

Small Size Virtual Slides in Pathology

O. Ferrer-Roca , F. Marcano & J.J. Quintana

Abstract— Small Size Virtual Slide (SSVS) is a novel technique developed by us and consistent in low power slide scan with high resolution cameras that allow digital zooming. Implemented in the TEXCAN-II® software, it allows distant diagnosis on through intranet or Internet. Complete virtual slide seen online provides a level of diagnosis comparable with regular microscopy, in a fast and reliable way, minimizing storage requirements.

In the present paper the SSVS technique was assess on fifteen cytology and pathology specimens evaluated by ten pathologists, that have never done distant diagnosis or try telepathology systems, obtaining a ROC diagnostic curve of 0.95.

I. INTRODUCTION

Several approaches have been proposed for an efficient distant diagnosis using static images in pathology. Among those Dynamic Robotic Telepathology (DRT)[1], Virtual Slides (VS) and recently Small-Size Virtual Slides (SSVS)[2][3].

In DRT, the remote pathologist browses and selects the slide field of views (FOV) are transmitted for diagnosis. Pathologist controls interactively the DRT microscope. Only selected FOV's are transmitted in the resolution allowed by the system, in real time.

Virtual slides provide a way for handling concurrent processes of analysis and diagnostic doing by any group of healthcare experts. Similar to DRT, pathologist can select for view a FOV's of the whole digitized slide; only this part will be transmitted. In VS there is no zoom-in and the zoom-out is handled by software.

By contrast, the novel SSVS® technique capture the slide at a low power and digitize in the highest compression possible to keep diagnostic quality of original slides. As a result of this size of the slide is 100 times smaller than VS facilitating transmission and storage[4].

The SSVS is JPEG2000 [5] format, and therefore use wavelet compression [6]. Apart from color standardization and wavelet compression well standardized [1][7], the SSVS established the capture technique at low power microscope objectives, producing high quality focused images (ZoomFocus®)[2] in a reduce storage space. Images are composed and compressed to allow their efficient transmission through Internet. Zoom-in of SSVS depends

on the high resolution of the camera and zoom-out on a panoramic view is similar to VS.

TEXCAN-II® implements SSVS technique, providing: a) a spatial resolution that allows a extreme digital zoom; b) a high quality focused images; c) minimal requirements for diagnostic-quality images; d) remote fast consultation of slides and e) a non-expensive digital virtual microscope.

This study assesses the diagnostic capability of SSVS in cytology and pathology.

II. MATERIALS AND METHODS

A. High resolution camera: AVT-Oscar F-810C.

Fireware IEEE1394 camera, CCD 2/3" Sony sensor, 8 Mpixels, 12 bits/pixel. The system is integrated into the TEXCAN-II®, using AVT-Allied Vision Technologies[8], CVB[9] y LeadTools[10] libraries. TEXCAN-II® controls white balance, image focus in zoom 1:1, image noise reduction, shading correction, etc.

B. Optical acquisition system: Olympus BH-2 microscope.

Total scan is carried out with SPlan 4x objective, 0.13 NA, relay tube lens NFK 2.5x LD of 125 and total power of 10x.

Each region of interest (ROI's) is scanned with a 0.46 NA SPlan 20x objective and total power of 50x. This includes random areas (red) or areas selected by technician (green).

C. SSVS samples

Fifteen cases were used, corresponding to three histological and twelve cytological samples, classified for malignancy.

D. SSVS generation

Individual FOVs were composed (*stitched*) by the TEXCAN-II® that integrate Panavue Image Assembler® 3.4 [11] (Figure 1).

D. SSVS transmission and browsing.

Transmission was carried out by the TEXCAN-II® server. It contains an efficient JPEG2000 transmission protocol (JPIP) [12][13], based on Kakadu 5.2 library[14]. It is located at www.cataibreezee.ull.es:81.

Browsing is done with the TEXCAN-II® Viewer, also based on Kakadu 5.2 library

E. Diagnostic assessment.

The diagnosis of cases are done "on line" in the TEXCAN-II® portal that can also be accessed through the TEXCAN-II® Viewer.

Diagnostic assessment was remotely performed by ten pathologists, individually and independently from each other, using the Web form shown in Figure 2. None of them have ever used a tediagnostic system.

Only malignancy was evaluated in this case according a discrete integer scale (1 to 5), being 1 – definitively

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O. Ferrer-Roca, PhD. MD. UNESCO Chair of Telemedicine, Full Professor of Pathology, University of La Laguna, Faculty of Medicine, 38071, Tenerife, Canary Islands, Spain. Phone: +34-922319321; Fax:+34-922641855; email: catai@teide.net

F. Marcano. Computer Scientist. UNESCO Chair of Telemedicine, University of La Laguna,

JJ. Quintana Melián, Tech. Computer Engineer, UNESCO Chair of Telemedicine, University of La Laguna.

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 negative, 2 – probably negative, 3 – with doubts, 4 – probably positive, 5 – definitively positive.

Any other comments were written in a specific box.

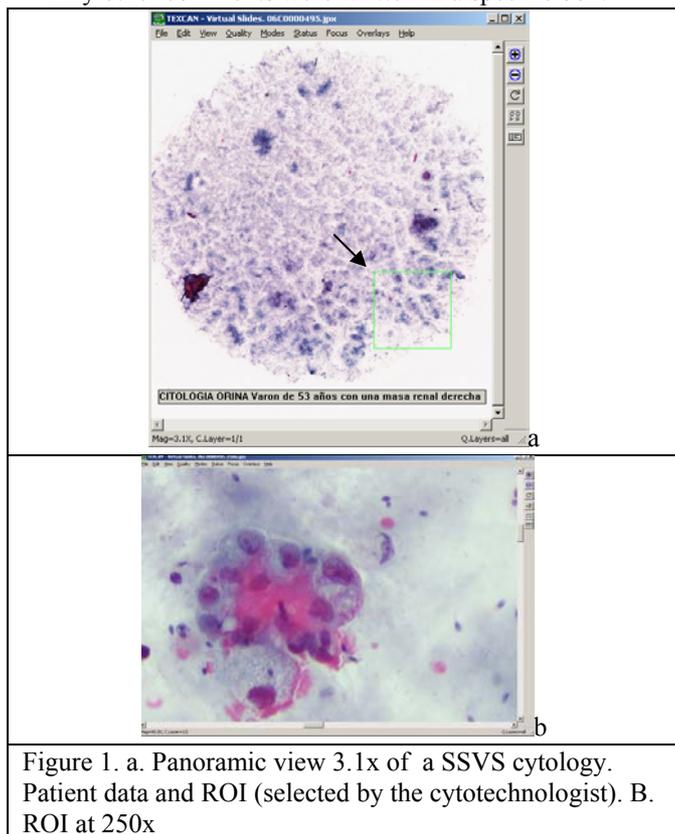


Figure 1. a. Panoramic view 3.1x of a SSVS cytology. Patient data and ROI (selected by the cytotechnologist). B. ROI at 250x

Figure 2 shows the TEXCAN-II evaluation form. At the top, it says 'Revisor: N. Smith (smith@ull.es)'. Below that, it lists 'Preparación Virtual # 06C000932' and 'Fecha: 9/25/2007 10:52:50 AM'. The main section is titled 'Posible Diagnóstico' and contains a table with five rows and three columns: 'Malignidad', 'Inflamación', and 'Fase Secretora Ciclo Menstrual'. Each row has radio buttons for different levels of suspicion. Below the table, there is a text box for 'Diagnóstico Citopatológico' containing the text: 'PUNCIÓN ASPIRACIÓN DE MAMA: Frotis sugestivos de mastopatía fibroquística con lesión epitelial proliferativa benigna intraquística (ver imagen)'. There are also buttons for 'Actualizar' and 'Enviar'.

Figure 2. TEXCAN-II® evaluation form.

ROC curves were plotted based on evaluation data provided by pathologists, using SPSS v.14.0[15] statistical software.

III. RESULTS

ROC analysis applied for malignancy is seen in Figure 3, where the area under the curve reached 0.95 with a $p < 0.0001$.

Comments of the users include the fact that would like to have more ROI areas, that security in diagnosis is higher in pathology specimens (Figures 4) than in the cytology ones (Figures 1). They were particularly impressed by the degree of zoom in pathology (Figure 4d).

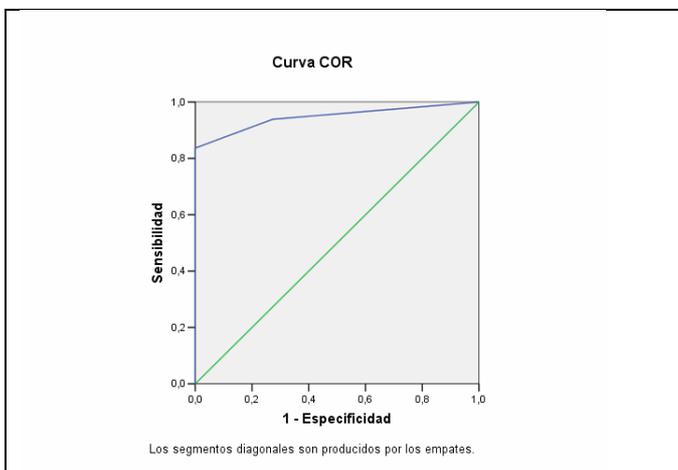
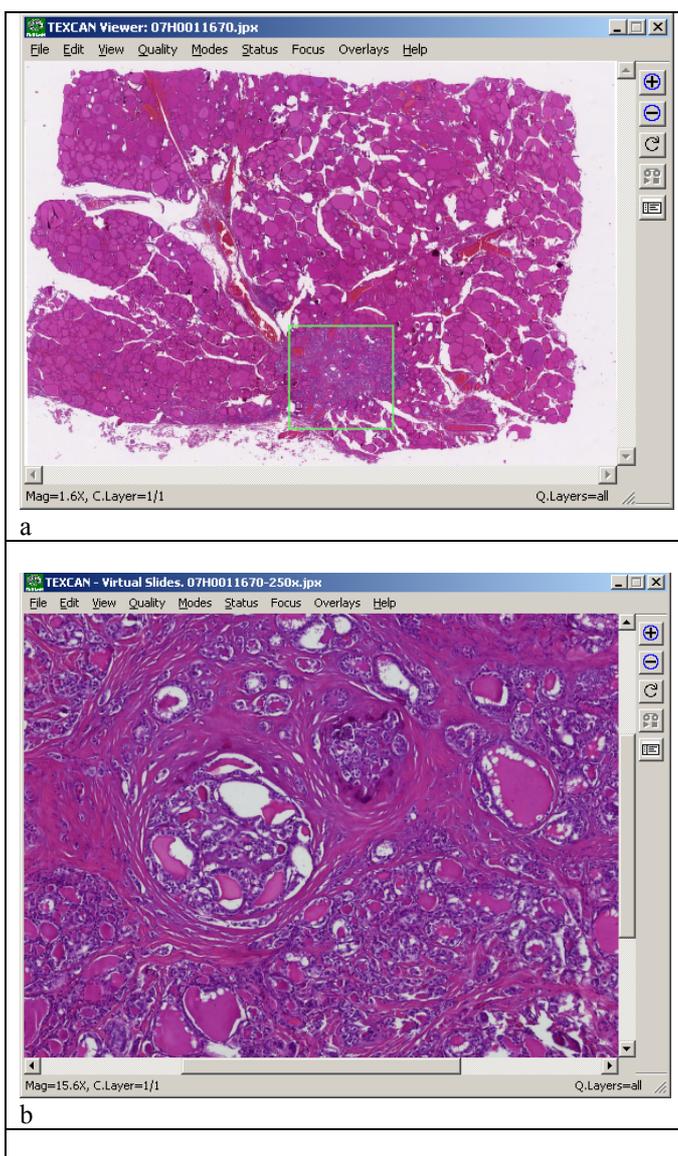


Figure 3. ROC curve for malignancy. Diagnostic area 0.95; $p < 0.0001$.



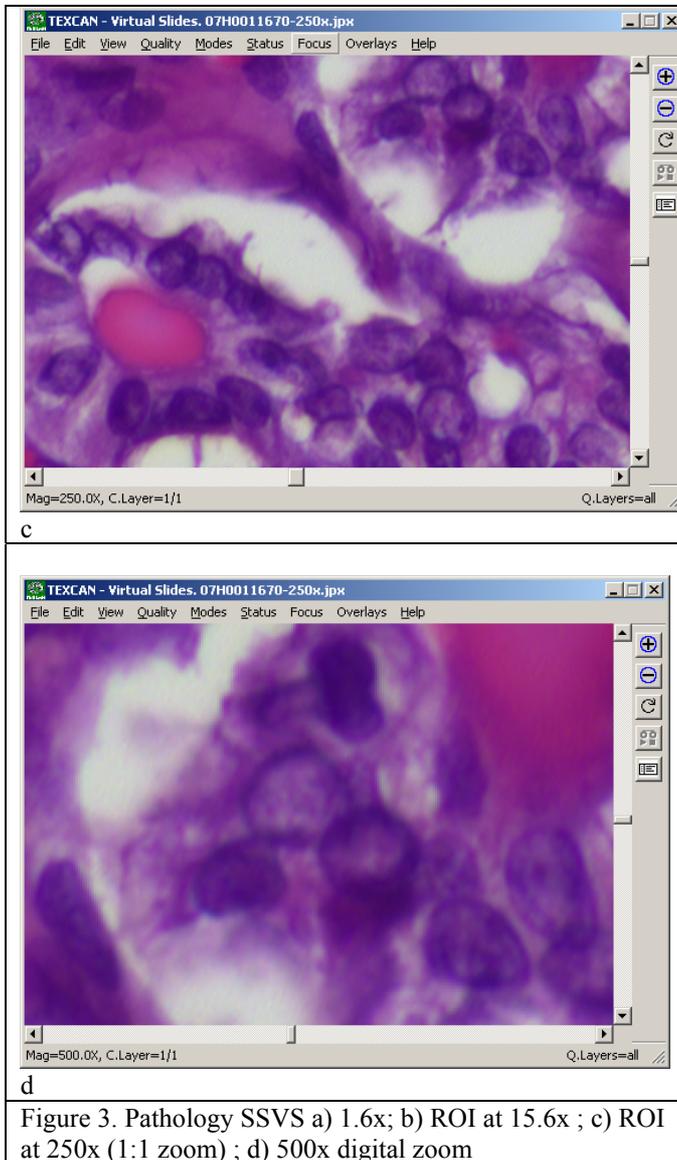


Figure 3. Pathology SSVS a) 1.6x; b) ROI at 15.6x ; c) ROI at 250x (1:1 zoom) ; d) 500x digital zoom

IV. DISCUSSION

The present paper evaluates the technique of the Small Size Virtual Slide (SSVS) for diagnostic purposes. This technique has been demonstrated very useful reducing the storage and transmission requirements and speed. In the present paper the diagnostic capability of the SSVS is assessed.

One of the main drawbacks for the pathology diagnosis at distance is the sampling error if the slide is not completely digitized. In the case the slide is fully digitized the VS technique use 40x objective; as a results the image have a huge size (around 10 GB) and is difficult to handle. Not only by new compression techniques base in wavelets, but also in order to be integrated into the hospital information system which images are DICOM in format, which limit of handling is 2 GB.

The technique of the SSVS using zoom-focus and digitizing with an objective of 4x with ROIs using 20x objective has been demonstrated ideal for storage and transmission [2]-[4][18]. In this paper we demonstrate that is also perfect for distant diagnosis.

Being tested by pathologists that have never been introduced into the distant diagnosis techniques, they found that the technique is extraordinary good for pathology

slides, and it also fine for cytology assuring that the ROI is done appropriately. For this reasons they demand either good cytotechnologists for ROI selection or more random ROIs .

In summary: TEXCAN-II® is an ideal system not only for local use in the pathology lab in order to store in a limited space the slides but also to use it to share discussions in the network of the lab or at distance.

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