Architecture of Communication System for Distance Learning of Deaf People

Rumen P. Mironov[1] and Roumen K. Kountchev[2]

Abstract - **Architecture of communication system for distance learning of deaf people is presented. The basic function is to combine standard video information with sign language information, received by speaker. Fundamental block in the system is a special contour detector, which is using for detection and compression of movements of the translator.**

Keywords – **digital image processing, software architectures, communication systems, sign language.**

I. Introduction

Video communication systems for deaf people are limited in terms of quality and performance. The analysis of the visual attention mechanisms for sign language may enable optimization of video coding, transmission, reconstruction and visualization systems for deaf users. Sign language is a complex combination of facial expressions, mouth/lip shapes, hand and body movements, and finger spelling [1].

Visual perception of sign language video requires sufficient spatial and temporal resolution to capture the detailed movements of the sign interpreter. Reasonable visual quality and frame rates can be obtained using contour image compression for video transmission by the Internet Communication System for Distance Learning of Deaf People (CSDLDP), developed in the Video Communication Laboratory, Technical University of Sofia.

The intelligent contours extraction and transmission permit to obtain very efficient lossless compression with high compression ratio and good sign language comprehensibility [2], which is a base for the development of various application tools for the mobile communications and distance learning.

In this paper architecture of the developed Internet communication system for distance learning of deaf people is presented. The basic idea is to use special contour detector, developed in [2], for movements of the sign language translator, make high efficiency compression of extracted objects [3], combine this information with standard video information to present and transmit over Internet [4]. The system is used in science research by the contract VU-MI-104 "Transmission of video information over Internet for distance learning of deaf people".

[1]Rumen P. Mironov is with the Faculty of Telecommunications, Technical University of Sofia, Kl. Ohridsky Str. 8, 1000 Sofia, Bulgaria, E-mail: rmironov@tu-sofia.bg.

[2]Roumen K. Kountchev is with the Faculty of Telecommunications, Technical University of Sofia, Kl. Ohridsky 8, 1000 Sofia, Bulgaria, E-mail: rkountch@tu-sofia.bg.

II. Architecture of the System

The architecture of the developed CSDLDP system is presented on Fig.1. It is organized on modular principle and includes the following blocks, worked on the base of the well-known [5], [6], [7] and the new developed methods [8], [9]:

- *Video coder*. In this module functions for compression of real video sequences with different rates and qualities are included.
- *Audio coder*. In this module functions for compression of real audio sequences with different rates and qualities are included. It contain also functions for transferring of audio and sound frequency band into the several frequency strips, which can be understand by the people with partial defection of the hearing.
- *Contour detector*. In this module functions for contours detection of movements of sign language translator are included [2].
- *Contour coder*. In this module functions for high efficiency compression of contour sequences, developed in [3], are included.
- *Video server*. In this server video or TV information can be accepted, managed, processed and distributed over the Internet. He also contains functions for video encryption and saving in special video presentation database. There are interface components for interactive distance learning of students, with or without teachers.
- *Video database*. This is multimedia database in which sign language video sequences, video clips, audio, presentations and text documents are saved [10],[11]. The DBMS can be MS SQL Server 2008, Oracle 11, MySQL 5 or other SQL oriented system.
- *Video streaming server*. This is a special media server for packaging and transmission of presented multimedia data flow over Internet.

The first four modules (video coder, audio coder, contour coder and detector) are incorporated in a new AVC Coder subsystem, which is used to combine the different compressed multimedia data flows into one multimedia audio-video format (MAVF) and transmit it to the video streaming server.

In the receiver side the functional blocks are the same. The video streamers are used for receiving Internet data and unpacking it and transmit to the decoders. The AVC Decoder subsystem, in which are incorporated video decoder, audio decoder and contour decoder, is used to separate the multimedia data flows into audio, video and contours, decompress audio, video and contour data and transmit the developed presentations to the computer classes, presentation halls or individual consumers.

The CSDLDP system is realizing as object-oriented software modules on C++ for operational systems Windows 98/2000/XP/Vista.

For real-time processing and transmission the hardware realization of all sender modules is necessary, which can be accomplished by the time-saving servers, specialized video controllers with TV tuner boards and signal processors from the Texas Instruments, like DSP DM6446 DaVinci.

III. Experimental Results

One of the most complicated blocks in the presented system is the contour detector of sign language interpreter. Using two contour frames from video film of sign language interpreter for deaf people, the visual quality analysis of contour extraction is made. The basic frames of size 320×240 and 24 bpp in BMP format are shown on Fig.2 and represent frame 37 and frame 44 of the signed sentence called “At each other's throat”.

Fig. 2. Basic images ateachot37.bmp and ateachot44.bmp (320x240 pixels, 8 bits)

On Fig.3 contour images, obtained from the basic ones by the developed algorithms for contour extraction of size 320×240 and 8 bpp in BMP format are shown.

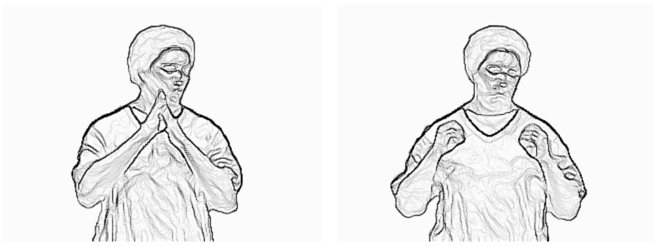

Fig. 3. Input contour images ateachot37c.bmp and ateachot44c.bmp

Then the extracted frames can be compressed separately by the high efficiency lossless compression algorithm, with compression ratio more then 100, as is shown in [2]. The visual quality of the moving contours is excellently and they are completely enough for understanding of sign language interpreter.

For the other video components of multimedia data standard compression techniques as H.264/AVC can be used. The audio decomposition and compression is in development now.

The efficiency of the developed multimedia database, which application programming interface (API) is shown on Fig.4, is testing by 8 clients for 5 video clips.

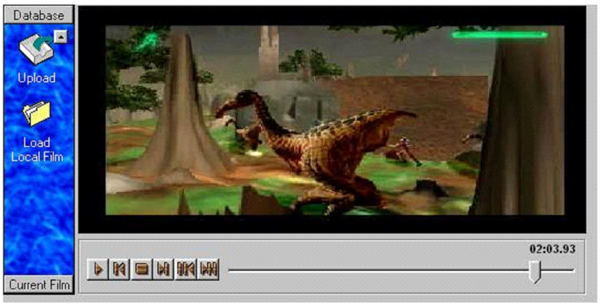

Fig. 4. Multimedia database API

The network tests for video transfer from/to the server with 10 Mb/s and 100 Mb/s in Intranet set are done and the measured times in seconds are given in Tabl.1.

TABLE I
DATABASE PERFORMANSE

Name of video clips	**Size of video clips (bytes)**	**Transfer to the server (sec)**	**Transfer from the server (sec)**
		(10 Mbit/s)	
Transmit.avi	34816	33.71	7.41
Test66.mpg	323761	129.60	12.25
IcVideo14.mpeg	563419	273.71	18.57
Model.avi	1828354	1106.41	79.26
IcVideo43.mpeg	8556548		
Name of video clips	**Size of video clips (bytes)**	**Transfer to the server (sec)**	**Transfer from the server (sec)**
		(100 Mbit/s)	
Transmit.avi	34816	2.57	0.57
Test66.mpg	323761	10.76	0.98
IcVideo14.mpeg	563419	22.17	1.51
Model.avi	1828354	105.41	7.55
IcVideo43.mpeg	8556548	1063.21	180.65

During the transfer time of video data to the server with 10 Mbit/s the CPU performance is average 15.7% and the virtual memory size is increasing from 100 MB to 140 MB. For transferring of video data from the server the CPU performance is average 9.4% and the virtual memory is increased from 100 MB to 105 MB. For the analogical tests with 100 Mbit/s the CPU performance is average 26.2% and for loading the CPU performance is decreasing about 0.8%. The virtual memory is the same as by the 10 Mbit/s tests. These results show that general factor for transfer time of video data is the performance of SQL components.

For testing of client-server performance an asynchronous test with 100 Mbit/s for 5 and 8 simultaneously connected clients is made. The CPU performance is 18.1% for 5 clients and 19.4% for 8 clients and the virtual memory is increased with about 8-9 MB. The received results are averaged for one client and shows increasing of requesting time with about 4%.

We have run also films with large size in order to estimate the developed MM Browser performance. The CPU Usage (in %) for data stream decompression and the used RAM (in Kbytes) are estimated. A comparison is performed with some software tools widespread on the market. The results are shown in Table II. The experimental files own MPEG, QT and AVI formats (OutCast.mpeg - 38.2 MB, Menace_480.mov - 24.8 MB, ICVIDEO27.AVI - 4.10 MB).

TABLE II
COMPARISION OF MM BROUSER

Program Name	OutCast.mpeg		Menace480.mov		ICVIDEO27.AVI	
	CPU	MEM	CPU	MEM	CPU	MEM
Xing Player	86%	6085	-	-	-	-
QT Movie Player	-	-	53%	8870	-	-
MS Media Player	88%	7496	65%	8432	18%	7532
MM Browser	98%	8860	75%	9483	51%	10606

The developed multimedia application for dealing with MM Data Base through Internet/Intranet allows the following options: maintenance of centralized database for films; saving the widespread video formats – AVI, QuickTime and MPEG; maintenance of extended information about the downloaded films, as well as easy access to them; downloading and playing films from files; Internet/Intranet connection for downloading and saving films from/to database; searching of film using the title; saving the current played film into the local hard disk.

Our application need higher CPU and MEM Usage since it works simultaneously with video data, situated on the local hard disk and video data located on SQL server. Note also that Xing Player and QT Movie Player don't support some of the basic video formats: MOV and AVI; MPEG and AVI respectively (see Table II).

IV. CONCLUSION

The developed architecture has the following advantages:

- communication over the standard IP network;
- module design, based on multimedia processing tasks;
- possibilities to use in presentation and interactive distance learning mode;
- using of advanced image and video processing algorithms for decomposition and compression;
- large possibilities for upgrades and improvements.

The developed Internet communication software system can be used in different areas for distance learning not only of deaf people, but for videoconferences, science research and etc. The system will allow improvements of human life quality and expand the possibilities for learning in different areas - quantitative microscopy, analysis of biomedical images, biotechnologies, robotics, ecological monitoring, visual control in the industry, economics, medicine, science researches and etc.

ACKNOWLEDGEMENT

The authors thank the National Fund for Scientific Research of the Bulgarian Ministry of Education and Science for the financial support by the contract VU-MI-104/2006.

REFERENCES

[1] D. Agrafiotisa, N. Canagarajaha, D.R. Bulla, J. Kyleb, H. Seersb, M. Dyec. "A perceptually optimised video coding system for sign language communication at low bit rates". *Signal Processing: Image Communication*. vol. 21, No. 7, pp. 531-549, 2006.

[2] R. Kountchev, S. Rubin, M. Milanova, Vl. Todorov, R. Kountcheva. "Extraction of Objects Contours for Body Language Study". *The 2008 IEEE Intern. Conference on Information Reuse and Integration (IEEE IRI'08)*, Las Vegas, USA, pp. 220-225, July 13-15, 2008.

[3] A. Cavender, D.K. Barney, R.E. Ladner, R. Vanam, E.A. Riskin. "Mobile ASL: Intelligibility of Sign Language Video as Constrained by Mobile Phone Technology". *Disability and Rehabilitation: Assistive Technologies*, Special Issue ASSETS 2006, vol. 3, pp. 93-105, 2008.

[4] ITU-T, Series H: Application profile – Sign language and lip-reading real-time conversation using low bit-rate video communication. *CCITT Recommendations.* Supplement 1, 05, 1999.

[5] Maher A., Sid-Ahmed, *Image Processing: Theory, Algorithms, and Architectures*. McGaw-Hill, Inc., 1995.

[6] B. Jähne. *Practical Handbook on Image Processing for Scientific and Technical Applications*. 2nd Ed., CRC Press, 2004.

[7] W. K. Pratt. *Digital Image Processing*. 4th Ed., John Wiley & Sons, 2007.

[8] C. Ware. *Information Visualization – Perception for Design*. 2nd Ed., Morgan Kaufmann, 2004.

[9] R. Kountchev, R. Mironov. "System for Image Processing, Analysis and Recognition". *Journal for Automatic and Informatic*, Sofia, Number 4, pp.41-44, 1996, (in Bulgarian).

[10] A. Mironov, R. Mironov. "Using database for presentation of multimedia information". *National Conference with foreign participation "Evolution of Telecommunications Networks and Systems"*, TELECOM'99, October 26-28, pp.642-649, Varna, Bulgaria.(in Bulgarian).

[11] R. Mironov, N. Sirakov, F. Muge. "An Architecture of Virtual Multimedia Library". *Proc. of V Ibero – American Symposium on Pattern Recognition*, SIARP'2000, Lisbon, pp.103-111, September 11-13, 2000.

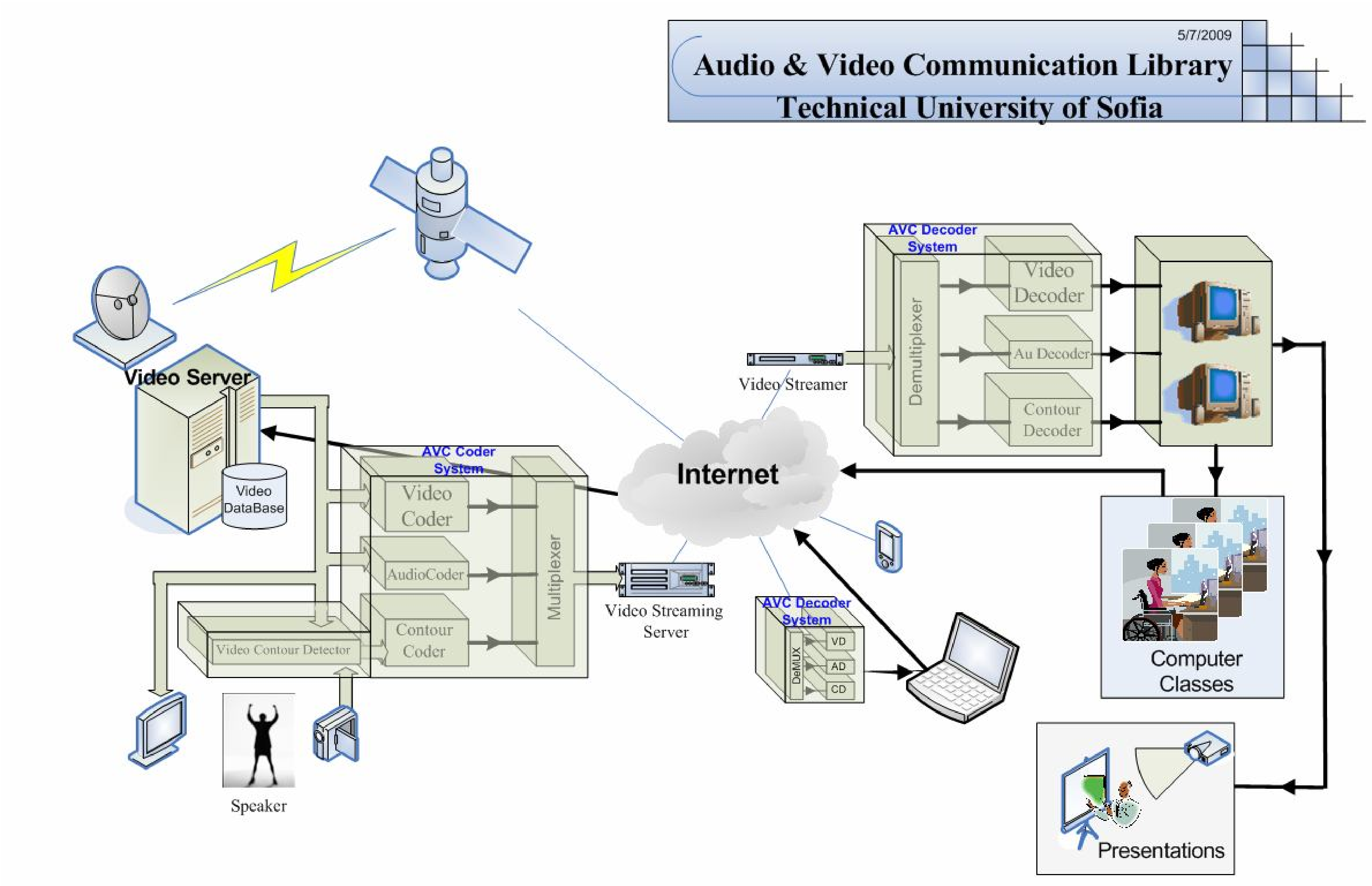

Fig. 1. Architecture of Internet Communication System for Distance Learning of Deaf People