

WCETR 2011

Sophisticated Educational Software for Dentistry Students using Dental Measurement System (DEMS)

A.Noraziah^{a,*}, Lim Cheh Siang^a, Ahmed N. Abdalla^b, Tutut Herawan^a, Wong Ying Tze^a, Mohd Helmy Abd Wahab^c

^aFaculty of Computer Systems and Software Engineering, Universiti Malaysia Pahang, Malaysia.

^bFaculty of Electrical and Electronic Engineering, Universiti Malaysia Pahang, Malaysia.

^cDepartment of Computer Engineering, Universiti Tun Hussein Onn Malaysia, Malaysia.

Abstract

Nowadays, the dental society is very successful since the technology they using are very modern and it bring many advantages to the dentist and patient such. Dental Measurement System (DEMS) has been developed as an educational software and technology to be used by the dentist or lecturer, in order to teach the dentistry student about the treatment of tooth decay in International Islamic University Malaysia (IIUM) dental clinic. Through DEMS dentist can obtain accurate tooth decay data analysis compared to the traditional method. DEMS is the supporting system for IIUM dental clinic to computerize the traditional method to ensure the process of tooth decay image clearer. In addition, it provides the calibration and measurement to allow the staff and students IIUM to measure the tooth decay based on image. This system is developed by using the Visual C++ that integrated with OpenCV, which is the library that enable image processing techniques enhance the image.

Keywords: Educational software, dental measurement system, Image processing techniques, calibration and measurement.

1. Introduction

Nowadays the dental society is very successful for the high technology country. The hardware and software they had used is sophisticated and modern, as such the paradigm sensors, fiber optic polar metric sensor, laser sensors and shade vision to provide 3D measurement and shape function, wave measurement function and X-ray function. This is due to urgent requirement to obtain data accurate and observe clearer the tooth decay. In particular, this sophisticated technology also can reduce the consume time for the dentist and patient to repair the decay tooth, thus patient does not always come to checking whether the repair tooth have any effect since the use of accurate technology to get analysis. In addition, teaching and learning should also take advantageous from this technology. In International Islamic University Malaysia (IIUM) dental clinic, it is very significant requirement to provide the modern and sophisticated technology. Furthermore, the dentistry students able to learn and train themselves on how to observe the tooth decay with using advance technology in order to get the accurate data.

In the develop country, most of the dental clinic unable to deploy the high technology hardware and software because it involve a very high cost. Thus, they used the traditional method which is using sliding caliper and

* A.Noraziah. Tel.: +609-5492121; fax: +609-5492144.

E-mail address: noraziah@ump.edu.my

intraoral video camera to observe the tooth decay. This method needs using a lot of time to get the accurate data and also difficult to observe the tooth decay.

Dental Measurement System (DEMS) has been developed as an educational technology to be used by the lecturer or dentist in order to teach the dentistry student about the treatment of tooth decay in International Islamic University Malaysia (IIUM). DEMS becomes as the supporting system for the IIUM dental clinic. This system computerizes the traditional method and used for process the image make the tooth decay image clearer and it also provides the calibration and measurement for the tooth decay by using image to allow the UIAM staff and student dentist to measure the tooth decay.

2. Literature Review

2.1 Tooth Decay Concept

According to the Brian Kerr whose is an expert author for the EzineArticle.com, the tooth decay have start occur when the bacteria called as plaque inside our mouth produces the acid surround the tooth. People would practice of poor hygiene and brushing teeth one time in a day is the fact make the tooth decay occurred [1]. There are a lot of bacteria inside one people mouth and just have one type of bacteria will produces acid to corrode teeth and it can be passed by sharing the same drink, kissing or eating from the same plate from one people to another people Brian Kerr et al, 2002. The decay process will move slowly when it set into the tooth's enamel to way through second layer of element. Inside the second layer of element have contains the tooth nerves and blood source called as pulp and when the decay reaches pulp the pain of tooth decay will apparent and it will eat the tooth nerves of the end. Based on the Brian Kerr research there has three types of tooth decay, smooth decay, root decay and pit decay. Smooth decay normally will begin a white spot in the tooth and dissolve the enamel of tooth and it generally targets the young adult between twenty thought thirty. Root decay will begin on the people surface of tooth's root and it usually come from dry mouth or eating a lot of sugar. Pit decay start at narrow divots nearest molars and this type of tooth decay normally moves quickly than the smooth decay.

2.2 Digital Image Concept

Torsten Seemann state that digital image is discrete two-dimensional function, $f(x, y)$, and it represent with rectangular by consisting of Y rows and X columns. $X \times Y$ is the resolution for the image and at the top left corner of image the $f(0,0)$ is taken and $f(X-1, Y-1)$ is taken by bottom right corner[2]. Each distinct coordinate in the image is called as pixel or picture element [3]. In addition, all the output of the pixel is dependent on the type of image and the measurement able to take the any numerical form. Figure 1 shows the rectangular digital image of resolution 16 X 8.

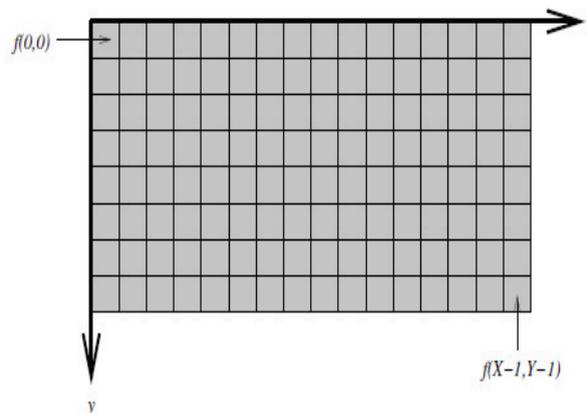


Figure 1: The rectangular digital image of resolution 16 X 8

2.3. Open Source Computer Vision (OPENCV)

Open Source Computer Vision (OpenCV) is a library of programming functions for real time computer vision and it's developing by the Intel Corporation. Insides the software library has more than 500 optimized algorithms [4]. OpenCV can be supported the C++ programming language to optimized and intended for real-time application. It can be provides several features which is image data manipulation, such as the allocation, release, copying, setting, conversion; image and video I/O such as the file and camera based input, image/video file output; matrix and vector manipulation and linear algebra routines, such as products, solvers, eigenvalues; matrix and vector manipulation and linear algebra routines (products, solvers, eigenvalues); various dynamic data structures (lists, queues, sets, trees, graphs); basic image processing (filtering, edge detection, corner detection, sampling and interpolation, color conversion, morphological operations, histograms, image pyramids); structural analysis (connected components, contour processing, distance transform, various moments, template matching, Hough transform, polygonal approximation, line fitting, ellipse fitting, Delaunay triangulation); camera calibration (finding and tracking calibration patterns, calibration, fundamental matrix estimation, homography estimation, stereo correspondence); motion analysis (optical flow, motion segmentation, tracking); object recognition (eigen-methods), Basic GUI (display image/video, keyboard and mouse handling, scroll-bars), and Image labeling (line, conic, polygon, text drawing) [5].

3. Development of Dental Measurement System (DEMS)

In this section, the development of DEMS is presented. This section elaborates on hardware and software specification to developed DEMS, and the system development.

3.1 Hardware Specifications

In this section, the hardware will be using in all the phases during development of system. Table below show the hardware used during development stages.

Table 1 Hardware use in the development of DEMS

Hardware	Specification	Unit	Description
Laptop	Compaq Presario V3000 Intel Core 2 Duo Processor 2.0GHz	1	Using in the all phases during the development of the system.
Hard Disk	Western Digital 320Gb	1	To store the all documentation and development system.
External Hard disk	Western Digital 500Gb	1	Using for backup the all documentation and development system.
Ram	Kingston 2Gb	2	To improve the laptop speed and meet the heavy software requirement.
DVD Rom	DVD +/- RW(Rewritable)	1	To burning the documentation and development system inside the CD or DVD.
Camera	Kodak 1000 Intraoral Video Camera	1	To capture the tooth decay image

3.2 Software Specifications

This section, will list out all the software will be using during the development of DEMS. The table below shows the software will be using during the development stages.

Table 2: Software use in development of DEMS

Software	Description
Operating System window vista	Using in all phases during the development of system.
Microsoft Visual Studio 2010	Using Microsoft Visual C++ which is the application inside the Microsoft Visual Studio 2010 to implement the coding and design for the developing of DEMS.
OpenCV 2.1	To build the function libraries
Nero 7 Essentials	To burn the documentation and development system.
Win RAR 3.8	File Compressor
ESET Nod32 Antivirus 3.0.642.0	Protection from virus
Internet Explorer 8.0	Research
Paint	Drawing and mapping the flow and chart.

3.3 System Development

Inside the system interface all the image processing techniques such as blur, gray scale, threshold, rotation, component labelling and feature extraction will be build out for user easy to using it function and the calibration and measurement also will be build out for user to key in the calibration and the system will be auto calculate the unit of the pixel and easy the user to measure the object.

There are five main steps which are image acquisition, image enhancement, image segmentation, component labelling, and image feature extraction. Image acquisition is the begin step for all application would using the image processing techniques. In normally, image acquisition is the alternative to load the image from the device and most commonly is using in the camera devices. In develop of DEMS the intraoral video camera will be using to capture the tooth decay image which is putting the small intraoral video camera inside the human mouth to capture the tooth decay image with 720 x 570 pixels and file format is Tagged Image File Format (tiff) and applied it in to develop of DEMS. Image enhancement processes consists of a collection of techniques that seek to improve the visual appearance of an image or to convert the image to a form better suited for analysis by a human or a machine [6]. Sometimes noises are unavoidable when in the first step which is image acquisition phase. Therefore, the image enhancement should be applied. For the development of DEMS, one of the enhancement techniques will be using is remove the color of the image and make the image to be the clay scale image before it apply segmentation. Segmentation of an image entails the division or separation of the image into regions of similar attribute [3, 6, 7]. Therefore, segmentation is meaning that separate out foreground and background [7, 8]. After the image enhancement the images become the clay scale and it easier to apply the segmentation which is using otsu method threshold techniques and change the image to the binary image. The binary image can make the image object more clear and easy to apply component labeling. Component Labeling is the fourth step image processing techniques would using in develop the DEMS. The objective of connected component labeling is to determine all the connected set of component in an image an assign a distinct label to each pixel in the same connected component. Component labeling is one of the important techniques to label out insides the image got how many object. After applied the segmentation, the image becomes the binary image which is black and white only and the component labeling algorithm will be using because it most commonly apply in binary image. It will determine and label each object in the image. Image feature extraction is the last step image processing techniques to apply in develop of DEMS. An image feature is a distinguishing primitive characteristic or attribute of an image [6]. After the component labeling is applied the object in the image will be define and at this time the image feature extraction will be applied to determine which object inside the image that we need. After determine the object, the calibration and measurement function will be applied which is assume or calibrate one of the object measurement in the image and calculate one pixels have how many unit inside the object than only measure the tooth decay in the image. Figure 2 shows an original tooth decay image, whereas Figure 3 shows the image after segmentation.

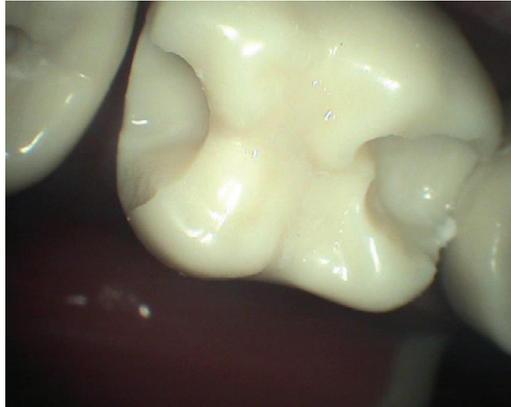


Figure 2: Original Tooth Decay Image



Figure 3: Image after applied Segmentation

4. Results and Discussion

Figure 4 shows the image after applied the image feature extraction. The red colour object is the object that we need to do calibration and measurement about the object. The green colour arrow is the object we doing assumption or calibration the object measurement such as it is 100mm and calculate it got how many unit inside one pixel than only doing measurement on other object. The black colour arrow is the tooth decay that we need to measure and the measurement result is 30.1075mm

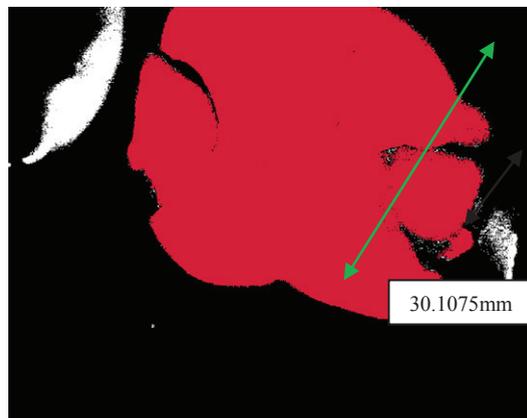


Figure 4: Image after applied the Image Feature Extraction

5. Conclusion

Dental Measurement System for UIAM (DEMS) is the system that has been developed to calibrate and measure the tooth decay image. The system is used by the dentist to teach dentistry student. It is the supporting system for the UIAM to computerize the most complex traditional method. By using the DEMS, user will be easy to enhance the image make the angle clear and measure out the width and range for the tooth decay image with a simple click on the image and the result will come out.

References

- [1] Brian Kerr (2002). *Tooth Decay Facts and Information*. Retrieved August 18, 2010 from EzineArticle.com: <http://ezinearticles.com/?Tooth-Decay-Facts-and-Information&id=3566448>
- [2] Torsten Seemann (2002). Digital Image Processing using Local Segmentation. School of Computer Science and Software Engineering Faculty of Information Technology Monash University. Thesis. Page.7-8. Gray
- [3] A.Noraziah, Suryanti Awang, Nurshabah Yalah, Norazaliza Mohd. Jamil, "Block Segmentation In Cross Stitch Application", 7th International Conference on Distributed Computing and Applications Business Engineering And Science, China, Vol. 1, pp. 254-257, July 2008
- [4] Bradski (2010). OpenCV. Retrieved September 11, 2010 from OpenCVWiki: <http://opencv.willowgarage.com/wiki/>
- [5] Gady Agam (2006). Introduction to programming with OpenCV. Retrieved September 11,2010 from Department of Computer Science Illinois Institute of Technology: <http://www.cs.iit.edu/~agam/cs512/lect-notes/opencv-intro/opencv-intro.html#SECTION00023000000000000000>
- [6] William K. Pratt (2007). Digital Image Processing Fourth Edition. Wiley-Interscience A John Wiley & Sons, Inc.,Publication.
- [7] Tinku Acharya, Ajoy K. Ray (2005). Image Processing Principles and Applications. John Wiley and Sons. Pages 311.
- [8] Siti Marziah, Noraziah Ahmad, "Vacant Space Car Park using Image Segmentation", International Conference on Software Engineering & Computer Systems 2009, Malaysia, Vol. 1, No. 1, pp. 312-316, Oct 2009.