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(Review Article)

Review on 3D Point Cloud

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Abstract

A collection of multidimensional points is represented by a data structure called a point cloud, which is frequently used to describe 3-D data. A point cloud is, technically speaking, a database of points in a three-dimensional coordinate system. However, from the viewpoint of a typical workflow, the only thing that matters is that a point cloud is an extremely accurate digital record of an item or region. It is saved as a very large number of points that cover a sensed object's surfaces. 3D point clouds have drawn more and more attention as a novel way to depict objects in recent years. In this paper, a brief introduction to point clouds is given. The study provides a discussion of point clouds, point cloud data collecting, processing, and applications.

Keywords: Point cloud; 3D data; Digital record; Object; Scene; Acquisition

1. Introduction

A point cloud is a collection of data points in a certain location. Although it appears more like nD, a point cloud is actually a collection of 3D points. Pay attention to 3D point clouds, which are groups of 3D points defined by spatial XYZ coordinates and may also be given extra qualities such as intensity information, heat information, special properties, or any other abstract information. The measured or created equivalent of physical surfaces in a scene is represented by 3D point clouds.

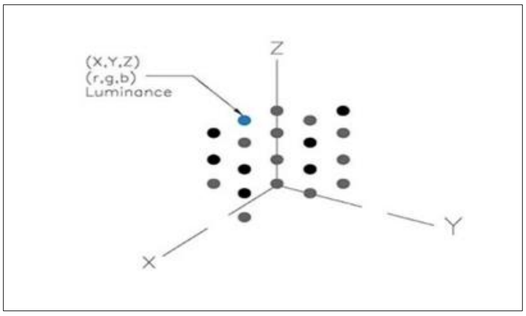

Figure 1 3D point clouds

The Points typically indicate the x, y, and z geometric coordinates of the sampled surface. When colour information is provided, the point cloud transforms into a 4D structure. Each point has the ability to hold additional information, such as RGB colours, intensity levels, etc. Point clouds are huge collections of 3D point data. Aerial LiDAR (Light Detection And Ranging) laser scanners are the most widely used techniques for collecting geographic point cloud data. The LAS (LiDAR Aerial Survey) and ASCII (.xyz) formats are the most often used for geographic LiDAR data. The LAS file format

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with a point categorization scheme was established as an industry standard by the American Society of Photogrammetry and Remote Sensing. A processed LAS file may contain points classified as barren ground, high or low vegetation, houses, etc.

Point clouds are produced using raw data scanned from real things, such as building exteriors and interiors, manufacturing facilities, topographies, and buildings. After collecting, the raw data must be converted into usable point cloud files. Autodesk ReCap transforms raw scan data into project files (RCP files), which contain several RCS files in addition to scan files (RCS files). Each of these formats is available in the AutoCAD Map 3D toolbox and can be included in your drawing. The Display Manager can then have a point cloud layer added, which gives you the option to filter the point cloud data or apply colour stylization. Buildings, roads, trees, and vehicles can all be described by point clouds, as well as things that range in size from a few millimetres to entire towns. In addition to the spatial data, they were able to add colour to every single 3D point, producing an incredibly lifelike presentation.

1	2	3	4	5	6
coord. X	coord. Y	coord. Z	Red (0-255)	Green (0-255)	Blue (0-255)
-5.084	-9.056	0.105	120	118	117
-5.076	-9.052	0.155	144	142	140
-5.041	-9.067	0.159	145	143	140
-5.101	-9.013	0.157	114	112	111
-4.986	-9.078	0.164	116	108	103
-5.108	-8.912	0.087	108	104	99
-5.094	-8.882	0.106	118	113	110
-5.093	-8.913	0.153	104	101	100
-5.086	-8.882	0.160	118	112	108
-5.070	-9.046	0.211	129	125	123
-5.035	-9.056	0.212	127	123	121
-5.079	-9.001	0.208	116	115	114
-5.038	-8.994	0.212	118	112	106
965	-9.057	0.209	123	115	112
[illegible]	-9.064	0.209	128	121	119

Figure 2 Point clouds as a set of points represent an object or a scene in a space

Point clouds are typically applied to an object to measure or compute attributes like distances, diameters, and curvatures. Point clouds serve as the basis for incredibly accurate 3D models. They are therefore a great source of information for 3D feature and object recognition as well as surface deformation analysis. Point clouds are employed in a variety of technology and application fields, including forestry, agriculture, quality assurance, and construction.

2. Acquisition of point clouds

The ability to access and see a scanned surface is essential for gathering point cloud data. Remembering that point clouds are produced by having observable access to real things is essential. Regardless of the technique of acquisition (pictures or a scanner). We cannot obtain points on surfaces that are invisible from the vantage point from which we collect data. This suggests that in order to cover all items, multiple scanning stations must be merged. In addition to the location of each point, most point cloud databases also provide descriptions of visual details like an object's colour or reflectivity.

They are a further factor that influences scan duration and may or may not be incorporated into the point cloud. Since data gathered in the form of a 3D point cloud is often not sufficient for directly resolving certain tasks, the data must then be translated to a different data representation that is a specific description and hence a function of the data. This indicates that a shift in the encoding of the data from one space to another is required. This change is specified by a function, which, depending on the task at hand, may be based on a model, some code, or an algorithm.

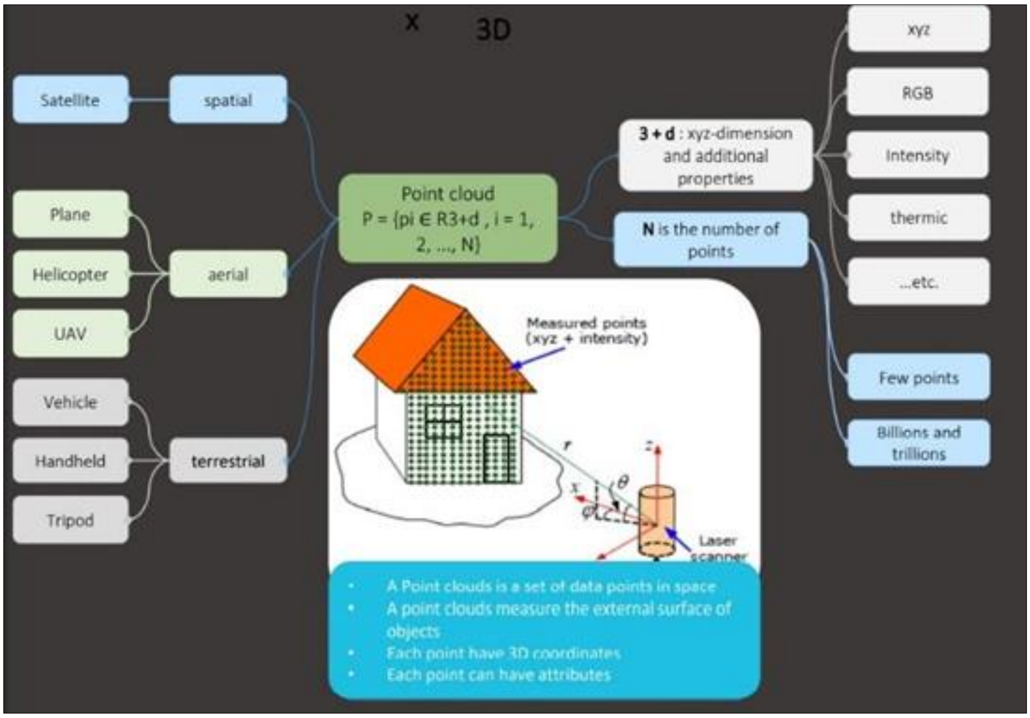

Figure 3 Acquisition methods of point clouds

For instance, it might be beneficial to try to eliminate as much information from the data as you can, retaining only what is required to complete the work or to save only the data that is relevant for a certain reason. It should be noted that this is compatible with the idea that we should keep all the data if we are unclear about the goal. These concepts can be developed further by providing a memory as a means of storing data or data representations and knowledge as a valuable tool for drawing inferences.

3. Point cloud file formats

Point clouds come in a variety of file formats, which can make it difficult to manage the raw data. The majority of formats, however, may be divided into two groups, with many of them being interchangeable and simple to convert between. While some formats are standard, others are exclusive and were created by 3D scanning hardware manufacturers.

3.1. ASCII

The American Standard Code for Information Interchange (ASCII), which uses text to exchange information, is the first main type of point cloud format. The X, Y, and Z spatial coordinates are represented by each line of text in an ASCII point cloud. XYZ, OBJ, ASC, and PTX are common ASCII extensions.

3.2. Binary

Binary is the other popular type of point cloud format, which keeps all data in binary code. Despite being more difficult to access and understand, binary data is stored in smaller files than ASCII data. The LAS, PCD, and FLS binary extensions.

4. Processing of point clouds

The four common processing techniques like data purification, data registration, data segmentation, and object recognition—are reviewed in order to examine the many approaches used to process 3D point cloud data. Several deep learning processing techniques and algorithms, including Point Nets, CNN-based, and RNN-based techniques, are employed for each processing procedure. The goal of data cleansing is to eliminate noise data from raw point cloud data. Acquired point cloud data inherently contain a variety of noise data types that are useless for the intended usage. Due to the limits of particular sensors, numerous sorts of incorrect data can also be generated. As a result, algorithms for noise reduction are needed to remove irrelevant data while keeping all relevant data. In order to align several point clouds that have been collected from various places in a single coordinate system, data registration is used. Due to the size of building sites and object occlusions, data collecting is usually necessary (particularly for laser scanning) in order to capture various areas of the target object.

Data registration refers to the alignment of these point clouds in a common coordinate system. In addition, data segmentation is carried out to divide the point cloud data into numerous useful segments or clusters. The point cloud data can be further processed by using these segments, which may represent various objects or various geometric primitives. Last but not least, object recognition seeks to identify particular objects from point cloud data. For instance, it is necessary to identify building components from point cloud data, such as walls, windows, and doors, in order to produce semantically rich 3D models of buildings.

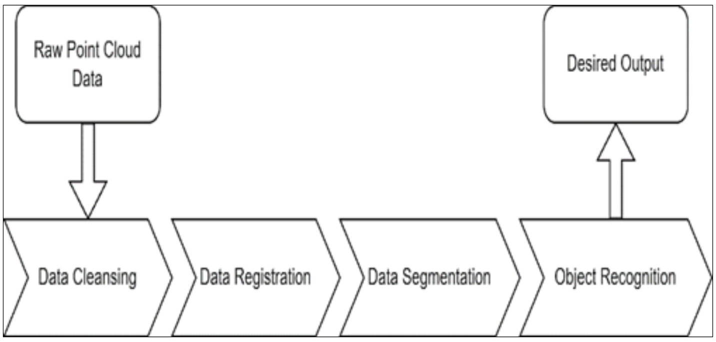

Figure 4 Typical Processing Procedures of Point Clouds Data

5. Making point clouds 3D printable

Along with 3D printing, 3D scanning is a useful tool. A 3D scanner can be used to capture a physical part; a 3D model can then be made (and changed), before being 3D printed, to produce a replica of the original part. This combination is beneficial for applications like creating spare and replacement parts. With mesh processing tools like MeshLab, point cloud data must be transformed into a triangle mesh in order to be 3D printable (free and open source). This type of software can fill in the point cloud's gaps and convert it to a format like STL, which is the preferred format for additive manufacturing. An STL file, as opposed to a point cloud, uses interconnected triangles to define a 3D object's surface geometry. Such a file can be "sliced" into G-code, which tells the 3D printer how to manufacture the part, via 3D printer slicing software.

6. Applications of point cloud

The collection, interpretation, and analysis of geological and geotechnical data now require the use of point cloud technology. In order to create 3D CAD models for manufactured parts, for metrology and quality inspection, as well as for a variety of rendering and mass customization applications, point clouds are used to create 3D meshes and other models. These models are used in 3D modeling for various fields including medical imaging, architecture, 3D printing, manufacturing, 3D gaming, and various virtual reality (VR) applications. Animation, visualization, and mass customization applications.

Autonomous vehicles that need to comprehend their surroundings and carry out simultaneous localization and mapping in real-time in order to move in the right direction and avoid obstacles find 3D point cloud data to be of particular use in healthcare, robots, self-driving cars, and assistance systems

7. Conclusion

Point cloud technology is a broad category of concepts that many researchers and businesses use to describe their work. The research, interpretation, and characterization of the site geology and rock mass attributes in open-pit and underground mines are being greatly enhanced by the high-resolution and expanding point cloud technology. Point clouds are the result of every 3D scanning technique. Your scans' digital output, whether you use a desktop structured light scanner, a handheld 3D laser scanner, or a photogrammetry setup with digital cameras, will be a point cloud. Processes are involved in the processing of point cloud data: data cleaning, data registration, data segmentation, and object recognition.

Due to their potential for being very huge and CPU-intensive thick clouds, processing the point cloud is not always simple. But, there are good software solutions, including those supplied with 3D scanning devices, as well as free tools like CloudCompare. In order to produce a 3D model that is more than just a collection of geographical data points, the majority of users will also need to execute surface reconstruction on their point cloud. The applications are numerous, ranging from 3D city mapping to animation to 3D printing, once you become familiar with point clouds and how to handle them.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors of this paper declare that there is no conflict of interest regarding the publication of this manuscript.

References

[1] Remondino, Fabio, From point cloud to surface: The modeling and Visualization problem, International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 2003. https://doi.org/10.3929/ethz-a-004655782

[2] M. Weinmann, Preliminaries of 3D Point Cloud Processing, Reconstruction and Analysis of 3D Scenes, DOI:10.1007/978-3-319-29246-5_2.Springer International Publishing Switzerland 2016.

[3] J.Lyons-Baral and J Kemeny,Applications of point cloud technology in geomechanical characterization, analysis and predictive modeling Mining Engineering Magazine, 2016 - researchgate.net

[4] Igor Bogoslavskyi, CyrillStachniss, Analyzing the Quality of Matched 3D Point Clouds of Objects,2017 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Vancouver, BC, Canada. DOI: 10.1109/IROS.2017.8206584

[5] Aleksey Golovinskiy, Vladimir G.Kim , Thomas Funkhouser, Shape-based recognition of 3D point clouds in urban environments, 2009 IEEE 12th International Conference on Computer Vision, Kyoto, Japan. DOI: 10.1109/ICCV.2009.5459471