

3D point cloud analysis for Objects, scenes, and building recognition and reconstruction

Amal El Fallah Seghrouchni, Omar Elharrouss

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1 Research Motivation

The development of acquisition technologies which various sensors, capturing point cloud of objects and monitored scenes become easier and with a min cost [1] . Also, the use of 3D point cloud can give efficient information on the captured objects and scenes which help many applications including objects reconstruction, automatic driving, scene scanning, etc. the novelty of the subject and the challenges of it excited researchers for finding effective methods on 3D point cloud for detection, recognition, segmentation, and reconstruction task [2]. The point cloud is basically the simplest shape of a 3D model. is a group of single points drawn in a 3D area. Every point holds several measurements, including its coordinates along the X, Y, and Z axes and additional data such as the color value, which is recorded in RGB format, and the lightness measure, which defines how bright the point is[3]. 3D point cloud has as an objective representing objects, it's growing up in a wide range of research fields. Also, for object recognition, segmentation, and reconstruction because of its simplicity, its flexibility, and its powerful capacity of visualization[4]. Working on this subject can be an added value for developing different approaches for object scenes and building recognition and reconstruction using 3D point cloud data.

2 Problem Statement

The point cloud representation is a new type of data that can be used to help many computer-aided applications. Also, it comes with various benefits in terms of data transfer cost, efficient shred data that include the multi-view data representation of objects, and the ability to reconstruct and generate the real objects from the point cloud data[5]. However, this technique can be collided by some challenges that make the analysis of data difficult and includes noisy points, blind and cluttered scenes, uncompleted parts of the objects, etc . By the following we present the current challenges that should be addressed in the proposed method:

Incomplete, noisy, and unstructured data: Using dots of XYZ coordinates can represent a 3D synthetic object, but using a sensor like Lidar these coordinates con not be perfectly represented due to the number of points (dots) captured as well as the distribution of these points. The number of points

generated can be considered as a cloud of noise while there are many objects in a complex scene. Due to the same reason, the gathered data can contain some uncompleted parts of the objects. These parts can be important for recognizing the object in order to segment it or reconstruct it.

Hard to storage and process: Lidar data that contains the information of the 3D objects represented with points in 3D space, can be massive files to store and transfer [5]. This can make these data hard to process. For training, a model with a large-scale dataset of these files is costly in terms of memory and needs high-performance machines

3 Research Scope

The aim of this thesis is to propose and develop and deep-learning-based methods to recognize and reconstruct 3D objects from 3D point cloud data. For that, a literature review should be done to understand different directions and existing approaches for 3D point cloud analysis systems. Then, proposing new deep-learning-based methods for 3D object recognition using 3D point cloud data. In addition, a collection of a 3D point cloud dataset of the historical sites using LiDAR or laser scanner to be used for the further steps. The last part of this thesis concerns using the proposed 3D object recognition to reconstruct objects, buildings, and scenes.

4 Admission Criteria

The PhD position is proposed by the International Center of Artificial Intelligence of Morocco, of the Mohammed VI Polytechnic University. Applicants with excellent cursus must be holders of a Master's, an engineering or an equivalent recognized degree in Computer Science or Applied Mathematics. In addition, they should have skills in Programming (Python and C++) and good communication skills in English. Particular attention will be given to the suitability of this research project with the applicant's background.

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