, the Vehicle Measurement Lab takes on the design lab's overload.

The Vehicle Measurement Lab's third role involves supporting DaimlerChrysler's racing efforts. Wind tunnel testing is used extensively by the racing group to improve vehicle aerodynamics. The lab measures the clay models used in the wind tunnel tests. Similar to the design process for consumer vehicles, designers of the racecars refine clay models until they have the shape they want. In this case, they are modifying the models in response to the wind tunnel results to improve aerodynamic performance. The measurement lab captures the shape of the modified models so the data can be used in CATIA.

METRIS

Case Study

Past measurement methods

In the past, the Vehicle Measurement Lab used either a CMM or a mechanical digitizer to measure and digitize competitors' vehicles and clay models. Both the CMM and the mechanical digitizer are contact devices, which means the technician must physically touch the object with a probe to record the x, y, z coordinate location of each point. Having to touch the object causes problems when digitizing clay models because it makes marks in the soft clay. A contact device also makes it difficult to accurately measure something very soft, such as a leather seat. Touching this type of surface, even very lightly, causes it to depress. Since it isn't possible for a technician to depress each point to the same exact degree, measurements of soft objects are prone to inaccuracy.

Even with firmer objects, accuracy was always a concern with these devices because the skill of the operator affects the measurements to such a large extent. With the CMM, for example, if the operator loses contact with the part surface for an instant, accuracy suffers. Similarly, with the mechanical digitizer, the technician must be highly trained and even when he works carefully, there can still be a great deal of variability in the data based on his influence. Aside from operator influence, a CMM machine is capable of achieving the required level accuracy, but another limitation is that it is not well suited to the task of scanning complete surfaces. The operator must carefully move the probe of the machine all over the part. This takes a lot of time, several weeks typically for an automotive door, which raises costs since this process ties up a high burden rate machine. The other significant limitation posed by contact devices stems from the type of data they generate. Since the effort of touching each coordinate location is so time-consuming, the level of data that is collected can be less than what the designers need. "Even if you scan every 50 millimeters, you can miss some detail of the surface," says Misson. The graphical result of a scan with a contact device is a series of sections. Designers must generate surfaces from the sections. Although this works well enough with simple surfaces since they can extrude from the lines and curves, it is not effective for complex shapes such as a car seat or body since the area in between the sections is not a straight line. As a result, constructing CAD surfaces from scanned data was a very labor-intensive process.

These limitations led Misson and his colleagues to evaluate non-contact devices for data capture. After evaluating the products on the market, they decided that the system that best fit their needs was a laser scanner called the ModelMaker from NVision, Irving, Texas. The major components of the ModelMaker system are a 3D laser sensor, a mechanical digitizer on which the sensor is attached, a PC, and software that extracts, displays, and manipulates the data. The software was one of the main reasons the lab chose this system, according to Mission. "We were very impressed with how the software simplified the act scanning, by removing duplicate data for example, and by how it can reduce the data size to a user-selected density," he says.

Non-contact process

To record the shape of a car body or other vehicle component, the technician simply holds the laser sensor so that a line of laser light appears on the body. The ModelMaker's sensor is a single viewpoint laser stripe sensor. Laser stripe sensors, which are significantly faster than simple laser point sensors, work by projecting a line of laser light onto the object while a small CCD camera views the line as it appears on the surface. The mechanical digitizer, a FaroArm from FARO Technologies Inc., Lake Mary, Florida, moves freely about the body, allowing the technician to position the sensor easily and capture data rapidly and with a high degree of resolution. As the technician moves the sensor over the surface of the body, a dedicated interface card translates the video image of the line into 3D coordinates. Real time rendering of the data gives immediate feedback. This is important because it lets the technician see areas that were missed and fill them in with another pass. The system combines the coordinate data with the Cartesian and angular co-ordinates generated at each position of the mechanical arm. The result is a dense cloud of 3D data describing the surface of the object. When the scanning is finished, the point cloud data is converted into ASCII format, then exported from the PC that runs ModelMaker and imported into CATIA. Tools within CATIA allow the designer to convert the imported data into surfaces.

"The advantage of the laser scanner is that it gives us a greater density of data," says Mission. "Rather than cross sections of an object we can provide complete surfaces, so there's much less time required to generate surface models in the CAD system." Accuracy is another important advantage of this device. Measurements are not affected by the operator to such a large extent because he is simply passing a beam of light over the object. Feedback from the system prevents him from missing areas. Since there is no probe on a laser scanner that must physically touch the object, the problems of depressing soft objects and making marks in clay have been eliminated.

For DaimlerChrysler's Vehicle Measurement Lab, a laser scanner is superior to both a CMM and a mechanical digitizer for capturing interior and exterior vehicle shapes. The non-contact nature of the laser scanner eliminates problems that used to compromise the accuracy of the scanned data. More importantly, it speeds the work of designers by giving them complete surface data with which to construct CAD surface models. Since the lab has been using the laser scanner, the job of creating surface models in CATIA has been transformed from a very labor-intensive process to an efficient, almost automatic routine.