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GIS Software for Airborne LiDAR Data

Introduction

Airborne Light Detection and Ranging (LiDAR) is an optical remote-detection method that uses laser pulses to record highly accurate xyz measurements of the Earth's surface from an airborne system (either a fixed-wing aircraft or helicopter) [1]. With current airborne LiDAR systems that are able to sample surfaces at less than 30 cm per data point, efficient Geographic Information System (GIS) software is required to process large amounts of LiDAR data into 3D images and spatial data point clouds for analysis [2]. Airborne LiDAR is currently implemented in various applications such as geography and geology, climatology and atmospheric physics, Internet-of-Things (primarily autonomous cars and drones), and military surveillance [3]. This paper is a brief review of the technology of GIS software for processing airborne LiDAR data as well as commercial applications and implementation.

Technology of GIS Software for Airborne LiDAR Data

Stored in ASCII format in the past, LiDAR data is currently stored in binary LAS format, which can be read more efficiently and manage massive amounts of data with the rise in resolution [4]. Each LAS file is a collection of data sets, which store LiDAR point attributes for each emitted laser pulse. Point attributes include pulse intensity, GPS time stamp, xyz location information, scan angle, pulse number, number of pulse returns, and surface point classification (ground, canopy, structure, or water) [5].

GIS software processes LAS datasets into point clouds to generate 2D and 3D color images with each LiDAR point assigned to its embedded RGB color value [3,6]. LAS datasets can also be imported into existing terrain datasets to generate multipoint raster datasets that are superior in both resolution and accuracy than LAS or terrain datasets. Top, commercially available GIS programs are able to process and manage huge volumes of LiDAR data points. In addition, they provide multiple analysis tools such as introducing ridgelines, running floodplain models against LiDAR points, and generating optimal point-to-point paths.

Commercial Applications of GIS Software for LiDAR Data

Offered by Blue Marble Geographics, the Global Mapper LiDAR Module is widely accepted as the best GIS software for processing airborne LiDAR data in the market. Able to access point cloud files with over a billion points, the product provides key functions such as pixel-to-point tools for creating high

density point clouds (with overlapping LAS datasets), multiple editing and analysis functions, and automatic point classification tools that automatically classify buildings, ground, canopy, and power lines [7]. The advantages of the Global Mapper LiDAR Module compared to other software are advanced filtering options to efficiently remove erroneous points and 3D digitization of data points. The Global Mapper LiDAR Module is marketed at \$499, with the Global Mapper software available for free download.

Another competing product is the ArcGIS Pro offered by ESRI. Like the Global Mapper LiDAR Module, the ArcGIS Pro is able to access large point cloud files and provide numerous LAS dataset analysis functions such as LiDAR point classification code manipulation to fix classification errors and intensity image generation [6,8]. However, the ArcGIS Pro provides more advanced statistical analysis for LAS datasets [9]. Despite this advantage, the ArcGIS Pro costs \$7,000 for single use or \$3,000 for annual subscription.

Implementation of GIS Software for LiDAR Data

When selecting a GIS software, the user should determine whether the software satisfies all of the specific needs. Most GIS software for processing LiDAR LAS datasets provide the same basic functionality such as 2D and 3D image generation, editing and analysis functions, and tools for generating point clouds. For users who only require basic functionality, open-source GIS software is recommended. However, more advanced software such as the Global Mapper LiDAR Module or the ArcGIS is recommended for users who require advanced analysis functionality such as automatic point classification tools and advanced filtering options.

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