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A New Approach of Composite Surface Reconstruction Based on Reverse Engineering

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Abstract

Reverse engineering technology plays an important role in reconstruction of a surface. It significantly reduces the reconstruction time and the costs of the part duplication. This paper presents a new approach to the reconstruction of a surface. The proposed methodology finds the basic parts of the surface and blends surfaces between them. Each basic geometric part is divided into triangular patches which are compared using normal vectors for face grouping.. Each basic geometric surface is then implemented to the infinitive surface. The infinitive surface's intersections are trimmed by boundary representation model reconstruction. The proposed methodology has several advan tages such as computational efficiency and automatic functional modelling in reverse engineering. Reverse engineering should be the 3D equipment of the photocopying process.

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Key words: Planar face; CAD/CAM;Reverse engineering

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.

The benefit of CAD/CAM is that the existence of computer models provides opportunities for improving the quality and efficiency of a design and is convenient for manufacture. 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].

Although reverse engineering technically does not include the machining process as one of its stages, an evaluation of the part dimensional accuracy after machining was nonetheless performed. Machining

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provides a physical model which can be compared easily to the original part, since better visualisation and measurement is possible. In addition, actual machining of the parts using CAM software establishes a foundation for the second phase of this project, i.e. reverse engineering and CAM system integration.

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 customised human surfaces, for mating parts including space suits, helmets, and so on. scanning data points, point filtering and fairing, data reduction, curve filtering and fairing, surface generating, and solid modelling. 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 realise 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.

The main research area of reverse engineering focuses on two methods: the edge-based method and the face-based method [5]. 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 edge-based 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. Rioux has tried to eliminate occlusion in an optical system which can measure an object with obstacles [7]. However, noise elimination in the data sample is a very difficult task. The accuracy of the system depends mainly on the resolution of the camera, the chosen field of view, and the appropriate illumination. Even a small region of shadow in the image may cause error in the digitisation process [8]. Precise computation of curvatures is extremely difficult and the detection of smooth edges almost impossible .

The purpose is to propose a new approach to the reconstruction of a surface by generating triangular patches, comparing the triangular patches with the normal vector, categorising the triangular patches, implementing an average planar face, and trimming all the edges. The underlying assumptions of the proposed method are that most of the parts are composed of basic surfaces and many parts consist of analytical basic surfaces such as planes, cylinders, cones, and spheres. If a sweep surface is included in the basic surface, a vast range of products can be dealt with. The method consists of two steps. The first step is to generate a triangular mesh model from the measurement data and the second step is to generate solid models from the mesh model. In order to generate a sold model, the edges, faces, and their topology have to be found. Most of the previous work has tried to find the edges first, and then connect them to form faces. Identifying edges directly from the triangular mesh is very difficult because edges exist only in the mathematical world; physical objects do not have edges, and therefore, the mesh models generated from the measurement data of physical objects do not have edges. In this study, the model is constructed in the opposite way, it finds the faces first, and then obtains their edges by intersecting the faces in order to enhance robustness and accuracy.