*2012 International Conference on Software and Computer Applications (ICSCA 2012)*
***IPCSIT vol. 41 (2012) © (2012) IACSIT Press, Singapore***

# A Study on the Geo-graphic Recognition for Handheld Computers and Smartphones in Location-Based Services

Jinsuk Kang [1 +]

[1] Jangwee Research Institute of National Defene, Ajou University, South Korea

**Abstract.** This paper discusses the design and implementation of a geocomputing platform for the development of Location-Based Services(LBS) focusing mobile mapping. During the analysis, design, and implementation of the geocomputing platform, an effective method was identified for the real-time processing of geographic information acquired by a camera attached to a Handheld Computers and Smartphone. This combines location information given by GPS with man’s ability to recognize the location of objects and their geographical relationship to improve object mapping.

**Keywords:** LBS, Mobile Mapping, Handheld computers and Smartphone, GIS

## 1. Introduction

Particularly in software engineering, modularity serves to produce a software system made of autonomous elements (modules) connected by coherent, simple structures. “Modularity of mobile mapping” in our geocomputing platform is related to two aspects: functional modularity within the platform and compatible modularity with other entities in the application development environment. Functional modularity means that necessary functionalities (e.g., location-awareness of a mobile user, thematic mapping, etc.) are grouped by module in the platform, and  compatible modularity mean the modules of the platform can communicate with external entities or components (e.g., generic map servers, database system, etc.) in the application development environment. The functional modularity and compatible modularity of the geocomputing platform support the application development of LBS by providing necessary functional modules and by coupling with necessary external components [1, 2].

In this paper, we propose to combine man's geographic recognition with a GPS to map objects. With the help of man's ability to recognize the placement of objects and geographical relations between objects, location information given by a GPS is effectively enhanced. This method improves the quality of a resulting map.

## 2. Prototype System

### 2.1. System Concept

Mobile Mapping Systems(MMS) are built on the concept of combining high-performance georeferencing with electronic imaging on a moving platform. In land-based mapping applications, digital cameras are mounted on the roof of the vehicle and images are collected proportionally to image sensor or vehicle motion, typically reaching a data acquisition rate of a few images per second. Although such configuration allows for license plate extraction, it is far from being optimal for this task.

Therefore, we propose a solution, which is completely dedicated to address the license plate extraction by optimising all the steps of the sensor integration, including hardware, data acquisition, and algorithmic

+ Corresponding author. Tel.: +82-31-219-3335; fax: +82-31-219-2993.
*E-mail address*: jskang01@ajou.ac.kr.

processing. MMS systems have been using image sequences for a long time since it is an essential part of the concept. The license plate extraction in our approach, however, represents a much more forgiving task from the automated image processing view because due to the special sensor arrangement the image scale changes are limited and the image contents are rather well defined. Traditional MMS systems work with forward- or side-looking cameras, while our system uses a down- looking camera, with an image sensor plane almost parallel to the road surface. This way the image scale changes very slightly and there is an almost constant scale along the vehicle trajectory. To compensate for the smaller footprint, the image covers the road area of about that of a vehicle;

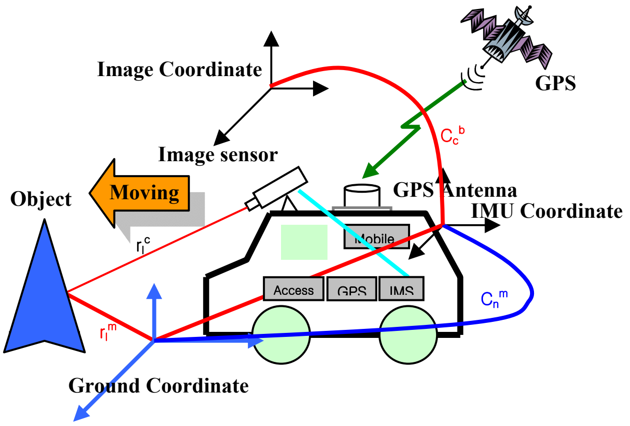



Fig. 1: Human geographic recognition of system concept

Therefore, extracting features from a well-defined set of possible objects from an almost constant scale imagery constitutes a much more formidable task compared to the generic MMS approach. Consequently, a large number of proven computer vision methods can be successfully applied for object extraction. Figure 1 shows the generic model of the dedicated system concept. This is a GPS/INS integrated system, able to supply high accuracy real time navigation data thanks to the aid of DPGS, a second GPS antenna for high precision Azimuth detection and 1 1024 pulses per revolution Distance Measuring Indicator(DMI). INS sensor has three Laser Gyros and three accelerometers. The core system is the LITTON LN-200 optic fibre gyro IMU. This is made of three accelerometers and three optic fibre gyros. It can supply 0.01° Pitch and Roll, and 0.04° true Heading accuracy in real time; 0.005° Pitch and Roll, and 0.02° true Heading accuracy after post-processing [3].

## 2.2. Performance of the Automated Image Sequence

To assess the feasibility of automated line extraction with 3D positioning and consequently its real-time realization, a rich set of the potential image processing functions was developed in a Visual Embedded C++ programming environment.

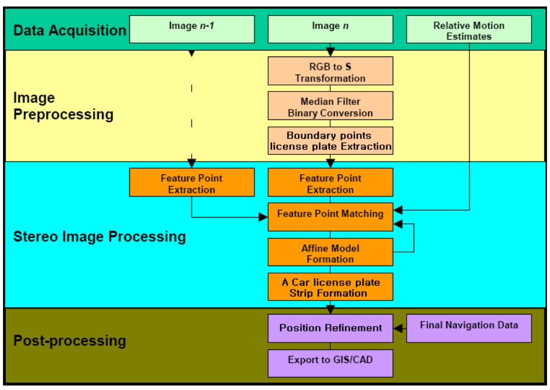



Fig. 2: Real-time image processing and post-processing workflow.

Figure 2 shows the overall dataflow and processing steps, which will be illustrated in more detail later. In short, the real-time image processing is feasible due to a simple sensor geometry and the limited complexity of the imagery collected.

## 3. Digital Image Measurement in GPS

### 3.1. Mobile Embedded Mapping

Our architecture for the mobile mapping in the embedded environment is composed of GPS Data handing Module, Mapping Module, and Map Data which are interconnected between mobile device and GPS receiver [Figure 3].

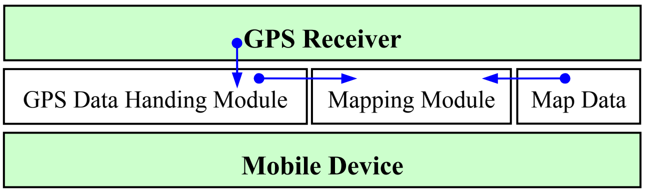



Fig. 3: Architecture of mobile embedded mapping in the geocomputing Platform

Table 1. Role of model, view and controller in graphics programming

| | |
|---|---|
| Model | The model object knows about all the data that need to be displayed. It also knows about all the operations that can be applied to transform that object. However, it knows nothing whatever about the GUI, the manner in which the data are to be displayed, nor the GUI actions that are used to manipulate the data. The data are accessed and manipulated through methods that are independent of the GUI. |
| View | The view object refers to the model. It uses the query methods of the model to obtain data from the model and then displays the information. |
| Controller | The controller object knows about the physical means by which users manipulate data within the model. In a GUI for example, the controller object would receive mouse clicks or keyboard input which it would translate into the manipulator method which the model understands. |

GPS Data Handling Module gets data from GPS receiver, and Mapping Module visualizes the GPS coordinate on a map using the Map Data embedded in the mobile device. As a stand-alone system, the overall structure may be similar to that of major vendor's mobile GIS products such as ESRI ArcPad, MapInfo MapX Mobile, and Pocket Systems PocketGIS.

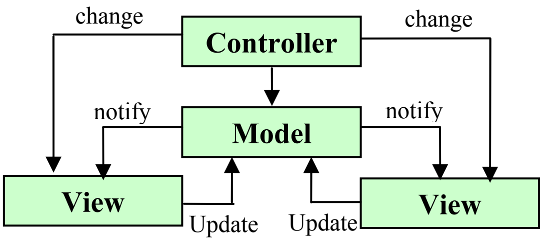



Fig. 4: Architecture of MVC(Model-View-Controller)

This Mapping Module has an MVC(Model–View-Controller) architecture whose goal is to separate the application object (model) from the way it is represented to the user (view) from the way in which the user controls it (controller), thereby allowing flexibility and reusability. The role of model, view, and controller is addressed in [Table 1], and the relationship between model, view, and controller objects is shown in Figure 4.

### 3.2. Steps for Mapping an Object

The user can then associate the object data with another object data that is already stored in the system. These steps are show in Figure 5. Two experiments were conducted to evaluate the cost of marking a map and the quality of a resulting map. A participant first made a map1 and then continued to work to make a map2. The steps to make maps were as follows:

- **Map1 (Uses GPS only)** : Each participant takes pictures of the 4 object by the digital camera and maps them by using GPS information only. This is comparable to a current most advanced system.
- **Map2 (Uses GPS plus human geographic recognition)** : After the map1 steps, the each participant associates the objects with the target objects. First the participant draws a target object and stores it to the system. Then the participant picks up a target object from the list and selects the relationship with each object. This is the unique step of the proposed system.

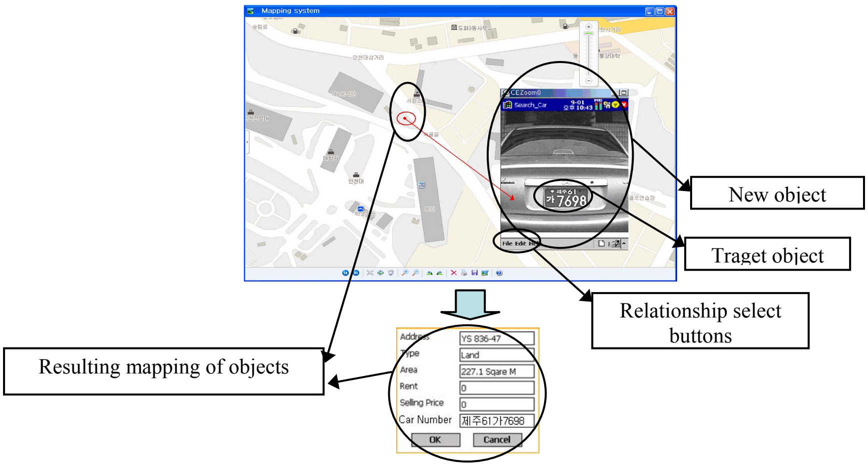


Fig. 5: Steps for mapping an object

## 4. Evaluation and Discussion

We improved the quality of the image through a high-frequency emphasis filter, and extracted the license plate domain through a partial image match using vertical brightness value distribution change and license plate model. During this process, data expression of the transformed image is not memorized in mobile PDA memory space as a sequential structure, but memorized as an index structure in order to provide a more efficient and fat search, extracting characteristics of license plate domain. Also, the map-making application, which is built by Java, can display and organize collected objects on the map. The application has the edit window [Figure 7] and the map window [Figure 8].

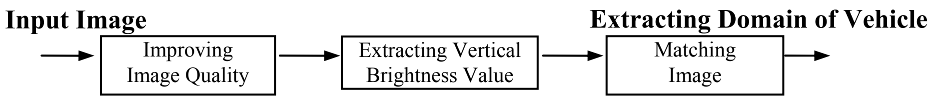
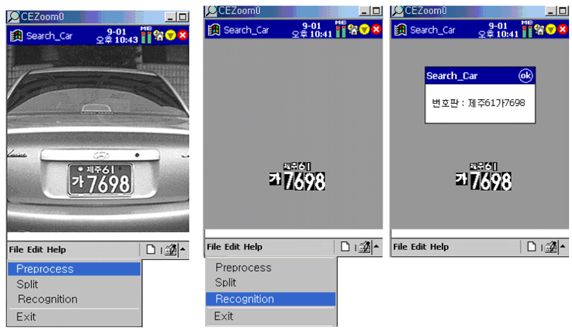


Fig. 6: A block diagram of preprocess stage

### 4.1. Edit Windows

In the edit window, a picture of the object is displayed after taken by the digital camera. The location information by the GPS is provided automatically at the same time. The important part of a still image taken by a PDA camera is the algorithm to detect the license plate domain. There are two general methods in use: one to detect license plates using brightness information, and the other to identify characteristics by edge detection and Hough transformation. The first one, however, is overly sensitive to the environment, with a lower recognition rate when there are noises around. The second uses vertical and horizontal components in the license plate domain, with lowered recognition rate and longer processing time in case of damage or noise in plate edge, which is not proper for real time processing.



(a) (b)

Fig. 7: Extracted result s of numbers and letters

This paper discusses an experiment with a gray image of size of 320 ×240 pixels, taken by a PDA camera of HP iPaq 3630model, which has Windows CE operating system and 128MB memory. The extracted result's of numbers and letters is shown in Figure 7. In particular, we reduce search time by sorting records in a successive index structure in an embedded system with limit of memory, and try to reduce to the utmost the rate of error in information on location of a vehicle through chasing location of spatial relative distance. We prove that it is possible to actualize processing procedures of pattern recognition for numbers and letters. This is used in PDA by matching images of stopped image data from a model license plate from an inputted vehicle through PDA camera [3].

### 4.2. Map Windows

The mapped objects are placed on a blank map in the map window. This map window also allows users to modify the map in addition to mapping objects. This is because the blank map does not always provide enough objects to associate with for the users. In this application, a mobile user can see the current location is pinpointed on the land parcel map according to the GPS coordinate and radius extent assigned. If the user clicks on a specific parcel, the information of the parcel such as parcel type, area, rent, selling, and register notes show up [Figure 8]. The application of field collection can assist mobile field work through the real-time notification of current location, on-site input of attribute value, and the compatibility with desktop GIS package. The application of cadastral information service is useful for the purchasers/renters of house or land through the real-time notification of current and on-site inquiry of cadastral information [4, 5].

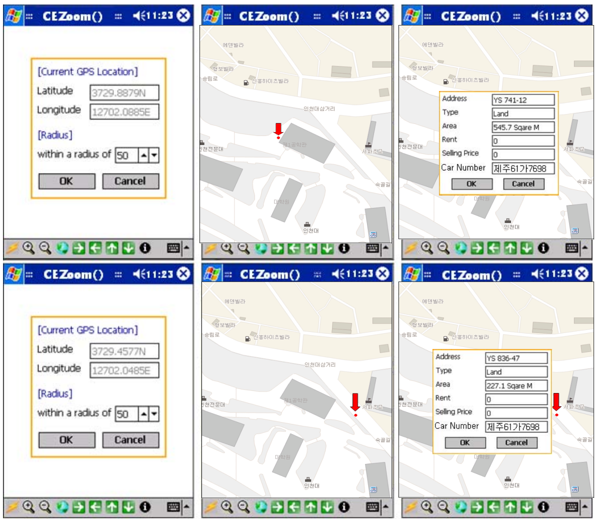


Fig. 8: Screenshot of cadastral information service

The decision to implement geospatial multimedia technology requires a thorough needs assessment spans data collection, data processing, and data use. Taking the time to understand the diverse capabilities of geospatial multimedia and more importantly, the needs of its users will augment success in implementation.

## 5. Acknowledgements

This research was supported by the Basic Science Research Program through the NRF funded by MEST (No.2012-0005127) and (No.2011-0026536).

## 6. References

[1] R. Li, K. P. Schwarz, M. A. Chapman, and M. Gravel. Integrate GPS, INS, and CCD Camera for rapid GIS data acquisition. *GIS World*, 1994, 7(4):41-43.

[2] A. Khotanzad and Y. H. Hong. Invariant Image Recognition by Zernike Moments. *IEEE Transaction on Pattern Analysis and Machine Intelligence*, 1990, vol.12, no.2, pp.489-497.

[3] Jin-suk kang, Taikyeong T. Jeong, Sang-hyun Oh and mee young Sung. Image Streaming and Recognition for Vehicle Location Tracking using Mobile Devices. *Springer LNCS 4459*, 2007, pp.730-737.

[4] J. S. Kang, C. H. Park, J. H. Kim and Y. S. Choi. Implementation of Embedded System Vehicle Tracking and License Plate Recognition using Spatial Relative Distance. *Proc. of 26th International Conference on Information Technology Interface*, 2004, pp.167-172.

[5] Jin-suk Kang, Yonghee You and Mee Young Sung. Design of MMS(Mobile Mapping Systems) applicable to LBS(Local Based Services). *Proc of IEEE ICDIM*, 2007, pp.487-495.