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3D building reconstruction based on line detection algorithm

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Abstract

Automatic accurate detection of 3D Buildings using Google Street view of a city is challenging due to the presence of various horizontal and vertical occlusions such as trees, cars etc. Using different algorithms in such cases e.g. Laser Scanning (ALS), Unmanned Aerial Vehicle and a Depth camera (UAV RGB-D) map reconstruction, Light Detection And Ranging (LiDAR), is very costly. In order to obtain the correct coordinate value, developers need to match with wrong coordinate information, such as, Point Cloud Data (PCL), Digital Surface Model(DSM), and Digital Terrain Model (DTM) data. In this paper, we propose a 3D Building Reconstruction algorithm that uses 2D images. In our experiment, we use Hough line detection algorithm of OpenCV computer vision library to find outline information in a graph of 2D position. We transform a 2D position to a 3D space position coordinate. 2D image building only provides the frontal view of a 2D image which is not enough to find the coordinate in order to model a 3D building. To solve this problem multiple camera view information is required. Street view can add different view 2D image when detecting noise or occluded object in a scene. Firstly, we locate the noise and divide the noise palace to find the building edge for building construction. Secondly, we detect the line in a building and construct it to the 3D world. Our proposed new algorithm is very efficient to detect lines and 3D object reconstruction in street view. Moreover, it can also use internet map API to simulate a smart city.

Keywords: 3D Building, Pattern Recognition, Computer Vision, SFM,

1. INTRODUCTION

3D City models became popular to urban planners, real estate companies, telecom industries and the general population (for navigation) by Anastasios L. Kesidis, Nikolaos Vassilas, Theocharis Tsenoglou, Djamchid Ghazanfarpour (2015) and L Ragia, F Sarri, K Mania (2015). Popular search engines such as Google, Baidu, Naver, and other companies such as Apple, have researched into three-dimensional city map building, where 3D reconstruction information of buildings coordinates are created automatically without human labor involvement. In order to decrease the human resource association, computer vision technology was used to reduce the participation of individuals. This paper is based on the core content for street view image resources. Satellite picture matches with the GPS coordinates and identifies the three-dimensional reconstruction method of the real world of the building. Traditional building reconstruction method suchs as LiDAR (Light Detection And Ranging) by Baohua Chen, Lei Deng, Yueqi Duan, Siyuan Huang (2015), Mahdi Javanmardi, Yanlei Gu, Ehsan Javanmardi, Li-Ta Hsu, Shunsuke Kamijo (2015) or 3D scanning hardware is very costly due to the (point cloud Library) data, DSM data and DTM data by Lihua Tong, Manchun Li, Yanming Chen, Yafei Wang, Wen Zhang, Liang Cheng (2012) andMin Li, Leong Keong Kwoh, Chin-Jung Yang, Soo Chin Liew (2015). One of the major challenges is to organize this data to identify the coordinate values from data reorganization and modify the incorrect coordinates. Reorganization of incorrect

coordinates delays the development time and increases the human labor cost by Rakesh Kumar, M. G. Petovello (2015).
The reverse order of structure, which reduces cost, is a focus of this paper. In our proposed line detection method, we mostly used open source software platforms, which reduced the development cost. On the other hand baidu API made things effortless for the end user. Therefore, our proposed method is cost effective for development, suitable for enhancement and maintenance. The problem of PCL is the result of large-scale 3D coordinate point data. It is difficult to use the actual environment and modify the coordinates for the multi-point results, which increases the cost of modeling by Laura Micoli, Gabriele Guidi, Davide Angheleddu, Michele Russo (2013).

Figure 1. Shows the Baidu street view face watermark

2. RELATED WORK

Baidu Map service includes location sharing features and Street view API which allows users to swivel 360. The Baidu Map module also provides wrapper API which allows other modules or APIs to integrate with Baidu Map. The Baidu Geofield module provides Baidu Geocoder with a display textual address in China. The main difference with Google is Geocoder Chinese character support.

WGS84：The world geodetic system is a standard coordinate system that was established in 1984. New WGS are available in the form of improved data and increased data coverage. An outstanding new satellite radar altimeter. Design least squares method called different types the Earth's gravity field. It is based on Global Positioning System (GPS).

GCJ02： (aka Mars Coordinates) is a geodetic datum formulated by the Chinese State Bureau of Surveying and Mapping and based on WGS-84. It uses an obfuscation algorithm by Donoser, M, Schmalstieg, D. (2014). which adds apparently random offsets to both the latitude and longitude, with the alleged goal of improving national security.
A marker with GCJ-02 coordinates is displayed at the correct location on a GCJ-02 map. However, the offsets can result in a 100 - 700-meter error from the actual location if a WGS-84 marker (such as a GPS location) is placed on a GCJ-02 map or vice versa.

BD09：BD-09 is a geographic coordinate system used by Baidu Maps, adding further encryption to the already encrypted GCJ-02 "to better protect user's privacy. Baidu provides an API call to convert from Google or GPS (WGS-84) coordinates into Baidu coordinates by Tabia, H, Laga, H, Picard D,Gosselin, P.H. (2014) Similar to GCJ-02, there are no APIs to convert in the other direction, but open source implementations in R Dimitrios Chrysostomou, Nikolaos Kyriakoulis, Antonios Gasteratos (2010) and various other languages exist.

3. METHODS

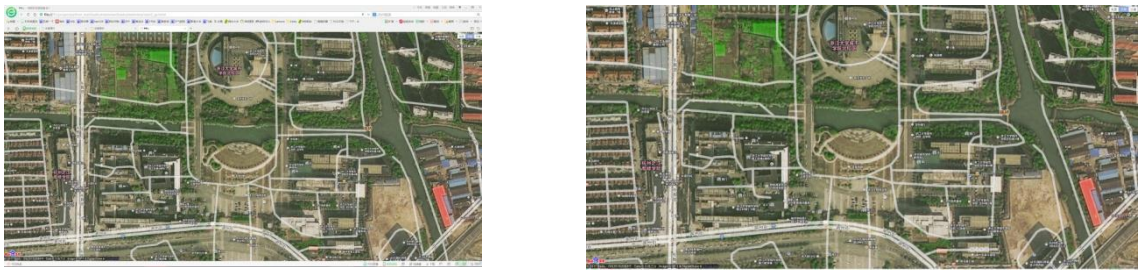

Figure 2. Seattle top view in baidu map API

Figure 2. shows a top view of Seattle City, China, using Baidu Map API. Baidu map API supports GPS address to find out buildings from street view image. We downloaded these map images of the same area in GPS localization path by Andrews, Rob W, Pollard, Andrew, Pearce, Joshua M (2013). First, we sett the top view image target building with GPS address, Web browser setting GPS value input into Baidu javascript map. Here centre and zoom (new BMap.Point(120.161502, 30.332646), 19); 120.161502 and 30.332646 is longitude and latitude 19 is zoom level. From Baidu Map API ak (primary access key) src="http://api.map.baidu.com/api?v=2.0&ak=primary access key similar to Google map API.

Figure 3. Top view of GPS addresses used canny edge and line detection

Second, find contour or line more than 3 points in the image to set the target building using OpenCV Canny edge detection algorithm. The few smaller lines are the GPS area outside.

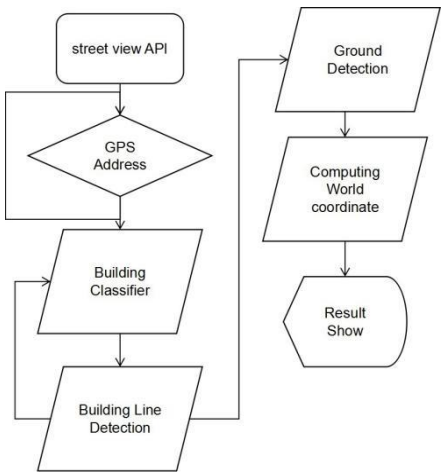

Figure 4.Method flowchart

Figure 4. shows the flow chart of our proposed algorithm. The GPS address was used to find street view images. The view angle requires the same target. From each location, a street view image was gathered in order to search the roof on the GPS coordinates classification into a building address.

The street view image of a building directly considered here with the coordinates to determine whether there is no classification to hide. The roof shape of a building and a street view of the segment shape structures are used together to compute the three-dimensional body estimation.

4. EXPERIMENT

Figure 5 and 6 show experimental results, downloaded, and captured from Baidu street view. These images were used to find line value. Pre-processes included bullring algorithms and produced complex image data which use corner detection in order to find Pilling of the line. These three lines make the 3D building corner.

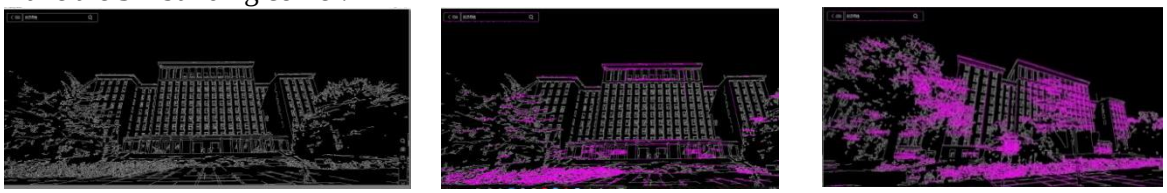

Figure 5. Automatic capture of GPS street view and line detection

Figure 6 shows building reconstruction based on 20 street view images being overlapped. After line detection, and automatic 3D building is created. These lines have left right and longest value. And three lines have one corner point which is pilling of the line.

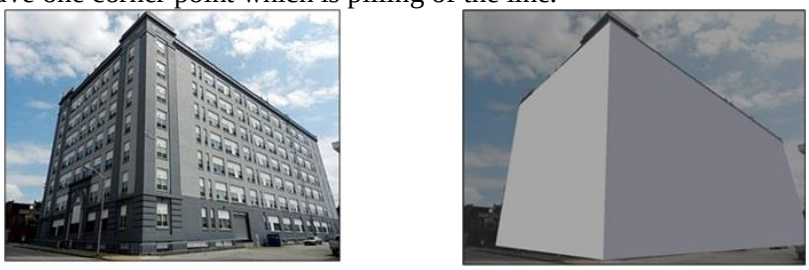

Figure 6. 3D Building Reconstruction

5. EXPERIMENTAL RESULT

In our experiment we used OpenCV 3.1 library with the integrated development environment visual studio 2015 and Microsoft .Net Framework 4.5. Our implementations were performed on two computers wither operating systems being Windows 7 and Windows 10, intel I5 and I7 CPU, primary memory 8Gb and 16Gb respectively. We used both programming languages python and C++.

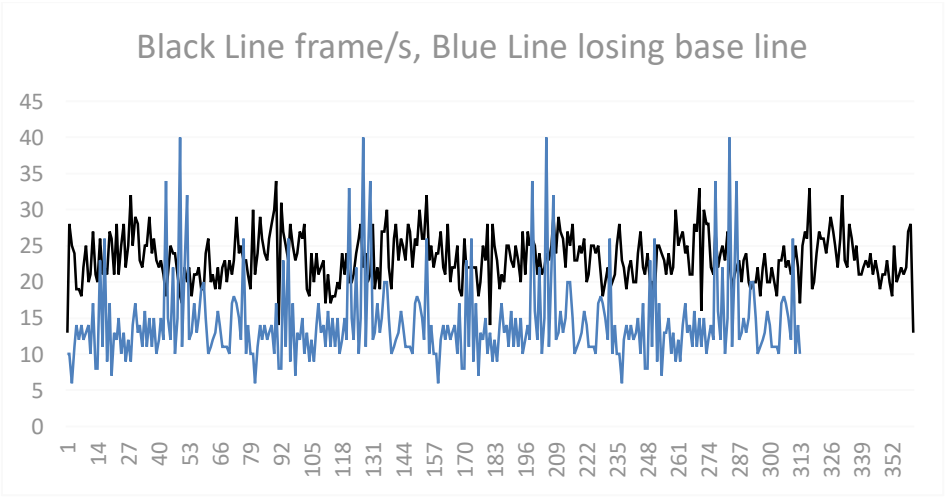

Figure 7. Frame performance and error rate of losing base line

Figure 7 shows frames with base line where the black line is the number of frame from Baidu MAP API and the blue line represents the error rate of losing base line. Frequency curves shows high and low line detection accuracy.

6. CONCLUSION

In this paper, we propose a cost effective way for 3D building reconstruction based on line detection algorithm. Our technique relied on street view map images and coordinate intersections. It is very time consuming and challenging to reconstruct three dimensional coordinates from two dimensional images.

7. ACKNOWLEDGMENTS

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