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Development And Analysis Of Connecting Rod From The 3d Scanned Data By Reverse Engineering Technique Using Catia

P.Shravan Kumar[1], B .Sridhar Babu[2]

[1] **Department of Mechanical Engineering,**
CMR Institute OF Technology, Hyderabad, India 501401

Abstract

In the modern days the mechanical industry is boosting worldwide with the advanced products which includes the sophisticated trends for the industry requirements. It take very high time for the development of the new component which involves the complete product life cycle management since the innovation of the thought of designing new component till the death of the product which includes the much of the investment in terms of the Time, Money skilled labour etc. inspite of investing all these there is a very high possible in the failure of the component in case of the designing or material selection or some other causes. Reverse engineering is one of the best techniques to overcome such kind of risks.

Reverse engineering of mechanical parts requires extraction of information about an instance of a particular part sufficient to replicate the part using appropriate manufacturing techniques. This is important in a wide variety of situations, since functional CAD models are often unavailable or unusable for parts which must be duplicated or modified. Computer vision techniques applied to three-dimensional (3-D) data acquired using noncontact, 3-D position digitizers have the potential for significantly aiding the process. Serious challenges must be overcome, however, if sufficient accuracy is to be obtained and if models produced from sensed data are to be truly useful for manufacturing operations.

The project is on the Development and Analysis of Connecting Rod from the 3D scanned data by Reverse Engineering Technique Using CATIA.in this project the 3D scanned data of the connecting rod for a non-parametric solid was taken and converted in to the complete parametric model and the deviation analysis of the connecting rod to the actual scanned data to the obtained surface model is analyzed by using the various workbenches like “Digitized Shape Editor” and “Quick surface reconstruction” in the CATIA V5 the and the Load sustainability of the component is checked by applying the suitable load on the component by using the Catia analysis. This type of the virtual analysis of the complete reverse engineering of the component optimized the process of the product life cycle management with the best results with the short time for the new product development.

Keywords: ***Development****, Modelling, Design, Crank shaft, CATIA.*

1. Introduction

3D scanning techniques including structured lighting technologies such as coded-pattern projection and laser-based triangulation to sample 3D points on the surfaces of objects and then to reconstruct these surfaces from the models of the stereo lithography (STL) files that are obtained from the 3D scanning Data then applying the static analysis to the Developed CAD model. This reverse engineering (RE) research presents reconstruction results for a military tire that is important to tire-soil simulations. The limitations of this approach are the current level of accuracy that imaging-based systems offer relative to more traditional CMM modeling systems. The benefit however is the potential for denser point samples and increased scanning speeds of objects, and with time, the imaging technologies should continue to improve to compete with CMM accuracy. This approach to RE should lead to high fidelity models of manufactured and prototyped components for comparison to the original CAD models and for analysis. We have considered a sample as Connecting Rod with the STL (which is a non-selectable) file format from the 3Dscanned Data which is completely a unparametric raw data that is taken in to the CAD software CATIA and developed the shape as a parametric model type and understanding the deviation analysis of the extracted parametric model with the 3D scanned data and then applying the static analysis to the solid model for analyzing the load sustainability of the connecting rod.

CAD MODELS are often unavailable or unusable for parts which must be duplicated or modified. This is a particular problem for long life cycle systems for which spare part inventories have been exhausted and original suppliers are unable or unwilling to provide custom manufacturing runs of spare parts at affordable prices and in a timely manner. For many parts, either CAD systems were not used in the original design or the documentation on the original design is otherwise inadequate or unavailable. For a variety of reasons, CAD models, even when they exist, may not be

sufficient to support modification or manufacturing using modern methods. Finally, shop floor changes to the original design may mean that the original CAD model no longer accurately reflects the geometry of the part.
Reverse engineering techniques can be used to create CAD models of a part based on sensed data acquired using three-dimensional (3-D) position digitization techniques. Part-to-CAD reverse engineering produces models which allow up to date NC fabrication and facilitate design modification. Successful instances include everything from sporting goods to aircraft parts. Reverse engineering of solid objects traces its roots back to the pantograph, which uses a mechanical linkage to duplicate arbitrary geometric shapes at any predetermined scale. Copy lathes and mills are more contemporary and automated versions of the pantograph. In a copy lathe, a mechanical stylus is moved along a template specifying a 1-D profile. The position of the cutter is adjusted based on this template, producing a revolute object with the same profile. A copy mill typically moves a stylus over a surface, using the height of the surface to set the axis in a three-axis mill, thus making a copy of the original object. Several vendors have produced copy mills which use noncontact sensors. These systems have the added advantage of storing the sensed profile, so that an object can be duplicated many times without repeated scanning. Copy lathes and mills duplicate a physical part without producing any intermediate model of the geometry of the part, other than stylus position or 3-D points acquired with a noncontact sensor. While some can produce NC code capable of driving other lathes and mills, none can produce a CAD model of an existing part. Such models are desirable for a number of reasons. Modifications to the part cannot easily be done at the level of NC code. Even if the part is to be duplicated as is, refixturing and hidden concavities often lead to situations in which multiple scans of an object's shape must be combined into a single, consistent representation. Some shape properties such as deep holes will not be accurately measured by either mechanical styli or noncontact sensors. The most straightforward approach to generating a reverse engineered geometric model of a mechanical part involves a designer or engineer making measurements using traditional devices such as calipers and gauges and entering the results into a standard CAD system. Hence high precision is required, contact coordinate measuring machines (CMM's) are often used. Positional accuracy on the order of 3m locally and 14m corner to corner is possible, but sensing of a large number of points is extremely slow and expensive damage can be done if the probe is not maneuvered toward the object along an appropriate path. More recently, noncontact CMM's produced by companies such as Cyberware, Digibotics, and Laser Designs have significantly increased the speed with which data can be collected. These devices project a spot or line of light and use triangulation to determine range. While less accurate than contact CMM's, the best are capable of
positional accuracy exceeding 50 m. Nonoptimal surface properties can degrade this, while deep concavities, discontinuous surface orientation, surface geometries forcing oblique viewing angles, or outright occlusion will cause data to be missing entirely. For comparison, commonly available NC milling machines can achieve precisions of 2–10 m for hole and bore spacing's and can produce cutting accuracies on the order of 50–250 m depending on the feature being cut and the tool being used, though special measures can be used to obtain higher precision.

1.1 Reverse Engineering

The process of duplicating an existing component, subassembly, or product, without the aid of drawings, documentation, or computer model is known as reverse engineering. Following figure 1.2 shows the schematic process of the forward engineering.

Reverse engineering is the process of discovering the technological principles of a device, object, or system through analysis of its structure, function, and operation. It often involves disassembling something (a mechanical device, electronic component, computer program, or biological, chemical, or organic matter) and analyzing its components and workings in detail for either purposes of maintenance or to support creation of a new device or program that does the same thing, without using or simply duplicating (without understanding) the original.
Reverse engineering has its origins in the analysis of hardware for commercial or military advantage. The purpose is to deduce design decisions from end products with little or no additional knowledge about the procedures involved in the original production. The forward engineering follows the sequence of the Specification-Design-Code.

1.2 Reverse Engineering in Traditional Manufacturing Industries

The law generally allows the reverse engineering of manufactured products.
While reverse engineering may be undertaken for many reasons, we concentrate here on reverse engineering for the purposes of making a competing product because this is the most economically significant reason to reverse engineer in this industrial context. From an economic standpoint, a right to reverse engineer is typically sound because the innovator is nevertheless protected in two ways: by the lead-time it enjoys and by the costliness of reverse engineering. Lead-time serves the same function as a short-lived intellectual property right. Costliness may prevent reverse engineering entirely, especially if the first comer licenses its innovation as a strategy for preventing

unlicensed entry. Provided the cost of reverse engineering is high enough, such licensing will be on terms that permit the innovator to recoup its R&D expenses, while at the same time constraining the exercise of market power in order to dissuade potential entrants. However, when a particular method of reverse engineering makes it so cheap, easy, and rapid to make competing products that innovators will find it difficult to recoup their R&D expenses, such as with the plug-molding of boat hulls, it may be economically sound to regulate this means of reverse engineering.

2.Modelling

CATIA (Computer Aided Three-Dimensional Interactive Application) started as an in-house development in 1977 by French aircraft manufacturer Avions Marcel Dassault, at that time customer of the CAD/CAM CAD software to develop Dassault's Mirage fighter jet. It was later adopted in the aerospace, automotive, shipbuilding, and other industries

CATIA (Computer Aided Three Dimensional Interactive Application) software is used to import the point cloud data in to the one of the work benches called Digitized Shape Editor and Quick Surface Reconstructor where the 3dscanned data can be imported either in the form of the points cloud data or the STL file format. The surfaces from the imported data can be developed and later converted in to the Solid model which is the fully parametric data which can be used further for the complete product development.

The Deviation analysis of the extracted geometry with the developed surfaces from the points cloud data or the STL file formats can also be analyzed and the variation in the dimensions can be found and further this part is used for the static analysis to understand the load sustainability for the material used for the Connecting rod. The entire process can be seen in the further chapters which gives the overall view of the product development and the analysis of the Connecting Rod.

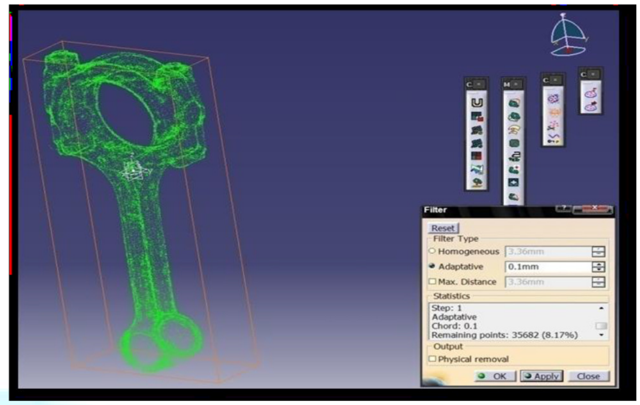

Figure .1 Points cloud data

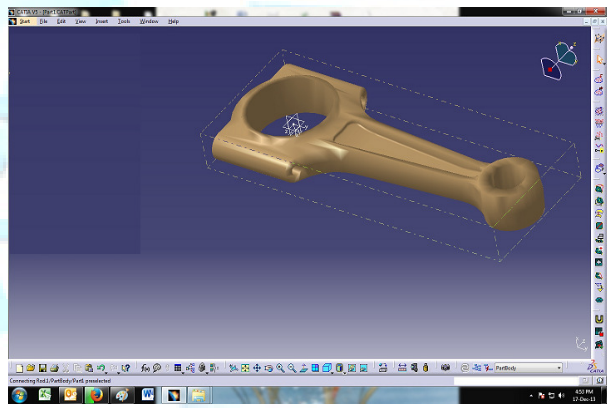

Figure 2 STL file

The surface formed from the automatic surface option was a formed by dividing the STL file in to the various number of surfaces instead of the single surface but for converting the surface model in to the solid model we may need to have the single closed surface with the allowable tolerance area of the within the range of the closed surface. For that we need to join all the surfaces by using the Join command. For this we need to go to the option join and select all the surfaces that are need to be joined. With this all the individual surfaces that are formed by the automatic surface option will be sewed in to the single closed surface and ready to convert the surface model in to the solid geometry.

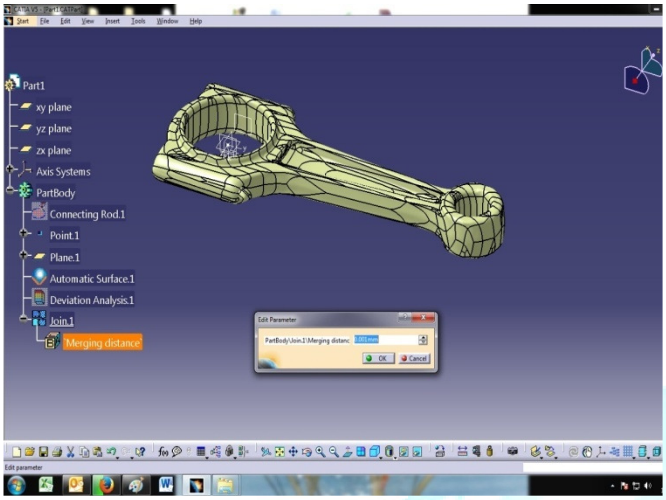

Figure3 Join surfaces

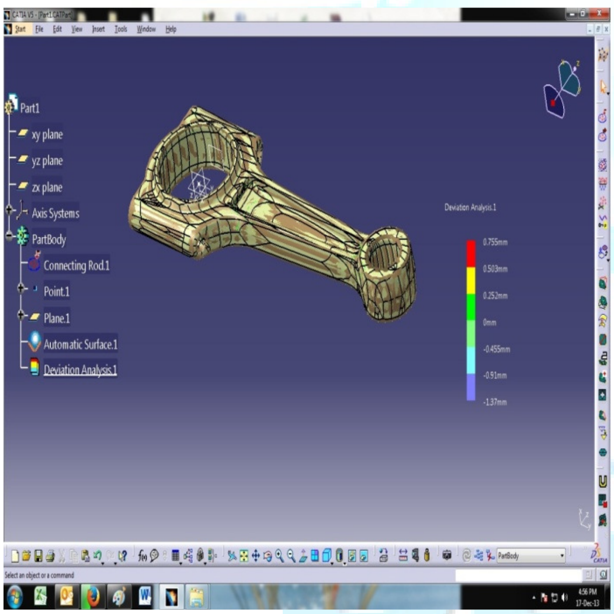

Figure 4 Deviation Analysis of the surface model.

4.Finite element analysis

Finite Element Analysis (FEA) is a numerical tool used for solving problems defined by ordinary or partial differential the most common Finite Element (FE) technique is displacement-based technique. In this approach, displacement is assumed to be an unknown quantity The problem is solved using FE methods to find out displacements

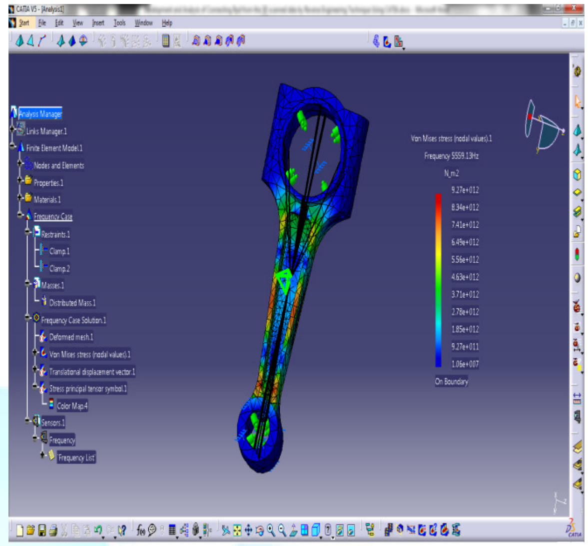

Figure 5 Von-Mises stress for the connecting rod

Compute the Result with the given values as the distributed mass of the 2kg and the two restraints. This will compute the result and can be saved as the html file for the analyzation purpose. The von-mises stress for the connecting rod at the various frequencies is analyzed

5.Results and discussions

The structure computation of the connecting rod is done and the following table shows the various parameters that are considered during the computation of the result for the connecting rod
Final result of the computed result of the connecting rod after the computation of the result for the various iterations of the frequencies that are applied during the frequency analysis is shown as follows

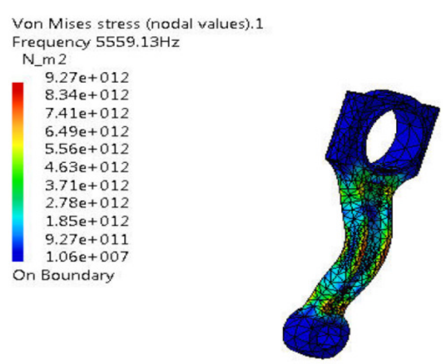

Figure 6 showing the deformed connecting rod after the frequency analysis

6.Conclusions

The work flow for the analyzing the parametric model from the 3d scanned data shall optimize the tedious job of entire product life cycle management for the new model of the connecting rod with the available sources of the 3D scanning and the various workbenches that are used in CATIA. By optimizing the final cloud by means of corresponding mesh, recognized in Catia delivered a smooth geometry and a lower number of points. Catia was the main processing solution because it produced a 3D solid replica of the physical model. The workflow extended on a period of almost two months work and it consisted out of a lot of trial & errors. The obtained 3D model is seen as a solid body by Catia. This allowed us to export a full copy of it for further FEA analyses in order to be validated from the geometrical and functional points of view. In this paper I have analyzed only the frequency analysis of the developed solid model. This can be further extended to the various analysis and on its basis further FEA analyses delivered an optimized 3D model which eventually was physically obtained by means of a CNC Centre. The aim of the project was to redesign the connecting rod from the 3d scanned data with the complete parametric model and the frequency analysis of the connecting rod to be analyzed for the maximum allowable frequency that was successfully achieved with the reverse engineering technique using CATIA.

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