A reverse engineering based approach for product form design

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A reverse engineering based approach for product form design is addressed in this article. In this method, the designer makes 3D product models based on his/her ideas with polyurethane or polystyrene foam first. The data points on the surface of the product are then measured using a non-contact 3D scan device, and the point clouds for 30 cross-sections of these products are obtained based on the measured information. New shapes are further generated with two different product models using four shape blending/morphing techniques. In this manner, the designer can generate creative product that fits user's demand in a shorter time.
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Idea development and mock-up making are key works for a designer to present his/her ideas during the process of product development. Traditionally, the designers usually used Polyurethane (PU) foam or Extruded Polystyrene (EK) foam, clay, gypsum, lumber, wax and so forth to make a mock-up after the ideas were developed. Lately, designers gradually make product-models with computer and related equipment automatically instead of manually, due to the rapid progress in computer hardware as well as software. After the CAD/CAM system was ushered into the product development process, the time schedule for product development and manufacture was reduced a lot. In today's highly competitive marketplace along with technology improvement, a good product should not only satisfy consumers' physical requirements, but should also satisfy their psychological needs. If the PU or EK foam, clay or other models can be scanned with a contact or non-contact scanner to obtain their geometric information, a real 3D product model can be created. Thus, reverse engineering[1,2] is a good method for new product-form development.

We know that the acquisition of geometric information of the product is

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the first step and the most important work for reverse engineering. The accuracy of the acquired configuration data affects the surface quality of the product model directly. Therefore, how to measure and, further to take proper regulation to obtain good data points, is a very important problem to be solved[3–9].

In the application of industrial design, the material used usually affects the accuracy of the constructed model. Thus, it is very important to cut off the improper measured data and reduce the number of data points before a 3D product model is constructed, if the point clouds are obtained with laser scanner[10]. Parametric model and shape averaging are two techniques usually used in constructing 3D configuration with computer graphics[11]. If 2D configurations are considered as the cross sections of an object, then a 3D product model could be constructed with them. On the other hand, if the shapes of these 2D cross sections are changed, a new 3D product model can be created.

Evoking design ideas is a very important task for a designer in the design process. Several methods usually used for this purpose such as the brainstorming, function analysis, morphological chart, synectics, and analysis of interconnected decision area (AIDA) etc. have been proposed[12,13]. In the mean time, a few researchers proposed theories for automatic generating product forms[11,14,15]. However, they were all focused on describing the surface blending method, and seldom considered a connection with reverse engineering. A parametric shape blending method[11] was usually used for automatic product configuration generation. Hui and Li[14] proposed a 2D curve blending method, which could be used to synthesize 3D configuration by combining outlines of 2D curves. This method is started by taking the features of curves that could be used for blending surfaces and then establishing the corresponding relationships among the features. It was applied to cases for shape design. Wang[16] proposed another method for shape generation. In the related research, the configuration of a product was usually blended with a set of discrete points. Thus, the corresponding relationships between the points on different sections should be known before a product configuration is generated. In establishing the corresponding relationships between points, Chen and Parent[11] proposed a method with the shortest distance between two points, while Sederberg and Greenwood[15] proposed another physically based approach, to avoid the constructed curves crisscrossing each other during the shape blending procedure.

As for the processing of the data information, a lot of researchers have paid much attention to the studies of how to deal with the data information

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