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### IMAGE PROCESSING SYSTEM PROPOSED TO BE APPLIED IN A GASTROSCOPIC LABORATORY

The article presents a way to integrate an endoscope with computer equipment. Software has been proposed to archive and access results of endoscopic tests. The data can be accessed at the hospital area and from outside it. Aside with standard descriptions and conclusions there is also an option to watch pictures and videos recorded during a medical examination. Software for real-time editing of the video material together with the option of applying graphics filters to the watched videos has been proposed for use in endoscopic laboratories.

Keywords: endoscopic tests, real-time processing, system for accessing examination results

#### 1. INTRODUCTION

Medicine like other science areas experiences a growing need for storing information concerning performed medical examinations and consultations. The information is indispensable for making records and elaborating databases about patient visits or performed testing. Recently, a new kind of information to be stored in computer systems has been introduced and it is graphical information (pictures, images, radiographs) and video files (like of USG or endoscopic tests). Later, the stored data can be freely processed by means of simple, quick and comparatively inexpensive techniques of data storage and transmission. It shows that previously experienced problems with free transmission lines and limited capacity of databases for storing graphical information have been overcome owing to new inexpensive graphics stations with capacious disks.

In an endoscopic lab recorded graphical and video information about the performed examination needs to be archived for later analysis and diagnostics. Such archiving makes possible to reduce the frequency of endoscopic testing which is time-consuming and expensive. Based on such information it is also possible to evaluate the duty performance of less experienced medical staff.

Database systems that store graphical information have been used in many branches of industry and medicine for quite a long time. Alas, endoscopic laboratories are still

poorly computerized and there is no legal requirement to archive medical images in a digital form.

There are many reasons that speak for changing the described situation. They can be classified into the following groups:

a) diagnostic reasons:

- a traditionally-obtained image, like on an endoscope screen or from a printer, cannot be processed as a computer image. There is no possibility to zoom it out, change the contrast, obtain automatic measurement of distance and angles, select an area of interest, watch the details. All of the named shortcomings decrease the diagnostic potential, which can be of negative consequence both for the patient and his diagnostician, and eventually - for the payer as well.
- an endoscope screen image at a given moment can be viewed only at one place and it is not possible for two specialists in two different places to discuss and work on the examined case.

b) reasons of the organization-financial kind:

- traditional archives are space-taking and need staff to be serviced,
- it is sometimes hard or even impossible to find a specific file in the traditional archives and it may happen that a file gets irreversibly lost, which makes necessary to perform all the needed testing again,
- patients (both of a hospital and outpatients) are given their examination records together with descriptions.

c) legal reasons:

- presently, when a number of patients who sue medical establishments for misdiagnoses or inadequate treatment grows, hospital documentation and reliable access to the records of previously performed examinations are of key importance.
- legal regulations require long-time archiving of examination data. In order to ensure optimal electronic archiving, medical images should be stored in databases [1].

An analysis of the above-given reasons indicates that no stimuli (e.g. legal requirements) to introduce digitalization to endoscopic labs (and the like) can render impossible or difficult:

- a) to enhance quality of medical testing,
- b) to introduce modern archiving,
- c) for hospitals to take advantage of EU funds assigned for digital techniques applied to exchange information among EU countries,
- d) to offer consultation potential for small medical units that have no laboratories of their own.

## 2. A STAND FOR PROCESSING AND ACCESSING MEDICAL EXAMINATION RESULTS

In order to process medical examination records without unnecessary signal losses an endoscope can be directly connected to a graphics station. (Fig. 1) [1].

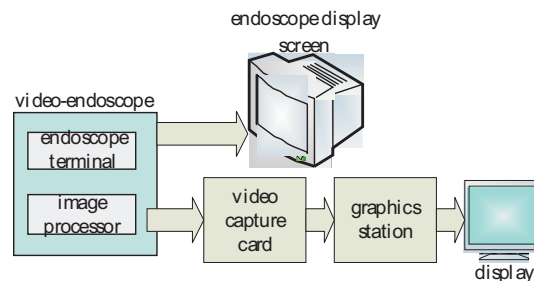


Fig. 1. Block diagram of recording endoscopic testing in the digital format.

Quality of information recorded the above way can be considerably enhanced by the application of known methods for graphical image processing, which can be of advantageous effect on the diagnostics.

An analysis of the software to store data in an endoscopic laboratory [4] proves that the replacement of local databases by a global one makes examination data accessible also from outside the lab without employing additional staff for that purpose [6]. Apart from the database itself the way of data organization as well as the access control should also be restructured. Presently, when almost all computers are connected to local networks and they in turn – to the Internet, the simplest way to make the data accessible is to apply the HTTPS protocol (HTTP coded by the SSL technology) It protects the transferred data from their interception and possible altering. On the other hand, with the granted authorization such data could be viewed on computers equipped only with a web browser operating based on any operating system (Fig. 2).

It can be seen in the above picture that the only extra cost of the proposed solution (apart from a PC-class unit for capturing and preliminary processing of pictures and videos [5]) is related to a server that is necessary to protect and exchange the data. All the software elements are free: operating system for the server (Linux, FreeBSD), protocols (SSL), databases (MySQL) and a web browser (Firefox).

The ways of performing an examination and then elaborating a report have not been changed. First, testing results in the picture and video formats can be viewed by the medical staff at a local computer – a graphics station. Next, they are preliminarily analyzed and supplemented with descriptions and then uploaded to the server. A patient gets an examination result (report) together with information that detailed data concerning the examination have been archived and can be accessed by authorized persons. (Fig. 3).

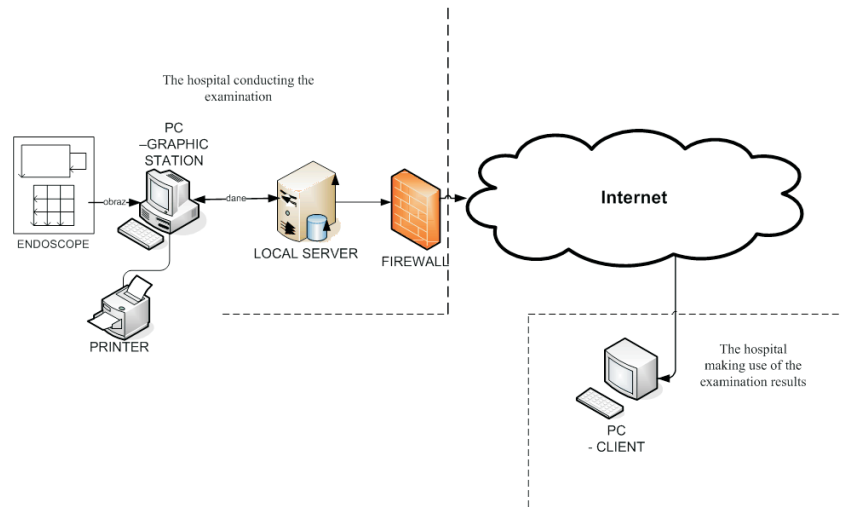


Fig. 2. Access to endoscopic examination data from outside a hospital unit.

Wyloguj Pacjenci Ustawienia Użytkownicy

**+** Nowy pacjent

**Szukaj Pacjenta**

Imię:

Nazwisko:

Pesel:

**Lista Pacjentów:**

Nr kartoteki	Imię	Nazwisko	Nr Pesel	Adres	Edycja	Nowe badanie	Ilość badań
12345	Henryk	Ceglowski	563423678	120-950		Dodaj Badanie	Ilość badań:1
23456	Jan	Kazimierz	78234567345	0mi		Dodaj Badanie	Ilość badań:10
345678	Lidia	Kostrubiec	568976543	020-445		Dodaj Badanie	Ilość badań:1
456789	Janina	Bryła	1234567890	020-446		Dodaj Badanie	Ilość badań:1
567890	Anna	Wąsek-Zentak	78765434567	020-345		Dodaj Badanie	Ilość badań:1

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Fig. 3. Main window of the application.

### 3. REALTIME PROCESSING OF THE VIDEO MATERIAL

The situation gets more complex when a filter to enhance the quality of a video sequence is to be applied. A smooth video sequence shows 24-25 frames per second. When typical programming tools like C++ Builder, Delphi, JAVA etc. are applied, video libraries comprised in the software make possible to apply any filter to a video material but smooth reproduction of such a filtered video with the use of typical graphics stations is not possible [3]. For that reason, the Edius software (Fig. 4) made by Canopus company, which is a software that is commercially used in professional studios for editing and conversion of videos, has been selected. It makes possible to realtime apply any available filter to an imported video material. Technical specifications for the selected software are not exaggerated (Table 1).

Table 1. Minimum parameters of a graphics a station for smooth operation of the selected software.

Processor	Intel® Pentium® 4 processor 3.0 GHz
Mainboard	Dedicated Intel , GBLAN, DualDDR2
RAM	1GB
Hard drive space	800 MB of free disk space
Graphics card	24-bit or 32-bit graphics card DirectDraw overlay at a resolution of 1024×768
DirectX	DirectX 9.0
Software	Windows® XP Home or Windows® XP Professional (Service Pack 2)

The applied graphics station meets the minimum requirements of the selected support software, which makes possible to take full advantage of the potential.

Key features of the EDIUS software:

- realtime previews of the material,
- realtime conversion of the material,
- big number of simultaneous layers,
- 30 video filters,
- 7 audio filters,
- 3D interpenetration of images,
- implemented Adobe Premiere Pro plug-in,
- support for PAL and NTSC standards,
- support for 16:9 and 4:3 modes,
- support for DV, DVCAM and Digital 8 formats,
- YUV 4:2:2 edition,
- 3 video tracks,
- realtime correction of the material,
- possible application of several filters simultaneously.

The only impediment could be that the software applies to a video already written to the disk. There is no possibility to capture an image directly from an endoscope. In this case it is not a problem because a detailed documentation of a patient is elaborated

after an examination is done and the application of filters during the procedure could only make the examination unnecessarily longer.

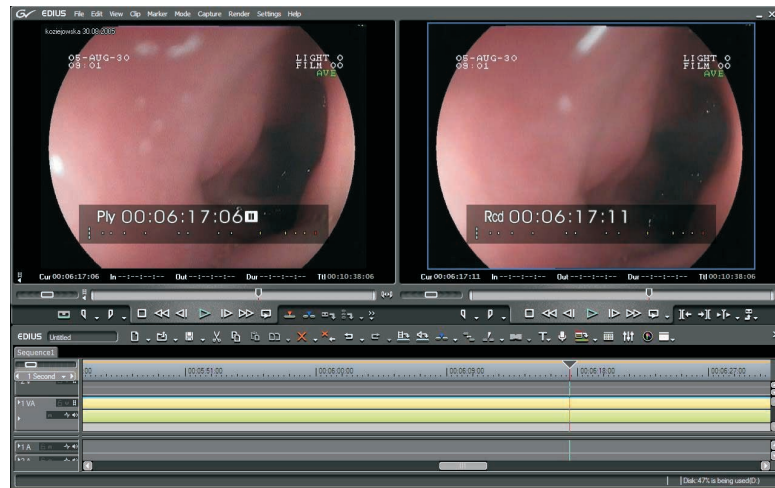


Fig. 4. EDIUS software – edit window.

Application of the discussed software makes also possible to watch the effect of the applied filter on vector and wave shapes of a selected frame (Figs. 5 and 6). The waveforms below present distributions of color (VectorScope – color distribution in an image) and brightness (WaveForm – with the IRE option ON). The effect of an applied filter on the original image can be seen there.

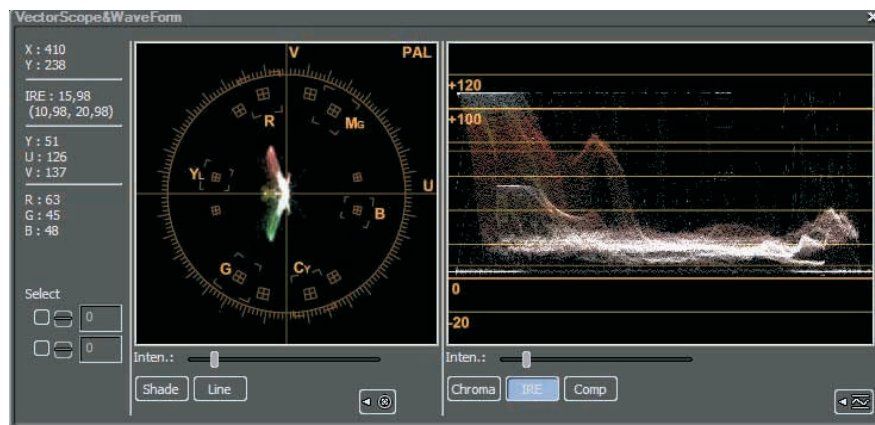


Fig. 5. Waveform of an original frame of the edited video.

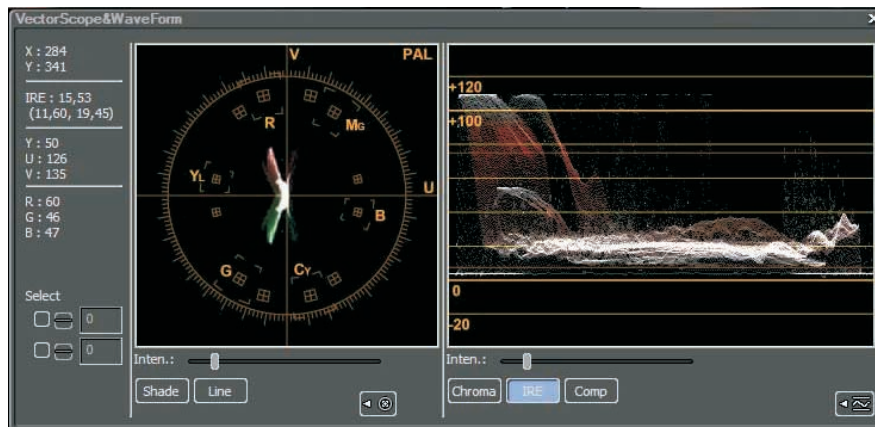


Fig. 6. Waveform of a frame after the "Blur:Strong" filter has been applied and eliminated reflection products.

It is not possible to define a filter by oneself and apply it within the selected software, but the number of available filters is sufficient for an operator to perform practically any intervention into the edited video material. Within the software there is also an option to apply a stop-frame and convert a single image. It makes possible to filter an observed pathological change in a digestive tract and obtain its sharp picture.

#### 4. CONCLUSIONS

The presented software makes possible to access results of an endoscopic examination together with pictures and videos in a given hospital and from outside. Owing to that immediate medical consultations are possible between hospital diagnosticians and medical practitioners of other units and it is also possible to evaluate a patient condition by a hospital unit that has sent a patient for testing to be done in some external endoscopic laboratory. Implementation of the discussed video-editing software Edius in an endoscopic laboratory makes possible to realtime apply any built-in filter, which contributes to time reduction of the examination and diagnosis based on an archived poor-quality video material. It is also possible to check and evaluate alterations that the filtering has introduced to the original image.

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