ISSN No:-2456-2165

Design of a Work Piece by Reverse Engineering

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Abstract:- In this paper, we will be using Reverse Engineering technique using Artec Space Spider Scanner to get the dimension soft he product. We will scan the object to get all the cloud data of this product. Point cloud data is then exported to CAD software to generate CAD model. Geomagic Design X is the CAD software we use to make our part's CAD model. Thus, this report shows the process of Reverse Engineering, from objects canning to CAD model reconstruction and error analysis. Our case study of Reverse Engineering using Artec Space Spider Scanner and CAD software is presented considering a simple part just to show the process.

Keywords:- *Reverse Engineering, Artec Space Spider Scanner, CAD Model.*

I. INTRODUCTION

Nowadays, Reverse engineering has uses in many fields (e.g., Mechanical devices, Electronic components or Software programs), not like before when it was restricted for one area only. Reverse engineering can be viewed as the process of analyzing a system by identifying its components and their inter relationship, the creating representation soft he system in another form or a higher level of abstraction (CAD model), and finally creating the physical representation of that system [1].

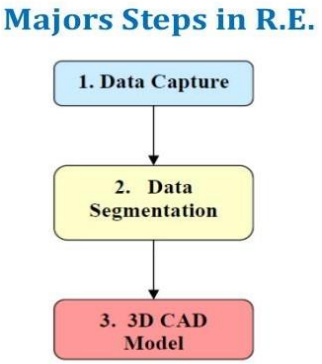

Fig1:- Major steps in Reverse Engineering

II. WHY DO WE NEED REVERSE ENGINEERING

- To explore new avenues to improve product performance and features.
- There is lack of information about the original design.
- The original manufacturer of a product is unknown but a customer needs the product.
- The original design documentation has been lost or never existed.
- Some bad properties of a part need to be improved.
- To strong then the good features of a product based on long-term us age of the product.
- To figure all features of competitor's product.
- The original manufacturer of a product stopped producing it.
- To develop better products than competitor ones.
- The original CAD model is not enough to support editing or current manufacturing methods.
- The original part manufacturers are either unwilling or unable to supply replacement parts, or demand in flatted costs for sole-source parts.

Hence, it is clear that Reverse Engineering is not limited for a specific field (industrial world), it is used in several applications that come from different areas and fields. The type of reverse engineering that our report will discuss is the technique where a simple part is being scanned, then it is taken to software to extra ctits features and the entry to copy or clone it by making a CAD model that has approximately the same features.

➢ *Objectives*

- The objectives of our case study are:
- To study the Reverse Engineering method.
- To find accurate values of the part's dimensions using Artec Space Spider Scanner.
- To study modeling software (Geomagic Design X) that can be utilized to model the STL data to for maCAD model.
- To prepare a CAD model for the scanned part.
- To suggest a proper method to get the accurate dimensions.

➢ *Problem Statement*

In this paper work, a simple part is considered for Reverse Engineering to learn the process. The CAD model of this part was not available and we were required to make one using Artec Space Spider Scanner.

➢ *Artec Space Spider Scanner*

The Artec Space Spider Scanner is a device used to do 3D scanning and measuring the geometrical properties of an object. This device is used manually by hands and the more skilled is the person doing the scan process, the better the scanning will be. It comes with software (Artec Studio) to show the captured object and edit the scan and finish the surface, and it comes also with many other features and tools.

As shown in figure2, the eye in the center is the RGB camera, surrounded by LED flash bulbs for capturing textures without the need of a special light setup. The eye in

ISSN No:-2456-2165

the bottom-right corner is the blue light pattern projector and the other eyes are sensors for that pattern. So there the most structured light scanners that have two 3D cameras, the Space Spider has three at various angles and depths. The result is that this scanner has are solution of 0.1mm (with an accuracy of 0.05mm) [2].

Fig 2:- Artec Space Spider Scanner

III. LITERATURE REVIEW

There are many studies which are contributed by many researchers and engineers regarding the applications of Reverse Engineering, and a large content of literature is available in journal sand books explaining the process of Reverse Engineering and its applications in many fields. Here's a review of relevant literature has been made.

Lin et al. (2005) had presented the measuring method to get better data points and the appropriate method to deal with points cloud data. Reverse engineering software was the used to create the free- form surfaces from the point cloud data [3]. Mohammad Shadabet.al. (2006) presented the applications of the reverse engineering method on the modeling of Pillion step holder of Hero Honda CBZ Motor Bike. The CAD model of Pillion step holder had been developed by CATIA V5 using the cloud data. The stress analysis of pillion step holder was also done. Results had shown that the maximum stress at critical section was with in the permissible limit as compared to the strength of the material and the deflections in the component were much lesser than the permissible value. Again the stress analysis was performed on the modified CAD model. It was found that the maximum stress and maximum deflection was still within the permissible limit. It also helped to understand the behavior of the CAD model under various loading conditions and further helped to modify it[4].

F.Belarifiet.al. (2008) propose method to optimize the module of cutting conical spur gear, after being worn or broken, with the aid of Computer-Aided Design (CAD). It also allowed creating a virtual model, by theoretical geometric characteristics, to calculate the volume. The suggested method allowed determining the geometric features of a pair of conical spur gear after worn. A simulation package, R2000, was used and special "Auto CAD" software had been developed to accomplish the drawing of 2D wheel conical spur gear, the verification of the system assembly and the drawing of a 3D volume pattern [5].

IV. CONCEPT

➢ *Stages in Reverse Engineering*

There are mainly three stages in reverse engineering.

- *Scanning:-*

Scan the part geometry by using contact or non-contact scanner. These scanners are able to capture all the geometric features as a cloud points

- *Point Processing*

This phase involve sim porting the point cloud data, reducing the noise in the data collected, and reducing the number of points using a range of predefined filters. At the end the cloud data will be in more appropriate format.

- *CAD Model*

At this stage engineers will produce a complete solid model from the surface data that are generated from point cloud data.

V. PART & METHOD

The part we used (Figure3) is a simple rectangular part that has 2 counter bore holes and semi-circular cuts on top. Unfortunately the surface finishing of the part is not that good but the process will be continued with taking that into consideration.

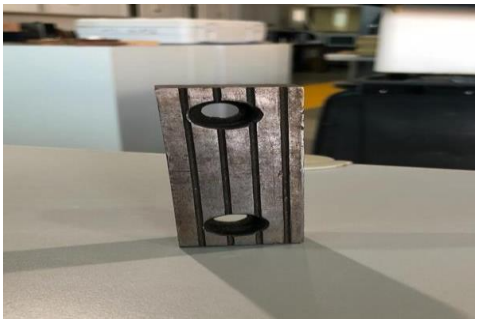

Fig 3:- Original part

A. Machine Used:-

Artec Space Spider Scanner is the device used in our study, it is shown in Figure 2.

B. Procedure for Scanning:-

➢ *Creating a new part program*

- Open the software (Artec Studio12).
- Connect the scanner with the computer and turn it on
- Place the object to be scanned on a paper.

➢ *Setting things up before scanning*

- On the home screen of the software, click on Scan (on top left) then choose "Geometry and Texture".
- Adjust the scanning speed as required for the part.
- If the part is black, reduce the brightness, and if it is metallic or steel part then increase it.

➢ *Scanning the part*

- Click on Preview and move your hand while holding the scanner until you find the right angle that's how all features and you are ready to scan.

ISSN No:-2456-2165

- Once you are ready, click on Recorder press the button that is on the back of the grip of the scanner to start scanning.
- Fix your hand place & angle, and move the paper under the part slowly in a circular motion so that the scanner captures all features of the part.
- Once finished from the sides raise your hand to capture the top side of the part (to ensure all sides are well scanned)
- After scanning all sides, click Stop or Press the same button behind the device again.

➢ *Preparing the scanned file:-*

- Next, you'll find on the right a list of all pictures taken, make sure that none of them exceeds 0.3 in the Maximum error column, if there's anyone of them does, and delete it.
- After getting the 3D picture of your scan, Click on Tools (on left) then register. After that click on Global Registration and finally apply.
- On Fusion, click on Outer Removal then Apply.
- Click on Sharp Fusion and then Apply.
- Click on Editor (on left) and choose 2D Section, Press on CTRL + highlight unwanted surfaces to be removed.
- Click on the Number of polygons.
- On Tools click on Post processing.
- Fast Mesh Specification and write the number of polygons divided by 2(e.g., 1000if#ofpolygonsis2000).

➢ *Saving the file*

- Click on Export Mesh.
- Name the file and save it as STL Object.

VI. CAD MODEL

After preparing the STL file, the file is taken to software to make the CAD model. The software we use is Geomagic Design X.

➢ *Procedure for Extracting the CAD Model*

- Open Geomagic Design X software.
- Import the STL file saved in the computer.
- Click on Region (on top) Auto segment, then click on √ to proceed.
- Click on Model Plane, and choose backplane (one with smaller diameter holes).
- On Model menu, choose Vector change the setting to Find Cylinder Axis, and click on any of the two holes.
- On Model menu choose Point select the plane and the vector that we did before so this point will connect them.
- Click Align, choose Interactive alignment Align with Global Coordinates Under the plane, Vector and point sections, select the plane, vector and point you've made Then click on√.
- On Sketch menu, click Mesh Sketch, select the plane you want to sketch on (after creating one) Sketch a rectangle that is exactly like the scan.
- Exit Sketch Click on Model menu Extrude, and extrude your sketch to have the same height of the real part.
- Then click on Mesh Sketch, select the plane you want to sketch on Sketch first the small radius circles Exit Sketch Click on Model menu then Extrude with cut through all the part.
- Click on Mesh Sketch select the opposite plane Sketch the circles with bigger radius Exit Mesh Sketch Click on Model menu then Extrude it withcutjust13.5mm.
- Click on Model menu, choose Fillet Make fillets only for the edges of the circles.
- Click on Mesh Sketch, select the plane you want to sketch on Sketch half circles Exit Mesh Sketch Click on Model menu then extrude them with cut through all the part to make the lines.
- Now you are finished with your CAD model so compare it with the scanned part using Accuracy Analyzer on the right of the screen.

VII. RESULT AND DISCUSSION

We finalized our process by comparing the CAD model with the scanned part using Accuracy Analyzer tool in Geomagic Design X software. It compares both of them by coloring the CAD model and shows on the right the meaning of each color, the closer to green the better the accurate the CAD model (i.e. Green, yellow and Light blue means perfect while Red and Dark blue means far away from the scanned model).

➢ *Final Product and Original Scan*

Snap shots of final model and scanned one are shown in addition to the comparing scale:

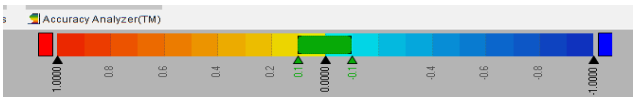

Fig 4:- Accuracy Analyzer scale

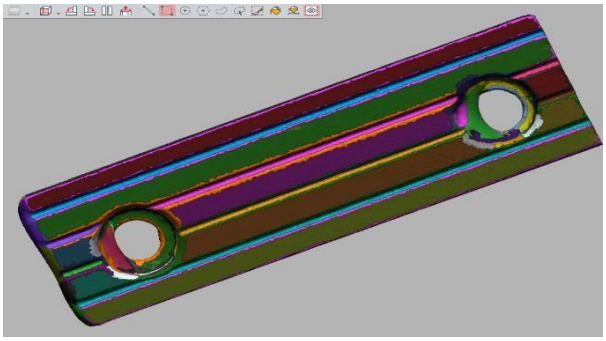

Fig 5:- Scanned model in GDX (Top)

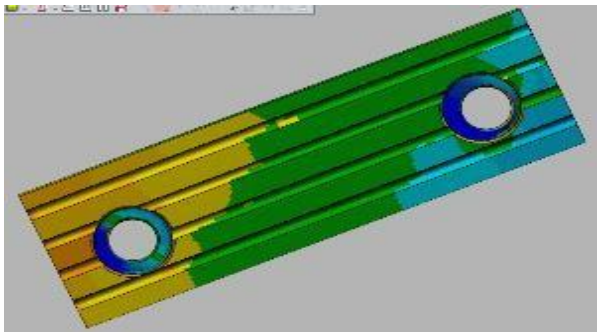

Fig 6:- CAD model in GDX (Top)

ISSN No:-2456-2165

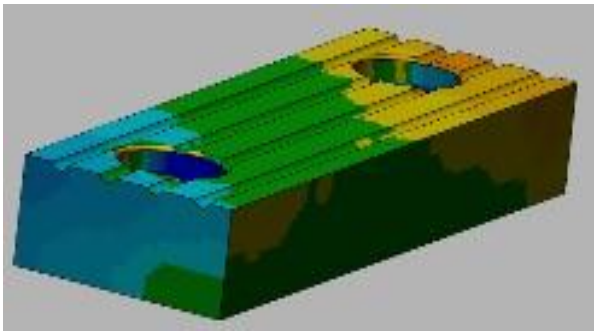
Fig 7:- CAD model in GDX (Right)

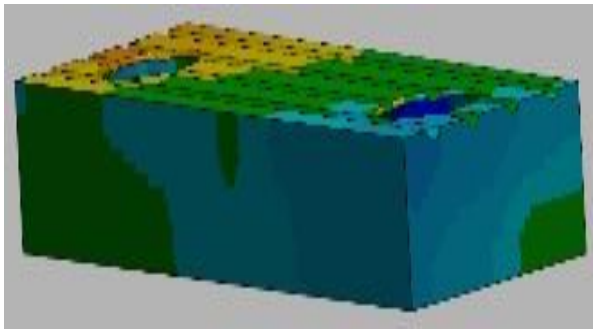
Fig 8:- CAD model in GDX (Left)

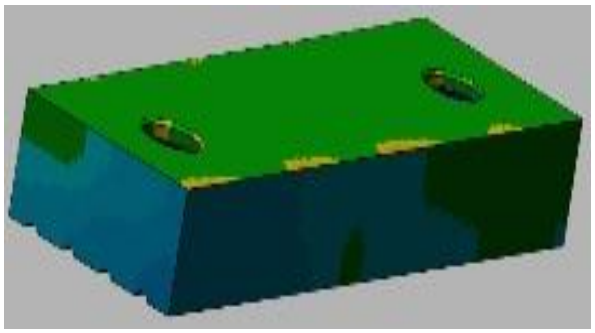
Fig 9:- CAD model in GDX (Bottom)

➢ *Level of accuracy*

Our CAD model is very good compared to the real object. Most parts in Accuracy Analyzer were colored Green which means great accuracy in these parts. Other parts were yellow or light blue and according to the scale, they are very close to the green which means that they are almost perfect. Inside the counter boreholes there are very small Dark blue regions which indicate bad accuracy, and the reason is that the real object's surface finish is not perfect and has some ups and downs.

VIII. CONCLUSION

In this paper work, a small rectangular object with two counter boreholes and semi-circle lines on top was chosen to apply Reverse Engineering.

Artec Space Spider Scanner was the device used to scan the object and its features, and with the help of its software Artec Studio 12, we were able to prepare the scan and convert it to STL file.

Geomagic Design X software was used to extract the features from the scan and clone it using its high quality tools.

The CAD model's accuracy was analyzed then using a tool in Geomagic Design X called Accuracy Analyzer. It is found that the CAD model is almost perfect and copies the features of the scan exactly.

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