Development and application of Optical Stereolithography for the big size model

Introducing SOLID CREATION SYSTEM of SONY

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The market trend recently compels us to find ways of realizing efficient small-volume production of multiple models, increasing chip-mounting density and improving product reliability while reducing lead time. In fact, Sony has been consistently striving to improve design and manufacturing efficiency by developing advanced production facilities and technologies , including various CAD/CAM/CAE, expert systems and flexible manufacturing systems . However , for Sony to secure a more advantageous position in this competitive industry, it has become essential to carry out more advanced design work in much shorter time. To facilitate such design work,we have developed the Solid Creation System(SCS).
SCS allows for the creation of 3D model directly from CAD data in a short time , using a laser and UV resin - featured stereolithographic technique.

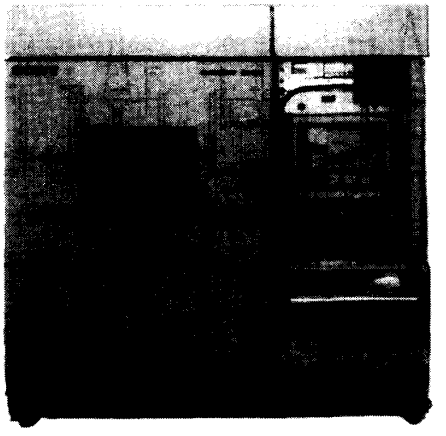
Recently , several companies have achieved successe in the business of stereo-lithographic systems. Most of these systems have the ability to create only mid-sized models (Max.50cm cubic). However , Sony has further developed the new SCS to be able to create large-sized models (Max. 1m cubic). This new SCS not only create most of real size models of products and parts , but also enhanced the efficency of product design.

This paper introduces the hardware and software technologies of the new SCS and presents the possibilities of applications for creating models using SCS.

SYSTEM OUTLINE

Sony's Solid Creation System consists of three main components, namely a laser scanning device, a UV resin box and a system controller. The process to create the solid model using SCS is as follows :

1. Controller (Workstation) in SCS obtains CAD data.
2. Cross-section slice data (Layer) is computed from CAD data at equal intervals of 0.1mm to 0.3mm.
(3. Actual product molding starts when the slice data are transferred to the system controller.)
4. Solid creation is ensured by repetitive scanning and hardening of the UV resin surface using the X-Y laser scanner, layer upon layer. (Fig-1)



Solid Creation System(SONY)

One of the important thing during the hardening process is to keep a eash depth constant. When the first layer is hardening on the stage, sometimes the problem of model peeling and deforming occurred as the hardening is on flat metal or flat glass surfaces . In order to prevent peeling , it is necessary to adopt the panching metal.

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Another important consideration is how to ensure the precision of the hardening model. If the stage is lowered at a constant pitch (eg. 0.2mm), the UV resin may not always cover the model (stage) because of varation viscosities. At the same time , it is more difficult to make big-sized models. To solve the problem, low-viscosity resins are used and a wiper is employed to keep the height of the resin layer constant.

To speed up the creation of the model , one of the method for saving time is to use high-powered laser. If the laser produces more power, the laser scanning speed can be increased . It is common to find He-Cd and Ar lasers in current systems. He-Cd laser has been used in many systems because it can be operated at low power requirement(20mW-50mW). It is also not so difficult to select a suitable resin . On the other hand , Ar laser has ten times the power (400mW)of He-Cd type. Therefore , the galvano-mirror method can be adopted for laser scanning (In He-Cd case, X-Y protter method is used). At the same time , high speed scanning (800mm/s)can be achieved when using high powered lasers , therefore resulting in much time

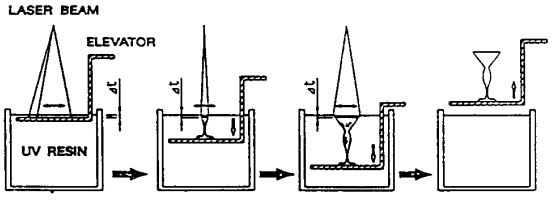


Fig-1. Process of Hardening

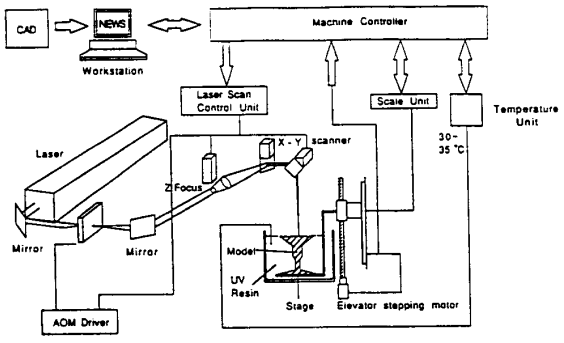
FEATURE of SCS

HARDWARE

The hardware structure is given by Fig-2. Main parts are

1. Workstation-Sony's NEWS (for data-processing and editing of slice data)
2. Machine Controller
3. Ar laser
4. Galvano-Mirror
5. Resin tank
6. Elevator added to Stage

NEWS is an Unix workstation developed by Sony that provides 15 MIPS of computing power . It can compute cross-section slice data (Layer) from CAD data at equal interval of 0.1mm to 0.3mm which is subsequently transferred into textfile. The NEWS system is designed to enhance the CAD data with certain features, such as the autocreation of support-data to model. If such a feature is not provided , due to using Ar laser and galvano-mirror , the system can scan and harden fast.



Hardware Structure

SOFTWARE

Main functions of software are the following ;

1. CAD Interface
2. Calculation of each cross-section data (LAYER)
3. Graphic editor
4. Offset scanning

Now , three dimension CAD systems uses either solid-modeling and / or surface modeling. When sending CAD data to SCS , it is necessary to tranfer the data to a format which the SCS's software can operate with ease. If the model's data is created in solid-model , the software will be able to get approximata facet data. If the model's data is generated by surface-model method , it is possible to get surface data or approximate facet data . In facet data case , there is a necessity to develop some conversion routines for transferring CAD data to approximata facet data . However , in the case of surface model , SCS can obtain IGES format

data which most CAD vendors support. Otherwise, SCS has unique format (SC-FORM) for CAD interface which supports not only facet and surface data but also slice-data.

After transferring the CAD data into the workstation (NEWS) , the SCS's software will calculate the cross-section slice data (LAYER) at equal interval(eg. 0.2mm). This is done in order to produced layer by layer of hardened resin. The Time required for the software to calculate the LAYERs using facet data appears to be faster than the time needed when using surface data. However , if it is required to make model with high precision , much data capacities is needed in the case of the facet data. This is due to the fact that it is necessary to use much facet data to approximated the real model. On the other hands , in using surface data, high-precision data can be catered for because the data can employ Bezier formulation . Simultaneously , regarding data capacities, there is no necessity to cater for large data volume . When the model is large , surface data (ex. Bezier data) is useful for workstation(Fig-3).

The SCS software provides the controlling functions to move the laser scan along LAYERs which is offset a half size of laser spot (Fig-4) . This control system enable the creation of high precision models . Other additional software functions that the SCS's provides include edit LAYERs, add support data etc...

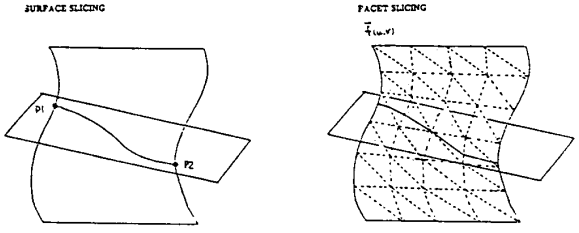


Fig-3.Cross-section data

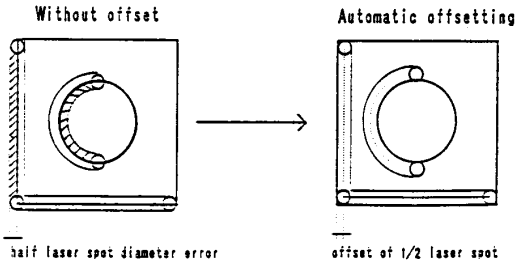


Fig-4.Laser offset

APPLICATION AREA

Many CAE/CAD/CAM systems and NC machines can be found in any company today.
This is especially true when there is design/manufacture of some new-products/new-parts.The number of such systems increase with the level of designing task performed. However, it's difficult to further shorten the lead time for designing using the current CAE/CAD/CAM systems. However ,through using optical stereo-lithodgraphic technology, the time for design, especially for rapid prototyping, is shortened significantly.
This technology can be applied to following areas:

1. to produce the mock-up for product design
2. to make sample products for feasibility study of new model
3. to be used as actual parts
4. to be used as master for manufacturing

In the area of home electronics, some mechanical parts of various precision level are needed which can be fulfilled by using stereo-lithographic technology.
Some modeling samples are shown below.

Photo-1 shows a mevius ring.This region is provided to enable the making of models which previously could not be manufactured in one process.

Photo-2 is an example of a mechanical parts (cover of 8mm video camera).

Photo-3 show an example of a precise parts (some parts of 8mm video camera).

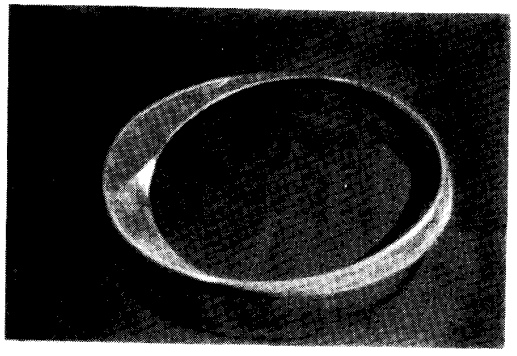


Photo-1

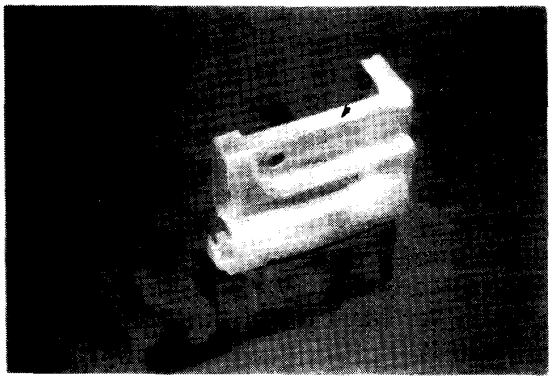


Photo-2

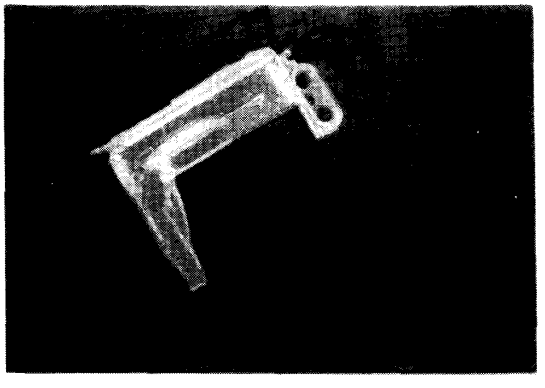


Photo-3

SUMMARY

Optical stereolithography technology is a new technology. It has been developed in order to establish efficiency of design. Some advantageous points of this technology are the ability to use any CAD data directly , to be able to make some real models under design environment, and do not require or necessitate any special technology for making the models. However, there are some problems to be overcome in this technology. For example , deformation when hardening , limitation on precision level of models, constituents of resin, the method of laser scanning , and so on. It is necessary to enhance this technology further in order to make it applicable to the industrial area.