Review Article

Received : 23-04-13
Review completed : 08-06-13
Accepted : 04-07-13

DIAGNOSTIC TOOLS IN DIGITAL RADIOGRAPHY AND THEIR CLINICAL IMPLICATIONS IN CONSERVATIVE DENTISTRY AND ENDODONTICS

Mohan Abarajithan, * Robert Justin, ** V Sunil Kumar, ***
Deivanayagam Kandaswamy, † Sowmia Natraj ††

* Senior Lecturer, Department of Conservative Dentistry & Endodontics, Ultra's Best Dental Sciences College, Madurai, Tamil Nadu, India
** Reader, Department of Conservative Dentistry & Endodontics, Ultra's Best Dental Sciences College, Madurai, Tamil Nadu, India
*** Senior Lecturer, Department of Prosthodontics, Crown & Bridge, Ultra's Best Dental Sciences College, Madurai, Tamil Nadu, India
† Dean, Professor & Head, Department of Conservative Dentistry & Endodontics, Sri Ramachandra Dental College & Hospitals, Chennai, India
†† Private Consultant, Department of Conservative Dentistry & Endodontics, Madurai, Tamil Nadu, India

ABSTRACT

Digital radiography has made a huge impact in imaging in dentistry. The numerous advantages include less radiation dosage, easy documentation and reduced chair side time. However there are a variety of software tools that each manufacturer provides which is not clearly discussed in the literature so far. The aim of this article is to highlight the application of various software tools available with the recent RVG systems.

KEYWORDS: RVG; Image enhancement; Digital radiography

INTRODUCTION

The digital intraoral radiograph has numerous advantages over the conventional intraoral radiograph, apart from the minimum radiation exposure. Various software programs along with these systems allow enhancement and modification of various properties in the radiograph which will help in a better diagnosis, many more clinical applications and easy communication and transfer of details. This article highlights the various features that are present in the modern digital radiography, their direct clinical significance and application in the field of conservative dentistry and endodontics. The digital image is made up of a large number of discrete picture elements called pixels.[1] Their size is so small that the image appears smooth at normal magnification. The value assigned to a pixel represents the intensity or gray scale value of the image at that location. The pixel or bit depth is a power of 2.This means the detector can theoretically capture 2^8 top 2^{16} different densities. Bit depth controls the number of possible grey levels in the image.[2] The following facilities are available through various software programs in modern digital radiography:

BRIGHTNESS ENHANCEMENT

Brightness defines the brightness level of mean grey values in the image. This value ranges between black and white and high levels of brightness produce lighter images.[3-5] When the brightness is altered, all pixel values are moved in one and in the same direction (towards black or white). Therefore the distance between the original and resultant values remains the same. By enhancing the visual appearance of an image to the observer's eye, this feature improves the detectability of the structures present on the image. Since the spatial resolution of the human eye depends on brightness and contrast, many observers use mainly these parameters of the software during diagnostic procedures (Fig. 1a & Fig 1b).

CONTRAST ENHANCEMENT

Contrast represents the difference between the lightest and the darkest grey shades in the image.[3-5] Since it is a linear function (i.e. it has a direct relationship between exposure and image density), all the pixel values are stretched during the increase of contrast and the dark shades get darker and the light shades get lighter.[6] However when the contrast is decreased all the pixel values are condensed towards the value 127/128, which is the median of the grey shades within the image (0-256).[7] Contrast, brightness enhanced images

Fig. 1a: Before brightness enhancement

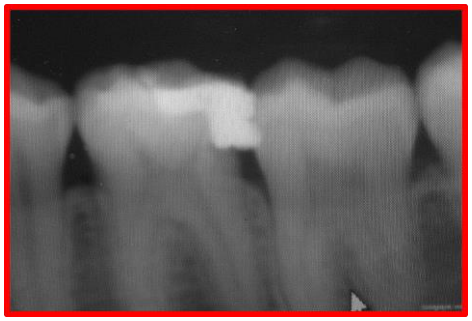

Fig. 1b: After brightness enhancement

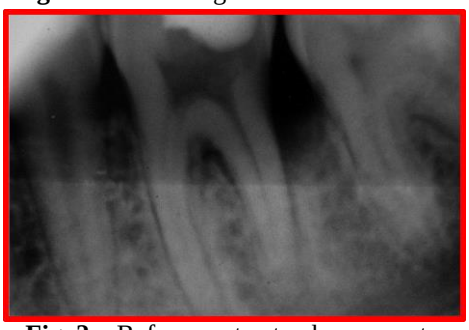

Fig. 2a: Before contrast enhancement

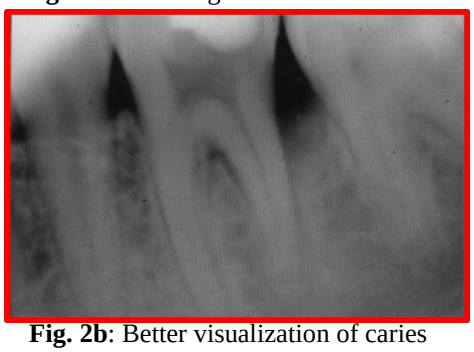

Fig. 2b: Better visualization of caries after enhancement

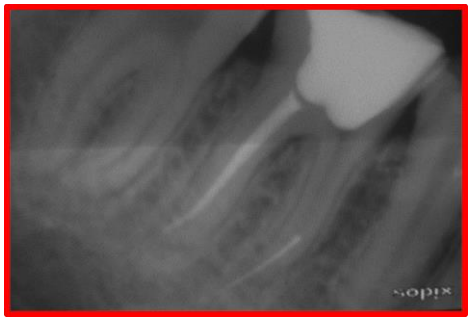

Fig. 3a: Separated instrument not easily differentiated in normal mode

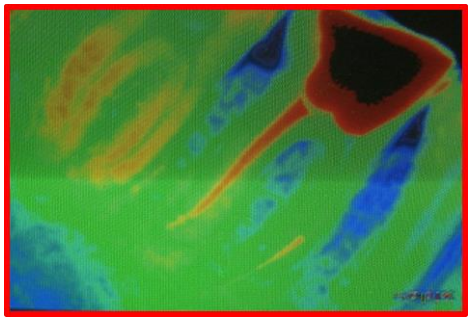

Fig. 3b: Pseudocolouring differentiates it from gutta percha

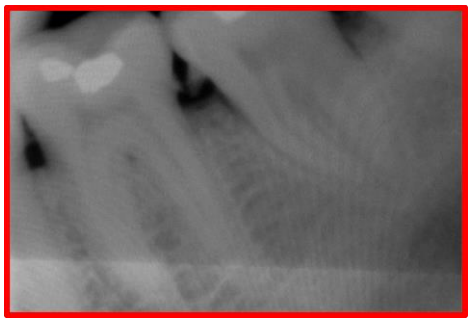

Fig. 4a

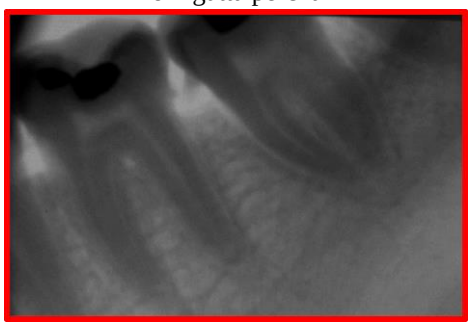

Fig. 4b

enable a better performance for diagnosing radiological changes like caries, periapical radiological changes like caries, periapical pathosis etc (Fig. 2a & Fig. 2b).

PSEUDOCOLOURING

Since human perception of grey values is limited, colouring images of various densities might enhance small local contrast. Arbitrary colours are usually obtained following the edges of red, green, blue cube. A certain range of equal grey scales can be shown with one, two or three colours.[8,9] Though pseudocolour enhancement is attractive, the diagnostic utility of this feature has not been well demonstrated. When a clinician looks at the radiographic image, he or she knows what the relationship between the different grey levels is. The addition of a colour without an understandable gradient provides less information

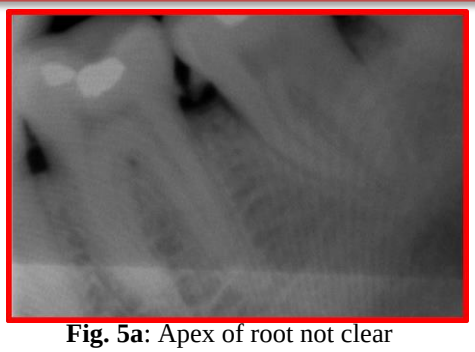

Fig. 5a: Apex of root not clear

Fig. 5b: Apex of root well differentiated

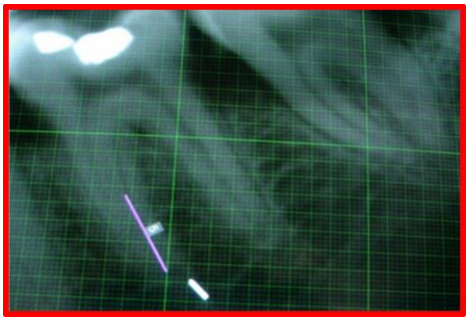

Fig. 6a: Linear measurements

Fig. 6b: Remaining dentin thickness

on the different radiolucencies. Obviously if a digital system could identify carious lesion as red, this enhancement would be of great value. Several software packages are in the developmental stages to perform such a task but not currently available. At present their use might be to find out the junction between different densities in the image (Fig. 3a & Fig. 3b).

VIDEO INVERSION

It is the inversion of the grey scale i.e. flip flop of black and white in the image. By doing so certain radiolucent areas which are not very apparent in the radiograph can be visualized better viewing them as a radio opaque area. The detection of small lesions or a small area was better with the video inversion than that for a larger lesion. This could be due to the lack of familiarization with the inverse pattern in combination with the anatomical, structural factors (Fig. 4a & Fig. 4b).

DENSITY

The density of the image can also be altered. The ability to alter density allows the clinician to 'salvage' an image that is either too dark or too light. Density can be manipulated by simply adding the same value to each pixel. But there is a limit to which the density can be enhanced to aid in better diagnosis (Fig. 5a & Fig. 5b).

BORDER ENHANCEMENT

It is the ability of the radiograph to define an edge or display density boundaries.[10] It is very useful helping the clinician understand the boundaries between various anatomical structures of different densities. The enhancement cannot increase the inherent information content of the image but it may increase the delectability of the structures or landmarks by condensing and thus decreasing information. They are very useful in diagnosing the extent of lesions like caries, detecting the exact radiographic apex etc.

LINEAR MEASUREMENTS

The length between two points can be measured by drawing a line between two the two desired points in the radiograph and the value can be determined.[3,11] This feature can be used for radiographic length determination procedures like endometrics, estimation of the depth of cavity preparation, post space preparation, etc. But the estimated length may not be the actual length of the tooth as it can be subject to various radiographic errors similar to conventional radiography (Fig. 6a & Fig. 6b).

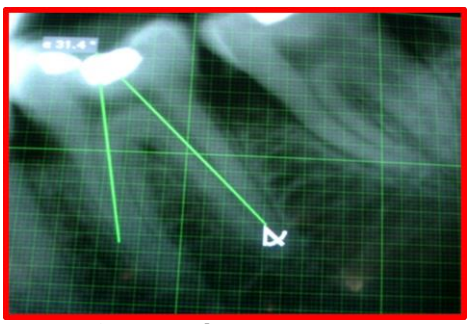

Fig. 7: Angle measurements

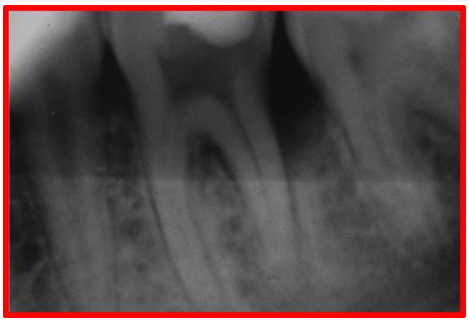

Fig. 8a: Colour channels

Fig. 8b: Colour channels

Fig. 9a

Fig. 9b: Particular area can be zoomed

ANGLE MEASUREMENTS

Also the angle between two desired lines can be obtained by drawing two lines using the appropriate feature. For example, the angulation of a tooth to the adjacent tooth can be obtained by drawing two lines along the long axis of the two teeth. This feature can also be used for measuring the curvatures in the root canals, taper of a crown preparation etc (Fig. 7).

COLOUR CHANNELS

This is a special feature to demarcate an area of particular density by colouring them alone. With the help of this feature, the demarcation between two structures can be done when it is difficult to be done in the normal mode. For example by choosing the periapical tissue, it takes up the colour and thus the termination of the root can be identified by the border of the coloured area. But this feature may not be applicable to structures with varying densities like a bone with a lesion in it (Fig. 8a & Fig. 8b).

ZOOM

This feature is one of the greatest advantages of a digital image over the conventional one. This is particularly of great importance in making out minute and precise details in the image which may not have been demonstrated in the normal mode. Applications like, finding out the exact termination of a root canal filling, observing an early radiographic change can be made which could have been missed out without it (Fig. 9a & Fig. 9b).

ROTATION

This feature may not have great diagnostic importance, but it can help the clinician to assume the tooth just as how he would like to look at it. When an image is recorded in an upside down way due to reverse placement of the sensor, this feature can be used to rotate the image and look at it in the normal way.

SYMMETRY

This is a feature to compare the image as it is looked from the buccal side and the lingual side, by doing so alternatively the clinician will be able to compare one half of the image with the other. The last two features can also be done in a conventional radiograph, where the clinician can manually turn the film and look at it from either side.

CONCLUSION

Thus the software tools play an important supportive aid for diagnosis and various procedures in operative dentistry and endodontics, and are definitely advantageous over the conventional intraoral periapical radiograph.

BIBLIOGRAPHY

1. Sund T, Moystad A. Sliding window adaptive histogram equalization of intraoral radiographs: effect on image quality. Dento Maxillofac Radiol. 2006;35(3):133-8.

2. Nair MK, Ludlow JB, May KN, Nair UP, Johnson MP, Close JM. Diagnostic accuracy of intraoral film and direct digital images for of intraoral film and direct digital images for detection of simulated recurrent decay. Oper Dent. 2001;26(3):223-30.
3. Borg E, Grondahl HG. Endodontic measurements in digital radiographs acquired by a photostimulable, storage phosphor system. Endod Dent Traumatol. 1996;12(1):20-4.
4. Wenzel A. Computer-aided image manipulation of intraoral radiographs to enhance diagnosis in dental practice: a review. Int Dent J. 1993;43(2):99-108.
5. Wenzel A. Effect of image enhancement for detectability of bone lesions in digitized intraoral radiographs. Scand J Dent Res. 1988;96(2):149-60.
6. Wenzel A, Haiter-Neto F, Gotfredsen E. Influence of spatial resolution and bit depth on detection of small caries lesions with digital receptors. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2007;103(3):418-22.
7. Moystad A, Svanaes DB, Risnes S, Larheim TA, Grondahl HG. Detection of approximal caries with a storage phosphor system. A comparison of enhanced digital images with dental X-ray film. Dentomaxillofac Radiol. 1996;25(4):202-6.
8. Shrout MK, Potter BJ, Yurgalavage MH, Hildebolt CF, Vannier MW. 35-mm film scanner as an intraoral dental radiograph digitizer. II: Effects of brightness and contrast adjustments. Oral Surg Oral Med Oral Pathol. 1993;76(4):510-8.
9. Guneri P, Lomcali G, Boyacioglu H, Kendir S. The effects of incremental brightness and contrast adjustments on radiographic data: a quantitative study. Dentomaxillofac Radiol. 2005;34(1):20-7.
10. Welande U, Yoshiura K, Li G, Sallstrom P, McDavid WD. Correction for attenuation and visual response in digital radiography. Dentomaxillofac Radiol. 2002;31(2):117-25.
11. Weisemann BR, Scheetz PJ, Silveira MA, Farman TT, Farman GA. Effect of Pixel Histogram Distribution on Perceived Anatomical Landmark Clarity of Photostimulable Phosphor Cephalograms. Arch Orthop Trauma Surg. 2006;124(7).

Source of Support: Nil
Conflict of Interest: Nil