Chapter XXIV
A Practical Perspective on Building Identification from Low-Resolution Mobile Images

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ABSTRACT

In this chapter, the idea of identification of outdoor buildings using mobile devices is presented. The prototype system involves integration of various hardware devices and a building identification application using sensor fusion. The goal is to allow real-time interaction with clients and provide 'location-based' information about the building after identification. Clients, such as a PDA, can wirelessly connect to a server that handles building identification requests. It consists of a GIS server, an application for communication with clients, an image database used to identify the building and a 'location-based' image processing application. The data collected include a captured image of the object concerned as well as the corresponding GPS positioning and orientation data. Several different image processing techniques are employed to study the different features of an image, including the colour structure, roof shape as well as building textures. Promising experimental results are presented showing both the individual feature matching and overall matching performance.

INTRODUCTION

With the increased availability and advanced features of low-cost, portable and mobile devices, there is the potential to develop a wide range of applications (Banerjee, Agarwal, Kamel, Kochut, Kommareddy, Nadeem, Thakkar, Trinh, Youssef, Youssef, Larsen, Udaya Shankar & Agrawala, 2002; Caceres, Donham, Fitterman, Joerg, Smith & Vetter, 2002). As technologies advance, the combination of mobile computational, imaging and satellite positioning, as well as internet access capabilities, opens the door to a variety of novel applications, such as pedestrian navigation aids, mobile information systems, electronic tourist guidance and other applications commonly referred to as 'location awareness services' (Böhm, Haala & Kapusy, 2002).

Most of the previous research in this area has been concerned with 'location-based services.' This chapter presents a 'location and image-based service' that delivers information about a specific building of interest in almost real-time to a mobile user through the Internet by identifying the building from a user-supplied image. Similar ideas have been mentioned in (Fritsch, Klinec & Volz, 2000; Klinec & Volz, 2000), which use still video camera images along with image interpretation and object extraction to locate the position and enable the user to navigate indoors. However, in this chapter, object recognition is applied to outdoor city navigation. Chevallet, Lim and Leong (2007) use images taken from mobile phones and an image database to identify tourist objects based on colour histogram matching. Recently, scale invariant feature transformation (SIFT) has become a popular technique in building identification (Paletta, Fritz, Seifert, Luley, & Almer, 2006; Zhang & Kosecka, 2005). However, they require training using a database with appropriate amounts of viewpoint changes, for example, ≈30° (Paletta et al., 2006), on the same building for accurate identification. The proposed approach does not have this restriction. Another project described by Böhm et al. (2002) improves the accuracy of global positioning systems (GPS) by combining GPS data with orientation and image data and employing the Hough transform. The hardware employed in this chapter is similar to Böhm et al. (2002) except that the system is mobile and portable, and the processing is carried out in real-time. Moreover, this research seeks to exploit the capabilities of a mobile device, namely the personal digital assistant (PDA), and its imaging functions for building identification. While it is recognized that more advanced mobile devices, such as Smartphone, are now available on the market, technologies can easily be adopted to other mobile platforms for improved usability and different applications.

As an example application, city visitors sometimes find problems in understanding tourist maps or guidebooks. In fact, surveys of pedestrians in University Square, Belfast found that a significant proportion (12% of males, 24% of females) had difficulty in locating themselves on a printed map (Sutherland, Tweed, Teller & Wedebrunn, 2002). The system presented here can potentially increase the location-awareness of visitors by identifying their locations and getting information about urban objects using user-captured images from PDAs.

In this PDA-based building identification system, each user is equipped with a PDA to capture the object concerned as an image, an orientation sensor, and a GPS unit for identifying location. The user then sends the information from the mobile platform to a server for further processing. On the server side, after receiving the captured object, image processing is used to provide building identification. At the same time, a geographical information system (GIS) is employed to provide location information and reduce the number of matching image candidates during data processing. If the captured image is confirmed to be part of a known building in the database, the object has been identified. It should be noted that positional data alone is not always