

## Research on Mobile Mapping System and its Application in Precision Agriculture

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**Abstract:** Integrating diversiform advanced technologies including mobile positioning technology, modern communication technology, spatial information technology, embedded technology, Mobile Mapping System supports real time data accessing and mapping with intelligent mobile terminal, and achieves geographic spatial data visualization. Mobile Mapping System has strong appliance potential in intelligent transport, precision agriculture, field surveying and environment engineering and so on, so its design and study have been paid more attention in GIS field. Based on the acquirement, compression, storage, transmission, mapping of multi-dimensional agriculture information, precision agriculture is a system engineering integrating information technology and agriculture production. GPS is a real time positioning system and it achieves mobile positioning. Integrating Mobile Mapping System and GPS, the spatial difference information in field can be getting quickly and accurately. Mobile Mapping System supports the display, edit and management of standard vector and grid data, collects and transmits multi-dimension field environment data by Internet and wireless communication equipment, and realizes the fast construction and real time update of field information database. In this paper the structure frame of Mobile Mapping System and its application in precision agriculture are studied and some key technologies involved with system construction are discussed, including intelligent integration of multi-dimension data, compression and decompression model of spatial information in field, efficient transmission of spatial information, interface of wireless communication and mobile intelligent terminal.

**Key words:** Mobile Mapping System, Precision Agriculture, Mobile Communication

### 1. Introduction

Mobile Mapping System is an information technology that has been developed since late 1980s with the advance and progress in mobile positioning technology, modern communication technology, spatial information technology and embedded technology, etc. Integrating diversiform advanced technologies above-mentioned, Mobile Mapping System is capable of real time data accessing, mapping and spatial data visualization. Mobile Mapping System not only collects dynamic data about some object in moving, but also manipulates these data in order to make decision efficiently, and make these data be downloaded into a desktop GIS simultaneously by wireless or wire communication as you like. Now Mobile Mapping System has been applied in many fields, such as intelligent transport, precision agriculture, field surveying and environment engineering and so on for outstanding real time supply is very essential in these fields and Mobile Mapping System can do.

Precision agriculture (precision farming, digital agriculture) has evolved from a concept

ten years ago into an emerging technology today. Its basic purpose is to manage farmland by the square meter instead of the square mile. It is certain that precision agriculture can be described as the next great evolution in agriculture. With Mobile Mapping System, every inch soil can be monitor and planting data in detail can be acquired anywhere anytime. How to use Mobile Mapping System in Precision Agriculture will be also discussed in this paper,

## 2. Mobile Mapping System Configuration

Mobile Mapping System consists generally of three parts, that is moving platform, navigation sensors and mapping sensors. Its configuration can be described as follow (figure 1).

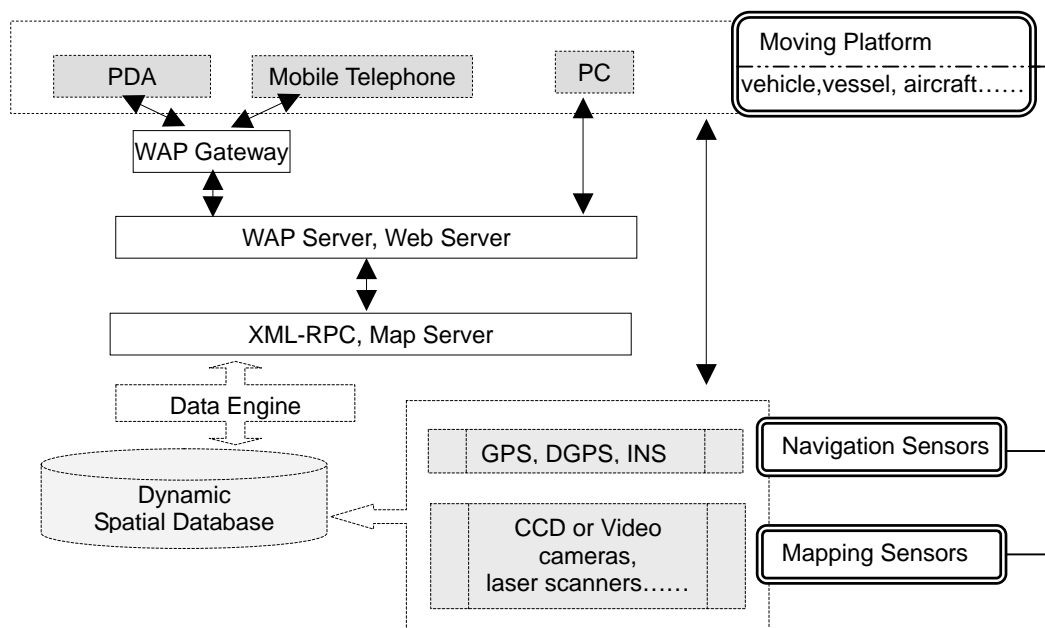


Figure 1 Mobile Mapping System Configuration

The mobile platform is designed to equip data acquisition devices including mapping sensors and positioning apparatus. It may be a land vehicle, a vessel, or an aircraft. Thus the system can observe objects at closer range flexibly. Generally, Mobile Mapping System monitor objects by CCD cameras, video cameras, laser scanners and radar sensors. These mapping sensors are selected according by purpose, but they must obtain high flexibility in data acquisition, more information with less time and effort, and high productivity.

Of course GPS (Global Positioning System) must be connected at the same time in order to record the position and time. Mobile Mapping System is essentially useless without GPS. GPS is developed and initiated by the United States of America. The system has capability of navigation and positioning anywhere on earth, anytime, and under any conditions. Since SA (Selective Availability) was permanently turned off at midnight May 1, 2000, the accuracy of GPS data has been increase. And differential GPS techniques can help to obtain high positional accuracies. In addition, vehicle wheel sensors and INS

(Inertial Navigation System) are important navigation instruments, too. Integrating with GPS, they can provide both the track of the vehicle and position and orientation information of the mapping sensors.

All these data acquisition devices can get plenty useful attribute information. The information will be edited and geo-referenced, then stored in the Spatial Database. Geo-reference process is very necessary because these data will be integrated with other information from multi-sources.

Field data collection is always a difficulty for cartographers, surveyors and researchers. The tools available for mapping applications have been bulky in size and weight, expensive, and difficult to learn for a long time. Fortunately, the advances of remote sensing, GPS technology, GIS and some data edit and analysis software drive the field data collection. The advance refers not only precision has been improved, but also the hardware has become smaller, lighter, and cheaper. And the software has become easier to learn, and more inexpensive. So the data collection task becomes easier, more economical and faster to complete.

Mobile terminals should be another important component of Mobile Mapping System. Spatial data can be displayed, edited, or analyzed with them. There are different terminals that can finish such task. They are PDA, Mobile telephones, and Land Phones. These handheld equipments can exchange data with desktop PC via serial or USB ports, and some can do this by Internet access. In many cases, Mobile Mapping System is equipped on vehicle, and above functions can be done on PC. Whatever terminals can interchange data with GPS data, and access data from long-distance database by Internet or wireless communication equipment. So the works need the support of modern communication technologies.

### **3. Key Technologies**

Integrates space information, modern communication and intelligent technologies, Mobile Mapping System is designed to collect real time field data with certain positioning information, editing, processing, visualizing, and mapping multi-source data. In its working, following key technologies exert important functions.

#### **3.1 Intelligent Integration of Multi-Dimension Data**

Usually field data derived by Mobile Mapping System at scales have to be combined with ancillary data layers from other sources. The resolution and format of multi-sources should be matching. Moreover it is necessary for GPS data properly matching with the geo-spatial database. Recently the integration method has been much more intelligent for dealing with and integrating quickly and accurately. Such study need further progress though great deal of work has been done on it.

#### **3.2 Compression and Decompression Models of Spatial Information**

Compression and decompression models study has been discussed for a long time. Almost every spatial database involves the problem because large data files not only take much more capacity of the database, but also at the same time its loading cost much longer time than small files.

Now there are many compression and decompression models for spatial information.

All of them have their own characteristics and their compressibility is different from each other. Generally higher compression ratio brings more information loss. When selecting the compression and decompression models, the safety, time cost and efficiency are main factors considered.

### **3.3 Efficient Transmission of Spatial Information**

Spatial data/information includes not only remote sensing data, survey data, but also graphic data and attribute data, so transmission of the large data is a difficulty especially when telecommuting or data synchronization between mobile terminals and desktop GIS. Thereby efficient transmission of spatial information is needed imminently.

To resolve the problem, bandwidth of the broadband networks should be improved. At present the new networks with 10 G/s transmission speed is building in USA. It is obvious that the transfers of large data depends on broadband networks technology.

### **3.4 Interface of Wireless Communication and Mobile Intelligent Terminal**

The capacity and computing ability of mobile intelligent terminal are limited, so it is impossible to store all the data in the limited memory and flash card. Thereby it is absolutely necessarily to transfer the data by Wireless Application Protocol (WAP) from server to user. Accordingly it becomes a key problem to make the interface friendly, and at the same time the data reading speed is another issue settled imminently. Thereby the study on interface of wireless communication and mobile terminals has been paid on much more attention.

## **4. Application in precision agriculture**

### **4.1 Precision agriculture**

Precision agriculture is a new agriculture technology system development quickly in recent years. Integrating agronomy, geography, biology, agrology, botany, geo-spatial science, precision agriculture can be defined as a comprehensive system designed to help farming. It involves various problems in crop planning and includes tillage, planting, chemical applications, harvesting, and post harvest processing of the crop. Precision farming is a pro-active approach that reduces some of the risk and variables common to agriculture, so we think that it has the potential of optimizing cost and ecological effects through the application of crop information, advanced technology and management practices. Accordingly, how to get these information and data quickly and accurately becomes the foundation of precision agriculture construction, while how to manage the information and make decision quickly and intelligently is the key technology in precision agriculture.

It is obvious that information technologies are foundation of precision agriculture, and positioning, timing, mapping and analysis are most important among them. Accordingly Mobile Mapping System can help agriculturist with a new capability of gathering information for implementing decision-based Precision Agriculture.

### **4.2 Mobile Mapping System in Precision Agriculture**

For precision farming, information technologies are so essential that Mobile Mapping System is important or beneficial. Equipped with mapping sensors and navigation sensors,

Mobile Mapping System can collect field data anytime, anywhere, in any manner. At the same time, Mobile Mapping System can be connected with a GIS or combine GIS software in its mobile terminals directly. Thus Mobile Mapping System can monitor planting process all along. Moreover it can contrast multi-temporal data collected or stored in database and find what changes occurred, where, when and how, then give an efficient plant plan. What function the Mobile Mapping System has in precision agriculture is narrated in Figure 2.

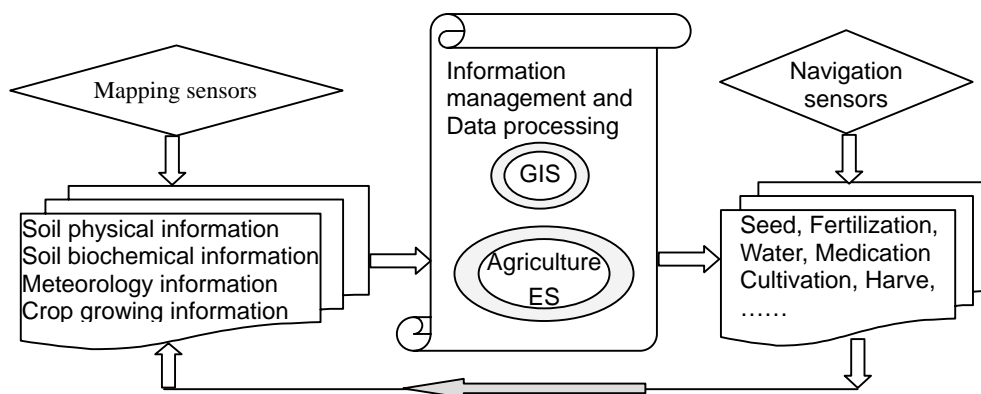


Figure 2 Function of Mobile Mapping System in precision agriculture

## Improve the Accuracy of Soil Sampling

Soil conditions and soil quality influence crop growth greatly. Usually how often do farmers fertilize the soil or water the land depends on the soil conditions and plant type. So it is a basic work to master the soil conditions. From the view of precision agriculture, soil is different meter by meter. Thereby soil sampling becomes the foundation step. The accuracy of soil sampling is requested higher.

Accuracy of soil sampling refers mainly to accurate degree of the position information where the soil samples were taken. With the accurate knowledge about the coordinate location of the soil samples, a soil data layer can be developed accordingly. With the accurate position information, navigating back to those locations for re-sampling is possible.

Mobile Mapping System has equipped navigation sensors, such as GPS and INS, so the time and position information can be recorded at the same time when soil samples are taken. Consequently a soil difference map can be create, on which physical attribute of soil is described.

## Plant Growth, Diseases and Insect Pests Monitor

Generally precision agriculture is constructed in a large area. Hereby it is impossible for all plants growing in like manner. Sometime only a single part suffers the diseases and insect pests. Then it is unnecessary and even harmful for all plants to spray pesticide or other medicine in the same way. Different solution should be taken according to the real conditions of plants.

Mobile Mapping System can finish the monitor task of all the plants. Using the scanners, the peculiar plants can be found quickly, and its position also can be recorded. In fact satellite remote sensing data also can provide such distinction information. Compare

with Mobile Mapping System, its spatial range is much larger but space resolution is lower and constrained by satellite calendar.

## **Analysis of the Crop and Field Information**

The purpose to get so much data about the soil, plant and so on is to master the planting conditions and to make decisions for all planting process. Accordingly GIS and Agriculture Expert System are usually imported in precision agriculture in order to edit, process, integrate and analyze the crop and field information and get corresponding resolve scheme.

Mobile Mapping System may Load multi-source information and different types of agricultural data to master the conditions of the field. Comparing the information or data, relationships within and between data sets can be found. That is the relationships among different factors can be made certain. By the relation, agronomist or Agriculture Expert System can make production plan.

After the production plan has been made, farmers can command the farming machines to work automatically, for these machines has been equipped intelligent implement and positioning devices. Moreover the entire process of one year farming also can be recorded and evaluated, and the experience can be analyzed to help next year work.

## **5. Discussion**

Mobile Mapping System is never a concept. Many applied Mobile Mapping Systems have been studying in many counties, and some have been used in practice. The Photogrammetric lab of the Institute of Geomatics at Swiss Federal Institute of Technology has developed a helicopter based portable handheld MMS for avalanche mapping. The Institute of Remote Sensing Applications of Chinese Academy of Sciences has developed a multi-sensor mapping system called Airborne Laser-Ranging and Multi-Spectral Imaging Mapping System (ALMIMS). It is clear that Mobile Mapping System can be used in many fields. There are many such samples. Its application in precision agriculture can be identified as available and efficient in this paper.

Mobile Mapping System technological development speed is still very rapid reasonably. With the development of spatial information technology and modern communication, as well as the advance in computer hardware and software technologies, Mobile Mapping System will explore new areas of applications and become more intelligent, efficient and steady. It may run online GIS module for an unmanned aerial vehicle, motion innovative intelligent traffic management and service, etc.

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