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ANALYSIS OF SOFTWARE AND HARDWARE REQUIREMENTS FOR THE COMPUTER VISION PLATFORM

Summary. The aim of this article is to present the Computer Vision Platform which was created to enable the multimedia data storage. The platform is equipped with devices necessary for image acquisition and management. Moreover the programs utilized for multimedia data processing are also presented. One of the crucial concerns, while the hardware and software design, was the easy accessibility of the proposed solution through the cost limitation.

Keywords: computer vision, multimedia databases

ANALIZA WYMAGAŃ PROGRAMOWYCH I SPRZĘTOWYCH DLA STANOWISKA WIZJI KOMPUTEROWEJ

Streszczenie. Celem tego artykułu jest zaprezentowanie platformy Komputerowej Wizji (CVP), którą stworzono w celu umożliwienia składowania multimedialnych danych. Platforma została wyposażona w urządzenia konieczne do akwizycji oraz zarządzania obrazem. Ponadto, zostały przedstawione programy wykorzystywane do przetwarzania multimedialnych danych. Jednym z ważniejszych założeń podczas doboru sprzętu oraz tworzenia oprogramowania było zapewnienie wysokiej dostępności rozwiązania poprzez ograniczenie kosztów.

Słowa kluczowe: wizja komputerowa, multimedialne bazy danych

1. Introduction

Images become widely used as a medium for information transfer. Due to the fast Internet connection, there are no more obstacles to take advantage of multimedia information with high quality, most commonly in daily life, work, etc. Moreover, parallel to the development of security systems, which employ images from PTZ (pan-tilt-zoom) or CCTV (closed-circuit

television) cameras, and the utilization of high resolution images for disease diagnosis as well as meeting participant activities research and sign language recognition, make the problem of storage and processing huge amounts of multimedia data crucial and valid. All the mentioned systems need not only sophisticated algorithms for image processing and understanding, but also proper data storage.

The computer vision is the domain which joins different areas of Computer Science. The development of large and more sophisticated systems, dedicated to work in the real world environment, require the engagement of the database mechanisms, advanced algorithms and hardware. Preparing the Computer Vision Platform (CVP) we have focused on hardware and software aspects. This paper describes the results of our analysis of the indispensable hardware and software for a universal computer vision system. In Section 2 the Computer Vision Platform is described. Following this section brief information is given about our main research interests, and finally conclusions are drawn.

2. Computer Vision Platform

The Computer Vision Platform has to face three main tasks: the data acquisition, the storage, maintenance and information analysis. The image acquisition engages equipment like digital or analog cameras, sampling devices like DVR (digital video recorder) cards or video servers. The camera choice is determined by the application area and usually it results from required image quality and price compromise. The data storage and maintenance should be directly connected with data analysis for example to improve performance as they influence the main node functionality and productivity.

The main node of the Computer Vision Platform is a dual processor server (dual Xeon 2.4 GHz) with two SCSI hard disk drives (400GB each) and a 2.5 GB RAM memory. The server is running the Windows 2003 Server operating system which supports remote access and allows a multi-logon on the server. The CVP is created to store, manage, process, and access multimedia resources. To assure maximum flexibility and comfort during accessing these resources we use services like FTP server, HTTP server and network disks. Network connection is realized with two standard interfaces 100 MB and 1 GB Ethernet. Multimedia management is also realized with the IBM database server DB2 Viper 9. This approach focuses not only on data storage, but also on data management and manipulation, directly on the server on a database level. Moreover, many external multimedia devices are connected to the server.

2.1. CVP Multimedia Devices

Our choice for image acquisition equipment includes the digital and analog devices, both.

The digital camera SONY DCR-TRV 125E [16] permits recording of images in the Digital8 format. The CCD (charged coupled device) sensor with optical zoom (x25) allows the acquisition of good quality images in 800x600 digital resolution. This camera, with an additional tripod, is utilized to register vehicles pulling in to the University faculty car-park and also to track the vehicles passing by adjacent street. This allows conveying research about the traffic in the University campus.

The data from remote IP controlled cameras (e.g. PANASONIC Wv nm100 and PLANET ICA-100W [18]) are uploaded to the server using built-in FTP client, SMTP and WWW services. These images are in high resolution digital quality (at least 640x480 pixels resolution) and are saved in a JPEG format with a speed up to 30 images per second. It allows developing soft real-time vision systems. Our experiments with low-cost web cameras proved that it can be also valuable source of images for video analysis systems, hence CVP consists of two such cameras (e.g. Logitech QuickCams). This research aims to create in a future a low-cost system for sign language learning and chatting, which could be used in a home environments.

Fig. 1. The Computer Vision Platform Equipment
Rys. 1. Sprzęt stanowiska wizji komputerowej

The building monitoring system is installed at the Faculty of Automatics, Electronics and Computer Science of the Silesian University of Technology. This system consists of eight (PANASONIC Wv nm100) analog cameras connected through DVR Card HiCap 50 [19]. The monitoring recordings are cyclically stored on the server where it is possible to store data from up to three months at a time. Additionally, the FTP service is set on monitoring server and therefore it is possible to get access to the recorded materials from the network. Although, a low resolution is the main disadvantage.

There is also a possibility to connect to the Sony SNC-RZ 30P [17] camera in the Institute of Theoretical and Applied Informatics of the Polish Academy of Sciences. This camera has impressive parameters 25x optical zoom and 736x544 resolution. Moreover, it gives an opportunity to develop applets and servlets commanding and controlling the camera movement.

2.2. CVP Programming Environments

Multimedia system development should be based on software development environment with support for multimedia data types, multimedia data access interfaces and specialized tools libraries. Already created systems are written in Microsoft C# and Sun Java languages. To develop, test and debug the Microsoft Visual Studio .NET and Eclipse programming environments are used. The chosen languages are well prepared to work with complex data like images and XML files. The created applications work as stand-alone, three layer architecture or database embedded systems. To execute Java programs the three versions of JVM are utilized:

- Standard Sun Java Virtual Machine for stand-alone applications,
- IBM WebSphere Server for server business code in three-tier architecture,
- Embedded JVM inside DB2 Server.

There are available additional plug-ins for the Eclipse platform, exploited to develop Java applications, which allows to employ this platform not only for editing program source code but also to manage application server state as well as to manipulate database structure and change its configuration. On the other hand, the Microsoft tools guarantee easy access to technologies such as ODBC, ADO.NET or Web Services.

3. Research Domains

Our research concentrates generally on the computer vision problems as well as effective data storage for such systems. In this section we would like to briefly describe the main investigated problems:

- multimedia databases,
- sign language recognition system,
- car plate recognition system.

3.1. Multimedia Databases

Still image is the most typical and the most important multimedia resource. Among various forms of real world recordings (i.e. sound, videos) images contain more semantic information, which describe presented objects. Image is a complex object by its nature, which implies it to be a real multimedia resource. In the current situation, generally, databases are used to work with atomic data, therefore introducing multimedia resources management is a real challenge [4]. Images are complex due to its semantic information and the description level. Both semantic and syntactic descriptions are usually based on XML documents. Employing additional structures supporting metadata comparison we have reached the situation when the created data model has to effectively maintain database binary large objects (BLOB), XML documents and typical relational data. It is convenient to use structural data types to achieve the required granularity of the description [3].

After a broad analysis of currently available complex data support in different database management systems [13, 14] we have chosen IBM DB2 9 DBMS. Provided in this system support for structural data, programming mechanisms on the database level [15] and completely native XML documents support [1] has caused that this database meets all the important requirements to manage a vision system data model [2].

The main objectives of our research are:

- creation of a hybrid data model for multimedia,
- multimedia analysis mechanisms implementation on the database programming level,
- multimedia semantic similarity measure optimization,
- user defined aggregates (UDA) and recursion queries in similarity measure.

The researches conveyed in this domain are simultaneously verified in other applications, like those described below.

3.2. Sign Language Recognition System

There are two ideas for a sign language recognition system development. Short term plans establish the implementation of the sign language recognition system where input data is taken from a digital image camera without markers. Currently, the step of hands and face detection module implementation is terminating and the results of performed researches of the optimal skin colour detector and lighting normalization problems may be found in articles [10] and [9, 12] respectively. Further plans of the sign language learning system with automatic gesture recognition were described in the paper [11]. Some examples of the system work are given in the Fig. 2.

Fig. 2. Sign language recognition system performance example
Rys. 2. Przykład wyniku rozpoznania języka migowego

3.3. Car Plate Recognition System

The second computer vision understanding project consists of car plate recognition. The system was implemented as a part of the MSc thesis [5]. The implemented application allows us to follow stages which transform an input image (a bitmap) into an ASCII string describing the car plate number [6, 7]. In Fig. 3 the following partial results of testing application are presented:

- colour input image,
- pre-processed bitmap (changed from a colour image into a grey-level one),
- detected plate,
- converted rectangle with a potential plate from 256 grey-level into a binary image,
- labelled coherent areas,
- filtered (removed areas that are not the ASCII characters),
- The last stage is a recognition of the particular signs using OCR algorithms.

Further research concentrates on the car plate detection and segmentation module development. We want to implement a set of new Polish car plate localization and segmentation algorithms to compare its efficiency [8]. Additionally, our work will be carried out to improve the recognition rate with artificial neural networks and genetic algorithms.

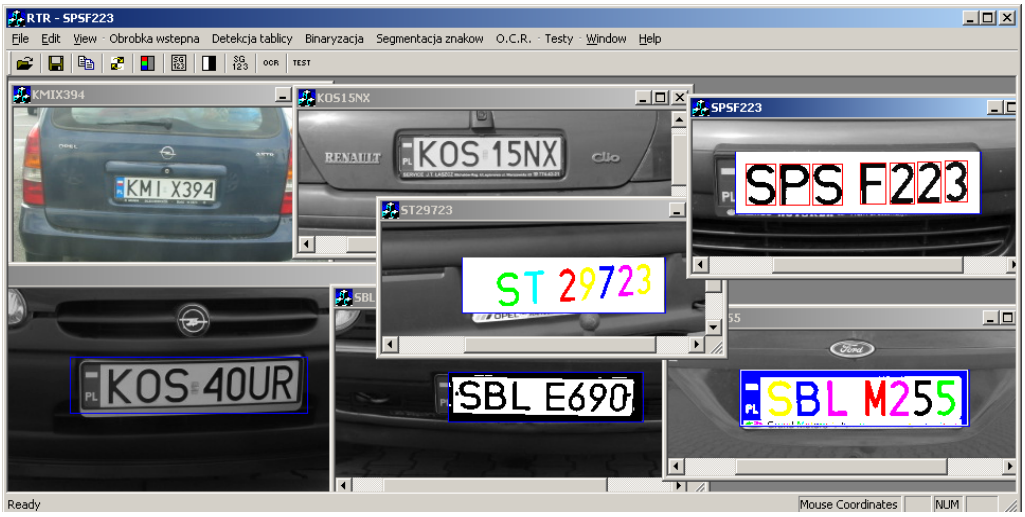

Fig. 3. Next steps of car plate recognition system performance
Rys. 3. Kolejne kroki rozpoznawania numerów tablic rejestracyjnych

4. Conclusions

The Computer Vision Platform is designed to exploit the multimedia databases, verify complex and hierarchical data access interfaces usability, develop the sign language and car plate recognition systems. The goal of creation of the hardware and software tool, which enables easy data recording, storage and processing, was achieved.

The necessary hardware and software tools were identified for developing the platform for described systems. In analysis of requirements for the platform both storage aspect and multimedia processing was taken into consideration with special treatment of still images processing capabilities. The proposed structure of the platform and selected software and development environments permit to activate it as a central server, accessible for selected researchers. In the next stage of the platform advancement selected resources and functionality will become available also for Internet users.

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Omówienie

Stanowisko wizji komputerowej zostało stworzone w celu prowadzenia badań nad multimedialnymi bazami danych, rozpoznawaniem języka migowego i tablic rejestracyjnych pojazdów. Głównym zadaniem stanowiska jest nagrywanie, przechowywanie i przetwarzanie danych.

Artykuł składa się z czterech rozdziałów. W pierwszej części autorzy uzasadnili potrzebę stworzenia kompleksowego stanowiska wizji komputerowej, umożliwiającego prowadzenie badań w Instytucie Informatyki Politechniki Śląskiej.

W rozdziale drugim artykułu opisano parametry techniczne stanowiska. Głównym elementem systemu jest serwer, na którym przechowywane są dane multimedialne. Dodatkowo podłączone są kamery analogowe oraz cyfrowe, pozwalające dokonać akwizycji danych niezbędnych do przeprowadzenia badań (rys. 1).

Opis przeprowadzanych badań został zawarty w części trzeciej. W ostatnim rozdziale przedstawiono wnioski, dotyczące przechowywania i przetwarzania multimedialnych danych, ze szczególnym uwzględnieniem konieczności przetwarzania dużej liczby statycznych obrazów. Zaproponowana struktura systemu, wyselekcjonowane programy oraz możliwości centralnego serwera mogą być wykorzystane do dalszych badań. Kolejny etap rozwoju stanowiska to poszerzenie jego funkcjonalności poprzez udostępnienie systemu użytkownikom Internetu.

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