A Mobile GIS Application to Heavily Resource-Constrained Devices

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ABSTRACT GIS applications to mobile devices are becoming increasingly popular, utilizing a diverse range of devices. Many of these devices suffer from serious constraints in three main areas: processor speed, memory space and screen size. This paper presents a GIS application, called "MacauMap", that is intended for heavily resource-constrained handheld devices. MacauMap is a tourism-oriented map application of the Macau territory for PalmOS and Pocket PC personal digital assistants. It was designed to perform satisfactorily on devices with as little as 16 MHz processor speed, and requires only 500 KB available memory for the GIS application and all GIS data. Memory requirements are kept low through a specially designed data format. The main challenge of satisfactory map drawing speed is addressed through a variety of techniques that were developed for this application. The paper describes the application's data format, outlines the map drawing techniques, and points out the areas for future development.

KEYWORDS personal digital assistant; mobile GIS; map drawing; GPS

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Introduction

GIS applications are software applications that process large amounts of geospatial data, involving heavy computations. Traditionally, these applications have resided on high-performance workstations and servers equipped with the necessary resources; large amounts of primary and secondary memory, fast CPUs and graphics processors, and large screens for displaying the data.

The recent decade, however, has seen a move of GIS applications onto smaller platforms, including mobile platforms such as personal digital assistants (PDAs). These platforms offer a number of attractive features, primary among which is their extreme mobility; because of its small size, a PDA can be carried and used practically anywhere.

Driven by the need to promote tourism in the Macau territory, the development of a tourist-oriented mobile GIS application was initiated. Since the Macau government declared Macau as a city of tourism in 1961[1], the tourism industry in the territory has experienced a rapid and continuous growth, becoming the leading economic sector in Macau. In 2001, around 10 million visitor arrivals to the territory were recorded, the majority of whom came to Macau for holiday purposes. Given this background, the promotion and continuous development of tourism is an important issue for the local economy.

The Macau territory is a place with unique characteristics; it consists of the Macau peninsula and two islands, Taipa and Coloane, which have recently been merged into one through land reclamation. The total land area measures only approximately 25 square kilometres, while it has a population of about 450 000. This makes it one of the most densely populated places in the...
world. The consequence is that most of Macau, and particularly Macau peninsula, is fully and densely covered with buildings and streets.

To provide information about the Macau territory to tourists, a mobile GIS application, designated "MacauMap", was developed at the University of Macau between 2001 and 2003, while development of improvements as well as versions on different platforms continues now and into the future. The main objectives of MacauMap are:

1. To provide basic geographic information about the Macau territory, such as coastal outlines and the network of streets.
2. To provide information about places that are of interest to tourists.
3. To provide information about public transport facilities in Macau.
4. To provide information about hotels and restaurants in Macau.

The aim of MacauMap can thus be summarized as facilitating and thereby making more enjoyable the stay of tourists in the Macau territory. However, it was also realized that local residents would have use for a GIS application like MacauMap, and from the outset this was considered in its development.

1 Overview of MacauMap

MacauMap is a PDA-based tourism-oriented GIS application. Two versions exist, one for PDAs running PalmOS, the other for PDAs running the Pocket PC operating system, thereby covering approximately 75% of the PDA market. Both versions are practically identical in function and they differ only slightly in their user interface due to platform dependencies. All screenshots shown in this paper are of the PalmOS version of MacauMap.

The MacauMap user interface is shown in Fig. 1. It consists of a map display area that occupies the majority of the screen, and a toolbar for accessing frequently used functions located at the bottom of the screen. Buttons in the toolbar allow the user to manipulate the map, traverse the navigation history, and to locate information. The main functions are listed below:

1. Map manipulation: zooming in/out, panning, navigation history (previous/next map view).
2. Search: searching for streets or places and displaying their location on the map.
3. Bilingual information: switching of lan-

Fig. 1 MacauMap user interface showing a map at 1x zoom level