GROUND BASED SENSOR INTEGRATION FOR SPATIAL DATA ACQUISITION AND DATABASE DEVELOPMENT

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ABSTRACT

Recent several years, Photogrammetry, GPS and their related technologies have been advanced. These technologies can be integrated under GIS. However GIS has an unsolved problem how cost-effective and accurate geo-data can generate.

In this paper, the authors describe on the development of a spatial data acquisition tool so called mobile system by combining ground-based sensors in order to generate cost-effective geo-data and its database construction for distribution of obtained information. Our final goal is to identify the both of specific land condition and distribution as three-dimensional data. Three-dimensional measurement can be introduced by photogrammetric approach. As the future study, the authors are planning to use the developed tool at an actual field information mapping in Southeast Asian study site.

1 INTRODUCTION

GIS related technologies, 1) Spatial Positioning, 2) Network Technology and 3) Remote Sensing have been advanced since recent years. They are becoming integrated, resulting in the tremendous expansion and rapid growth of these markets. However the spatial data acquisition and its database construction are the most of bottleneck problems in GIS. If some of them can be improved, total volume of actual research work should decrease and as its result, most of GIS investigation can extend to larger regions and longer time period than the previous.

On the other hand, at the most of GIS, Remote Sensing and its related projects, most of used spatial and statistical data must be gathered as the preliminary stage. Actually it is difficult to obtain existing detail maps or some other spatial materials. Especially in developing countries such as Asian or Africa regions, even if they are available, most of them are subject to restriction by government. Moreover times and opportunities to visit and investigate as field observation are limited. Accordingly the authors developed the spatial data acquisition tool and constructed spatial database. Finally we discussed the developed database exchange/distribute.

2 DEVELOPMENT OF SPATIAL DATA ACQUISITION TOOL

2.1 Concepts of Development

The view photograph gives us a good impression with location and actual phenomena at each observed point. However on the view photo, the area where some phenomena occurred can not measure as absolute numerical values. Resultantly the authors designed the spatial data acquisition tool by applying mobile mapping technology. Main object of our developed tool is to identify and provide 1) When, 2) Where, 3) What, 4) How many area as the specific land condition. Followings are our development concepts based on ground-based sensors;

1) All of vehicle mounted equipment come into operation by the vehicle electric power supply,

2) Operator can monitor each position and condition (through continuous view imagery) while observing,

3) All of informations related to generating thematic map, can be obtained at field observation,

4) All observed data can be recorded in same time dimension,

5) Obtained data can be checked by vehicle mounted system,

6) Re-play all of data at Lab. level.

2.2 Hardware Configuration and Functions

Hardware configuration that we developed is illustrated in Fig.1. GPS, CCD camera, Video-recorder, 3D sensor (gyro) and PC are used as basic components. This system can classify to three parts from its functions. Each of them is separated by bold solid line.

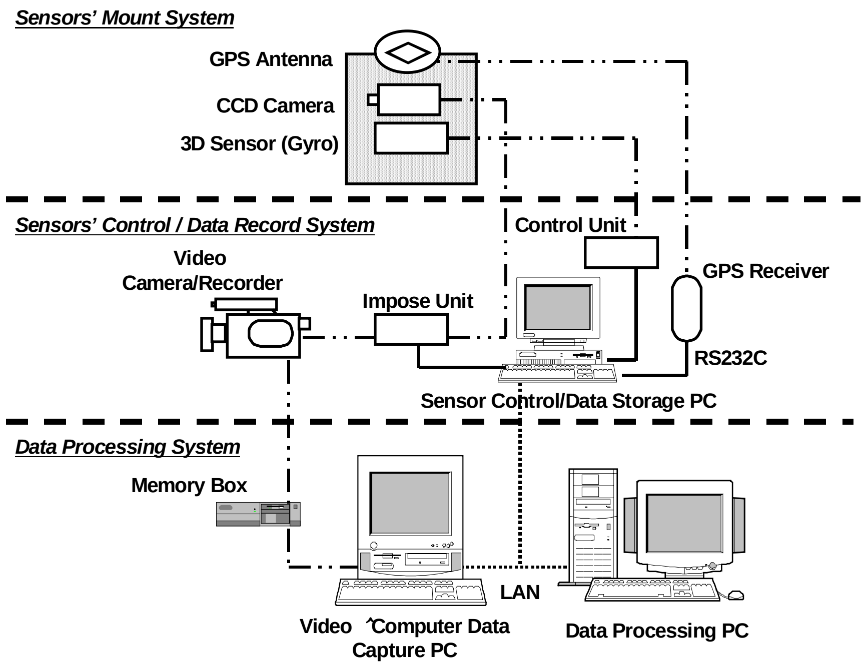

Fig. 1. Hardware Configuration

An upper part of this figure is the sensors and their mount system block.

A middle part is sensors' control and obtained data record block. These two blocks are mobile system that put on the vehicle. A bottom part is data processing block. Main functions of every part are summarized as followings;

1) Sensors' mount system

Fig.2 shows the sensor and mount system that put on the top of vehicle roof. Here we developed the preventive oscillation mount in order to decrease the vehicle oscillation effects. Because each of sensors is sensitive for an oscillation caused by the movement of vehicle. Furthermore this oscillation provide significant influence to the measurement accuracy. This mount has two mechanical absorbing structures. Firstly the urethane damper was used and secondly particular rubber was adopted as shock absorber. The developed mount can absorb at least 1/100 acceleration force. The CCD camera is put in the mount on the rectangular against the vehicle progress direction and observes continuous view imagery. The 3D sensor measures the CCD camera condition (ω, ϕ, κ) and GPS receiver obtains its position(X_0,Y_0,Z_0) at every one second respectively.

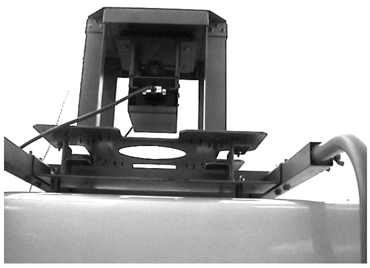

Fig.2 Sensors' mount system

2) Sensors' control/Data record system

Fig.3 shows the sensors' control unit and obtained data recording equipment that are set in the vehicle. Here the control unit box controls the data transformation from the 3D sensor to PC and electric power supply. The impose unit box operates the superimposition of the GPS information on video imagery. PC operates and controls all of observations. And all of obtained data is recorded by the filing function of PC. Also it has data retrieval function. The video camera/recorder is used

Fig.3 Sensors' control/Data record system

for monitoring and recording observed view imagery.

3) Data processing system

Here is the data processing and database construction system at Laboratory. The recorded data is transferred from the sensor control/data storage PC to data processing PC and compiled as database. The camera position (X_0, Y_0, Z_0) is revised by comparing with base station GPS data and used in 3D measurement. The video camera/recorder is connected to video/computer data capture PC and digital imagery with 1,500 width x 1,125 depth, RGB at any interest point, is generated. The database, GIS and photogrammetric software are installed in Data processing PC. 3D measurement and mapping are also performed on this PC.

Fig.4 Data Processing System

2.3 Observed Data and Adjustment of Time Dimension

Each of observed data is adjusted in the same time dimension according to GPS (GPS time). Followings are the used measurement eqipments and their sort of obtained information;

・GPS: Latitude, Longitude, Altitude above sea level and a number of the caught GPS satellites

・3D sensor: Accelerations in right-and-left direction, Acceleration in up-and-down, Angle of Direction, Roll-Pitch-Yaw Angles

・CCD camera: Continuous view imagery

The GPS receiver and 3D sensor are synchronized according to the following procedures;

・When command of measurement start is accepted at PC, PC inside clock is replaced to GPS time by referring the observed GPS information

・When PC receives the first of data from GPS receiver, data-filing function is started and all kinds of data are compiled in the GPS time.

・After the mentioned initial operations, all of measurements are automatically continued and their data are recorded in data file at every one-second.

3 EXPERIMENT AND DATABASE DEVELOPMENT

The experiment of vehicle mounted spatial data acquisition tool was carried out at Lake Biwa as aims to obtain the basic materials for database development and to verify data potentials for 3D measurement.

3.1 Vehicle Experiment

This experiment was done at 6.5km road course. The observations were carried out four times under the almost same condition. The vehicle speed was always 40km/h. It took approximately 45 minutes for this measurement. Through this experiment, we obtained 2476 data set that consists of mentioned GPS and 3D sensor. And continuous view imageries were also recorded.

3.2 Database Development

Using observed data, we developed the database experimentally. The Arc-view was used as GIS software by considering the exchange/distribution of Geo-information through Internet.

At first step of database development, as the generation of base information, topographic map with 1/25,000 scale was digitized by the image scanner and the UTM (x,y) coordinate was given on it.

As for camera position, the differential correction was performed and latitude-and-longitude data was converted to the UTM coordinate system. This conversion was done for all of observed 2476 data set and compiled them as Dbase format database. Then they input to GIS software.

As for continuous view imageries, we selected several interested points and each of view imagery was digitized as digital image. Its image catalogue information was also generated and compiled into the database.

All of data is managed under GIS software. Accordingly if more kinds of information will be accumulated, it should be added as one of additional attributes in existing database.

Fig. 4 shows the sample output of developed database. This sample was generated by using Arc-view Ver.3.1. On base the map, the locations of vehicle are expressed by (●). And selected some of interested points with view digital image are also expressed by (■). Each of view images corresponds to the designated interested points. Also the location with latitude and longitude and its observed date and time are superimposed on the lower part of displayed imageries.

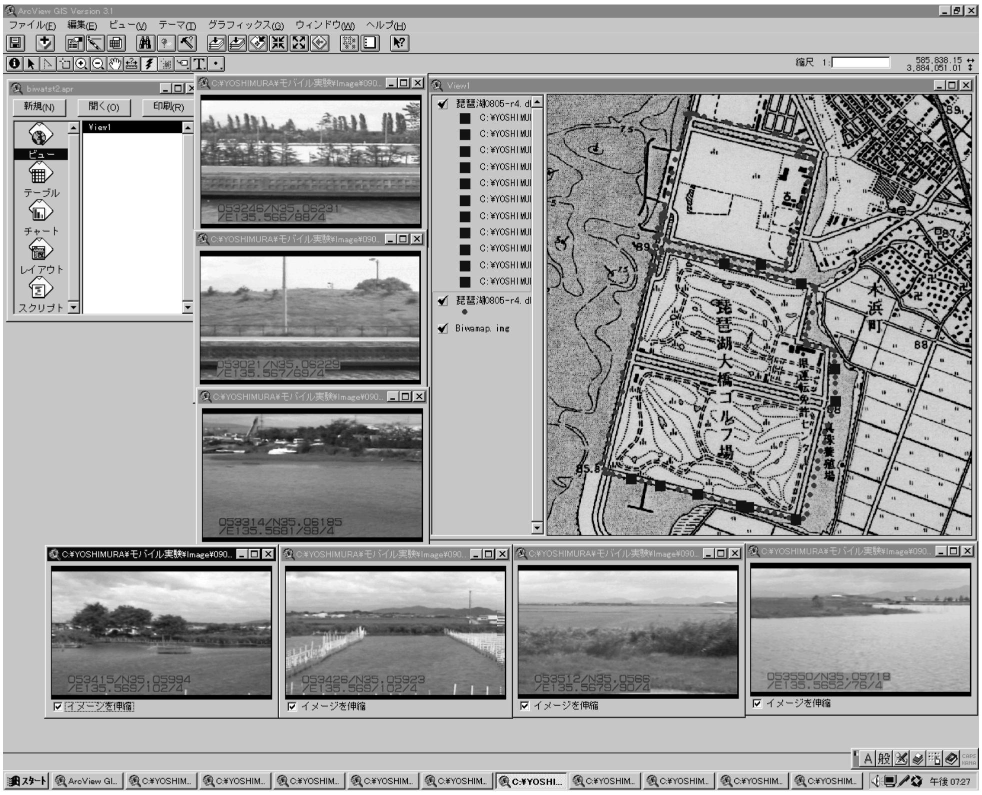

Fig. 4 The sample output using database

Our developed tool is pointing to the real time 3D mapping system without orientation. As for 3D measurement, the camera position (X_0, Y_0, Z_0) as one of the external orientation parameters is calculated by the differential correction. The camera condition (ω, Φ, κ) is obtained by 3D sensor. The internal parameters have already obtained through the laboratory experiment. As for ongoing experiment, the 3D measurement and its database development also have started.

4 CONCLUSION

In this study, we developed the spatial acquisition tool based on the mobile mapping technology and discussed its database development. Trough our fundamental experiment, the developed tool was confirmed to have enough potential for GIS database development and also to obtain the basic components of GIS data that are 1) When, 2) Where 3) What, 4) How many area for the specific land condition. As the future plan of our study, the authors should conduct an actual data accumulation through the field investigation.

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