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Reverse Engineering of Miniaturized Product: Syringe Needle

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ABSTRACT

Reverse engineering (RE) technology enables us to create CAD models of new or existing products by capturing surface data. This study presents a new method of using computerized tomography images combined with the reverse engineering technique. RE encompasses any activity that is done to determine how a product works, to learn the ideas and technology that were used in developing that product. RE can be done at many levels. A goal of a reverse engineering system is to realize an intelligent 3D scanner. In addition, it can also be applied into some recent emerging applications such as custom-made manufacture, design simulation, medical application, animation, sculpture, etc. Scanning data points, point filtering and fairing, curve filtering and fairing, surface generating, and solid modeling. This case study represents reverse engineering of needle to confirming the capacity of scanner that for how much minute product is scanned using the scanner. What accuracy is given by the scanner? In this paper for scanning the needle the whitelight scanner is used. This scanner is used because of high accuracy and fully automated.

Keywords: Reverse Engineering (RE), Miniaturized product (MP), 3D scanner

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1. INTRODUCTION

Reverse engineering is the method that reconstructs CAD models from physical models. The main process of reverse engineering consists of data acquisition, data pre-processing, surface fitting, and making a CAD model. In reverse engineering, we mainly handle point data of the surfaces of a model acquired by measuring devices such as CMMs or 3D laser scanners. Usually a complex freeform shape model cannot be represented by a single patch; therefore, it must be divided into several less complicated surfaces. Reverse engineering starts with measuring an existing object using a laser scanner, and then the measuring data is used to construct a surface or solid model [1]. There are several application areas of reverse engineering. One area of application is aesthetic design in the automobile industry where designers compare real 3D objects with a clay or wooden model. Another important area of application is to generate customized human surfaces, for mating parts including space suits, helmets, etc.
RE encompasses any activity that is done to determine how a product works, to learn the ideas and technology that were used in developing that product. RE can be done at many levels.

1.2 What Is Reverse Engineering?

Reverse Engineering (RE) techniques RE encompasses many engineering approaches in which an existing product is investigated either prior to or during the reconstruction process. In addition, it can also be applied into some recent emerging applications such as custom-made manufacture, design simulation, medical application, animation, sculpture, etc. Scanning data points, point filtering and fairing, curve filtering and fairing, surface generating, and solid modeling. This traditional reverse engineering procedure has several disadvantages, such as a complicated procedure which requires a large amount of time for manual operation. It is difficult to derive a piecewise smooth and continuous model automatically from a discrete data set. The direct application of this method to real cases is limited because of lack of cost efficiency and accuracy [2].A goal of a reverse engineering system is to realize an intelligent 3D scanner. This means that based on a discrete scanning point cloud, CAD models must be generated which not only represent the original parts approximately, but clearly reflect the underlying structure of the object [5]. The most important thing is to apply the reverse engineering technology of 3D copying and 3D scanning [6]. A 3D copier or 3D scanner reproduces a 3D component. This is similar to a 2D photocopier taking a piece of paper and producing a copy just like the original one.
Procedure of RE may consist of three major phases:

(1) Digitizing the physical object with measuring devices.
(2) Obtaining a shape model of the measured object in the form of a geometric model.
(3) Realizing the geometric model with NC machining or rapid Prototyping.

The existence of geometric models provides enormous profits in improving the quality and efficiency of design, manufacture, and analysis. In reverse engineering (RE), the shape of a three-dimensional (3D) physical object is scanned using 3D position scanners such as coordinate measuring machines (CMMs), laser-based range finders, optic-based scanners, and so forth. Then the scanned data are turned into a description for computer-aided design (CAD) or transferred into computer-aided manufacturing (CAM) like rapid prototyping (RP) or NC milling to make the 3D replicas of the scanned objects. A number of RE applications have been widely investigated [5]. RE encompasses many engineering approaches in which an existing product is investigated either prior to or during the reconstruction process. In addition, it can also be applied into some recent emerging applications such as custom-made manufacture, design simulation, medical application, animation, sculpture, etc. RE procedure generally consists of three fundamental steps: data capture, data process, and model manufacture. Firstly, the data capture is to scan the surfaces of a target physical part in order to take a point cloud by appropriate 3D scanners. Secondly, the scanned point cloud must then be refined and edited with the point- or polygon-based technologies in the data processing step, such as sampling, triangulating, aligning merging, hole filling, smoothing, etc. Finally, the model manufacture is the process of creating CAD models or physical replicas from the refined polygonal data. Therefore the relative orientation between the scanner and the needle model needs to be changed several times.
A goal of reverse engineering system is to realise an intelligent 3D scanner. This means a that based on a discrete scanning point cloud, CAD models must be generated which not only represent the original parts approximately, but clearly reflect the underlying structure of the object . The most important thing is to apply the reverse engineering technology of 3D copying and 3D scanning . A 3D copier or 3D scanner reproduces a 3D component. This is similar to a 2D photocopier taking a piece of paper and producing a copy just like the original one.
The main research area of reverse engineering focuses on two methods: the edge-based method and the face-based method . The sequence of the edge-based method is data acquisition, preprocessing, segmentation, surface fitting and creation of the CAD model. In the data acquisition phase of the edgebased method, the main

procedure of the method is the geometric part of reverse engineering. Data structures for representing shape can vary from point clouds to complete boundary representation models. However, there exist several problems such as accuracy, accessibility and occlusion. For any sensing system, the accuracy of measuring data depends on camera positions and orientation. An important issue of scanning data is accessibility. Another problem is occlusion, that is, blocking the scanning medium owing to shadowing or obstruction.

1.3 Necessity of RE in case of minute product.

For confirming the capacity of the scanner. Reverse engineering technology has become a practical tool to create a three-dimensional virtual model of an existing physical part. The reverse-engineering process needs hardware and software that work together. The hardware is used to measure an object, and the software reconstructs it as a 3-D model.

High degree of Precision for wide range of surfaces as compared to manual measurements.

Quicker turnaround time as compared to conventional methods.

Reproduce existing machine part or object efficiently & cost- effectively.

Faster time-to-market for your products.

1.4 Specification of needle:

Needle size: 0.60X25mm

Length : 21g

Nominal O.D:0.813mm

Nominal I.D:0.495mm

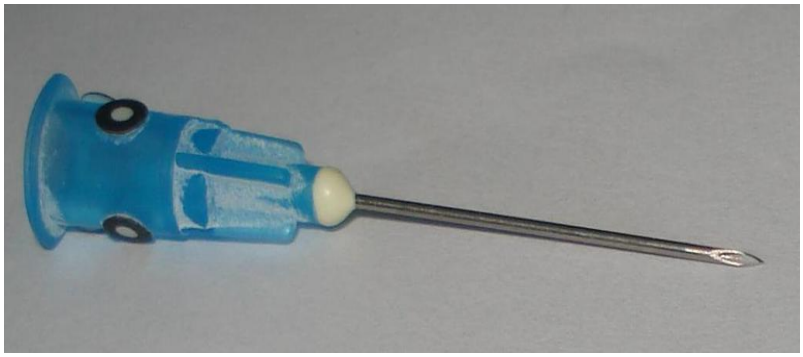

Figure 1.1: Syringe Needle

2. CASE STUDY OF SYRINGE NEEDLE USING WHITELIGHT SCANNER

2.1 Introduction about scanner:

Supports 20 different scanning areas. The user can select the most appropriate scanning area for the object to measure. One set of lenses included in the basic package supports 4 different measuring volumes. The supplied software handles up to 100 millions of points. The calibration process is extremely simple, and it takes only a few minutes. Together with the ARX 300/600 automatic motion system, is a powerful automatic scanning system. A wireless remote controller enables the user to control. It increases user-friendliness and reduces the scanning time when the user is measuring large objects. Is actually as easy to use as it looks Automated Scan Compact size: appropriately sized that it fits into the desk space, genuinely portable its accuracy & scan data quality is as good as the high-end white light scanner can get reasonably priced.

Figure 2.1: White Light Scanner

Blue LED
Integration of Controller & Sensor in one body
2.0 Mega pixels, Twin camera
Portable size : 400 x 110 x 210mm

2.2 Features:

2.2.1 Automatic scanning & Active sync.

3D scanning does not always take lots of work .With just a single click of a button, users can get their whole object scanning done very easily and quickly. A mouse click away for actively synchronizing the model and camera views, enabling users to recognize any scanning position and to add more scans where it may be needed.

2.2.2 No targets or manual alignment needed

Targets are no longer in need for your scanning job. Using the pre-calculated information of the axis calibration, accurate alignment is carried out without the need for targets or manual registration.

2.2.3 Ease of scanning path generation

Depending upon the complexity of the scan object, it may require a different scanning path. Flexibility of the scanning path generation makes it easy for users to make their own scanning path, allowing repeat data collection on various object sizes and shapes.

2.2.4 Automatic calibration

Once the calibration panel is installed, clicking the calibration wizard will guide you through an automated calibration process. The whole calibration process may have been essential, but difficult for you to do before. Now user-friendly system that allows the automated calibration for every user.

2.2.5 Detachable

In most cases will do all the scanning jobs automatically. What if you're in need of scanning objects that are smaller and precised than what you've been normally scanning on? You can easily detach the scanner sensor from, and can still proceed with all the scanning needs by having it installed on either a tri-pod or stand.

3. PROCEDURE OF REVERSE ENGINEERING:

3.1 Automatic calibration

The first step is to calibrate the scanner for scanning of the syringe needle. Once the calibration panel is installed, clicking the calibration wizard will guide you through an automated calibration process. The whole calibration process may have been essential, but difficult for to do before. For the detection of cracks developer spray is used.

3.2 To Generate point cloud data:

The orientation of the scanned data might not coincide with the coordinate system. For the sake of convenience to construct the product model, the orientation of the scanned point clouds should be regulated to coincide with the coordinate system. The regulating procedure is specified as follows.

(1) Construct three fundamental planes at origin.
(2) Select a flat part of the point cloud as a reference plane.
(3) Stick the point cloud on one of the fundamental planes constructed

The second step is to generate point cloud data acquired fro the needle which is placed on the rotary table. The method is based on the EZ scan software is used for data registration technique, and requires a user input of choosing two subsets, A and B in the point cloud that possess an approximate symmetric property.

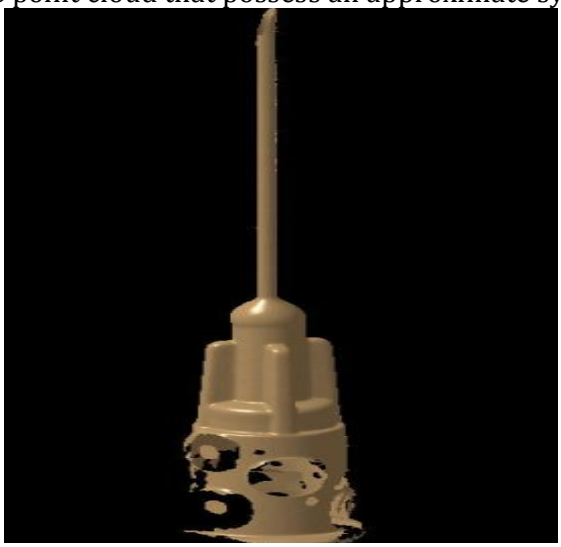

Figure 2.2: Scan Data of Needle

3.3 Create the CAD model:

Although, a point cloud acquired from a symmetric object does not have exact symmetry planes in the mathematical sense, the data usually carries adequate symmetric information for reverse engineering. The raw scanned data acquired using the scanner are not well suited for direct use in further downstream engineering activities. Hence high quality polygonal modules for processing digital geometry information are essential in RE application. To generate a CAD model satisfying the original aesthetic and functional design, it is essential to extract approximate
symmetry planes. So that after getting the point cloud data of the needle then we generate the CAD model of the needle by using the CAD software CATIA .The CAD model is the final part of the Reverse Engineering.

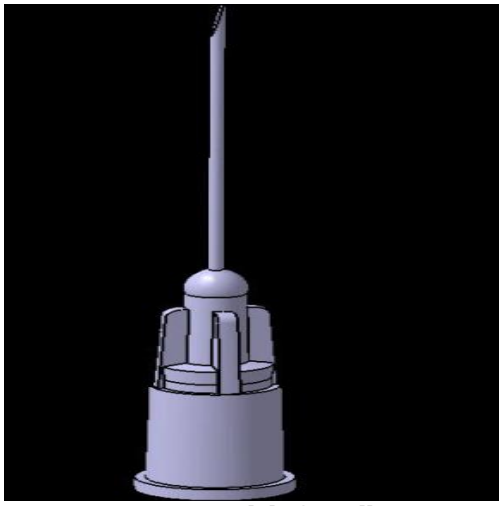

Fig: CAD model of Needle.

4. CONCLUSION:

This paper represents Reverse engineering which is a development method that uses information about an existing entity to produce a new entity that has some of the same properties of the existing entity.

In this paper Reverse Engineering is applied on the miniaturized product. For that we use the syringe needle as a case study. The miniaturized needle is scanned using the normal scanner and then modeled using CAD software. Thus any minute product can be studied by reverse engineering process and we can achieve accuracy by applying RE to any micro product.

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