3D Reconstruction of Urban Building using Laser range finder and CCD camera

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Abstract : In this paper, we describe reconstructed 3D-urban modeling techniques for laser scanner and CCD camera system, which are loading on the vehicle. We use two laser scanners, the one is horizon scanner and the other is vertical scanner. Horizon scanner acquires the horizon data of building for localization. Vertical scan data are main information for constructing a building. We compared extraction of edge aerial image with laser scan data. This method is able to correct the cumulative error of self-localization. Then we remove obstacles of 3D-reconstructed building. Real-texture information that is acquired with CCD camera is mapped by 3D-depth information. 3D building of urban is reconstructed to 3D-virtual world. These techniques apply to city plan, 3D-environment game, movie background, unmanned-patrol etc.

Key word : 3D-reconstruction, laser scanner, texture-mapping, CCD camera

1. Introdution

The recovery and representation of 3D geometric of the real world is one of the most challengeable problems in computer vision researches. With this work, we would like to address the need for highly realistic geometric models of the world, in particular to create models that represent outdoor urban environment. Those models can be used in applications such as virtual reality, tele-presence, digital cinematography and urban planning.

There are many approaches to create 3D city modeling.

In remote sensing field, satellite or aerial images are used to create 3D models using stereo matching method. But their resolution is too low compared with laser scan data. So, they can't make detailed street scenes to be shown like walk-through.

Our goal is to create an accurate geometric representation of urban areas, and then cover a range sensor data with texture information. The range sensor data is acquired using Laser range finder (SICK). And the data is rearranged with GPS and GYRO scope for relative position. And then texture information is acquired using CCD Camera.

2. System constitution

We use a car as our mobile-sensing platform. The system is consists of three parts: Sensor parts, processing part, and power part. The sensor part is consists of a 2D laser range finder, 3D GYRO scope, a GPS (used for relative position correct), and a CCD camera (CIS). The processing part is consists of 3.4Ghz processor PC, and high speed serial interface card for RS422 data communication. The power part has two 12V DC battery and DC-AC converter to supply power to sensor and PC. Fig. 1 shows sensor part. Laser range finder can scan 180 degrees with 0.5 degrees' resolution and 30 times per second. 3D GYRO scope can take 3D acceleration and angle velocity(pitch, roll, yaw) 200Hz per second. And CCD camera can take a image(1024*768).

Fig 1. Sensor part

3. Ground-based Data Processing

1) Relative Pose Estimates

The former paper[1][2]'s Laser Scan Matching method has a few shortcoming that can't divide into corner path and straight path. For solve this problem, we use 3D GYRO scope (XSCAN) and GPS (Leica). 3D GYRO scope's acceleration can be convert to car's relative pose, and angle velocity (pitch, roll, yaw) correct to the laser data's shaking. GYRO scope's data have noise components, so we use kalman filter for solve this problem[5]. Fig. 2 show GYRO scope's data have noise components.

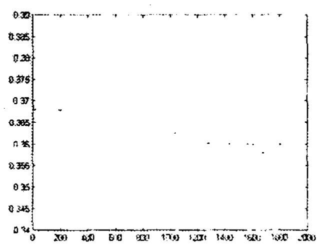

Fig2. noise components

2) Texture mapping with CCD Camera

We create 3D-mesh with laser data and convert to VRML view file. Create panorama image using CCD camera. KLT[7] method can find the corresponding points, we can make panorama image using corresponding points. And then texture mapping after VRML view file matching with panorama image

Fig 3. a) VRML view b) texture mapping

4. Experimental result

After filtering GYRO scope data, we can detect the car's path.

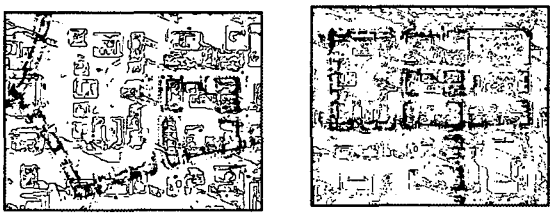

Fig 4. GYRO and GPS correction

a) before b) after

Some of Created mesh are incorrect mesh, so we apply threshold to mesh. And then texture mapping.

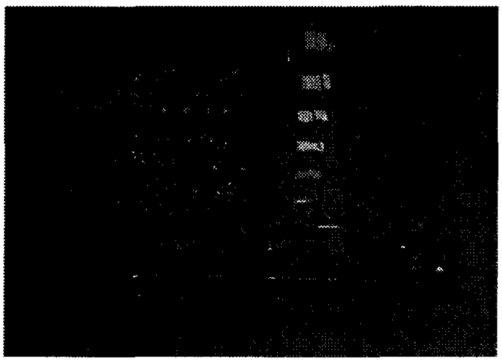

Fig 5. 3D mesh create and VMRL file view

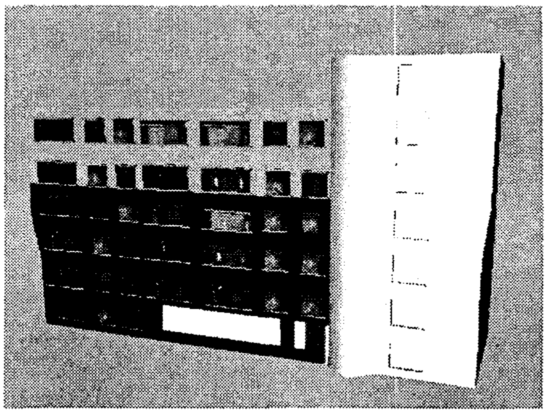

Fig 6. Texture mapping building

5. Future work

So far, we will make airborne-modeling. And fusing with DTM from the satellite images, we will realize 3D reality.

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