An Image Search for Tourist Information Using a Mobile Phone

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Abstract: - Currently**,** Mobile phones perform like a personal computer. In searching for information, people generally use keywords or character sets to search for information using a computer or mobile phone. When using keyword to search, users have to define the appropriate keywords for things that they want to search for. In some cases, multiple keywords must be given in order to obtain satisfactory results. However, defining the appropriate keyword is sometimes difficult. This paper proposes a mobile application for searching travel related information by using images to search instead of keywords. The image used in this application is taken from a mobile phone camera and sent to the server. The Auto-correlogram and Color Different Correlogram (AC/CDC) algorithms are deployed in the image retrieval system. The images and travel related information are sent back and forth through the Internet by using Web-services. This proposed system could provide more convenience for users and/or tourists and decrease the restriction of searching information from a mobile phone through GPRS.

Key-Words: - Autocorrelogram, Autocorrelogram and Color Different Correlogram, AC/CDC, Image search, Mobile phone, Web Services.

1 Introduction

The number of mobile phone users has been significantly increasing each year. They typically take their mobile phones everywhere they go or travel to. Furthermore, almost all models of mobile phone being built today have a high efficiency/resolution digital camera and are provided with a GPRS function for connecting to the Internet effortlessly. Therefore, it is possible to use mobile phones to search for information though the Internet. Users generally use keywords to search for information. However, it is sometimes difficult to identify the appropriate keywords or phrases for things in a specific language. To resolve these problems, the use of images for searching information instead of using keywords is introduced and many research projects in the area of image retrieval have been developed [19-27].

Content-based Image Retrieval (CBIR) has been an ongoing area of research for decades but is still not appearing in the mainstream. Many applications like Qbic [1], VisualSeek [2], Blobworld [3], and MetaSEEk [4] are attracting attention, but they are still not very common. Most current CBIR systems presented in academic and research papers tend to focus on new technical issues and algorithms, and frequently ignore the end user's point of view.

Image representation schemes designed for image retrieval systems can be categorized into three classes including a textual (keyword) feature, a visual feature, and their combinations [6]. The very first attempts of image retrieval were a keyword-based approach, which requires a previous annotation of the database images. It is relatively simple and computationally efficient and a more direct mapping of high-level semantics than that of low-level visual features. However, there are two main drawbacks. First, manual annotation is a tedious and expensive process when the size of image database is large [6]. Second, building keyword models from visual features of a set of images labeled with keywords is critical [6]. In the area of CBIR, it overcomes the difficulties of manual annotations by using visual feature-based representations, such as color, texture, shape, etc.

Therefore, an image search will help users, especially tourists, search for information they want without worrying about describing keywords in any specific language. For example, while tourists are travelling and they find interesting places without having any information in advance, how do they get information about those places? In such cases, asking other people around that location or using a keyword search on the Internet are possible solutions. However, it may be very difficult to do that because of a language barrier or difficulty in finding the appropriate keyword. But the tourists know exactly "What things they are looking at". Therefore, it would be very useful for tourists if they could search and get more information such as name, location, etc. by using the image of what they are looking at.

This paper proposes an information retrieval scheme using images taken from a mobile phone camera. The Auto-correlogram and Color Different Correlogram (AC/CDC) algorithm [10] are deployed in the image retrieval system. The images and travel information are sent back and forth through the system by using Web-services. The rest of this paper is organized as follows: Section 2 describes the overview of related research. Section 3 describes the image retrieval algorithm. Section 4 describes the implementation and testing of the proposed system. Section 5 is the conclusion of this paper.

2 Mobile technology and tourism

Today, mobile devices present many unique characteristics that make their use as electronic tourist guides particularly attractive, such as ubiquity and convenience: unlike PCs, handheld devices are typically operated by a single user, thereby enabling the provision of personalized services by wireless web portals [28, 29]. However, mobile computing still has several restrictions such as: restricted energy capacity, limited computing power, amount of memory and storage space; small display size, limited color and limited font support, small and hard to use keyboards; limited bandwidth and the high cost of wireless connections. Admittedly, although the capabilities of mobile devices tend to increase, the 'resource gap' between mobile and stationary devices will always be present. Most existing commercial applications and research approaches in the field of mobile tourism basically fall into three main categories that involve [28, 29]:

• Tourist or museum guides with pre-installed applications, namely rigidly defined content (in text, visual and auditory format) that cannot be customized according to user preferences.

• Mobile devices used to access mobile web portals and browse tourist information of interest. This approach implies the use of a mobile or wireless network to access Internet resources. The main disadvantage of these services is their requirement for a constant connection (airtime) of the mobile device with a mobile network in order to offer access to web content. Thus, users are charged for the wireless connections either as pay-per-minute or pay-per-packet as the billing policy specifies.

• Mobile electronic guide devices that use either wireless or mobile network connections to access context-aware services. This approach assumes some type of network connection and tracking systems such as GPS to provide location-based services. Hence, whenever a user is out of coverage of the mobile network (i.e., ''has no signal'') he/she cannot access any service.

The mobile technology is growing rapidly worldwide. The level of innovation is high and new technologies, devices, applications and services are emerging in a rapidly. The number of mobile users is increasing (worldwide) and has already surpassed the number of household's internet access. The roll-out of mobile broadband access using access networks such as UMTS, Wireless LAN is beginning to reach a critical mass for users that have terminals with multimedia and data capabilities. The availability to make contact with people at any time and anyplace brings interesting possibilities for many areas. Therefore, there are a number of reasons in using mobile technology for tourism [30]:

● When people are travelling, navigation problems arise almost immediately. Mobile technologies can help people in finding their way in strange or changing environments. Mobile technologies are also seen as a possible channel to decrease the digital divide caused by the fact that not everybody has access to a pc and/or internet connection. Mobile penetration has already surpassed internet penetration

● Being in an unfamiliar environment imposes information needs that cannot always be anticipated. Mobile technologies, with multimedia and data processing capabilities, can help people to get/find the information they need. Mobile technologies allow for direct, person-to-person, communication.

● The mobile device is carried 24 hours a day by many people, so it is 'always' at hand to access relevant information/ communication. Individuals can be informed and/or consulted directly anywhere and anytime if needed. In case of emergencies, a dedicated person can be reached at any time, regardless of his/her current location.

- Commercially, tourists can be a very attractive target group. Mobile technologies are in favor with young citizens. This might also create opportunities for establishing a lower threshold for interacting with governmental institutions.

- Personalization is often considered as an added value, because mobile technologies services can be tailored to the individual tourist. If a person is mainly interested in historical information, this can be taken into account when selecting/displaying information to that person. Advances in mobile technologies are growing very fast. So does the number of interaction channels that governments potentially can have with/from the citizens.

Tourists usually use information communication technology (ICT) for travelling in three ways: before trip, on site (during a trip) and after a trip as shown in Fig. 1.

Fig. 1. The use of ICT for Tourists

a) Before Trip

Tourists use ICT for finding information about the destinations they wanted to visit, make accommodation reservations and ticket reservations.

b) On Site

Tourists use ICT for finding some things they need while travelling such as restaurants, hospitals or a police station around the location they are visiting.

c) After Trip

Tourists use ICT to communicate with their family and friends to inform then about their travel experience and also share some photos they have taken from the sites they visited.

For the before trip and after trip information, there are many good web sites that provide services in these categories such as facebook and hi5. However, there are still a few services for the on site service. Therefore, this work is aimed at providing the service in the category of the on site service.

3 Proposed system overview

In order to design successful mobile device applications, it involves factors related to the technical characteristics of the device, the use of the applications [31] and the business model [32]. Therefore, there are many challenges in designing the system such as: design for mobility; design for a wide audience with various levels of competency in the use of new technologies, that do not necessarily have a history of experience with similar applications to draw on in learning a new one; design for limited input (small and impractical keyboard)/output facilities (small screen size, limited color and font size support); and design for user multitasking at levels unfamiliar to most desktop users [33, 34].

For interface design and usage, mobile device applications should pursue criteria similar to web sites development [35]. The design of an aesthetically pleasing interface is important, however, the success of the system is based on accessing information in an intuitive and easy manner [36]. Canadian Heritage Information Network adds some practical guidelines for the graphic design of mobile cultural guide's interfaces [37] which specify that: each screen node of the application should fit the size of the mobile device screen; the navigation should be structured hierarchically; and backtrack and easy access to the home page should be supported [28].

The idea of the proposed system can be described by using the following scenarios. First, a tourist takes a picture of he/she sees and saves it into the mobile phone. Next, he/she selects a picture and sends it to the image information retrieval application and database server through GPRS from the mobile device. When the server receives the picture, the search/image retrieval process begins immediately. The Autocorrelogram and Color Different Correlogram (AC/CDC) algorithms are used for image retrieval in this proposed system. After searching, the system will list the top ten most similar pictures and return those pictures to the mobile phone. The tourist then selects the picture they that think it is most appropriate for this case. After making a selection, the picture plus related information are displayed on the mobile phone screen. The details of the image retrieval algorithms are described in the next section. The overview of the proposed system is shown in Fig. 2.

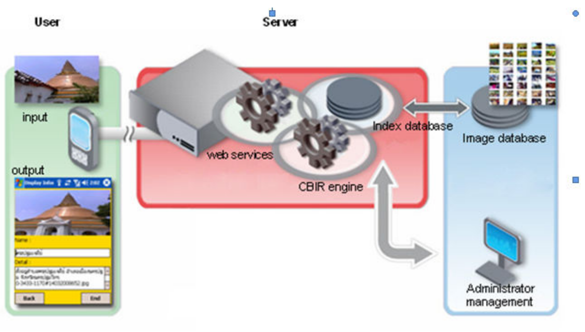

Fig. 2 The overview of the proposed system.

4 Background

This section outlines the concept of web services and the details of the algorithms used in the proposed system. A web service is designed to support interoperable mobile-to-server interaction over a network. The AutoCorrelogram (AC) technique is widely used as a visual feature extraction technique for content-based image retrieval (CBIR) systems. The Color Difference Correlogram (CDC) is an extended algorithm based on the Auto Correlogram developed by the authors [8, 10]. These two algorithms are implemented in the image retrieval system.

4.1 Web Services

A web service [7] is a software system designed to support interoperable machine-to-machine interaction over a network. It has an interface described in a machine-processable format (specifically WSDL). Other systems interact with the web service in a manner prescribed by its description using SOAP messages, typically conveyed using HTTP with an XML serialization in conjunction with other web-related standards. An overview of the use of web services is shown in Fig. 3.

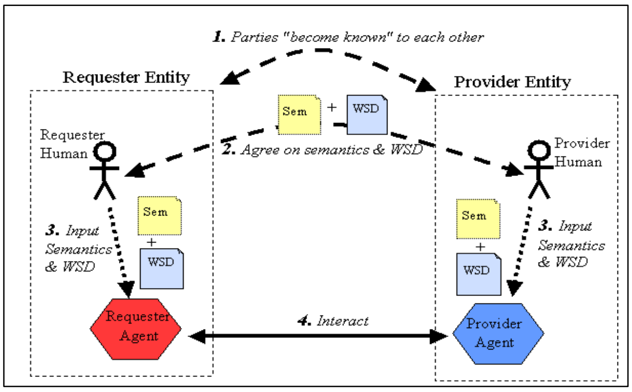

Fig. 3 Overview of the use of web services.

4.2 AutoCorrelogram

The AutoCorrelogram algorithm is one of the most widely used visual feature extraction techniques used in content-based image retrieval (CBIR) systems. It is a subset of the color correlogram [9]. The color correlogram of an image is a table indexed by color pairs. It represents a spatial correlation where the k-th entry for pixel (i, j) specifies the probability of finding a pixel of color j at a distance k from a pixel of color i in the image.

Let I be an n1 x n2 image. The colors in I are quantized into m colors: $c_1,\ldots,c_m$. $H_{ci}(I)$ is the number of a pixel with color c_i in I. For a pixel, let C(p) denotes its color. Let $I_c = \{p|C(p) = c\}$. The distance between 2 pixels is shown in the example below:

Given that p1= (x1, y1), p2 = (x2,y2), defined |p1-p2| = max{|x1-x2|-|y1-y2|} and let n denote the set {1,2,3,…,n}.

Let a distance d∈[n] be fixed a priori. i, j ∈[m], and k∈[d]. The color correlogram of image I is defined by Eq. 1 and 2.

$$\gamma^{(k)}_{c_i,c_j}(I) \cong \Pr_{p_1\in p_i, p_2\in I}[p_2 \in p_j \,||\, p_1 - p_2| = k] \quad (1)$$

$$\gamma^{(k)}_{c_i,c_j}(I) \cong \frac{\Gamma^{(k)}_{c_i,c_j}(I)}{H_{c_i} \text{ x } 8k} \quad (2)$$

The AutoCorrelogram only captures the spatial correlation between identical colors [9]. The technique used by the AutoCorrelogram is to pick any pixel p_1 of color C_i in the image I, at distance k away from p_1, and pick another pixel p_2, what is the probability that p_2 is also of color C_i as shown in Fig. 4.

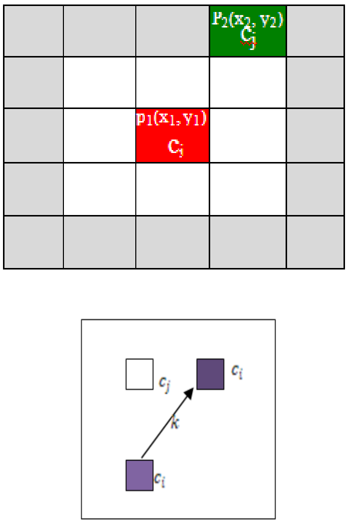

Fig. 4. Autocorrelogram of color c_i at distance k

The two sample images P1 and P2 are used to test the Autocorrelogram algorithm (See Fig. 5). A graph of Autocorrelogram versus Distance of two sample images is shown in Fig. 6.

P1 P2

Fig. 5. Sample Images P1 and P2

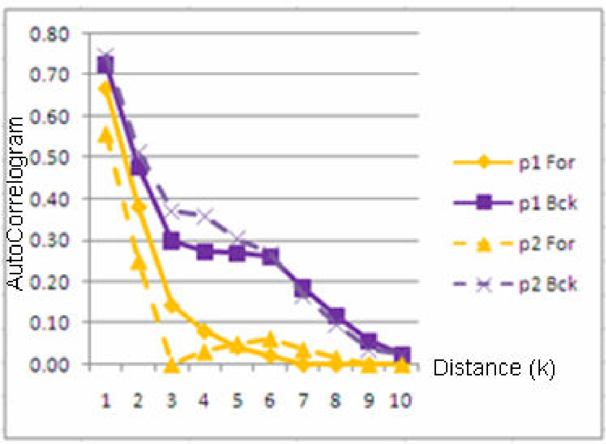

Fig. 6. Graph of AutoCorrelogram of the Images in Fig. 5.

Figure P1 and P2 have the same histogram. The two pictures can be differentiated by using AutoCorrelogram as shown in Fig. 6.

4.3 Color Difference Correlogram (CDC)

The Color difference correlogram (CDC) is the scheme that the authors modified from the texture description technique [8, 10]. The Color difference correlogram of an image is a graph or table that is indexed by color difference values, where the k-th entry for $Diff_i$ specifies the probability of finding the color difference value $Diff_i$ of pixels at distance k from any pixels in image. The color difference value between two pixels having distance equal to k is defined by Eq. 4.

$$diff_i = |\,C(p1) - C(p2)\,| \qquad (4)$$

$$\text{where } |\,p1 - p2\,| = k$$

The color difference correlogram is calculated by the formula in Eq. 5 and Eq. 6.

$$CDC^{k}_{diff_i}(I) \cong \Pr_{p_1,p_2\in I}\left[\,|C(p_1)-C(p_2)| = diff_i \mid |p_1-p_2| = k\right] \qquad (5)$$

$$CDC^{k}_{diff_i}(I) = \frac{\beta^{k}_{diff_i}(I)}{n_1 x\, n_2 x\, 8k} \qquad (6)$$

Where $\beta^{k}_{diff_i}(I)$ is the number of pixels having a distance from the centre equal to k and having a color difference equal to $Diff_i$. The graph of CDC versus Distance of two sample images is shown in Fig. 7.

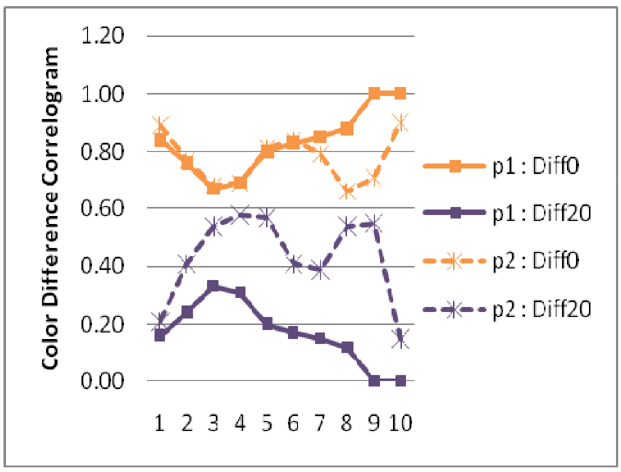

Fig. 7. Graph of Color Difference Correlogram of the images in Fig. 5.

4.4 Image Retrieval Scheme

The process used to retrieve images from the image database. The technique of distance measure (Huang et al., 1997) is employed in the process. This paper uses the d1 distance measure for comparing histogram, autocorrelogram, color difference correlogram, and AC/CDC because it is a "relative" measure of distance. The d1 distance measure for histogram, autocorrelogram, color difference correlogram and AC/CDC is defined by Eq. 7 to 10.

$$d_1(h) = |I - I'|_{h,d_1} \cong \sum_{i \in [m]} \frac{|h_{c_i}(I) - h_{c_i}(I')|}{1 + h_{c_i}(I) + h_{c_i}(I')} \quad (7)$$

$$d_1(\gamma) = |I - I'|_{\gamma,d_1} \cong \sum_{i,j \in [m],\, k \in [d]} \frac{|\gamma^k_{c_i}(I) - \gamma^k_{c_i}(I')|}{1 + \gamma^k_{c_i}(I) + \gamma^k_{c_i}(I')} \quad (8)$$

$$d_1(CDC) = |I - I'|_{CDC,d_1} \cong \sum_{diff_i \in [diff],\, k \in [d]} \frac{|CDC^k_{diff_i}(I) - CDC^k_{diff_i}(I')|}{1 + CDC^k_{diff_i}(I) + CDC^k_{diff_i}(I')} \quad (9)$$

$$d_1(\gamma, CDC) = d_1(\gamma) + d_1(CDC) \quad (10)$$

5 Implementation and testing

In this section, we describe how each of the separate steps in the system architecture have been designed and implemented for Information Retrieval using an Image from a mobile phone. An overview of the implementation of the proposed system is shown in Fig. 8. The picture is captured and sent over the Internet to the web server through GPRS. Web-services on the web server side are provided to handle incoming pictures from the mobile phone. The Mobile phone application interacts with the web service in a manner prescribed by its description using SOAP messages, typically conveyed using HTTP with an XML serialization in conjunction with other web-related standards. The mobile phone picture file is indexed and compared with the indexes of all pictures in the database by using the AutoCorrelogram and Color Difference Correlogram (AC/CDC) algorithms. After finishing the index comparison, the top ten similar pictures will be returned and displayed using the mobile phone application through GPRS.

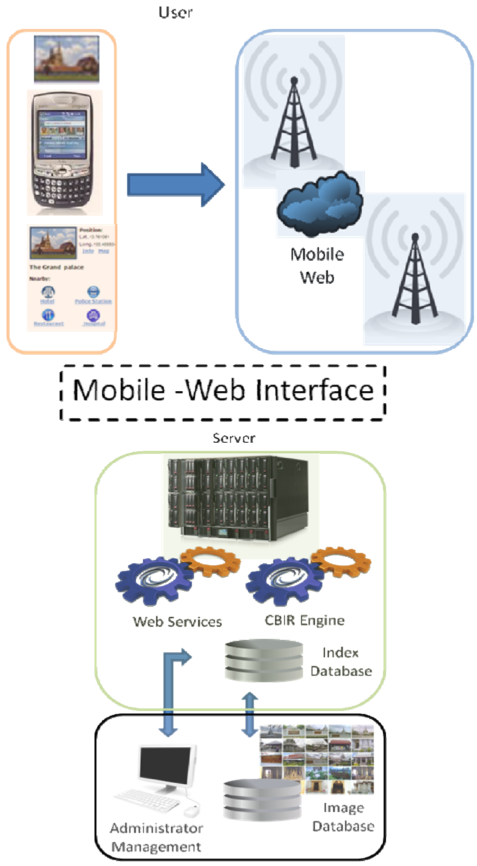

Fig. 8. An overview of the implementation of the proposed system

The details of the implementation are as follows:

5.1 Web Services Development

In this research project, a web service named "WsSIAMTO T.asmx" was developed. The details of web services are described as follows:

- Web Service Name is Service.asmx.
- Web Method Name is SaveFileAsType. This SaveFileAsType method converts all image file formats such as *JPG, *.GIF, *.BMP, *.ICO to binary file and saved into a database. The data type specified in the database is BLOB (Binary Large Object).
- Web Method Name is UpLoadPic. This UpLoadPic method returns all retrieved pictures to the mobile phone application.

5.2 Image Database

Microsoft SQL Server 2005 is used for database development in this research. Those pictures in the database have different sizes, resolution and file formats (JPEG BMP and GIF).

5.3 Sample Picture for the Test

One of the more interesting and well-known places in Bangkok, Thailand is named the Chakri Maha Prasat Throne Hall and the location around this place was used as the experimental location. The pictures of the Chakri Maha Prasat Throne Hall are taken from different perspectives. Note that in any pictures taken of a particular place, the main objects of interest must account for at least sixty percent of the picture as shown in Fig. 9.

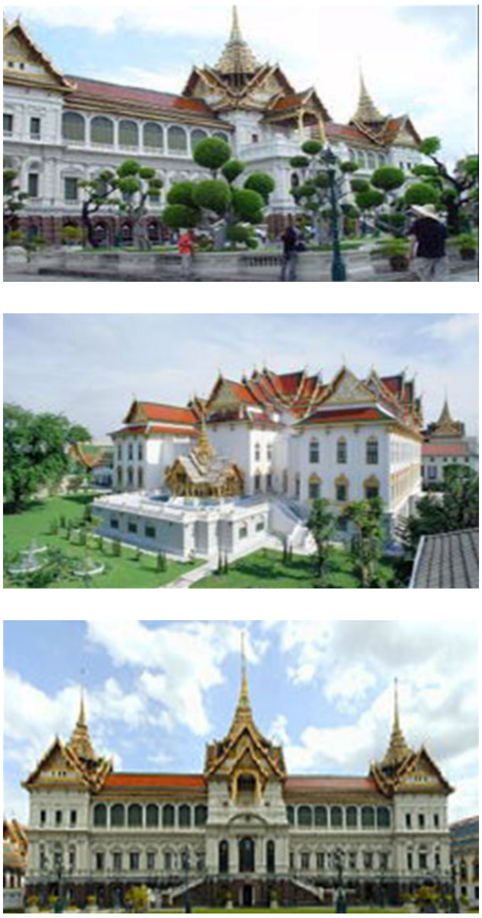

Fig. 9 The Chakri Maha Prasat Throne Hall

5.4 Performance Measures

The performance measures use the same parameters as those described in [9] as follows.

a) r-measure sums up of the correct answer for queries and average r-measure is the r-measure divided by the number of queries q as shown in the formula below.

$$r - measure = \sum_{i=1}^{q} Rank(Q_i) \quad (7)$$

$$Avg\ r - measure = \frac{r - measure}{q} \quad (8)$$

b) p1-measure is the sum of the precision with the recall equal to 1 and the average p1-measure is the p1-measure divided by q as shown below.

$$p_1 - measure = \frac{1}{\sum_{i=1}^{q} Rank(Q_i)} \quad (9)$$

$$Avg\ p_1 - measure = \frac{p_1 - measure}{q} \quad (10)$$

6 Experimental results

The image database consists of 1,061 images in various formats such as JPEG, BMP and GIF of various sizes. The database is considered as a heterogeneous image database. Consider the RGB color space with color quantization into 64 colors. Thus, the color difference values is the set {0,1, …,63} and the distance set d = {1,3,5,7,9,11,13,15,17,19}. The query set consists of 100 queries, each with a unique correct answer. An example of the use of the system is shown in Fig. 10 and a sample query is shown in Fig. 10.

Fig. 10. The implementation of the proposed system

Table 1 shows the results of the experiments that were performed. The performance of the proposed scheme was also compared with other methods, namely, the autocorrelogram and color difference correlogram [8, 10].

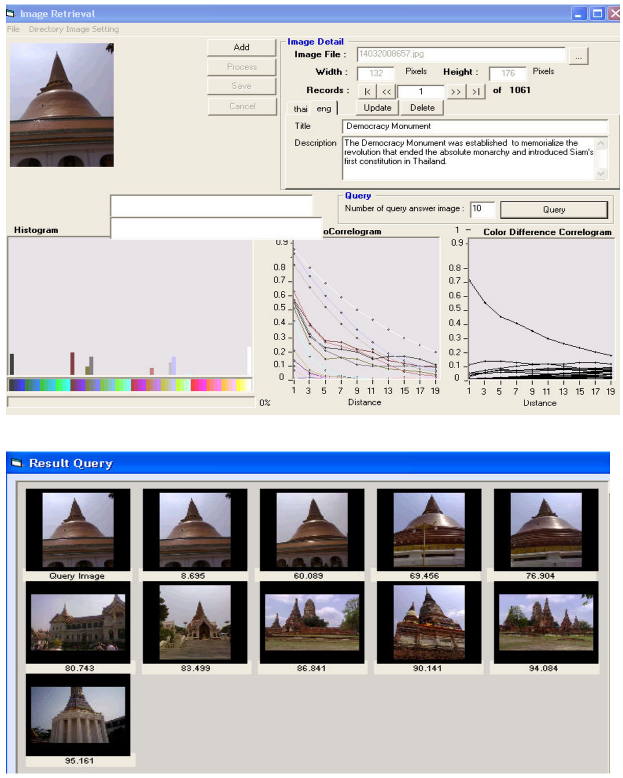

Fig. 11. An example of query and its results

Table 1. Performances of Various Methods

Method	AC	CDC	AC/CDC
r-measure	432	3899	227
Avg r- measure	6	53	3
p_1- measure	61	37	73
Avg p_1- measure	0.61	0.37	0.73

The response time for thirty image queries was individually measured and recorded. The average response time is 3.15 seconds. The response time starts measuring when the user clicks “Search”. The image is sent over the Internet through GPRS to the web server. After finishing the search, the image results are sent back to the mobile phone. When the mobile phone receives those images, the response time is recorded immediately.

7 Conclusion

An information retrieval scheme using images taken from a mobile phone camera is described. The Auto-correlogram and Color Different Correlogram (AC/CDC) algorithm [4] are utilized in the image retrieval system. The system was implemented and tested with real mobile phone queries. The experimental results show that the proposed system could be applied for practical uses. However, the system also needs to improve the overall speed of the system for a large image database.

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