Research of Ship Shaft Three-dimensional Point Cloud Completion through GAN Inversion

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ABSTRACT

The quality and duration of the ship’s construction have an impact on the efficiency and precision of the propulsion shafting alignment. A ship’s shaft system alignment requires precise positioning parameters. The ship’s shaft system’s installation area is, however, extremely constrained, and the model created by scanning is frequently a partial point cloud shape from which precise positional data cannot be determined. Most techniques for 3D shape completion are learnt through supervised learning. In order to complete the shape of the ship shaft system point cloud, the Generative Adversarial Network (GAN) inversion is introduced in this research. Based on a ship shaft assembly test stand, a series of point cloud data was collected to simulate an actual flange scanning situation and the data was studied using GAN Inversion to complement the data. The results were analyzed.

KEY WORDS: Point cloud data; Ship shafting; Shape completion; Generative adversarial network.

INTRODUCTION

The assembly of ship’s shaft system has always been an important part of the ship production and construction process, and its assembly quality directly affects the performance of ship navigation. Realization of intelligent assembly of ship’s shaft system is essential to improve its efficiency of ship’s shaft system. Intelligent assembly of ship shaft systems requires accurate spatial position and attitude information of the butt flange. The accurate measurement of the shaft system position is particularly important as a prerequisite for the rapid adjustment of the shaft system position. In the traditional ship shaft system butt jointing process, the offset zigzag value of the butt flange is measured by using a stopper, straightedge, or percentage table, which requires contact with the flange surface when measuring, and there are problems such as low efficiency, poor accuracy and large random error of human operation. Currently, handheld laser 3D scanners are well-used for high-precision structural measurement and positional estimation of complex parts.

Point cloud is a collection of points in three-dimensional space, denoted by (x, y, z) for each point, containing the most primitive spatial information of the target object. Point clouds are preferred over other forms of data representation for describing 3D objects due to their uniform and simple representation, high accuracy, efficiency, and flexibility. However, due to the influence of many factors, such as the resolution of the measuring instrument, the surface reflectivity of the measured object, the measurement angle of view, and the occlusion, the original point cloud generated by the optical three-dimensional measurement is often accompanied by a variety of missing, such as local hole missing, component missing, blind point cloud missing. This limits the development of point cloud representation in point cloud classification (see Goyal and Law et al., 2021), point cloud segmentation (see Nguyen and Le, 2013), scene segmentation based on point cloud (see Engelmann and Bokeloh et al., 2020), facial recognition (see Atik and Duran, 2021), object detection (see Meng and Wang et al., 2021), three-dimensional modeling (see Battulwarv and Zar-Naghadehi, 2021) and other fields. Therefore, point cloud completion is an urgent and significant task.

Point cloud completion has always been an important research topic in the field of deep learning and three-dimensional reconstruction. The 3D point cloud shape completion goals can be broadly classified into completion based on the original input point cloud to recover the geometry of the target object (see Tchapmi and Kosaraju et al., 2019) and generation of the missing point cloud based on the given point cloud (see Wu and Zhang et al., 2016). Deep learning for point clouds has become very popular in recent years, and many methods have been proposed to solve different problems in the field, but there are unique challenges in using deep neural networks to process point clouds. Point cloud has the characteristics of non-structure and disorder. First, the point cloud is a series of uneven sampling points. On the one hand, it makes the correlation between points difficult for feature extraction; On the other hand, the convolutional neural network widely used in image and video processing cannot be directly used for point cloud processing. Secondly, unlike images and videos, point clouds are a group of points without a specific order.

Since the installation space of the ship’s shaft system is very limited and there are often bearing seats and other equipment near the flange, the docking process is a small movement adjustment process, and the