A low cost system for telepathology

DIANA CALVA MENDEZ, ALEJANDRO LANDA QUEZADA, MARIO LEHMAN
División de Investigación y Desarrollo, Sofilab SACV,
06600 México DF, MEXICO

Abstract: - We present here a system (hardware+software) for telemicroscopy and telecolposcopy, which can be extended for other pathological studies. Their application is intended for the support of the diagnostics and treatment of patients in remote zones within Mexico, without having to spend the resources associated with transporting them to the cities or towns where this instruments and techniques are available. This equipment will allow performing an accurate diagnostic that will help in the prevention of cancer. The novelty of this system, is that it is implemented over an already developed platform of a LIMS [10], which allows a complete integration with the clinical laboratory.

Key-Words: - Telepathology, telemicroscopy, telecolposcopy, automatic control, telemedicine, telediagnostics.

1 Introduction

Due to the complications associated with performing cytology screening in order to detect and prevent cervical cancer in remote populations in rural zones, as well as the implications related with this test that have to do with issues ranging from the technical to the social complications, it is difficult to have an organized screening which according to the World Health Organization is the best way of reducing mortality associated to this disease [1]. An organized screening is based on the routinely inspection of cytology samples (Pap smear) and has to be performed by qualified and well trained personnel, when this conditions are not accomplished, the incidence of reported false negatives increases, since the interpretation of this tests is highly related with the quality of the sample as well as the quality of the interpretation. In remote towns the medical services available are basic, and therefore, they do not have the necessary equipment and personnel in order to accomplish an organized screening of the population. Telemedicine is an option for making these screening techniques available for communities where medical services do not have the adequate equipment and personnel, here we propose a telemicroscopy and telecolposcopy system. The principle of optical microscopy is used in several medical devices [2-4], and it is also an important tool in the clinical laboratory. The instruments presented in the present work will support the diagnostics and treatment of cervical cancer in remote communities lacking of medical services [5-7]. Cervical cancer has a very high incidence in Mexico. Our LIMS (Laboratory Information Management System) Sofilab and some of its new results [8-11] are adapted for the management of the whole system.

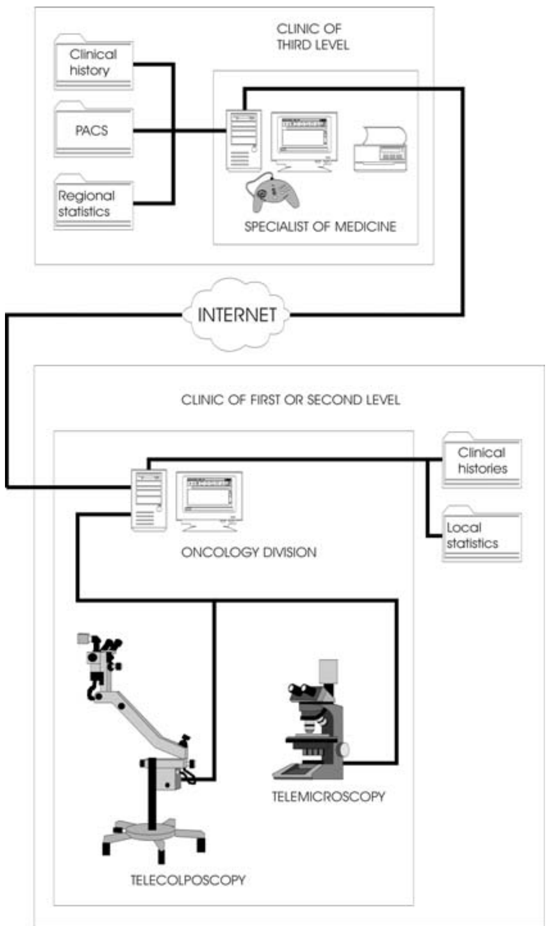

Figure 1 – Schematic visualization of the system for telediagnosis of cervical cancer.

2 Part I: Structure of the Project TeleSofilab

The general structure of the system is shown in Fig. 1. Among the operations that can be performed we include the possibility of receiving results and images

[12], and interacting with such equipments through the Internet.

The Basic software allows keeping the patients records in a central Server on the specialty hospital, in this electronic record images, video, and data can be stored. This way one of the first obstacles for a proper screening is achieved, since in many cases an interpretation can not be properly addressed because the patient basic information (age, date of last menstrual period, obstetrical and gynecological history, hormone therapy and a brief description of any previous clinical findings) is not available. This information might later be used for a clinical follow up, with educational purposes, or for the generation of epidemiological statistics, and also in order to comply with certification programs. The cost of the whole system is very low compared with other technologies already available for the automation of the cytological screening of pap smears, since we use videoconference cameras for obtaining the images of neoplasias and pap-smears.

3 Part II: Hardware and Software

We developed the hardware and software for a telemicroscopy equipment [13], we performed several tests through our intranet by using a broadband service (512 MB).

Hardware is composed by two optical microscopes with systems for controlling the movement in the focalization axis, and for both axis on the microscope plate. This equipment can be seen in Fig. 2. Control, analysis and communications are managed through software which was programmed in Java, and Visual Basic, which we named TELECONTROL 2. The main window for this software and its main functions can be seen in Fig. 3.

The system can be used in real time, or the technician may capture the images for a certain slide for the pathologist to make the interpretation later, this allows performing the test even if the pathologist is not available at the time the sample is taken in the remote community. The system includes a hierarchical neural network which is trained in order to determine the adequacy of the specimen [14,15]. A previous classification through classical methods of image processing (segmentation, morphology, etc.), using fractal geometry [16,17] and other more recent methods are included in the method. Then, the system makes an initial screening process by analyzing (for example) and obtaining the fractal dimension for the texture of the images obtained as seen in Fig. 4. This is the method for obtaining a more precise report from the pathologist through the Internet connection. This way the technician is able to know if the sample is suitable for examination when the patient is still there, eliminating this way the need for asking the patient to return for a new sample to be taken. All the system is based on the platform of a previous development which is a LIMS [10], this allows an integration to a greater scale with a hospital and any system of electronic clinical records.

Figure 2 – Telemicroscopy equipment.

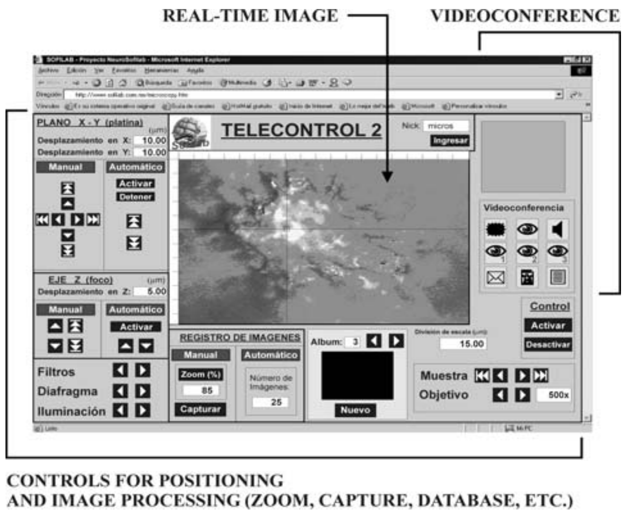

Figure 3 – Software for control through Internet.

4 Conclusions

We show a system (hard+soft) for the integration of the results obtained during the screening of cervical cancer. The system is composed by a software with a LIMS as a platform combined with a telemicroscope and a telecolposcope. A neural network is useful to assist the pathologist in the final report. This neural network is included in both computers, which are connected through a broadband Internet service. Other studies performed with optical microscopy and applications for telepathology are also supported including those involving other configurations (dark field and fluorescence) and new applications in biomedicine from other technological areas [13,17].

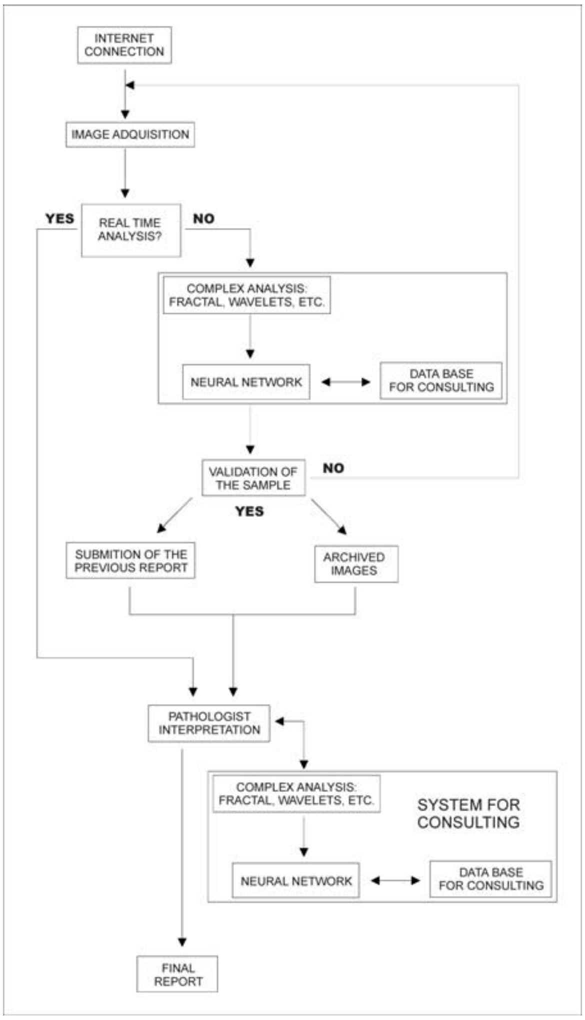

Figure 4 – Block diagram which show the structure to obtain the report from the pathologist.

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References:

[1] Cytology Screening, http://www.who.int/cancer/detection/cytologyscreen/en

[2] B. Herman, J. J. Lemasters, *Optical Microscopy : Emerging Methods and Applications*, Academic Press, 1997.

[3] K. Burton and D. L. Parkas, “Telemicroscopy: Net progress”, *Nature* 391, 540-1 (1998).

[4] G. Y. Fan, P. J. Mercurio, S. J. Young, M. H. Ellisman, “Telemicroscopy”, *Ultramicroscopy*, 52, 499-503 (1993).

[5] J. P. A. Baak, S. Lowe, J. Oort, J. S. Ploem, “Equipment for quantitative cell and tissue analysis”, in *Manual of Quantitative Pathology in Cancer Diagnosis and Prognosis*, 57-76. Ed.: J.P.A. Baak, Springer-Verlag, Berlin, 1991.

[6] J. Linder, “The coming era of cytologic automation”, *Am. J. Clin. Pathol.* 96, 293-294 (1991).

[7] G. Daron, G. Ferris, S. Mark Litaker, Michael S. Macafee, Jill A. Miller, “Remote diagnosis of cervical neoplasia: 2 types of telecolposcopy compared with cervicography”, *J. Family Pract.* (2003).

[8] T. Kisiel, *Laboratory Information Management System (LIMS): Steps to useful implementation*, DAI White Papers, Digital Applications International Ltd. (2002).

[9] R. Megargle, *Laboratory Information Management Systems*, VCH Publishing (2002).

[10] D. Calva Méndez, A. Landa Quezada, M. Lehman, “Information management in the clinical laboratory”, *WSEAS Trans. Comp.* 5(3) 1238-1240.

[11] D. L. Nigon, *Clinical Laboratory Management*, Mc Graw Hill, New York (2000).

[12] Y. Kim, S. C. Horii (eds.), *Handbook of Medical Imaging* vol. 3, SPIE Press, Washington (2000).

[13] D. Calva Méndez, M. Lehman, “Application of Neural Networks and Fractals for Urinalysis”, *Proc. WSEAS Int. Conf. on Applied Mathematics* (2004).

[14] C. Pasquier and S.J. Hamodrakas, “A hierarchical artificial neural network system for the classification of transmembrane proteins”, *Protein Engineering* 12(8), 631-634 (1999).

[15] P. Sajda, C. Spence, J. Pearson, “A hierarchical neural network architecture that learns target context: applications to digital mammography”, *IEEE International Conference on Image Processing* (Vol. 3) 3149-3156 (1995).

[16] A. J. Einstein, H. S. Wu, J. Gil, Fractal characterization of nuclear texture in breast cytology: frequency and spatial domain approches, in *Fractals in Biology and Medicine*, G. Losa, D. Merlini, T. F. Nonnenmacher, E. R. Weibel (eds.), 191-206, Birkhäuser, 1998.

[17] H. Sanders, J. Crocker, “A simple technique for the measurement of fractal dimensions in histopathological specimens”, *J. Pathol.* 169, 383-385 (1993).