DOGS2010

DOGS2010 is the eighth conference offering an overview of current state and research directions in digital signal processing. Traditional conference topics are digital speech, image and biomedical signal processing.
The eighth DOGS will take place at the hotel Norcev at Iriški venac, one of the mountain tops of Fruška gora, from December 16th to 18th, 2010. The previous conferences took place in Novi Sad (1996), on Fruška gora (1998), in Novi Sad and Sremski Karlovci (2000), in the Dunđerski castle near Bečej (2002), in Sombor (2004), Vršac (2006) and Kelebija (2008).
This conference is unique within the boundaries of former Yugoslavia. Among its topics speech technologies traditionally stand out, being a very challenging problem highly dependent on language. Speech technologies help us to preserve our languages through application in various user services, and they are of immense importance to visually or hearing impaired people.

CONFERENCE TOPICS

Digital speech signal processing: speech generation and perception, phonology and phonetics, speech pathology, speech technologies (speech analysis and synthesis, speech recognition, speaker identification and verification), speech coding and transmission, speech cryptography techniques, noise reduction, analog and digital speech processing systems, implementation and applications (communications, computer telephony, etc.), and others.

Digital image processing: image coding and transmission, image analysis and segmentation, linear and non-linear image filtering and restauration, image modelling and representation, digital transformations, movement detection and estimation, implementation and applications (communications, multimedia, robotics, control, etc.), and others.

Digital Biomedical Signal Processing: linear and non-linear processing of 1-D biomedical (cardiovascular, neural and other) signals, decomposition, transformation, biomedical imaging, medical statistics.

CONFERENCE OVERVIEW

- Introductory invited papers
- Papers presenting an overview of current research (reviews of noteworthy papers published between two DOGSes)
- Original, previously unpublished papers
- Practical demonstrations of digital signal processing applications
- Round table discussions

DOGS is organized by the Faculty of Technical Sciences of Novi Sad, in cooperation with the Faculty of Electrical Engineering in Beograd, the Faculty of Electronics in Niš and Provincial Secretariate for Science and Technological Development of Vojvodina, under the auspices of the Ministry of Science and Technological Development of the Republic of Serbia and the IEEE Section of Serbia and Montenegro.

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OFFICIAL LANGUAGES

The official languages of the conference will be Serbian and English. Papers must be written and abstracts presented in one of the two.

ATTENDANCE FEE

The conference attendance fee is 5000 RSD, and it covers:

- Participation in programme activities
- Cost of proceedings (hard-copy and CD-ROM)
- Extra-curricular activities

Attendance fees should be paid into the bank account that will be announced shortly.

INSTRUCTIONS FOR WRITING PAPERS

Papers should be submitted abridged (1 to 2 pages) and/or unabridged, according to the instructions for authors (in Serbian orEnglish language), in an electronic form to the e-mail address:

secujski@uns.ac.rs

PROCEEDINGS

Accepted papers will be published in the Proceedings, available as a Book and a CD-ROM. Both will be available at the conference.

DEADLINES

31.07.2010. Submission of abstracts
15.10.2010. Submission of unabridged papers (up to 4 pages; invited up to 8 pages)
15.11.2010. Acceptance information

dogs2010

digitalna obrada govora i slike
iriški venac, decembar 2010.

PROGRAM KONFERENCIJE

Četvrtak, 16. decembar

19.00 Registracija učesnika

20.00 Koktel dobrodošlice

Petak, 17. decembar

9.00 Sala A – Sesija A1 (Govor)

A1.1 ROLE OF PROSODY IN HUMAN-COMPUTER INTERACTION – Milana Bojanić, Vlado Delić

A1.2 PROSODIC CONSTITUENTS IN SERBIAN – Maja Marković, Tanja Milićev

A1.3 TRAJANJE GLASOVA I NAJUTICAJNIJI FAKTORI U SRPSKOM JEZIKU – Sandra Sovilj-Nikić

A1.4 ANALIZA TRAJANJA I INTENZITETA ZVUČNIH GLASOVA /dž, ž, r, l/ U TIPIČNOJ I ATIPIČNOJ PRODUKCIJI – Silvana Punišić, Slobodan Jovičić, Zorka Kašić, Slavica Golubović

A1.5 MODELOVANJE IZGOVORA AFRIKATA /c/ – Milan Vojnović, Miško Subotić

A1.6 MODELOVANJE ATIPIČNOG IZGOVORA AFRIKATA /c/ – Milan Vojnović, Silvana Punišić

9.00 Sala B – Sesija B1 (Biomedicinski signali)

B1.1 IDENTIFIKACIJA GOVORNIH MOŽDANIH ZONA FUNKCIONALNOM MAGNETNOM REZONANCOM – Olivera Šveljo, Katarina Koprivšek, Miloš Lučić, Mladen Prvulović, Branimir Reljin, Milka Ćulić

B1.2 ROBUST FEATURE-BASED REGISTRATION FOR CT-MR IMAGES – Nemir Ahmed Al-Azzawi, Wan Ahmed K. Wan Abdullah

B3.4 KORIŠĆENJE GENETSKOG PROGRAMIRANJA ZA DETEKCIJU POPLAVLJENOG POLJOPRIVREDNOG ZEMLJIŠTA – Predrag Lugonja, Nemanja Petrović, Dubravko Ćulibrk, Vladimir Crnojević

B3.5 KLASIFIKACIJA SLIKA ZASNOVANA NA ADABOOST ALGORITMU I STABLIMA ODLUKE SA HOG I LBP OBELEŽJIMA – Marko Panić, Predrag Lugonja, Dragan Letić, Dubravko Ćulibrk, Vladimir Crnojević

B3.6 PREPOZNAVANJE PEŠAKA ZASNOVANO NA HOG I LBP OBELEŽJIMA PRIMENOM RANDOM FOREST ALGORITMA – Dubravko Ćulibrk, Marko Panić, Dragan Letić, Predrag Lugonja, Vladimir Crnojević

B3.7 AUTOMATIZOVANI VIDEO NADZOR SAOBRAĆAJA KORIŠĆENJEM DETEKCIJE I PRAĆENJA POKRETNIH OBJEKATA – Dragan Letić, Branko Brkljač, Predrag Lugonja, Dubravko Ćulibrk, Vladimir Crnojević

B3.8 EYE LOCALIZATION USING CORRELATION FILTERS – Vitomir Štruc, Jerneja Žganec Gros, Nikola Pavešić

B3.9 APPLICATION OF THE PROGRESSIVE WAVELET CORRELATION TO CONTENT-BASED IMAGE RETRIEVING – Igor Stojanović, Ivan Kraljevski, Slavčo Čungurski

18.00 Sala A – Sesija A4 (Govor)

A4.1 KONSTRUKCIJA DEO PO DEO UNIFORMNOG KVANTIZERA I PRIMENA U KODOVANJU GOVORNOG SIGNALA – Zoran Perić, Jelena Nikolić, Aleksandra Jovanović

A4.2 KOMPRESIJA SA GUBICIMA I BEZ GUBITAKA GOVORNOG SIGNALA VISOKOG KVALITETA – Zoran Perić, Milan Savić, Milan Dinčić

A4.3 UTICAJ KARAKTERISTIKA AMBIJENTA NA KVALITET GOVORNOG SIGNALA – Petar Prokić, Slobodan Jovičić

A4.4 UTICAJ NAČINA UPOTREBE MOBILNOG TELEFONA NA FORMANTNE FREKVENCIJE – Nikola Jovanović, Slobodan Jovičić

A4.5 PRIMENA GOVORNIH TEHNOLOGIJA U ADAPTACIJI RAČUNARSKE IGRE LUGRAM ZA SLEPU I SLABOVIDU DECU – Branko Lučić, Nataša Vujnović Sedlar

A4.6 MODELING MACEDONIAN INTONATION FOR TEXT-TO-SPEECH SYNTHESIS – Branislav Gerazov, Zoran Ivanovski, Ružica Bilibajkić

A4.7 TIME ENCODED SIGNAL PROCESSING FOR SPEECH QUALITY ASSESSMENT – Ivan Kraljevski, Igor Stojanović, Slavčo Čungurski, Sime Arsenovski

A4.8 SPEECH SYNTHESIS OF DISSIMILAR LANGUAGES USING THEIR PHONETIC SUPERSET – Slavčo Čungurski, Ivan Kraljevski, Igor Stojanović, Blerta Prevalla

APPLICATION OF THE PROGRESSIVE WAVELET CORRELATION TO CONTENT-BASED IMAGE RETRIEVING

Igor Stojanović[1], Ivan Kraljevski[2], Slavčo Čungurski[3]

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ABSTRACT

The following study presents a method for search and retrieval of images from massive image collections. The method consists of two phases. The first phase uses well-known methods of image searching by descriptors based on the content of the searched image. In the second phase the progressive wavelet correlation method is applied on the small number of image candidates selected in previous search phase. The final search result is the wanted image, if it is in the data base. Experiments are performed with data bases of 1000 and 10 000 images.

1. INTRODUCTION

Images digitalization system itself doesn't entail an easy management of collection of images. A particular form of cataloguing and indexing is still required. The only difference being that most of the information needed can potentially be automatically retrieved from the images themselves. The need for efficient storage and retrieval of images was recognized by managers of large collections of images long time ago and was prompted again via workshop sponsored by the American National Science Foundation in 1992 [1].

There have been recognized certain areas requiring further researches data representation, feature extractions and indexing, image query matching and user interfacing. One of the main difficulties highlighted here is the one that arises when locating the required picture from a large and diverse collection of images.

There are several techniques for image searching: descriptor-based search, pixel-based search and image understanding techniques.

The earliest and the most sophisticated descriptor-based image search engine is IBM QBIC [2]. Examples for such tools are WebSEEk and Virage. The described image search engines are based on compact image representation in order to produce high processing speed. Generally there is no time for image analysis during the search phase. The main descriptor-based search techniques are limited in two ways: Firstly, they do not contain the details of the image, and secondly, they do not cover the overall features within the frames of the image descriptors. Large complex images can contain many details and as a result a suitable compact presentation will be hard to determine.

On the other side, pixel-based search represents a somewhat different direction that has promise for applications that require high resolution, such as satellite images and medical images, particularly in geosciences. Pixel-based search techniques work by locating a particular pattern in a given image library. Popular criteria for matching are the normalized correlation coefficients [3], which measure the differences between images and patterns from the library. The particular strength of these criteria is that they are insensitive to uniform differences in brightness.

Some of the work done in the area of content-based image retrieval and PWC (Progressive Wavelet Correlation) [3] are outlined in Section 2 and 3. Our proposal about applying of the combination of content-based method and PWC for searching images stored in a database is presented in section 4. Results of experiments that use the proposed system are presented in Section 5.

2. CONTENT BASED IMAGE RETRIEVAL

Content-based image retrieval (CBIR) aims at inventing techniques that support effective searching and browsing of large image digital libraries based on automatically derived image features. In the past decade, many general-purpose image retrieval systems have been developed, including QBIC, Photobook, Virage, VisualSEEK, WebSEEK, and others. A typical CBIR system views the query image and images in the database (target images) as a collection of features, and ranks the relevance between the query image and any target images in proportion to feature similarities.

Many research works have been published in the field of CBIR. However, no universally accepted model has yet been developed. The research concentrates on image segmentation based on low-level features like color, shape, texture and spatial relations.

To find the semantic meanings or high-level meanings of an image, like whether it is the image of human beings or a bus or a train and so on, is still a problem. Attempts are being made to link low-level and high-level features. However, it is proving difficult for the very simple reason that there remains a vast gap between human perception and computer perception.

CBIR systems include two main sub-systems: the server subsystem and the client subsystem [4]. The server subsystem handles the processes of feature extraction, database indexing/filtering, feature matching and system learning. The client subsystem handles the process of querying.

3. PROGRESSIVE WAVELET CORRELATION

3.1. Overview

The PWC pixel-based method for retrieval of images involves correlation in the frequency domain for fast computation, discrete cosine transform (DCT) in factorizing form and wavelet representation of signals for efficient compression [3]. The primary idea is based on Vaidyanathan's theorem [5] for computing convolutions of wavelet-packet representations of signals. Progressive wavelet correlation summarizes Vaidyanathan's results replacing the operation of convolution in the wavelet domain with the equivalent operation in the Fourier-transform domain.

In this method the correlation between the two signals is formed in their original domain, without reverting from the transform domain. This method is progressive in the sense that each resolution level is calculated based only on the preceding level; lower resolution levels are irrelevant.

The algorithm can be described as follow:

Step 1: A candidate image is coarsely correlated with the pattern. Every eighth point of the correlation is generated.

Step 2: It is determined whether the pattern suitably matches the candidate image. If not, then another candidate image may be chosen or the search abandoned.

Step 3: If the match was suitable, then the candidate image is medium correlated with the pattern. We obtain the correlation at indices that are multiples of 4 mod 8 of the full correlation.

Step 4: Another similar match test is performed.

Step 5: A candidate image is finely correlated with the pattern. The fine correlation obtains the correlation at indices that are multiples of 2 mod 8 and 6 mod 8 of the full correlation.

Step 6: Another similar match test is performed.

Step 7: Full correlation: Obtain the correlation at odd indices.

Step 8: If a suitable match is found for the fully correlated image, then the image has been found.

3.2. Extension to two dimensions

Let the image size be N by N. In step 1, we have 64 subbands of length $N^2/64$. We perform one step of the inverse 2D JPEG transfer function, and one 2D step of the forward Fourier transform function. The next step involves adding the 64 subbands point by point to create a 2D array of size $N/8$ by $N/8$. Taking the inverse Fourier transform, we obtain the correlations at points that lie on a grid that is coarser than the original pixel grid by a factor of 8 in each dimension. In step 2, we obtain 16 subbands of size $N^2/16$ by adding the 16 subbands point by point, and taking the Fourier inverse. We obtain the correlation values on a grid that is coarser than the original grid by a factor of 4 in each dimension. In step 3, we obtain 4 subbands of size $N^2/4$. Finally, in step 4, the full resolution is obtained.

Formulas for calculating normalized correlation coefficients that measure differences between images and patterns are given in [3]. Normalized correlation coefficients can be computed from the correlations described above. The normalization is very important because it allows for a threshold to be set. Such a threshold is independent of the encoding of the images.

4. PROPOSED SYSTEM FOR IMAGE RETRIEVING

4.1. Adaptation of PWC for searching in a database

The progressive wavelet correlation provides guidelines on how to locate an image in the image library. To make this method practical, we must first decide how to store the images. The initial choice is to store them in a disk file system. This can be seen as the quickest and simplest approach. A better alternative that should be considered is to store those images in a database. Databases offer several strengths over traditional file system storage, including manageability, security, backup/recovery, extensibility, and flexibility.

We use the Oracle Database for investigation purposes. There are two ways of storing an image into the Oracle Database. The first one is the use of Large Objects – LOB, and the second one is the use of Oracle *inter*Media.

To store images into the database we use the BLOB datatype. After creation of one BLOB column defined table we also create a PL/SQL package with a procedure for loading images (named load). This procedure is used to store images into the database.

The implementation of the progressive wavelet correlation in Matlab and the connection between the algorithm with the database are the next steps. The Database Toolbox is part of an extensive collection of toolboxes for use with Matlab.

Before the Database Toolbox is connected to a database, a data source must be set. A data source consists of data for the toolbox to access, and information about how to find the data, such as driver, directory, server, or network names. Instructions for setting up a data source depend on the type of database driver, ODBC or JDBC. For testing purposes JDBC drivers were usually used [4].

After setting up the data source for connecting to and importing data from a database we have used several standard functions of the Matlab Database Toolbox. We can retrieve BINARY or OTHER Java SQL data types. However, the data might require additional processing once retrieved. For example, data can be retrieved from a MAT-file or from an image file. Matlab cannot process these data types directly. One needs knowledge of the content and might need to massage the data in order to work with it in Matlab, such as stripping off leading entries added by the driver during data retrieval.

The last step in the adaptation is to create Matlab applications that use the capabilities of the World Wide Web to send data to Matlab for computation and to display the results in a Web browser. In the simplest configuration, a Web browser runs on a client workstation, while Matlab, the Matlab Web Server (matlabserver), and the Web server daemon (httpd) run on another machine. In a more complex network, the Web server daemon can run on a separate machine [4].

4.2. Combination of content-based method and PWC

Pixel-based search using progressive wavelet correlation is too expensive computationally to apply to large collections of images, especially when it is possible to discover in advance that no match is likely. It has to be combined with descriptor-based search or some other means of reducing the search space. After descriptor matches narrow the search, pixel-based search can find matches based on detailed content.

Results obtained from a number of performed experiments by retrieving images from a database via application of both CBIR and progressive wavelet correlation led us to the idea of combining them in order to make the best use of their positive features. The initial idea was extended into a developed proposal for a new system intended for searching and retrieving images from a database. The modular scheme of this system is given in Figure 1.

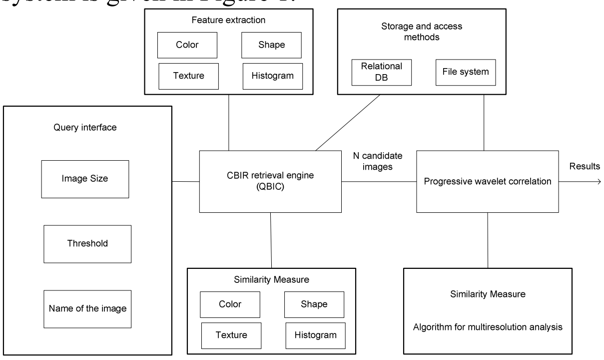

Figure 1: A modular scheme for the proposed retrieval system.

5. EXPERIMENTAL RESULTS

Using QBIC, we established a database for the following characteristics of images: color, text, color histogram, and texture feature. We query the database for those images in the library with the most similar characteristics to the input image. On this set of candidates, we apply the normalized correlation coefficients to obtain the desired image. As an example, we show our work on locating the image 21.jpg (Figure 2) in a database. Using QBIC, we isolated ten candidate images based on the Color Histogram Feature. After that these images are subjected to detailed pixel-based search based on PWC.

For testing we used two PC on 3 GHz with 1 GB RAM. On one of them we installed Oracle Database Server version 10.1.0.2.0 and on the other we installed MATLAB version 7.0.4.365 (R14) Service Pack 2. We tested a different number of images stored in the database for different values of threshold *thr*. The results of retrieval performance are shown in Figure 3.

Figure 2: *21.jpg* and *flower10.jpg*.

We can conclude from Figure 3 that the time required searching and retrieving increases approximately linearly with the rise in the number of images stored in the database. On the other hand when the proposed algorithm is used for image retrieval, the retrieval performance is practically independent of the database capacity.

Investigating how the number of selected images depends on the number of images into database we obtain practically the same shape (Figure 4).

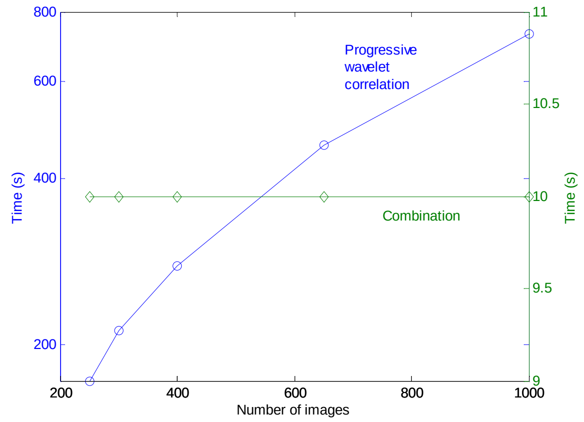

Figure 3: Retrieval performance for different number of images for the image *21.jpg* and $thr \geq 0{,}7$.

Based on our experience we propose the following minimum threshold values when the combination of two methods is used:

- 0.5 for images not having visually similar images in the database (image *21.jpg*) ;
- 0.7 for images having visually similar images in the database (image *flower10.jpg*).

Using the PWC, the value of the threshold should be equal or higher than 0.7. Figure 4 presents number of located images for constant value of threshold *thr*=0.5. When PWC are used, increasing the number of images into the database will result with an increased number of located images.

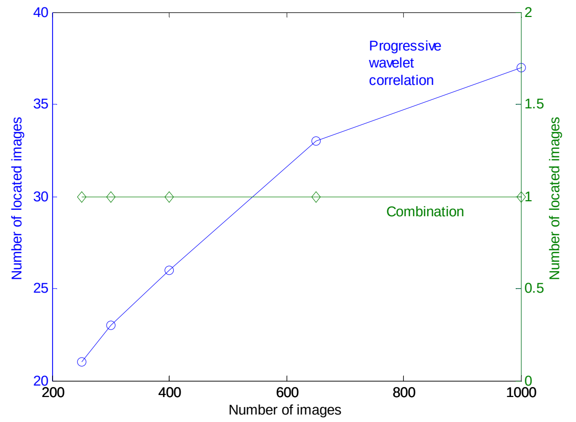

Figure 4: Number of located images versus number of images into database for the image *21.jpg* and *thr* =0,5.

5.1. Results obtained by applying the proposed system to large databases

Considering the results obtained from a number of image retrieval examples, we become aware that the use of the proposed algorithm for search and retrieval of images from a database can be very useful.

The results demonstrated in the previous examples referred to a database of 1000 images. The following charts present results concerning the time needed to retrieve image from a database of 10 000 images. The database used in these experiments is taken from http://wang.ist.psu.edu/docs/related.shtml.

In this section the adopted value of the image size is *N*=80, while the correlation threshold value is 0.7.

Table 1: flower01.jpg.

Number of images	2000	4000	7000	10000
Time (sec) (proposed system)	11.07	11.09	11.42	11.88

Table 2: flower10.jpg.

Number of images	2000	4000	7000	10000
Time (sec) (proposed system)	9.07	9.15	9.23	9.26

Table 3: 21.jpg.

Number of images	2000	4000	7000	10000
Time (sec) (proposed system)	4.5	4.67	4.72	4.91

Figure 5: *flower01.jpg* and *1795.jpg*.

Table 4: 1795.jpg.

Number of images	2000	4000	7000	10000
Time (sec) (proposed system)	7.18	7.26	7.36	7.64

Figure 6: *1890.jpg* and *1993.jpg*.

Table 5: 1890.jpg.

Number of images	2000	4000	7000	10000
Time (sec) (proposed system)	4.58	4.84	5.09	5.27

Table 6: 1993.jpg.

Number of images	2000	4000	7000	10000
Time (sec) (proposed system)	4.53	4.69	5.96	5.17

The time required for retrieving of image *flower01.jpg* with proposed system for image retrieval from the database is takes approximately 11 seconds because the image appears eight times in the database. Image *flower10.jpg* appears six times in the database and the time needed for search and retrieve is 9 seconds. For image *1795.jpg* time for search and retrieve is 7 seconds, the image appears four times in the database. The time require to locate the images *21.jpg*, *1890.jpg*, and *1993.jpg*, is approximately the same as the usage of the proposed system for image retrieval because the three images too, appear once in the database.

From Figure 7 we can conclude that with using of proposed system for searching and retrieving of images the time required to locate an image doesn't depend on the number of images stored in the database.

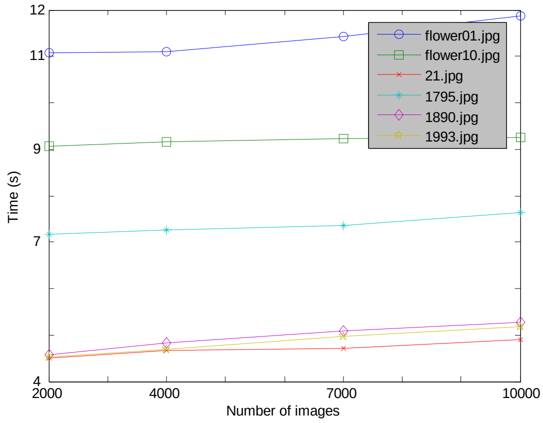

Figure 7: Retrieval performance for different number of images.

5. CONCLUSIONS

The efficiency of joint content and pixel-based retrieval of images from a database can be improved in some applications such as satellite and medical imaging by appropriate selection of the threshold value. Content-based image retrieval is fast, but it normally gives more than one image due to the vast differences in perception capacity between humans and computers. On the other hand, pixel-based retrieval using progressive wavelet correlation is impractical, due to the numerous operations per image it entails. However, a positive outcome should be expected if we combine the good features of content-based and pixel-based searches: speed and accuracy.

In the following years commercial systems are expected to be capable of performing extensive analysis for about one thousand images per second. Such procession speed will facilitate the construction of a real system that will operate as a combination of both content-based and pixel-based retrieval.

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