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Applicability Estimation of Mobile Mapping System for Road Management

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Abstract

This study was conducted to test the applicability of MMS to the pavement management. The data of the targeted areas for this study was acquired using MMS. Vehicle trajectory was generated using IMU, GNSS and DMI; and the information including pavement marking and road signs was effectively extracted using point clouds and image data synchronized with GNSS time. Furthermore the classification of images was used to extract the cracks of pavement, implying its applicability to road management for improving work efficiency.

Keywords: MMS, Pavement Management, Point Cloud, Image Classification

1 Introduction

Introduced by the research team of Ohio State University in the United States in 1992, R&D of MMS (Mobile Mapping System) has been continuously conducted until present date. As a result, the studies of its location accuracy are almost completed and enterprises both at home and are preparing to launch commercial products [1] [2] [3]. MMS, compared with the existing survey method required to build and manage topographic information and facility information DB, is a state-of-the-art information system to improve economic efficiency and its applicability in the future in terms of cost and time [4] [5]. Equipped with vision system such as CCD (Charge Coupled Device) camera, a laser scanner, a video camera and DMI (Distance Measuring Indicator) and similar navigation information acquiring devices, MMS solution integrates navigation technology, photogrammetry and image processing technology, etc [6] [7]. MMS, considering the most ideal solution to acquire diverse and complex information of terrain features in real time, uses image acquisition system, satellite positioning system and laser scanning system [8] [9] [10].

This study aims to suggest the applications of MMS for acquiring road information and the information of surrounding spaces and generating the spatial information for effective road management.

2 Data Acquisition and Processing

2.1 Data Acquisition and Processing

The data for the road management for the targeted areas was acquired using Trimble MX8. MX8 is composed of laser scanner, IMU, GNSS, camera, DMI and server computer for system operation. POD system, the core of system architecture, is composed of IMU, GNSS, a laser scanner and camera and sensor-sensor calibration is achieved, which enables it to acquire accurate point clouds and image data. MX8 POD is shown in Fig. 1 [11].

Fig. 1. MX8 POD

To improve the accuracy of the data acquired in GNSS shaded areas such as tunnels, IMU-based DMI (Distance Measurement Unit) were used together. Fig. 2 demonstrates DMI and Fig. 3 demonstrate the server computer for data acquisition.

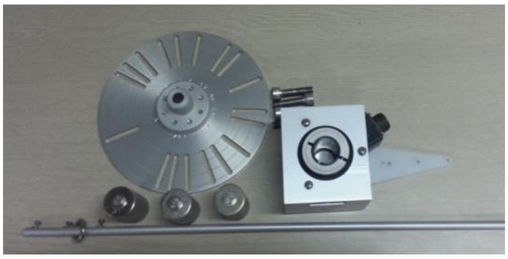

Fig. 2. DMI

Fig. 3. Sever Computer

The data of Mapo areas in Seoul, South Korea was acquired using MMS. The total distance from which the data was acquired was approximated 5km. GNSS data, IMU data, laser scanned data and image data were acquired.

2.2 Data Processing

Spatial information building using MMS follows following procedure: data acquisition, post-processing of paths, point cloud and image matching, information extraction, the extraction of output. Fig. 4 demonstrates MMS work flow.

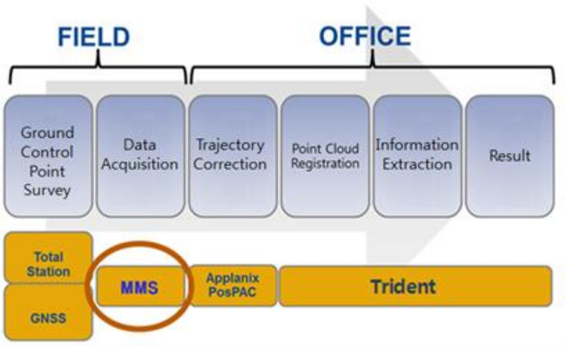

Fig. 4. MMS work flow

To generate accurate vehicle trajectory information, post-processing of GNSS, IMU, DMI data was performed using Applanix POSPac. The 1-sec observation data at Seoul regular observatory of the National Geographic Information Institute was used as the reference point for processing GPS. Fig. 5 demonstrates the execution screen of POSPac, and Fig. 6 demonstrates the post-processed vehicle trajectory.

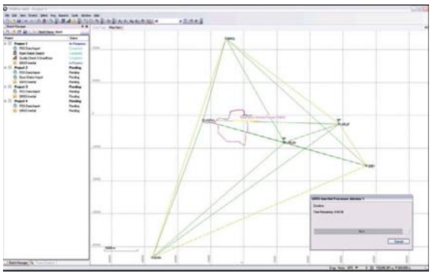

Fig. 5. Screen of POSPac Processing

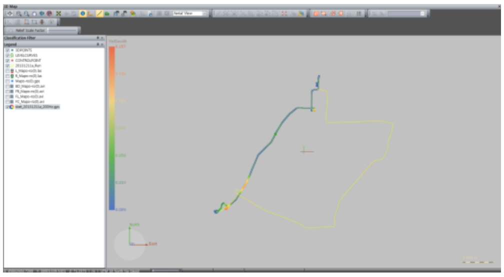

Fig. 6. Post-processed Trajectory

The color of the post-processed vehicle trajectory represents the standard deviation in the direction of height in conjunction with the results of trajectory processing and the increase of red color represents the increase of standard deviation. The standard deviation at arrow points is greater than other areas, implying that GNSS reception is interrupted by the tunnels in the targeted areas.
Images and point clouds are synchronized with GPS time and matched on the basis of post-processed vehicle trajectory. Fig. 8 and Fig. 9 demonstrates images and point clouds respectively.

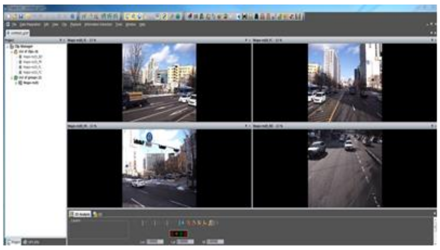

Fig. 8. Images

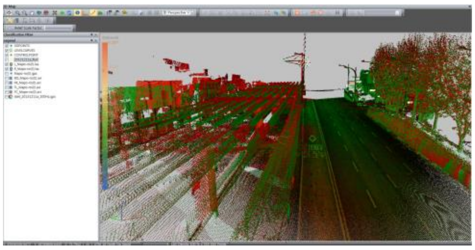

Fig. 9. Point Cloud

3 Application of MMS Data for Road Pavement Management

3.1 Data Extraction

Pavement information was extracted using the point clouds and images acquired using MMS and Trident software. Fig. 10 demonstrates the pavement markings.

Pavement markings were extracted by filtering the point clouds acquired using the reflection intensity of laser data and the distance from the center of vehicles. Automated vectoring using Trident software was possible to achieve. But since the pavement markings were extracted in line forms, it was hard to determine the shape of pavement marking. So point cloud filtering using the reflection intensity of laser data and the distance from the center of vehicles was used. The road-side markings were extracted using the same method. In the case of road signs, they use metallic materials and thus show greater refection than pavement, so effective extraction was achieved using the intensity of reflection.

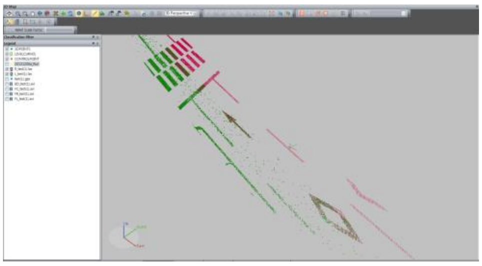

Fig. 10. Pavement Marking Detection

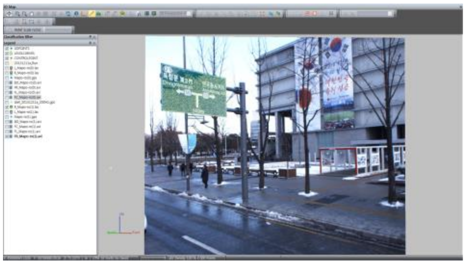

Fig. 11. Sign Detection

In the case of road signs, road sign library enables it extract location information through detection and automatically extract road sigh attributes information using road signs library and image matching technique, which in turn will improve the work efficiency by far. The distance in height between roads and sidewalks was used. The extracted results are shown in Fig. 12. The use of MMS for the data showing the basic road pattern for road management is anticipated to make great contribution to reducing manpower and time required for acquiring and processing data.

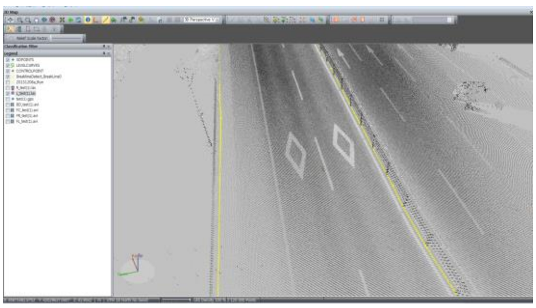

Fig. 12. Pavement Edge Detection

3.2 Crack Detection

To extract the crack information critical to pavement management automatically, the cracks were automatically extracted using the images acquired using MMS extracted. For data processing, pixel-based classification technique was applied to images acquired and ENVY S / W was applied to the classification process. Fig. 13 and Fig. 14 demonstrate the original images and the results of crack detection respectively.

Fig. 13. Original Image for Crack Detection

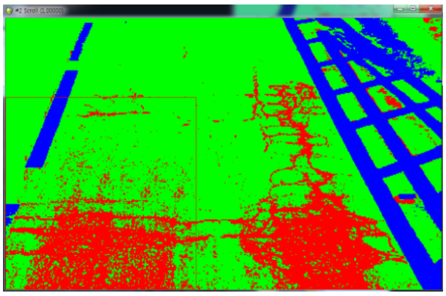

Fig. 14. Result of Crack Detection

In Fig. 14, red color represents cracks; green represents cracks; and green represents pavements. The results of this study showed that the use of the data extracted using MMS allows to effectively extract a wide range of output required for road management. Thus the use of MMS is expected to reduce personnel and time required for works and to facilitate the 3D modelling of road facilities using point clouds and images.

4 Conclusion

The purpose of this study is to test the applicability of MMS to pavement management. The findings of this study can be summarized as follows:

1. The use of MMS composing of IMU, GNSS, Laser Scanner, Camera, etc. enables I it to acquire the accurate point clouds and images of the targeted areas of this study.
2. The use of Point Cloud Filtering using the reflection intensity of laser data and the distance from the center of vehicles enables the automated extraction of road signs and road markings. The use of the difference in height between roads and the distance from vehicle trajectory enables it to effectively generate the outline of roads.
3. The classification of the images acquired using MMS enables it to automatically extract the cracks of pavement and the use of the data acquired using

MMS enables the extraction of a wide range of output, implying the high applicability of MMS to road management.

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