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Principle and application of Laser Radar

Technology for tree measurement

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Abstract: High density LiDAR is a Advanced active remote Sensing Technology so can obtain high density 3 D point cloud information a Object efficient ly and quicklywith Fast , Accurate then non-contact advantages . This paper describes , measuring principle a High density LiDAR and The characteristics of 3 kinds The scanningmethods. Analysis Was conducted on the accuracy Difference between Artificial Precision Measurement and 3D Laser scanning Measurement To tree DBH andvolume by experiment. Finally , This paper discusses the future Development trend of This Technology .

Keywords: Laser Radar , forest Resources , tree Measurement

high-density LiDAR (LiDAR) Measurement Technology is an advanced Remote Sensing measurement technology , can efficiently and accurately obtain the tested target high-density three-dimensional point cloud information , with Quick , exact , not

The notable benefits of contacts , The is thus widely applied to the three-dimensional letter generate , Object Surface Model reconstruction Tasks . based on this special sex ,The technology gradually replaces manual measurements in forest resource surveys .

In This paper, the principle of lidar and its application in Forest resources survey Application and technology implementation _ Brief overview .

Three-dimensional laser scanning technology is _ A fully automatic high-precision plane Scan Technology , also known as Virtual replication technology . It adopts non-contact High -speed laser measurement form , can drill down into complex onsite environments and scan in space , by obtaining three-dimensional coordinate data andDigital Photos quick access to large entities or virtual objects The three-dimensional planar information . Use reverse three-dimensional modeling and refactoring technologyto build its three-dimensional data model , to reproduce the true form of objective things sex . current , Europe , Australia , Canada , United States , Japan etc very Multi-Company launches research and development of three-dimensional laser scanning technology , has formed a larger industry , in product actions , Data Fine degree , Has reached a higher level of scanning speed, etc. , and get the has certain results . as an active telemetry method , airborne Li- DAR with Strong maneuverability , efficient , wide range of job benefits , no susceptible to climate and cloud changes , High resolution , don't need or very few people need to enter the measurement field , do not require a large number of ground marks checkpoint , Zone measurement for dangerous zones , provides a straight Connect Efficient quick measures .

1. LiDAR principles and methods

1.1 LiDAR Scanning system principles

The three-dimensional lidar is a major scanner , Computer and the three-dimensional modeling system of the power supply system, . three D laser Scanning imaging system at work , requires no data break collection and processing . It creates a space with a scanning instrument for the Origin coordinate system , The point cloud in the space coordinate system to express the systems to the target Mark object Surface sample Results [1].

The original observations of the three-dimensional laser scanning system are mainly :

1) 2 A continuously rotated reflection of a pulsed laser Mirror Angle value , is the horizontal orientation value a and vertical distance values 0;

2) time calculated by Pulse laser to calculate the distance from the to scan point S ;

3) The reflection intensity of the scan point .

Data (a ,, S) to compute the three-dimensional coordinates of a scan point , The reflection intensity of the scan point is used to match the color to the reflection point . based on (a , ,, S3) kind of data to get the three-dimensional coordinates of a scan point .

Distance S _ by detecting laser pulses from emitting to accepting The time delay calculation gets the target point P vs scanner distance S for :

S =1 /2Ct (+) [] () 1

type : Ti to send a pulse round trip time interval ; C is the speed of light .

1.2 measuring principle of timber product

First according to the location of the tree to be scanned , size form and need obtain control points design the locations of each scan station and control target . then start scanner , scan target Wood . last used Cyclone Software provides rich point cloud data processing features , through Get , intercepts , Fence-selected point cloud data matching generation surface and duplicate Irregular triangles on the surface of the surfaces , building Three-dimensional tree trunks of wood surface model [H] . after the three-dimensional trunk surface model is known , can apply The trunk simulates a number of cylinders or a round table to make a . then Calculate the timber product by the software .

1.3 LiDAR measurement sweep surface mode

in the Forest resource survey , A common method for is for the operator to be in opposition field observations or slope gradient , slope to , slope position and delineation valley back Line terrain factor , This method is difficult to quickly , Science , to accurately tune terrain factor for large areas , and heavy field work .

compared to traditional methods , heavy with three-dimensional laser scanning technology Three-dimensional data model of forest land , finished to meet the cutting design , Afforestation Design , Forest resource adjustment for tending logging design check , not only easier to achieve on woodland area ,, Wood volume and sen Forest Coverage Resource survey , and promote domestic computer view The development of awareness discipline and the popularization of its application .

LiDAR methods for the measurement of forest vegetation are mainly divided into machine load mode and ground static scan and ground dynamic scanning way 3species .

1.3.1 Airborne LiDAR scan

Airborne LiDAR The Profile measurement system is a that measures the topography of the forest simultaneously , measuring canopy height of vegetation , Data Processing to reverse The height of the tree, Crown width , Breast Height , Forest Boundary , can be used with rating forest canopy , effectively manage forest resourcesreason . But the disadvantage is poor precision , Point cloud is sparse , cannot be well model individual trees , allows the algorithm to not effectively pair a single Tree Detail features for analysis and classification . diagram 1 (a) for airborne excitation light radar to forest area $ m X - m scan image [S] , diagram 1 (b) is the digital image for the corresponding region .

1.3.2 ground static lidar scan

1) because airborne lidar data is sparse , from The space sampling method on the is not able to obtain three-dimensional

Model Details , and more rough applied to larger areas of trees feature . The ground static lidar can effectively address this problem by using high-density sample overlays for tree trunks and branches , so you can accurately model individual tree three-dimensional shapes .

2) Three-dimensional reconstruction process requires a tree point cloud data as enter , the point cloud data acquisition and preprocessing process includes the use ofLaser scanner scans scenes from different azimuth , to get more complete tree trunk surface data then Use high reflection rate targ*et al*l kinds of natural or man-made feature points , Lines or faces , will not Match the point cloud data obtained by the site , make them in the same - in the coordinate system ; Point Cloud denoising , patching and simplifying preprocessing all affects the quality of the data . data with higher precision on the following continued tree species classification and tree growth record details data processing the has better help with .

3) characterized by high precision , to one , Two type of survey-like list tree details remain intact , facilitate post-processing and tree classification . But the disadvantage is that a manual static scan device is required set up and ground mark , Inefficient . in a large number of trees in the block or ground undulating area , requires multiple on the target sample Station scan , more time-consuming .

1.3.3 Ground Mobile LiDAR scan

Ground Mobile lidar can be divided into hand-held by scanning , On -vehicle and backpack 3 species .

1) on ground Mobile LiDAR system , Handheld Laser Thunder up to the lightest , but because its range is small, so apply the the The greater the limit, typically used for small static objects 3D Modeling .

2) on- vehicle lidar range farthest from , can be faster Point Cloud Measurement and modeling for large buildings and urban environments , but is too large , Unable to penetrate forest resources survey line Point Cloud collection .

3) Piggyback LiDAR system can overcome the above disadvantages , on get higher precision point cloud data at the same time , can be flexibly in woodland move , but due to woodland GPS weak signal , so sensor in forest positioning of the requires the use of a mobile robot SLAM (sync location on map build) Technology to resolve . because positioning precision will have a Significant effect on the matching and stitching of a point cloud model , so SLAM question also becomes the core issue of the Backpack LiDAR system . but is Backpack Mobile measurement because of its flexibility , High-precision attributes , will will gradually become the future indoor or woodland movement measurement of the main Way .

2. Apply Instance

in Fujian Dickinson Forest Farm , Fujian Dickinson and Xiamen University cooperate to open Exhibition Research and exploration of digitized forest resources survey . based on VZ -1000 and Trimble TX 5 laser scanner data collection work complete Forest resource survey _, Two class-like location cloud stitching , on this basis , completes the sample elevation model automatic build ,, Sample single tree diameter extraction , Sample Tree identification category and sample vegetation count .

extracts point cloud coordinate data in X YZ axis direction max. and minimum . through Z The difference between the maximum and minimum values , meter count tree height H ; at a height of 1.3m on, extracting X axis and Y difference between the maximum and minimum values of the axis , to calculate the average of the vertical chestpath D in point cloud data internal , Use the BODY element simulation method to calculate the wood product V. diagram 2 Show artificial tree height extraction based on point cloud , table 1 for manual field measurement and three-dimensional laser scanning point cloud measurement of real Check data comparison .

You can see the with the result of precision analysis , at breast height and volume measurement amount to , Three-dimensional laser scanning measurements and manual measurements average relative error to 4. 6% and 13.6%, so , in measuring breast diameter , three Dimension laser scanner get measured values differ from manual measurements ; There is a certain error in measuring the volume of the product . , manual measure use of two yuan volume tables cannot accurately respond to specificstands volume , lack of

individual practicality more applicable to forest points , The three-dimensional laser Scanner measurement method appears more objective .

Table 1 Manual measurement and three-dimensional laser scanning measurement of the volume accuracy of the vertical diameter of a tree

Tab . 1 Precision Analysis of manual and 3 D Laser scanning measurement on DBH and volume

artificially measured value Scan measured values relative error /%

Tree numbering	Tree species	Tree code-	Breast Height/cm	Volume/ m^3	Breast Height /cm	Volume / m^3	Dbh	Volume
1	Pinus massoniana	121	20.7	0.2262	21.2	0. 2404	2.42	6.28
2	Chinese fir	111	23.2	0.3003	22.5	0.2770	3.02	7.76
3	Pinus massoniana	121	16.7	0.1301	15.3	0.1036	8.38	20.37
4	Chinese fir	111	26.1	0.4090	24.3	0.3392	6.90	17.07
5	Chinese fir	111	28.8	0.5282	28.8	0.5282	0.00	0.00
6	Chinese fir	111	17.3	0.1372	17.9	0.1504	3.47	9.62
7	Pinus massoniana	121	26.7	0.4309	25.0	0.3652	6.37	15.25
8	Chinese fir	111	19.2	0.1816	20.8	0.2249	8.33	23.84
9	Chinese fir	111	22.9	0.2002	22.1	0.2641	3.49	31.92
10	Pinus massoniana	121	26.5	0.4228	25.0	0.3652	5.66	13.62
11	Chinese fir	111	22.0	0.2610	20.6	0.2192	6.36	16.02
12	Pinus massoniana	121	28.7	0.5161	28.9	0.5251	0.70	1.74
Average		23.2	0.3	22.7	0.3	4.6	13.6	

3. Conclusion and discussion

1) High density laser radar (LiDAR) The measurement technique is a advanced Active Remote Sensing measurement technology , can be efficient and accurate fastquickly get the high-density three-dimensional point cloud information for the object being tested , With with quick , exact , Non-contact and other notable benefits , thus extensively The applies to the Forest resource survey . The results of the experiment show that The point cloud data obtained from the static state laser scan has a higher measurement accuracy accurate .

2) Three-dimensional laser scanning for point cloud data with information Volume large , Collection relatively simple , quick and rich detail benefits . so , in point cloud data for large complex scenarios , for Scanner Job methods , Data Registration , Precision Control , Optimizing pressure indent surface reconstruction , is a three-dimensional data in recent years Challenging research topics .

3) This case is a three-dimensional laser scanning technique successfully in Application of laser scanning technology in forest resource survey , survey knot

Fruit fit _ growth Pattern , With a higher precision . Three-dimensional laser sweep tracing Technology has great prospects in forest resource survey .

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