Reverse engineering as a solution in parts restoration process

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Abstract

The main purpose of this paper is to present and describe in details the method of transformation of real life object into a discrete one, on the basis of which the creation of surface – solid computer model will be shown. The investigated object is a motorcycle front fender in 1:12 scale. Due to incorrect assembly process the part has been damaged. The only method of solution is a restoration by means of digitalization and modeling with CAD software. The finished model is 3D printed and after completeness of this stage it will be used as a spare part.

Keywords: Reverse engineering; point cloud; 3d scanning; surface design; solid design;

1. Introduction

Between the design and production processes a hard connection exists. The product after the design and CAD model creation is submitted to production. Each design is described by the proper set of characteristic properties and saved for future use. In some cases creation of the technical drawing is very complicated due to complexity of the model. It can be realized by simple transferring the CAD model to 3D printers or CNC machines. No other form of transfer of knowledge between designer and producer is possible.

Sometimes we do not have an access to this documentation. For example in the scale models, the destruction of single element forces the modeler to buy whole model set or when we want to duplicate/change own part or obtain the digital copy. As shown in this paper the restoration process by means of 3D scanning and 3D printing allows on to reproduce single elements.

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3D scanning is a technique which uses a combination of a (white, green, blue) light source with high intensity and a detector with cooperation of complex software in order to recreate a shape of an object. The scanned element is being converted into a point cloud (or triangle mesh) on the basis of which the further restoration process can be done. Based on the obtained point/triangle cloud [1] the use of CAD tools for the recreations of a shape and all additional features such as color and texture are done. This process can be called reverse engineering or back engineering. The reverse engineering is a method of analysis of a components aiming at creation of a copy or its documentation. The main disadvantage of a 3D scanning process is that the part of a data (details of an original element) can be irreversibly lost. All lost features must be recreated by the CAD designer (shapes, curvatures, details) as faithfully as possible. The designer uses surface modeling technique [2] to recreate an external/internal form of an object. Later on the creation of a hybrid model [3] is done (combination of surface and solid structures) on the basis of which the final details are being added. In the similar way an upgrade of a part design can be obtained if the original technical drawings are unreadable, unreachable or lost. In this paper a restoration technique of a damaged fender part in 1:12 scale from Ducati Panigale model produced by Tamiya [4] is presented. The use of CAD programs such as Mesh3D [5] and CATIA [6] are shown with detail descriptions (verbal and graphical) as well as final view of a restored object.

2. Digitalization and modeling

The discussed object is a very small part with overall dimensions: 1cm – 2cm – 3cm and approximately 1 mm thickness (Fig 1a). It is worth noticing that the front fender is created by gluing two symmetrical parts (Fig. 1b).

![Molded part (a) and front fender assembly views (b) [4].](image)

Later on it is prepared for painting (puttying, priming, final color coating) and installation. The molds are very accurate (screws and housing connection imitations) what creates a very challenging job for the scanner operator and CAD designer.

In the digitalization process the Scan3D Universe (Smarttech3D company) scanner has been used with parameters presented in Table 1.

<table>
<thead>
<tr>
<th>Measurement Method</th>
<th>Parameters</th>
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<td>Simple scanning</td>
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<td>Full scanning</td>
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The equipment allows one to use one of the following measurement methods:
- simple scanning of an object placed (at least partially) in the measurement space,
- full scanning with a rotary table,
- full scanning with tags.
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