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Additive manufacturing of fixture for automated 3D scanning – case study

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Abstract

Additive technologies have their place in process of making new parts, from idea to final product. First step in all additive manufacturing is the development of a 3D CAD model which can be made by 3D modeling in any CAD software or 3D scanning and reverse engineering. When scanning parts in automated measuring cell on rotation table, some kind of fixture or jig is needed to keep part in place. Thin-wall plastic parts tend to deform under effect of their own weight or if they are pressed to tight in fixture. This paper shows case study of developing of 3D CAD model of fixture that holds parts during automated 3D scanning for large number of same parts. Also this special fixture that holds part with its geometry in place is made with additive technology, which enables production of complex geometry with lower costs of production because you need for each product special fixture, which in most cases is impossible or difficult to produce using conventional methods.

Keywords: 3D modeling, additive manufacturing, scanning, special fixture

1. Introduction

More and more complex geometric shapes, including freeform surfaces, are adopted for the design of products to emphasise styling or aesthetics. Modelling of these products is extremely difficult, and often impossible. Reverse engineering is an emerging technology that can resolve this problem by generating CAD models from the physical mockups or prototype models. [1]

The purpose of reverse engineering is to manufacture another object based on a physic and existing object for which 3D CAD is not available. When the product has free formed surfaces, 3D scanning technology can be used to obtain point cloud of existing object. With the help of the point cloud, 3D CAD model can be developed, which will be used for manufacturing. Reverse engineering is a kind of engineering which takes advantage of an already created object. The final purpose is to create another object similar to the existing object. Getting this is essential to get information about the physic object. Reverse engineering can be applied in different fields and industry. [2, 3]

For reverse engineering 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 scanning. [4]

3D scanning is a method which allows us transferring scanned points from space to CAD software and to utilize them. There are more types of digitizing devices that allow this transfer. Main types are: optical, laser, contact, destructive. Fastest and in machine industry most used are laser and optical 3D scan devices. These devices allow us to scan shapes of the real parts with machine industry precision demands. [5]

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2. Additive manufacturing

When it comes to scanning products with large dimensions, but also small products with complex geometry it need to be scanned from several positions. When scanning parts in automated measuring cell, this is achieved in some cases on rotation table, but it is necessary to have a special fixture to hold product and that allow scanning without deformations in the scanned model. This deformations are especially noticeable in the thin-walled products. Such fixture can be used for multiple scans of the specific product.

There is more than one way of using fixtures: as a measurement fixture, checking fixture or climate fixture for both tactile and optimal measurements. [6]

But the question is how to produce such specific fixture in short time with a small cost of production. In the case of polymer fixture, when using conventional processes, in most cases we need mould. But when we need only one fixture with specific geometry costs are too high if we use a conventional process.

Thanks to additive manufacturing production it is possible to produce complex functional products in short time (Fig. 1). Principles of additive manufacturing processes enable easy production of even the most demanding geometric shapes without a substantial increase in production costs. It can therefore be concluded that the justification for the application of additive manufacturing processes increases with the complexity of the product. [7]

The task of every manufacture is to produce items of highest possible quality, with the best possible performance characteristics, lower price, appealing design and realizing maximum yield.

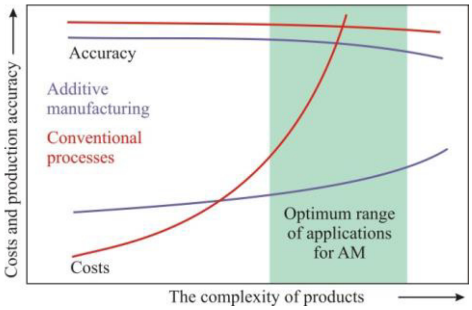

Fig. 1. Justification of additive manufacturing application [7]

Since the production processes significantly change the initial material properties, an essential criterion for the selection of the material is technologicality. Structural design, selection of material, and selection of the production processes are inseparable and related activities. The production must ensure the desired quality for the given material, shape, dimensions, surface quality, tolerances of the product at minimal costs and time of production. For the production of the fixture PolyJet processes have been selected.

PolyJet (mesh of nozzles) procedure combines the upsides of stereolithography (SLA) and 3D printing. [8] (Fig. 2).

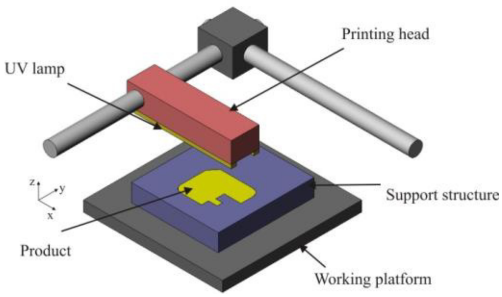

Fig. 2. PolyJet process [9]

The mesh of nozzles slides back and forth in the direction of y – axis and applies / prints the layer of photosensitive polymer material on the working platform, of 16 μm thickness, which is about 1/5 of the thickness of the stereolithographic layer. Every layer of the photosensitive polymer solidifies under the action of UV light, immediately upon printing, creating a completely cross-linked product, without subsequent crosslinking. Two different materials are used: one for the model and the other as