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Curve Reconstruction of Digitized Surface using K-means Algorithm

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Abstract

The K-means algorithm has good ability to handle the large number of scanned data. It is best suited for creation a desired shape curve-likes shape for near-best approximation of the scanned data point set. It presented an approximate set of scanned data points with a simple curves or surfaces. In this paper, the reverse engineering use for scanning the spur gear using 3D laser scanner and data is stored in point cloud format. Using this scanned data, reconstructing the smooth curve is achieved by proposed algorithm in MATLAB environment. In this study, scanned geometry and curve reconstruction technique suggested and it has been demonstrated to tooth curve reconstruction of spur gear as a complex surface object. Result of methodology is helpful to recreate the 3D CAD model of scanned object, which can be improve in work efficiency and reduce the product development cycle time with the application of CAD/CAE/CAM tools.

Keywords: K-means algorithm; reverse engineering; digitized surface; spur gear tooth surface; curve reconstruction

1. Introduction

Reverse Engineering refers to the process of creating engineering design data from existing parts [1]. However the reconstructing the curves or surfaces using point set is one of the most important problems in the reverse engineering for geometric models. The use of reverse engineering in product design has markedly increased day per day. To capture the designer's intent, through reverse engineering, into an accurate CAD model is an important and fundamental step in product re-design cycle [2, 3]. As product varieties increase and life cycles shorten, it is necessary to reduce product development time becomes more critical to maintain competitiveness in the market.

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Both reverse engineering and rapid prototyping are emerging technologies through logical aspect that can play a promising role to reducing the product development time [4, 5]. The laser scanner has emerged as an effective non-contact tool for digitizing 3-D surfaces. The 3D laser scanner has further improved the scanning efficiency from the point laser scanning with white coated surface. Recently, the laser scanner has been utilized for part inspection by assessment the recreated accurate surface profile of the scanned objects. In computer graphics a large variety of geometry representations has been used for reconstruction, modeling, editing, and rendering of 3D CAD objects [6]. In recent years there has been a marked shift from using triangles to modeling primitives of object in computer graphics applications [7]. A scanned model usually contains millions of points and can be saved it in stl. Or any desired file formats [8]. Knowledge for 3D scanning actually comprises several steps, which are Considering the whole process from data collection to final 3D CAD model, a rough distinction may be made as follows:

- 3D scanning and control the scanning parameter
- Point Processing of point cloud data,
- Module selection for fitting of primitives to the point cloud,
- Creation of complex surface models,
- Recreation of 3D CAD model using any modeling software

Some of the fundamental operations performed on a freshly scanned point-cloud data set include the computation of surface normal in order to be able to illuminate the scanned object. The output obtained from some sorts of scanner devices, as commonly done for reverse engineering applications. The most common surface representation in real world applications our aim is to reconstruct the surface from the scanned data. For surface reconstruction there are two stages have been follow as surface parameterization and surface fitting. PSO is applied to determine all relevant surface data from set of 3D data points assumed to lie on an unknown NURBS surface of a certain order [9]. The any type of noise removal from the scanned parts is the tools that are registered of scanned-model into the desired level with the help of generated program or other preferable tool. These data point may be edited by inbuilt scanning software [10]. The generation of product curve profile is obtained by the k means algorithm for each point in point cloud data set and genetic algorithm method also addressed for the surface reconstruction problem [11]. There are two important distinctions from other applications where the computation of neighbors is required. First, when neighbors need to be computed for all points in the dataset. Second, no assumption can be made about scanned dataset. In this work, focus on the reconstruction of a curve from an unorganized point cloud having no ordering of the point elements using the K-means algorithm, which takes a point cloud dataset as an input and computes the k nearest distance for each point and finally produce the part profile in MATLAB environment. However, this algorithm has some limitations:

- It is not easy to determine the size of pixel of the image. For the too small pixel the point set is to be separated into several different components. If the pixel is too large, the current position axis may not represent the best approximation curve of the point set.
- In open curves, current position axis does not represent the shapes of the point set near the end points of the curve.

2. Laser scanning and spur gear setup

The 3D scanning system has been implemented with a laser beam and a motorized rotary table. The laser scanner is a stripe-type device with a rotating table and three orthogonal transportation axes. For part scanning from any direction, overall system has six degrees of freedom, out of them four degrees of freedom has for laser device and the remaining two degrees of freedom for rotary table. For better scanning and registration of captured data the spur gear correct setup process is must. The spur gear should be white coating and fixed on the motorized rotary table. Before that, each axis of the rotary table should be aligned with the axis of the laser scanner. The spur gear part will be located with a specially designed fixture and attached on the rotary table.