

Chapter 13

The Use of the Terrestrial Photogrammetry in Reverse Engineering Applications

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ABSTRACT

The reverse engineering applications has gained great momentum in industrial production with developments in the fields of computer vision and computer-aided design (CAD). The reproduction of an existing product or a spare part, reproduction of an existing surface, elimination of the defect or improvement of the available product are the goals of industrial reverse engineering applications. The first and the most important step in reverse engineering applications is the generation of the three dimensional (3D) metric model of an existing product in computer environment. After this stage, many operations such as the preparation of molds for mass production, the performance testing, the comparison of the existing product with other products and prototypes which are available on the market are performed by using the generated 3D models. In reverse engineering applications, the laser scanner system or digital terrestrial photogrammetry methods, also called contactless method, are preferred for the generation of the 3D models. In particular, terrestrial photogrammetry has become a popular method since require only photographs for the 3-dimensional drawing, the generation of the dense point cloud using the image matching algorithms and the orthoimage generation as well as its low cost. In this paper, an industrial application of 3D information modelling is presented which concerns the measurement and 3D metric modelling of the ship model. The possible usage of terrestrial photogrammetry in reverse engineering application is investigated based on low cost photogrammetric system. The main aim was the generation of the dense point cloud and 3D line drawing of the ship model by using terrestrial photogrammetry, for the production of the ship in real size as a reverse engineering application. For this purpose, the images were recorded with digital SLR camera and orientations have been performed. Then 3D line drawing operations, point cloud and orthoimage generations have been accomplished by using PhotoModeler software. As a result of the proposed terrestrial photogrammetric steps, 0.5 mm spaced dense point cloud and orthoimage have been generated. The obtained results from experimental study were discussed and possible use of proposed methods was evaluated for reverse engineering application.

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1. INTRODUCTION

In recent years, 3D information modelling has made great progress with the help of the computer visualization. Today, computer-aided design has been widely used in 3D city models, building information modeling, 3D geographical information system (GIS), and integration of 3D information in the urban built environment and industrial production. In modern industrial production, the 3D model generation is the first step for mass production of an object. In this step, the object transferred to the computer environment and then 3D CAD model is created.

The reverse engineering is comprehended if the object is exist or produced before and recreation of existing product or its part is required. The reverse engineering includes the fast production steps of an existing product or its part. Nowadays, reverse engineering has been used successfully in many different applications such as; mold manufacturing for production, reproduction for machine or its part, adding new functions or upgrading functions for existing product, maintenance, performance analysis, and re-vamping of an industrial installation, production of historical ship models, remodeling and restoration of historical and cultural old buildings, modeling and restoration of archaeological sites and remains etc. (Cheng & Jin, 2006; Fernández-Hernandez et al., 2012; Gerbino et al., 2004a; Górski et al., 2010; Koelman, 2010; Menna et al., 2011; Menna & Troisi, 2010; Tangelder et al., 2003). Especially in recent years, advances in 3D printer technology are contributed to production of prototypes of the objects which have 3D CAD model (Cavagnini et al., 2008; Górski et al., 2010).

Digital terrestrial photogrammetry has been used successfully for many years in the documentation of historical and cultural heritage property and 3D modeling (Emem et al., 2002; Emem et al., 2004; Yastikli, 2007; Yastikli & Alkis, 2003; Yastikli et al., 2007; Yastikli & Guler, 2013). As mentioned earlier, the first step in reverse engineering application is the generation of object metric 3D model in computer environment. In this step, digital terrestrial photogrammetry is successfully used for the creation of 3D models of the existing objects. The terrestrial laser scanner systems is the another system which is used in reverse engineering for 3D modelling (Opitz et al., 2012). Most of the time, terrestrial photogrammetry is preferred because of image based system which includes low cost digital cameras and software. Especially recent image matching approaches such as dense image matching algorithms (Gehrig et al., 2009; Haala, 2013; Hirschmüller, 2008; Hirschmüller et al., 2012; Hosseininaveh Ahmadabadian et al., 2013; Remondino et al., 2013; Remondino et al., 2014), produces more dense point cloud in comparison to the terrestrial laser scanners. The terrestrial photogrammetry became more common in reverse engineering applications with the help of the recent improvement in image matching approach.

In this study, we aimed to generate dense point cloud and 3D line drawing of the ship model at 1/15 scale by terrestrial photogrammetry method for the production of the ship in real size as a reverse engineering application. For this purpose, an overview of the reverse engineering application, processing steps and procedures are presented in the sections to follow. The experimental study which is presented in Section 3 provides the technical information about proposed dense point cloud and 3D line drawing process with terrestrial photogrammetry. The result of the experimental study is discussed, and possible use of terrestrial photogrammetry for reverse engineering application is assessed.

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