Application of Land-based Mobile Mapping System in Wenchuan earthquake

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ABSTRACT:

After earthquakes or other natural disasters, the continuous images both sides of the road can be gathered by the CCD cameras on Land-based Mobile Mapping System (L-MMS), which can be used to establish the database of Digital Measurable Images (DMI). With the database, we can measure geographical information of the facilities in the disaster.
LD-2000RH is a typical L-MMS from Leador Co., Ltd, China, which consists of dual-frequency GPS receiver, IMU, Odometer, and 6 CCD cameras and corresponding devices. After Wenchuan earthquake, by using LD-2000RH, the continuous image sequences of Wenchuan were gathered. Based on Digital Measurable Images, a great deal useful information, including the status of road surface, geographical information of the facilities, were measured, 3D model and panoramic images of key establishments were created too.

1. INTRODUCTION

In recent years, Land-based Mobile Mapping System has been widely used in different fields. The images gathered by L-MMS, with the characteristic of continuing in time and space, have been used in Image Map, such as Leador TrueMap, which can be measured by operator through internet.
Generally, many techniques, including SAR, satellite images and so on, have been applied in post-disaster (L. Gusella 2007). These technologies can be able to carry out disaster assessment and decision-making. But the images provided by them are the two-dimensional plane projection, not real images. So it isn't intuitionist and can not achieve to cm spatial resolution.
In this paper, firstly, LD-2000RH and Digital Measurable Images are introduced. Secondly, DMI were collected with the LD-2000RH in Wenchuan earthquake, and were applied for several purposes. we measured facilities , such as the position, height and area in the images. Also the buildings were modeled to analysis the characteristic of this earthquake, to inverse the rescue process. After the panoramic images of key establishment were created, the particular status in disaster area were displayed intuitively, which were better than single image.

2. MMS and DMI

2.1 LD-2000RH

LD-2000RH includes one dual-frequency GPS receiver, one stripdown IMU, 6~8 CCD cameras, one synchronizer, one odometer, several Attribute panels and other sensors or devices. The precise position and attitude resolution of the vehicle is got from the integration of GPS, IMU and odometer. By the calibration, the positions and attitudes of CCD cameras can be got from the position and attitude of vehicle (Deren Li 2004).
Continuous images can be get and save with the time label, when the synchronizer is cooperated harmoniously with a collection program in PC. The times of the GPS, synchronizer and IMU are aligned by the PPS signal from GPS. By the time label, images are matched with the positions and attitudes of CCD cameras. Then the index of DMI can be created. With the DMI and corresponding application software, organizers and individual users can use services according to their own requirements and implement browse and surveying. Figure 1

shows the flow to create the index of DMI

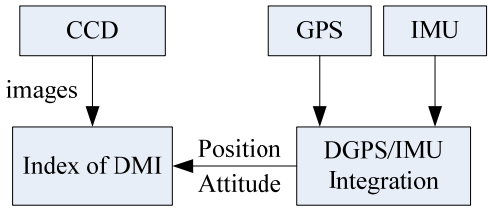


Figure 1. Flow chart

2.2 Digital Measurable Images (DMI)

DMI are the collective of air, space, ground-based images, which contains the External Orientation Elements and continuous images in time and space. Based on DMI, by the application of professional software, plug-ins and API, users can carry out some operation, such as direct browsing, relative measurement (height, slope, etc.), the absolute orientation measurement and analytical data mining attributes (Deren Li 2007).

So the information in DMI includes visual geo-information, measurable geo-information and minable geo-information.

2.3 The information in DMI

2.3.1 Visual geo-information

The database of DMI contains the visualization data. A series of images and video images of the whole street, which are obtained by multi-cameras, can be offered to user. As a new product introduced to spatial database, the goal is to make the representation of objects more vivid and comprehensive. By the help of corresponding application software, users can refer DMI and rapidly find the useful visual information accord with the custom of human activities.

2.3.2 Measurable geo-information

External Orientation Elements, Attitude Elements and time parameters are contained in DMI, which constitute the basis of surveying on multiple level and seamless merging of database. With the database of DMI and software, according to their own requirements, organizers and individual users can implement surveying.

2.3.3 Minable geo-information

Based on the DMI, user not only can get the geo-information which can be measured and visible, but also can achieve attribute information mining through corresponding application software according to their needs, which can be offered to support further application including visibility analysis, transportation ability, position selecting .

The information that a great deal of users need relates with professional application and personal lives such as electric equipment of Electric Power Department, Municipal Facilities of Administrative Department, safeguards of police department, traffic information of transportation department and position demand of dining-room etc. All of this information can be mined in DMI.

2.4 The Utility after Disaster

With DMI, application software is able to be applied in post-disaster, which can provide the following function:

1) Browsing function: to direct selective image and video browsing, Users can quickly know the disaster scene.

2) Measurement function: able to measured object in the DMI, the information measured can be used to aid decision-making.

3) Mining function: the three-dimensional model and panoramic images of the key establishment can be provided, which can be used in disaster analysis.

4) Exhibit function: the images can be provided to build Wenchuan Earthquake Museum.

3. Application

3.1 Acquisition

An earthquake, measured 8.0 degree on the richer scale, struck Wenchuan Country, Sichuan Province at 14:28 on May 12, 2008. The epicenter was at Yingxiu, a town in Wenchuan. Recorded on 25 April 2009, 69225 killed, 374640 injured, 17939 missing, about 4,800,000 homeless. Approximately 15,000,000 lived in the earthquake affected area.

On 25 June 2008, LD-2000RH and Portable Measurement Equipment (figure 2) were sent to Wenchuan to collect Digital Measurable Images. Operating group used LD-2000RH to collect the images and video of both sides of the road. For the area damaged greatly by earthquake, vehicle can’t pass the road there. Then operating group used Portable Measurement Equipment to gather the images of key establishment. It spent two weeks in gathering the images.

Figure 2. LD-2000RH and Portable Measurement Equipment

3.2 Processing

The principle of MMS is based on the geo-referencing of a photogrammetric model by integrating it with data obtained from GPS, IMU and the odometer. Up to now, L-MMS need a GPS base station for DGPS. Because the lithosphere in the disaster area has been distorted and aftershock existing, the stability and reliability of GPS base station can't be ensured. The technique of visual reference station (VRS) is used.

There are three IGS GPS stations around Wenchuan in 1,000 kilometers. They are Wuhn, Kumn and Xian. The raw data of the three IGS station were processed by the VRS software, and then we got the raw data of VRS in Wenchuan, which was used as GPS base data. The precise position and attitude resolution of the vehicle is got from the integration of DGPS, IMU and odometer. With the calibration parameter, the positions and attitudes of CCD cameras were got too. Then the index of DMI and the database of DMI had been created.

3.3 Applications

We select some software to process DMI: AutoCAD with plug-ins, 3d MAX and 3D Vista. By the use of software, we achieved the goal of measuring objects attributes, 3D modeling and panorama processing. all of these were used in rescue, damage assessment, rebuild and other fields.

3.3.1 Rescue

Figure 3 shows the AutoCAD with measurable plug-ins. The line in the below of the figure is track of LD-2000RH; The square block on the line is position of LD-2000RH; The images is gathered by CCD1 and CCD2.By the software; we measured the coordinates of the damaged vehicle and the road attributes (width) in images. The coordinates information measured can help rescue units to find the vehicle quickly, and the road attributes can be used to decision-making.

With the object's statistics in the images, we can provide accurate and reliable map to rescue.

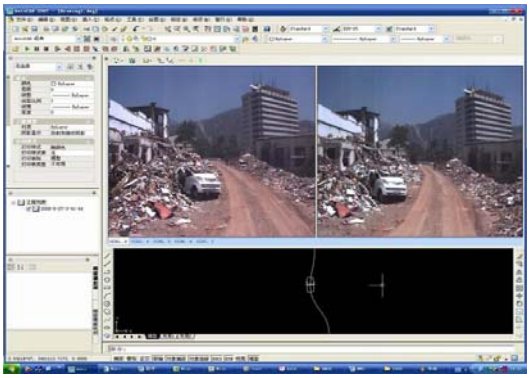


Figure 3. Measured images

3.3.2 Damage assessment

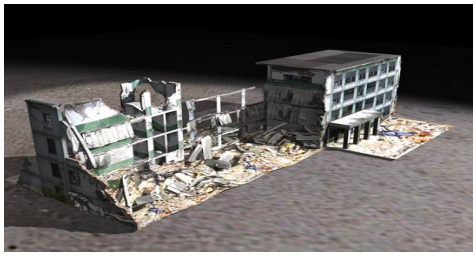
Traditional methods of damage assessment involve walking surveys, which require a large amount of manpower and time. With the DMI and software, we can assess the damage of object in images, such as house collapse, road damage, landslides and so on. Based on the statistics of this information, an assessment of the economic losses to the affected areas can be conducted. Of course, we can carry out the mission with same software, because the damage area of the building in the image can be measured by AutoCAD too.

3.3.3 Three-Dimensional Model

Based on DMI and software, we generated 3D model of the key establishments after the earthquake. The 3D model contains large amounts of information, which can be used to analysis the characteristic of this earthquake and inverse the rescue process. in addition, the model can be provide to the rescue institution to guide the electricity grid, water supply and drainage networks, oil and gas pipeline network, communication network rehabilitation and reconstruction work

Figure 4 shows two group images. The first group (Figure 4-a) is the image of DongQi School gathered by Portable Measurement Equipment after earthquake. The second group (Figure 4-b) is the model of DongQi School. We got the model by 3DMAX.

a) Images of DongQi School



b) 3-D model of DongQi School

Figure 4. Images and 3D Model

3.3.4 Panoramic images

Panoramic image can provide 360-degree field of vision, which have advantage on display. Panoramic images need to provide to exhibit in Wenchuan Earthquake Museum. So we processed the DMI to get panoramic images by 3D VISTA.

In the figure 5, panoramic image shows one tea warehouse in Beichuan town.

Figure 5. Panoramic images

4. Conclusion

After earthquake, the images of Wenchuan were quickly collected by LD-2000RH and Portable Measurement Equipment. Based the Digital Measurable Images and application software, we measured the attribute of the object on the images, model the key establishment and created the panoramic images. All of them were provided to earthquake department of Sichuan. Part of them had been provided to build Wenchuan Earthquake Museum.

In conclusion, L-MMS shows the high efficiency to collect the Digital Measurable Images. Application of DMI proves that L-MMS are suitable for post-disaster.

REFERENCES

L. Gusella, B. J. Adams, G. Bitelli, 2007. Use of Mobile Mapping Technology for post-disaster damage information collection and integration with remote sensing imagery. Mobile Mapping symposium 2007. Padua, Italy.

Deren Li, Sheng Guo, Vicent Tao, Hongxing Sun, Qinwu Hu, Zhiyong Chen,2004. The 4th International Symposium on Mobile Mapping Technology. Kunming, China.

Deren LI, Qingwu HU, Sheng GUO,2007.LBS Based Digital Measuable Image.Mobile Mapping symposium 2007. Padua, Italy.