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IMAGE PROCESSING IN ADVANCED ESTHETIC DENTISTRY

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ABSTRACT

Image processing of dental digital photographs is a novel technique which has to be studied thoroughly and implemented in the dental practice especially in patients requiring esthetic rehabilitation. Image processing system although available and widely used in dental digital radiography its use in dental digital photography is introduced off late. Digital acquisition of dental photographs enables computer based image processing to enhance image quality and increase the accuracy of interpretation. Usage of Matlab image processing system helps in image processing operations like image restoration, image enhancement, image analysis, image segmentation and image compression. Image processing not only helps extensively in analysis and treatment planning, but also helps the patient understand and appreciate the treatment outcome. Digital photographic imaging process helps in improving diagnostic efficacy, better patient communication and planning a comprehensive treatment to the patients

INTRODUCTION

A very good personal appearance is highly demanding in the modern era. A beautiful smile not only signifies healthy oral condition but also enhances the confidence. Esthetic dentistry is one of the leading branches of dentistry; with growing awareness of the facial esthetics and the availability of various recent treatment procedures the demand for straighter, whiter, brighter teeth is enhanced. Dental digital photographs are one of the key requirements during patient examination, record maintenance and treatment planning especially in case of esthetic dentistry. Esthetic dentistry comprises of various treatment procedures like bleaching, veneering, gingival de-pigmentation, tooth jewellery, orthodontic treatment and full mouth rehabilitation. All of these procedures enhance the patient's looks. In this day and age, if a practitioner is going to embark on performing aesthetic dentistry, digital photography must be an integral component of their armamentarium.

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Digital photography affords the practitioner many benefits such as medico - legal documentation, laboratory and peer communication, patient education, third – party communication, and ease in adaptation to marketing campaigns. However, the single greatest benefit as it relates to aesthetic dentistry is the ability to critically evaluate one's own work. As the general public becomes more dentally educated, one must assume that its expectations of elective treatment outcomes will also rise. In order to meet if not exceed the public's expectations, digital dental photography must be utilized to increase the practitioner's skills in delivering invisible beauty (Parag *et al.*, 2010).

In diagnostic imaging the objective of image processing is to make relevant information more evident by creating images that are better suited for human visual perceptions or to gather data by analyzing the image content. Human visual perception despite its sophistication has number of flaws and biases that limit the quality and reliability of the image perceived. Dental digital imaging has created new opportunity to address these flaws.[2] Dental digital image processing applications can easily

be practiced in dental office by a computer and image processing programs. Digital image processing operation comprises of image restoration, image enhancement, image analysis, image segmentation compression (Ozlem Gormez and Hasan Huseyin Yilmaz, 2009). All of these digital image processing systems help in arriving at correct diagnosis and treatment planning .This paper helps us understand and implement the usage of Matlab image processing system in dental digital image processing all of which enhances the quality of dental practice.

Choosing the Correct Equipment

In order to produce high - quality photography that can be used for communication and evaluation, one must consider purchasing the proper equipment that is geared specifically toward the macro photography of dentistry. Digital cameras can be broken into two categories: digital view finder cameras (DVF) and digital single lens reflex cameras (DSLR) When considering which type of equipment to purchase, the practitioner must consider three major components: the DSLR camera body, the lens, and the type of flash. Selecting each of these components is an essential part of ensuring success (Parag *et al.*, 2010).

One of the most important-advantage of digital photography is its ability to process the image data so that the information content of the image is more accessible to the human visual system (Li, 2004 and van der Stelt, 2005).

DIGITAL IMAGE

For a better understanding of the mechanism of image processing, it is good to know what a digital image actually is (van der Stelt, 2005). A digital image seen on the screen as a collection of brighter and darker areas is composed of a set of cells that are ordered in rows and columns. Individual cells are called “picture elements,” which has been shortened to “pixels” (van der Stelt, 2005 and van der Stelt, 2008). Each of these pixels has a number or digit assigned to it, based upon the amount of exposure the sensor received for the corresponding area (Ozlem Gormez and Hasan Huseyin Yilmaz, 2009).

Because there are numbers assigned to each pixel, and because these numbers are used by the computer program to assign a different gray scale value to that area, which results in what is seen as an image (Ozlem Gormez and Hasan Huseyin Yilmaz, 2009), Mathematical formulas can be applied to these numerical representations of the digital image to alter these values in specific way, which results in a new set of pixel values. The resulting set of numbers is used to display the processed (altered) image on the monitor screen (van der Stelt, 2005).

IMAGE PROCESSING

Image processing is a computer-based procedure which changes recorded electronic (digital) image (van der Stelt, 2005and van der Stelt, 2008). Any operation that acts to improve, restore, analyze or in some way change a digital image is a form of image post-processing (White *et al.*, 2004). There are five groups of digital image processing (Gö ğüs *et al.*, 2007):

1.Image restoration 2.Image enhancement 3.Image analysis 4.Image segmentation 5.Image compression.

Image Restoration

When the raw image data is entered to the computer, they are usually not yet ready for storage or display. A number of preprocessing steps need to be performed to correct the image for known defects and to adjust the image intensities so that they are suitable for viewing. Most of the preprocessing operations are set by the manufacturer and cannot be changed (White *et al.*, 2004).

Image Enhancement

Most image enhancement operations are applied to make the image visually more appealing. This can be accomplished by increasing contrast, optimizing brightness and reducing unsharpness and noise (White *et al.*, 2004).

Brightness and contrast

Brightness and contrast setting can be used to correct overexposure or underexposure of an image (van der Stelt, 2008). Correct “exposure settings” will result in an image with good contrast and density. Exposure conditions can be corrected to some extent: an overexposed image can be made lighter and, similarly, the density of an underexposed image can be made darker (van der Stelt, 2005).

Zoom in

Another simple but effective tool is the zoom function, which permits enlargement of the image. By using a twofold or threefold magnification, the user can recognize details more easily. To perform this action, the computer duplicates or interpolates rows and columns of the digital image, thus increasing the size of the image on the screen (van der Stelt, 2008). For example, if the original image extends partly outside the screen because of the large number of pixels vertically and horizontally placed, resolution is reduced to fit the image within the size of the screen. In these cases, magnification of the image is required to show the original pixel resolution. If magnification is increased beyond the original pixel resolution, it results in pixilation (White*et al.*, 2004).

Sharpening and Smoothing

The purpose of sharpening and smoothing filters is to improve image quality by removing noise. Noise is irrelevant components of an image that hamper recognition and interpretation of the data of interest and it is often categorized as low-frequency noise (gradual intensity changes) or high-frequency noise (speckling) (White *et al.*, 2004; Gö ğüs *et al.*, 2007 and Shrout *et al.*, 1996).

Filters that sharpen an image remove low-frequency noise and intended to enhance the detail in an image. Filters that smooth an image, remove high-frequency noise and intended to reduce the amplitude of small detail in an image. For the correct application of filters, it is important to know what type of noise they reduce and how that affects features of interest. Without this knowledge, important image features may degrade or disappear as noise is removed (White *et al.*, 2004).

Image Analysis

When the user performs certain calculations extracting specific information from the image, it is considered "image analysis" (van der Stelt, 2008). This information can range from simple linear measurements to fully automated diagnosis (White *et al.*, 2004).

Measurement

Digital imaging software programs offer many tools for image analysis (Lehmann *et al*., 2002). Digital rulers, densitometers and a variety of other tools are readily available. With these tools measurements of length, angle and area can be made on a digital image (van der Stelt, 2005 and Amenábar, 2006). The easiest way is to express the measurement as the number of pixels; however, a more convenient method is to use millimeters or inches as the unit of measurement (van der Stelt, 2005). Calibration of the magnification factor of a particular sensor is needed to convert pixel measurements in real length measurements (van der Stelt, 2005). Dental examples of measurement include intensity of discoloration, assessing alignment of tooth (White *et al*., 2004 and Gö üs *et al.*, 2007).

Image Segmentation

An important image post-processing technique used for medical image analysis and computer-assisted medical diagnosis is image segmentation (Li, 2006). The purpose of the image segmentation is to simplify and reduce basic components of the image. This process requires subdividing the image and separating objects from the background. Objects of interest are defined by diagnostic task (for example a discoloration, tooth shape, zenith of gingival) (Gö üs *et al.*, 2007).

Properties Finding

After segmentation of objects from image, several features are found that help to determine which classes belong to each object. For example some operations are performed to determine discolorations automatically on a digital photograph. Similar applications are applied such process as scanning of the face, fingerprint or pupil of the eye for security (Gö üs *et al*., 2007; Onder, 1997 and Kahraman *et al*., 2005).

Image Compression

Proposed by White et al, (White *et al.*, 2004) "The purpose of image compression is to reduce the size of digital image files for archiving or transmission. Image compression methods are generally classified as lossless or lossy. Lossless methods do not discard any image data and an exact copy of the image is reproduced after decompression. Lossy compression methods achieve higher levels of compression by discarding image data. Empirical evidence suggests that this does not necessarily affect the diagnostic quality of an image. Version 3.0 of the DICOM (Digital Imaging and Communications in Medicine) standard adopted JPEG (Joint Photographic Experts Group) as the compression method which provides a range of compression levels. Other types of image compression methods are being investigated for their use in medical imaging."

Conclusions

Dental digital image processing not only affords the practitioner many benefits such as medico - legal documentation, laboratory and peer communication, patient education, third – party communication, and ease in adaptation to marketing campaigns but also helps mainly in proper diagnosis and treatment planning. Thus image processing system is especially beneficial in practice of aesthetic dentistry

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