Case Report Article

Image adjustments on digital panoramic radiographs using Adobe Photoshop CS3 software

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Abstract

Introduction: Favourable manipulation of images may be the greatest advantage of the digital radiographic compared to the conventional film. The current development of the cost-benefit of intra- and extraoral digital technology, besides the increase of computerized practices has turned the digital image into a superior alternative to conventional radiographs, in several aspects. **Objective:** To demonstrate image adjustments on digital panoramic radiographs using Adobe Photoshop CS3 (Creative Suite 3) software in order to enhance digital images. **Case reports:** Digital treatment was conducted in two different cases using two filters available in Adobe Photoshop CS3: Smart Sharpen and Unsharp-Mask. **Both filters improve overall image quality.** In the second case, after brightness and contrast adjustments, it was possible to have a detailed visualization of radiopaque and radiolucent areas. **Conclusion:** The application of brightness and contrast adjustments and filters are feasible methods in order to achieve diagnostic precision.

Introduction

Informatics evolution, as well as its propagation, has increasingly enabled the use of this technology in Dentistry. This has been motivating the substitution of patients' conventional written files and images by digital files, which allows the radiographic image adjustments. There are three ways of obtaining a digital image. The first has been called digitized radiograph, where the image is acquired through the radiographic film, using a scanner, camera, or videocamera. The second way would be the direct image acquisition through Charge-Coupled Device (CCD) sensors, which is a silicon chip sensible to light or X-rays where the image can be immediately seen on a computer screen, after the exposure. The last way would be the indirect way that involves the use of phosphor plaques.

Positive manipulation of images may be the greatest advantage of the digital radiographic compared to the conventional film. The current development of the cost-benefit of intra- and extraoral digital technology, besides the increase of computerized practices has turned the digital image into a superior alternative to conventional radiographs in several aspects [4].

Many previous studies [1, 5-8, 10, 12, 14, 17, 19, 21] used images processed in the different versions of Adobe Photoshop (Adobe Systems Inc., San Jose, CA), and according to the authors, this software enabled the examiners to change brightness and contrast, to enlarge or reduce the images, to obtain negative or three-dimensional (3D) images, to identify the contour and evaluate the pixel grey levels of radiographs images. Besides, the software has the histogram function which promotes obtaining the mean and standard deviations of two areas to subtracted images [5, 10].

The application of Adobe Photoshop is an auxiliary method in the radiographic diagnosis and highlights the use of sharpness filters for optimizing these images [6]. These filters localized unfocused areas, increasing the contrast of adjacent pixels. They considered that the most appropriate filter for image adjustment function was the "Unsharpen Mask" filter. According to Kreich *et al.* [12], when an image produced by a digital camera is opened, or a scanner image is imported, or the pixels dimension are changed, one invariably needs to adjust the image sharpness. Several filter options can be found at Adobe Photoshop, but none has the accuracy of the "Unsharpen Mask" tool. The filter selection should be executed after the brightness and contrast adjustments on the image [14].

Adobe Photoshop CS2 (Creative Suite 2) introduced the Smart Objects. This tool was upgraded at the CS3 software, by adding the Smart filters. The Smart Object is an image layer that enables a non-destructive treatment of the image. It also enables keeping the original image, in a way that the available content can be re-edited and undone, without losing the quality. Other tool that can be used for tuning localized points at the image, is shadow and highlight adjustments. In Photoshop CS3, this control can be executed by the "Smart Sharpen" filter [7]. The aim of this study was to **demonstrate image adjustments on digital panoramic radiographs using Adobe Photoshop CS3 (Creative Suite 3) software in order to enhance digital** images and to achieve diagnostic precision.

Case reports

Two direct digital panoramic radiographs were selected from a retrospective study with 1,130 direct, digitized digital panoramic radiographs of patients treated in the Radiology Dental Service at the São Leopoldo Mandic School of Dentistry located in Campinas, São Paulo, Brazil, from 2003 to 2007. The digital images were directly selected from the files of the clinic's database. This research was previously approved by the Ethical Committee in Research, under protocol #07/175 and patients' personal information kept confidential.

Digital treatment was performed in two different cases, each one having a direct digital panoramic radiograph image, enhancing image contour with the use of two sharpening filters available in Adobe Photoshop CS3: Smart Sharpen and Unsharp-mask. Brightness and contrast adjustment was done in the latter before using the filter.

Case report 1

Direct digital panoramic radiograph from a 12 year-old male patient where Smart Sharpen filter was used allowing a non-destructive edition of the image, preserving its original characteristics and contents, amplifying its details.

The process was to go to the software's tool bar and perform the following sequence: Filter → Sharpen → Smart Sharpen, according to figure 1.
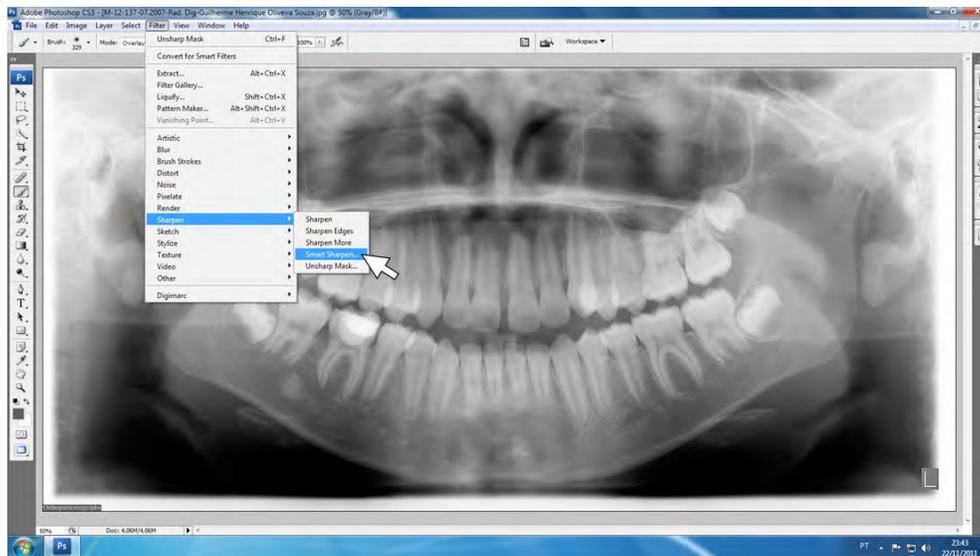
Figure 1 – Demonstration of tool bar to apply "Smart Sharpen filter"

The changes to image sharpness in Smart Sharpen filter may be adjusted with the use of the tools Amount (sharpness intensity); Radius (radius adjustment); and Lens Blur. These features are shown in a dialog box in the software after the filter is chosen.

Sharpness intensity control (Amount) makes possible to control image contour surface. Its values range from 1 to 500% and the bigger the values, the bigger is sharpness due to higher pixel contrast. In the present case, the Sharpness Intensity (Amount) was 250%. Radius determines the number of pixels around the pixels of the edges that are affected by sharpness, establishing the amount of pixels of the image contour enhancing sharpness. Higher values determine sharpness of a bigger group of pixels in this area. Its value varies from 0.1 to 64 pixels. The selected Radius was 3.0 pixels. Fine adjustment was used with the use of Lens Blur tool, which detects edges and details in the images providing a finer adjustment to them (figure 2). Later, dialog box was closed and the image was saved with the selected adjustments.
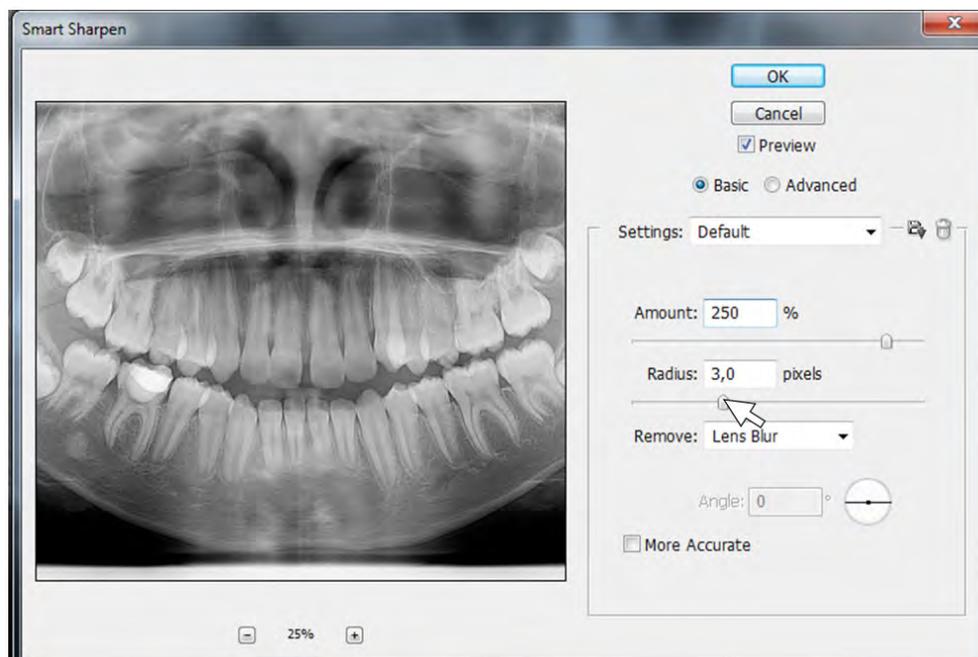
Figure 2 – Configurations of the "Smart Sharpen" filter

Case report 2

Direct digital panoramic radiograph from a 13 year-old female patient, where the choice was to reduce brightness and increasing contrast followed by the filter Unsharp-Mask: Filter → Sharpen → Unsharp-mask.

Unsharp-mask is used to correct image focus altering the contrast in the edge details, highlighting them and creating a perception of a sharper image.

Changing brightness and contrast was used as a step of pre-filter application, aiming to previously harmonize shade scale. The adjustment in the brightness aims to control the amount of light in the image, making it lighter or darker. In the present case, the option was to decrease brightness to -30. Contrast adjustment controls the mean shades in the image, the spectrum between the dark and light shades, increasing or reducing contrast between the shades. Contrast enhancement may effectively compensate low or high exposure of a digital image, making it more perceptible to the amount of information on the image, subjectively improving visual quality, balancing harmony between the shades; contrast was adjusted to +30.

Then, filter from the tools Amount, Radius and Threshold were use. In the present case, the intensity adjustment (Amount) was 279%. Radius adjustment ranges from 0.1 to 250 and the chosen number was 3.6 pixels. Threshold adjustment allows the filter to perform in a bigger or smaller area of the image. Its values vary from 0 to 255. A lower figure makes the majority of the image pixels sharper while a higher figure eliminates the action of the filter in most pixels. Usually the standard value for Threshold is 0 levels, and this was the selected value (figure 3).

Posteriorly, the dialog box was closed so the image could be saved with the selected adjustments. The adjustments of Unsharp-mask as well as Smart Sharpen filters vary from image to image so the most adequate ones have to be tested for sharpness control.
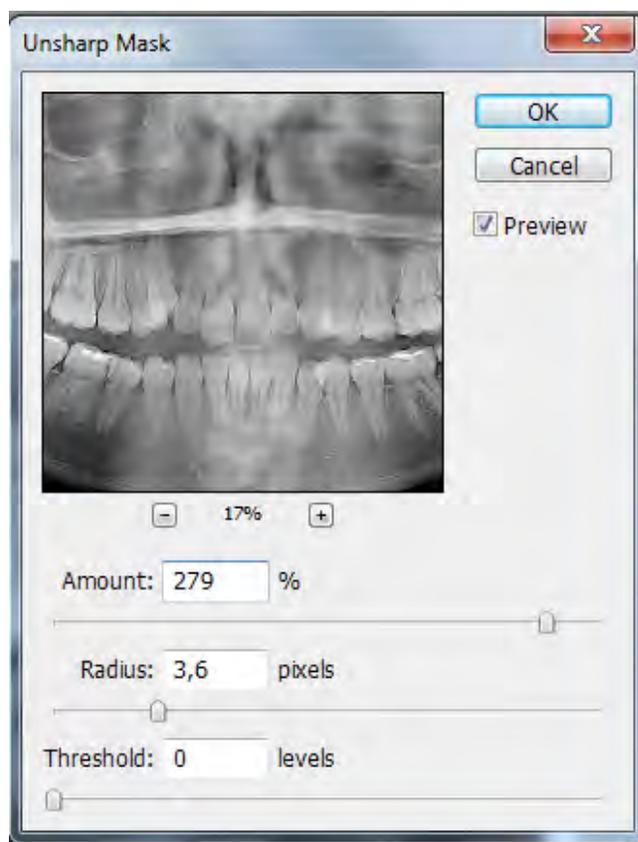
Figure 3 – Configurations of the "Unsharp-mask filter"

The results demonstrated that the use of sharpening filters from Adobe PhotoShop CS3 in panoramic radiograph is possible and they aim to enhance the general aspect of the structures present in the radiographic images. The adjustment made with Smart Sharpen filter showed that the sharpening tools from this software, such as Amount, Radius and Lens Blur can be used in panoramic radiograph with satisfactory results according to the authors' observation when they compared the images before and after the use of such filters. Figure 4 illustrates the initial radiograph, without adjustments, and the results after the use of Smart Sharpen.
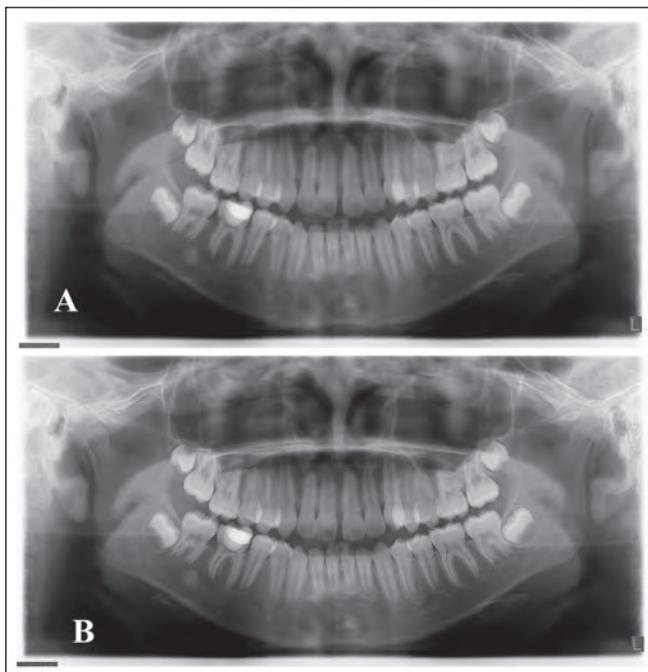
Figure 4 – Comparison of images before and after use of the Smart Sharpen filter. A: Initial direct digital radiograph, without image adjustments; B: Image result after the application of the "Sharpen – Smart Sharpen" filter

The adjustments made with Unsharp-mask filter with the tolls Amount, Radius and Threshold were used in the digital panoramic radiograph from case 2 with satisfactory results, enabling a more detailed visualization of the radiopaque and radiolucent areas present in the image. Figure 5 shows the comparison of the initial image, without adjustments and the result after using Unsharp-mask.

The brightness and contrast adjustments demonstrated in this work are optional corrections, once the sharpening filters can be directly applied. This may occur in cases in which the professional understands the images need these corrections. In case 2 the filter was directly applied over the image, without brightness and contrast adjustments, for comparison. Therefore, it can be observed that the image after the use of the filter seemed to be clearer than that without the adjustment of brightness-contrast commands (figure 6).

Figure 5 – Comparison of images before and after use of the Unsharp-mask filter. A: Initial direct digital radiograph, without image adjustments; B: Image result after the application of the "Sharpen – Unsharp-Mask" filter
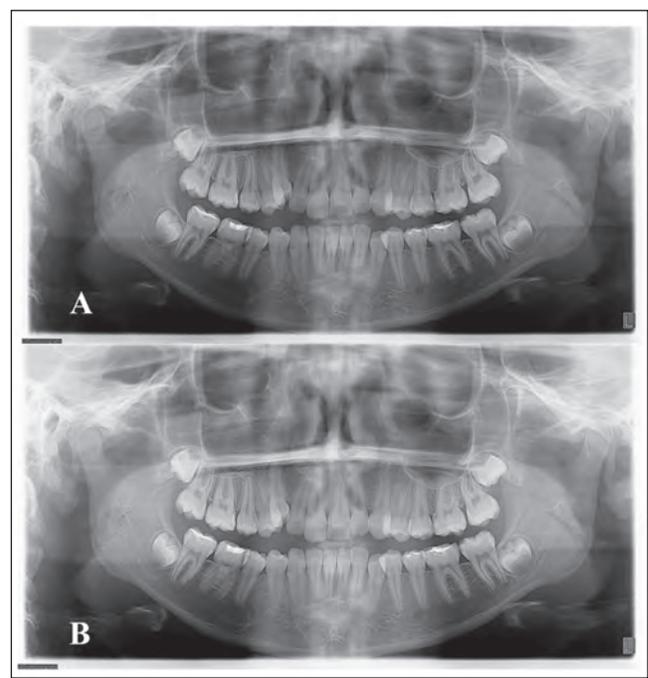
Figure 6 – Comparison of images after using the Unsharp-mask filter. A: Image result without adjustments of the brightness/contrast; B: Image result image without adjustments of the brightness/contrast

Discussion

Contrast and brightness adjustments, as well as the use of software, as auxiliary methods for the improvement of digital radiographic diagnosis have currently been employed in Dentistry bringing new perspectives in the perception of unclear areas of images [1, 7, 17, 19]. Moreover, digital processing and filtering of radiographic images may further enhance diagnostic interpretation of radiographs in terms of reliability and accuracy. Although, according to Tihanyi *et al.* [18], the digital brightness and contrast adjustments used in their study failed to improve the accuracy of linear measurements on radiographic images compared to the assessments on digitized but un-manipulated images. For the authors, digital adjustment of radiographs cannot increase information. Digital adjustment may increase the ability to detect structures or landmarks by decreasing information, which may compensate for lack of quality (*e.g.* low contrast, under or overexposure).

Furthermore, the human eye can better discriminate between colours than between grey values. Thus, it was attempted to improve accuracy of radiographic assessments by transferring grey values into colours. However, the use of a colour-coding algorithm failed to improve accuracy of radiographic assessments of interproximal bone loss [13]. In addition, even digital filters that had been developed to image and assess periodontal bone failed to improve the accuracy of radiographic measurements [11].

The processing of digital images with the aid of various filters is recommended to produce a "conventional look" besides overcoming the limitations of conventional radiographic film [16]. However, so far, only few studies have compared the effect of image filters that may enhance the quality of panoramic image [9, 15, 20]. The filters enhanced the overall quality of the image but visualization of important structures, which may aid in the distinction of pathology from anatomy, was not considered. For this purpose, Gijbels *et al.* [9] tested the effect of different filters on the overall image quality using a charged-coupled device (CCD) based panoramic system and reported a significant effect of contrast enhancement.

Some authors [6, 7, 17] stated that digital radiograph has many positive characteristics for the diagnostic procedure when compared to conventional radiograph. One of them is the possibility to make digital adjustments to increase the image quality, which facilitates the detection of structures on the image. A number of software offers a tool to adjust the grey scale, brightness, contrast, edge sharpening, colour modification and grey scale inversion to improve visualization by examiners.

In case 1 of this present study, the behaviour of panoramic radiograph digital treatment was tested with the use of the "Smart Sharpen" filter. Panoramic radiograph is an examination that has been increasingly consolidated in Dentistry [16]. The direct digital image treatment, comprising adjustments followed by the use of the Smart Sharpen filter, resulted in improvement of the image quality with general visualization of the radiograph details. It also revealed previously unclear areas, consequently distinguishing: the maxillary and mandibular trabecular bone, teeth and their periapical area, erupting teeth and their follicular area, temporomandibular joint, among other areas. This filter is present in Adobe Photoshop CS3 version [7], offering very satisfactory resources to the clinician to help the search for a more precise diagnosis. The shadow and highlight area adjustments and the removal of blurs are some examples of the innovations presented in this filter.

The applications of the adjustment methods on images also demonstrated an improvement in the anatomical and pathological details of the analysed radiographs, when the Unsharp-mask filter was applied. These adjustments were satisfactory on the anterior area of the jaws. Nevertheless, there were serious limitations of images showed by panoramic radiographs [9]. This can be seen in figures 4 to 6, where the anterior area of the initial radiograph is blurred when compared to the image submitted to the brightness and contrast adjustments and the application of the Unsharp-mask filter.

The smart filter increases the pixels contrast of the edges and corners, without adding noise to the images [14]. However, depending on the sharpness degree of each radiograph, the adjustments can be greater or lesser. For instance, very high values on the sharpness and radius amount should be avoided in order not to produce excessively sharp images, which would accordingly increase the noises.

According to some authors [8, 12, 17], digital manipulation of the radiographic images may improve the reproducibility and the diagnostic value of radiographic interpretation, as the structures are better visualized. Once the radiographs are digitalized, filters may be readily applied to enhance visualization of bone architecture. Researches on density, contrast and edge enhancement have already

proved their usefulness to the diagnosis of caries and alterations of the alveolar bone [2, 9]. In their study, Baksi *et al.* [3] asserted the sharpening filter may be recommended for enhancing SPP panoramic images to improve the visual perception of most of the anatomical structures as well as overall quality.

The use of these filters has advantages such as the non-destructive treatment of the image, allowing their favourable manipulation and enabling a more comprehensive diagnosis, searching for the details that cannot be seen in the panoramic radiograph when the before mentioned software is not applied.

Conclusion

The increasingly use of digital radiographs in Dentistry and its optimization resources brings several advantages, which are not available in the conventional radiographic method. Adobe Photoshop, version CS3 provided tools such as brightness and contrast adjustments and filters which allowed an improvement in the visualization of anatomical details, pathologic images, and other images of the panoramic radiographs comprising this study.

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