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Research paper

Design of Plastic Component Using Reverse Engineering Approach

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Abstract

The Reverse Engineering (RE) technique for the design of plastic components of money counting machine using articulated laser scanner and CatiaV5 is presented. Initially it is physically digitized to generate point cloud data with the help of a scanner through scanning and is exported to CAD software CatiaV5. Thus, this paper describes the processes of RE of plastic component from object digitization and analyze the error to reconstruct the CAD model. To study the behaviour of the component, the analysis has been performed with stress distribution, factor of safety and displacement of modified plastic component with existing one at minimum to maximum loads.

Keywords: *Reverse Engineering, plastic component, laser scanner.*

1. Introduction

In the conventional engineering practice while designing any products, it starts with drafting and designing coupling with the necessary materials incorporated with the requisite tolerances for manufacturing and assembly. This method has been in vogue from inception for the physical implementation of it. But in some special situations like antiques, bio medical parts the drawings and other relevant records are scarcely available and hence given a scope for developing through reverse engineering. In this process a geometric CAD model from 3D point cloud data scanned and thereby adopted for implementation in the manufacturing of products.

2. Literature Survey

Michal Dúbravþík and Stefan Kender [1] proposed a damaged transmission gear wheel. There are number of techniques are available for substitution of damaged parts in very short time period. By applying reverse engineering, the damaged part will be 3D scanned and point cloud data is aroused subsequently by using CATIA the surface is reconstructed and solid model is designed along with the missing part. Qingjin Peng Hector Sanchez [2] proposed the shape recovery of three-dimensional objects. It analyze the current 3D data acquisition technology and discusses the 3D shape recovery and techniques in product reverse design. Generally, noncontact device is a convenient technology for 3D data acquisition. The time used for data acquisition is shorter than other methods. Niranjan Singh, Dr. Jagdev Singh [3] Implemented with a reverse engineered brake rod of a two wheeler manufactured by BAJAJ PULSUR 150cc bike and thereby eliminating the persisting problems. Z.Q. Chenga , J.G. Thackera , W.D. Pilkeya , W.T. Hollowellb, S.W. Reagana , E.M. Sievekaa [4] reported a finite element model with the experiences gained during the development, modifications, and refinement of a fourdoor1997 Honda Accord DX Sedan. Bardell et al. [5] was used coordinate measuring machine (CMM) to verification the freeform surface. Computer-aided geometric design (CAGD) is used to analyze the surface for optimum continuity and assess the CMM data accuracy. Xie et. al. [6] have presented a multi-probe measuring system integrated with a CMM making use of the reverse engineering technique. Mohammad Shadab et. al. [7] presented solution for CBZ motor bike component by CATIA v5 using the cloud data, resulting in the stresses are within the prescribed design limits. F. Belarifi et. al. [8] proposed a method to optimize the module of cutting conical spur gear, after being worn or broken. A.R. Ismail et. al. [9] explained the modeling and machining of four stroke piston engine.

3. Description

A plastic component i.e. enclosure of a money counting machine as shown in Figure 1&2. This enclosure is made of thermoplastic material i.e. ABS (Acrylonitrile Butadiene Styrene) which is manufactured by Injection moulding process.

Figure: 1 & 2: Plastic component (money counting machine enclosure)

4. Methodology

In reverse engineering the complete study of the product which includes structure, operating conditions, materials and surface qualities etc.. Collection of the data is first step of this methodology and followed by Pre-processing and solid model creation.

4.1. 3D Digitization:

Initially digitize the physical model using reverse engineering technique. During this process collected data of the physical model convert into digital form by using non contact sensing technique. After the multiple scans and it is combined into a single point cloud to reconstruct the surface. The scanner used for capturing the data of physical model is FAROs portable measurement laser scan arm. It is an ideal tool for inspection as shown in the Figure 3. It is the multiple axis articulated arm with a circular work volume and each joint has a revolving transducer. The signals from these transducers are processed and sent through the Serial communications cable, which attaches to the port in the rear of the computer.

Figure 3: FARO's portable measurement laser scan arm

This part is digitized using portable laser scanner which has a deviation of 40 microns. While scanning Figure 4 the free form shapes, multiple scans Figure 5 in various orientations is required in order to capture all curvatures and its features and we acquire the point cloud data from these shapes.

Figure 4: Scanning the component

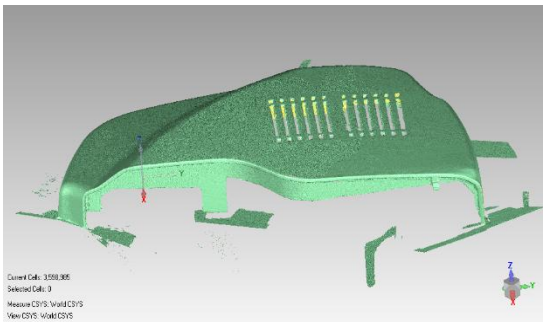

Figure 5: Process of scanning

4.2. Pre-Processing of Data and Segmentation

The point cloud data contains numbers of scrap, severance, noise which result in enormous data size. The processing of parametric model from each point cloud triangulation is perfect to the novel shape of the digitized object as shown in the figure 6. About 35, 98,985 points have been acquired for building the 3D solid model.

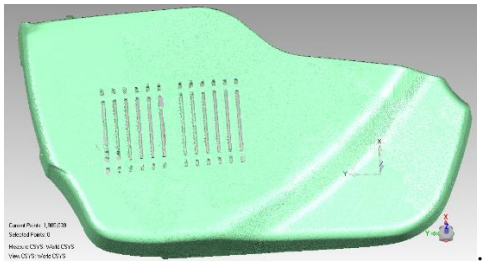

Figure 6: 3D solid model after pre-processing

4.2.1. Mesh Generation

It is an automated development of linking the closest three points to shape of a triangle and also referred to as 'Tessellation' Figure 7. Repetition of the procedure from the entire point cloud data until unambiguous, triangular and surfaces achieved. STL format is preferable for exporting the mesh is STL. The exported STL file can be used based on quality and accuracy of the mesh directly in Rapid Prototyping, CAM, FEM and CFD Analysis.

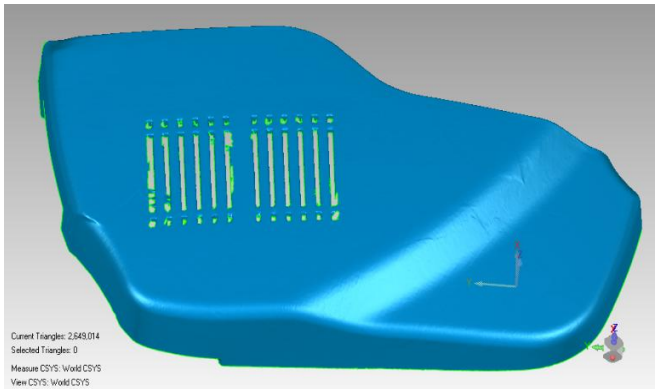

Figure 7: 3D model component after triangulation

4.3. Surface Reconstruction:

The surfaces are reconstructed from Feature Extraction, Surface Fitting and Networking of curves. While working with the free form shapes fitting NURBS or curves surface patches to the segmented mesh is used primarily and for the surface construction Reverse engineering software used. The .stl file is imported to Design X and the mesh is optimized still further.

Once the surface reconstruction is accomplished partially, the component is saved as an IGES file. The part is thickened to form a solid and further design modifications are done in CATIA V5. Workbenches like Generative Shape Design and Part Design have been used. The design optimization is made by using some dress-up features like Fill, Extrude, Boolean operations, Fillet, Trim, Pad, Pocket, etc., and the solid parametric model Figure 8 & 9 is reconstructed in CATIA V5 according to the design criteria mentioned above.

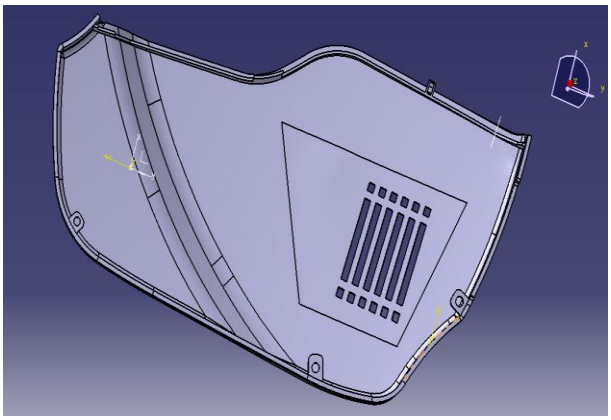

Figure 8: 3D Solid model 1

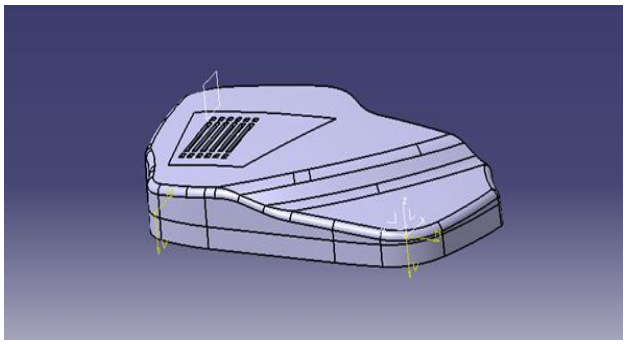

Figure 9: 3D Solid model 2

5. Conclusions

It describes the methodology of free-form shapes of plastic components implemented using reverse engineering from digitizing through surface reconstruction. As designing a plastic component from the scratch is time consuming, this project mainly focuses on reverse engineering a plastic component in less time by taking design considerations into account. Thus, any intricate shapes of plastic components whose design is not available or whose design is required for benchmarking (Rapid product Development) or for which modifications have to be made can be easily redesigned using the methodology of reverse engineering within minimum possible time. As a result, Reverse Engineering will decrease the manufacturing cost and increase the speed for product realization system.

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