QUERY BY IMAGE CONTENT USING MOBILE INFORMATION DEVICE PROFILE (MIDP)

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1. ABSTRACT

In this paper we present a Java-based client-server application for content-based image retrieval over wireless networks. The application on the client side is running on the Mobile Information device profile (MIDP) and is written in Java^{TM}.

Index Terms- Content, Retrieval, Indexing, Multimedia, Image, Search, Wireless, Mobile.

2. INTRODUCTION

2.1. Wireless Communications and Terminals

The way people communicate is changing very fast. Few years ago, mobile phones were used exclusively for voice calls. Today the mobile terminal usage is no longer restricted to voice communication only. In Finland, it is widely accepted among youngsters to use a GSM phone for sending SMS messages, to chat with friends or to play games. Adults may be more interested in checking their stocks or paying a bill using their wireless terminal and the Wireless Application Protocol (WAP). In Japan a phenomenal change in the use of mobile phones happened by the introduction of the "iMode" [1] system. The number of users since its introduction two years ago has risen to 20 millions.

The third generation, or 3G [2], phones will create new opportunities for content providers, by providing a way of transmitting text, voice, images, and streamed video. Moreover, their ability to be connected to Internet all the time will provide users with an overwhelming access to a huge amount of information. Users will then face the problem of how to retrieve the information of interest to them in an efficient manner. The goal is to allow for searching and navigation in this wealth of data without the need to make text-based queries for three obvious reasons:

- The user may be unable to type in commands,
- The keyboards of portable devices are not very comfortable for text-based commands,
- Text-based queries may not be very appropriate in the case of images, video or music.

In this paper we will introduce a content-based search engine and its graphical user interface. Even though, the newly introduced pervasive devices are having faster processors, larger memories and their available communication bandwidth is getting wider, they remain far behind the PC capabilities. Therefore, a major challenge in designing such a system is to understand the characteristics of such devices and their hardware and software limitations.

2.2. Content-based Indexing and Retrieval

Since the early 1990s, content-based indexing and retrieval (CBIR) of digital images became a very active area of research. Both industrial and academic systems for image retrieval have been proposed. Most of these systems (e.g. QBIC [3] from IBM, NETRA [4] from UCSB, Virage [5] from Virage Inc., MUVIS [6] from TUT) support one or more of the following options: browse, search by example, search based on a single or a combination of low level features. These features can be extracted from the image, such as color, shape, texture, spatial layout of objects in the scene or added to it after its capture, such as contextual information and keywords

3. CLIENT-SERVER ARCHITECTURE

3.1. The Client Side: The Mobile Information Device Profile (MIDP)

3.1.1. Introduction

As Java 2 Micro Edition is becoming the defacto stand of wireless device so we have selected J2ME platform as our client side. We are doing as little processing of the information as possible on the client side due to the resource limitions on the client side.

MIDP clients can come in many sizes, ranging from wireless mobile devices and Personal Digital Assistant (PD) all the way up to the desktop. The functionality supported by clients can vary as well. Simple clients deliver only web pages. More sophisticated clients, known as rich clients, can deliver services with multimedia content: sampled audio, synthetic tones, MIDI, and video.

3.1.2. Hardware Details

The objective of the MIDP is to establish an open, third-party application development environment for the Mobile Information Devices (MID). So the MID should have following hardware specifications: Screen-Size: 96 x 54, Display depth: 1-bit, Pixel shape (aspect ratio): approximately 1:1. The input through one or more of the following user-input mechanisms:

- One-handed keyboard,
- Two-handed keyboard,
- Touch screen

Memory:

- 128 kilobytes of non-volatile memory for the MIDP components
- 8 kilobytes of non-volatile memory for application-created persistent data
- 32 kilobytes of volatile memory for the Java runtime (e.g., the Java heap)

Networking is a two-way, wireless, possibly intermittent, with limited bandwidth.

3.1.3. Operating System

A minimal kernel to manage the underlying hardware (i.e., handling of interrupts, exceptions, and minimal scheduling). This kernel must provide at least one schedulable entity to run the Java Virtual Machine (JVM).

3.1.4. The Server Side

On the server side we are using a servlet [7]. The client sends the query to the servlet; which checks the query media type and passes it to the appropriate query handler.

The heavy processing required for the feature extraction, similarity estimation and results presentation are done on the server through calls from the Java side to methods implemented in native code. In this way we take advantage of the more efficient native code as compared to the pure Java implementation.

3.2. Communication Protocol

A communication protocol is defined between the client and the server. This protocol specifies the media type (Image media, Video media, or Audio media, currently we are using Image media only), query type (random query from database, query by image data or query with an image from the database) and query data (image data if the image is not in the database or images' index in the database).

The server sends back to the client the status of query execution and the results of the query, which consists of the list of names of the images and their similarity scores with respect to the query image. The client later fetches scaled versions of the images to be presented to the user. Scaling is done on the server side, in order to reduce the traffic.

4. THE USER INTERFACE AND SCREEN SIZE CONSIDERATION

In this application addition to the processing and memory issues, the designer has to consider the screen size of the wireless devices. Normally MIDP devices can show only one image at a time.

5. RESULTS AND ASSESSMENTS

Figures 1-3 show the results of different types of queries made to the image database, namely, color histogram, shape and texture queries. In each case, one similar image is retrieved and displayed on the Mobile Information Device (MID) screen. Server is running on the PC (PII, [8] 300MHz, 124MB RAM, windows XP [9] operating system), Table 1 and 3 show the query time on the server side. Time on the server include only query time on the server. However it is not including time to read the query information from the client and the time to send the results to the client (7650 [10] and 3650 [11]). Where as client time shows the time to send the query to the server, query time on the server and retrieval of the query results. Clients are connected to the server with the circuit switch data (CSD) call [12]. Where as table 2 and 4 show the image retrieval time from the server. Server first resizes the image to the size requested by the client and then

Table 1. Time taken to make a query on the server side and on the client 7650

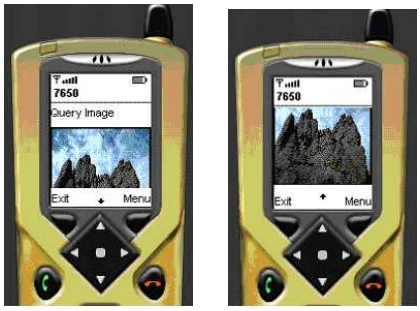
Query DataBase	Server Time	Client Time
Histogram	851ms	38650ms
Texture	481ms	7159ms
Shape	1392ms	32153ms

converts the image to the Portable Network Graphics (PNG) [13] image format. Server is always sending the PNG image to the client. Results in the table 1 to 4 depend upon many dynamic factors, load on the network, server status and available memory in the client.

6. CONCLUSIONS AND FUTURE WORK

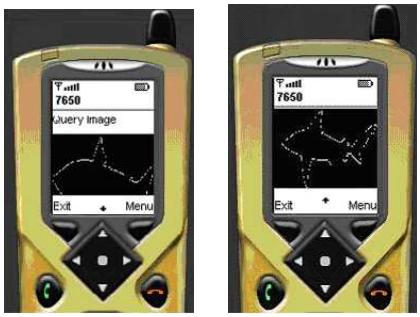
A novel implementation of TUT's MUVIS image query system has been proposed and tested on the MIDP emulator using a Java-based client server paradigm. A functional GUI was implemented taking into account the small size of the Mobile devices. however, due to the limiting factors in both the hardware and software of the wireless terminal as well as the communication channel, very limited results have been obtained, namely, reduced sizes of image query results, small number of images, long process and access times. The good news is that with the advent of 3G networks, offering higher data rates and more processing power in wireless devices and more memory, such an application would be possible.

Due to the restrictions imposed by the mobile devices technical specifications especially the screen size and by the communication cost. Moreover, the usage of pseudo relevance feedback [14], [15] will enhance the performance of our retrieval process; without increasing the communication cost or crowding the user interface with additional check boxes or radio buttons.



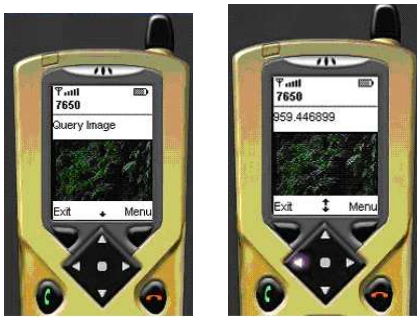
(a) (b)

Fig. 1. Histogram based (a) query and (b) retrieved images.



(a) (b)

Fig. 2. Shape based (a) query and (b) retrieved images.



(a) (b)

Fig. 3. Texture based (a) query and (b) retrieved images.

Table 2. Image retrieval time on 7650

Query DataBase	Server Time	Client Time	Image Size
Histogram	8331ms	38594ms	41936B
Texture	641ms	40625ms	44122B
Shape	1692ms	2656ms	878B

Table 3. Time taken to make a query on 3650

Query DataBase	Server Time	Client Time
Histogram	711ms	38703ms
Texture	411ms	7109ms
Shape	1495ms	32203ms

7. REFERENCES

[1] http://www.ntt.docomo.com/i/.

[2] http://www.3gpp.org/.

[3] http://wwwqbic.almaden.ibm.com/ qbic.

[4] http://maya.ece.ucsb.edu/netra.

[5] http://www.virage.com.

[6] http://www.iva.cs.tut.fi/homepage/mainmuvi.html.

[7] http://java.sun.com/products/servlets.

[8] http://www.intel.com/.

[9] http://www.microsoft.com/windowsxp/.

[10] http://www.nokia.com/nokia/0,5184,137,00.html.

[11] http://www.nokia.com/nokia/0,5184,2273,00.html.

[12] http://www.forum.nokia.com.

[13] http://www.libpng.org/pub/png/.

[14] J.J. Rocchio. Relevance feedback in information retrieval, in the smart retrieval system. *Experiments in Automatic Document Processing*, pages 313–323, 1971. Prentice Hall, Englewood Cliffs, New Jersey, USA.

[15] Y. Rui, T.S. Huang, and S. Mehrotra. “content-based image retrieval with relevance feedback in MARS”.