Knee Joint Modeling using Laser Scanner Technique

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Abstract

Knee joint is the most important joint in the human body. 3D CAD modelling is the most important part for analysis Reverse engineering is one of the process by which 3D CAD model can be easily generated. Different techniques available for generating CAD models. The paper describes the methodology applied in the development of an anatomically detailed three-dimensional knee model from 3D laser scanner machine. 3D laser scanner machine is used for generating CAD model which requires 3D solid model as an input. It is made of box type and then solid model id kept on platform provided in box. Laser rays are applied on the periphery of the model and return time of the laser is calculated by which the model is generated on monitor screen.

Keywords- 3D CAD model, Laser Scanner

I. INTRODUCTION

The knee is the largest joint in the body and it is also one of the most complex joints. The knee joint is made up of four bones: femur, tibia, fibula and patella. The articulation of these bones forms the knee joint, and is shown in Figure 1, which is adopted from website http://www.aclsolutions.com/default.php. The two major articulations within the knee are the tibia-femoral and patella-femoral joints.

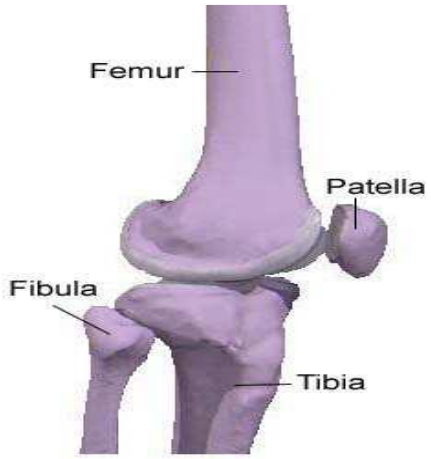

Fig. 1: Knee joint

A. Reasons of RE

There are various reasons why this reverse technology is used.

- The main reason of using this reverse technology is to compress product development time. In this fast paced competitive global market, manufacturers are constantly seeking new ways to shorten times to market a new product. By using this reverse engineering, a three-dimensional product can be quickly confined in digital form, re-modeled, and exported for rapid manufacturing.
- It is also used if there is inadequate documentation of the original design. It is used if the original documentation is lost or never existed.
- This reverse engineering is used for the reason to strengthen the good features of the existing products and work on the bad features. It is also used to analyze the good and bad features of the competitors' products.
- If you will gain the knowledge of other's products then you can be more competitive with others by coming up with the latest advanced features.

B. Reverse Engineering Differs From Other Types of Engineering

1) Forward-Reverse Engineering

Engineering is the profession involved in designing, manufacturing, and maintaining products, systems, and structures. The whole engineering process can be broadly classified in two groups; forward engineering and reverse engineering.

Forward engineering is the traditional process of moving from high-level abstractions and logical designs to the physical implementation of a system.

The process of duplicating an existing component, subassembly, or product, without the aid of drawings, documentation, or computer model is known as Reverse engineering.

Reverse engineering can be mainly viewed as the process of analyzing a system to identify its components and their inter relationship to create representations of it in another form or a higher level of abstraction. An important reason for application of reverse engineering is reduction of product development times. In the intensely competitive global market, manufacturers are constantly seeking new ways to shorten lead-times to market a new product. For example, injection-molding companies must drastically reduce the tool and die development times. By using reverse engineering, a three-dimensional product or model can be quickly captured in digital form, re-modeled, and exported for rapid prototyping/tooling or rapid manufacturing.

C. Different Reverse Engineering Techniques

There are mainly two types of reverse engineering techniques.

1) Contact type (CMM)
2) Non-contact type (Using software (MIMICS), laser scanner, online technique etc.).

In contact type technique, Coordinate measuring machine (CMM) is used to measure outer dimensions of the geometry and from that geometrical data 3D CAD model is generated.

In non-contact technique, there are different software like (MIMICS, XOR etc.), laser scanner machine and online techniques are available to generate 3D CAD models using CT scan data of the patient.

II. PROCEDURE TO GENERATE MODEL

A. Set Up of Scanner LPX-60

The Laser-Picza is a series of desktop 3D laser scanners that allow you to scan a model from all sides. As these are non-contact scanners, the process is much quicker than with the mechanical Picza scanners. Model LPX-60 is the successor of the successful model LPX-250. Most important improvement is the higher accuracy due to the more stable construction of the machine.

LPX-60 was used to generate point cloud data of knee joint model and that point cloud data was imported into Rapid form XOR2 software to generate baseline model of hip implant.

B. Rapid form XOR2

Rapid form XOR2 is the first software solution that allows users to go from 3D scan data to a fully parametric CAD model (COMPLETO A. et al., 2009). While traditional 3D scan data processing software has focused solely on improving the tools for optimizing polygon mesh models or generating high quality NURBS surfaces from 3D scan data, the needs of those who require parametric CAD model from 3D scan data have been largely ignored. XOR has key benefits; Automatic point cloud/mesh healing & cleaning, Hole filling with high curvature continuity, Automatic extraction of 2D/3D design features from mesh, Faster than any other reverse engineering approach. Rapid form XOR addresses the limitations of existing 3D scan data processing software by complementing its mesh modeling and NURBS surfacing capabilities with newly developed CAD modeling capabilities, providing users with the tools to go from 3D scan data to a parametric CAD model.

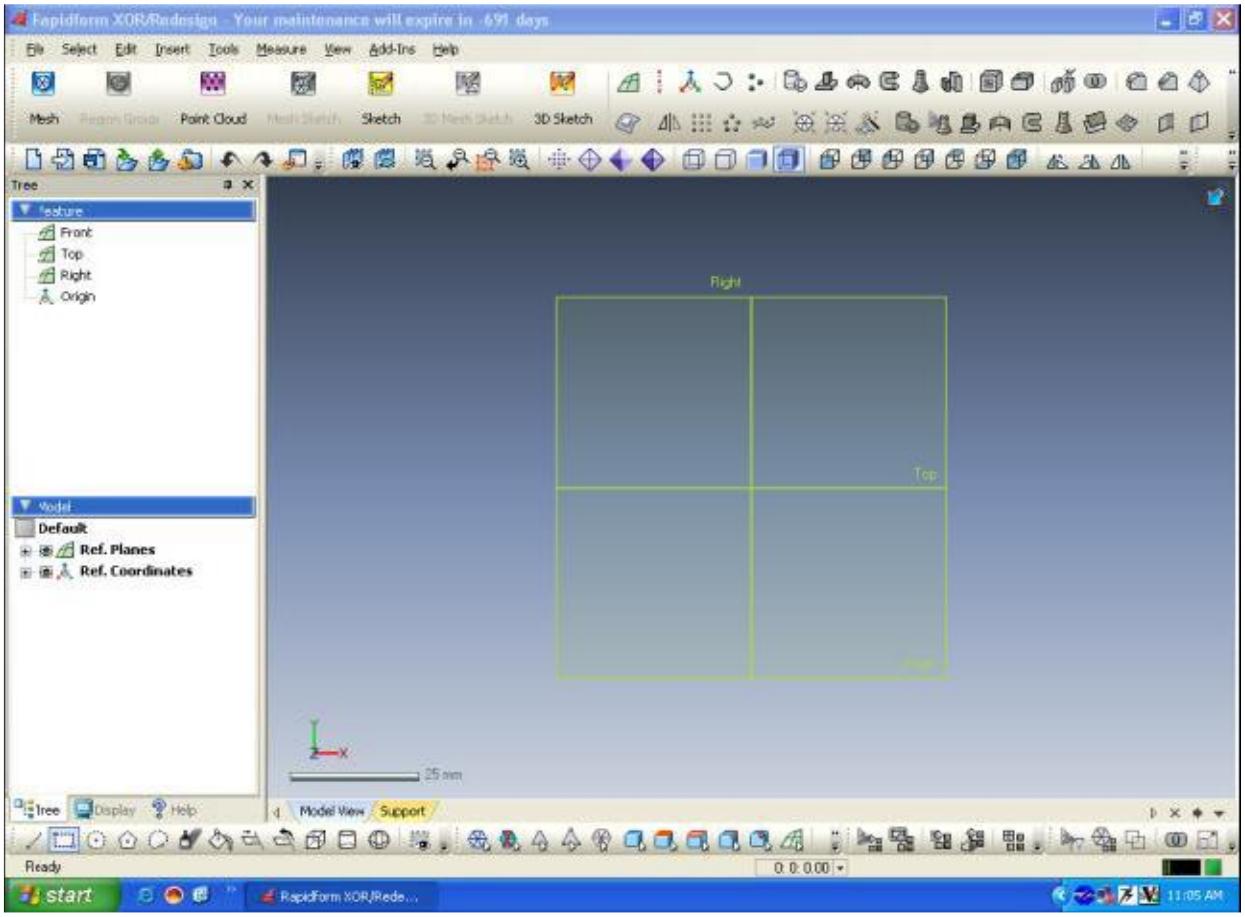

Fig. 2: Starting window of rapid form XOR2

Starting window of Rapid form XOR2 is shown in the fig. 2.7. Creating a parametric CAD model from 3D scan data allows users to fully realize the value of 3D scanning. Rapid form XOR2 features a set of tools designed specifically to address the unique requirements of reverse engineering, ensuring that the final redesigned model is built within user-defined tolerances.

III. PROCEDURES

In this technique the artificial model is taken and this model is put into the machine called 3D laser scanner. The different parameters like rotation angle, axial distance and number of planes are chosen. More the number of planes more time are required to generate model. I have chosen 8 planes and rotation angle 50 degree. The model is placed on the middle platform of the machine. Laser rays are transformed on the surfaces continuously and model is rotated. At the same time the surface is generated which can be shown in the monitor screen. After complete Processing the model is shown. The model generated is in .stl format.

Fig. 3: Artificial knee joint model

Fig. 4: laser scanner machine

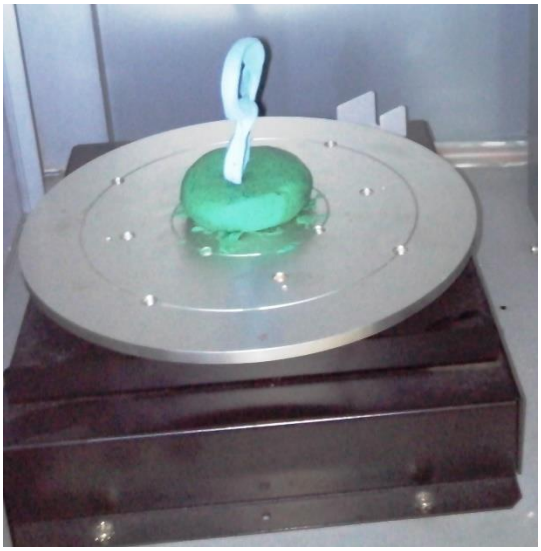

Fig. 5: Platform

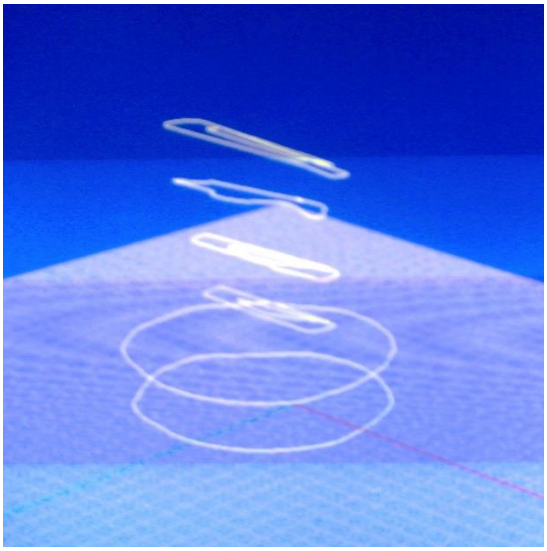

Fig. 6: surface line

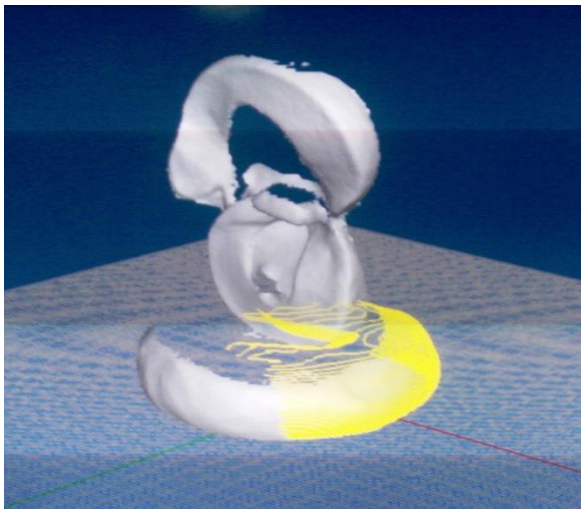

Fig. 7: Surface creation

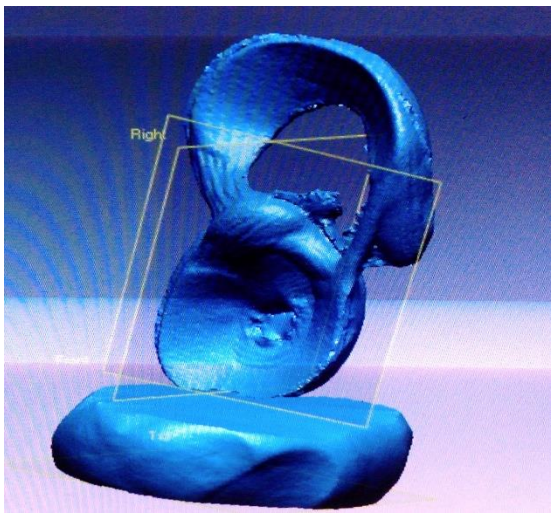

Fig. 8: menisci

C. File Format Conversion

We saw two different techniques to generate 3D CAD model. In both the technique the model is in .stl which is not supported in analysis software. So this .stl file is imported into hyper mesh or pro-E and it is exported as .iges format which is supported in ansys, abacus and hyper mesh. I have done this in hyper mesh.

IV. MODEL GENERATED VIA LASER SCANNER

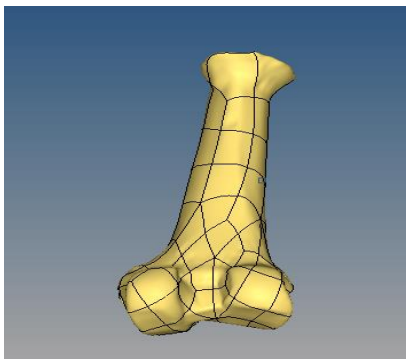

Fig. 9: Laser scanner femur

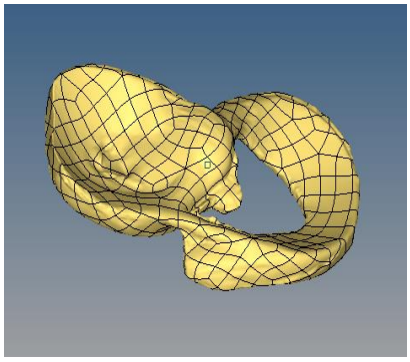

Fig. 10: laser scanner menisci

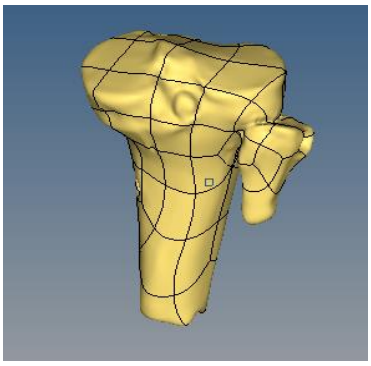

Fig. 11: laser scanner tibia & Fibula

V. CONCLUSION

From the different technique of the reverse engineering this technique gives the accurate result with the less time. The model generated by this technique can be useful for the further analysis.

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