3 D Reconstruction of dental pieces with data acquisition by the system APSED

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Abstract: - The present work shows the results about the treatment of acquisition data on the surface of dental enamel using the reflectometry method, to which a noise reduction algorithm was applied since the data is acquired by the optoelectronic device, therefore it can generate outlier data, besides an interpolation algorithm was applied so the curve is smoother and the form of the sample is observed. It also presents the development of a software to visualize a three dimensions reconstruction of dental pieces starting from the data acquisition that analyzes the dental enamel ruggedness and a possible diagnosis of the defects on the surface. The APDSED system (Acquisition and Processing of Defects of the Surface of Dental Enamel) is an experimental prototype for the detection of physical abnormalities of the dental enamel.

Key-Words: **-** Noninvasive Method, Data acquisition, Reflectometry, Image reconstruction, Solid reconstruction, Interpolation Method

1 INTRODUCTION

The devices used to make dental pieces analysis have been modernized and new methods have been developed to make a more precise analysis and to find defects such as caries and demineralization zones. The invasive methods are: X rays with digital plates where the images appear in a computer and the processing is faster and the diagnosis is more clear since the images can be seen on RGB or in a scale of grays [1], although the radiation dose absorbed by the organs is still high. The dental laser allows to treat caries and fissures but there is no clear information about the ray wave length and the size of the demineralization zones that may be detected [2]. Besides, an explorer is used to detect fissures and demineralization zones but only detects those higher than 200 microns. The Noninvasive methods are: revealing tablets, chemical methods, intraoral cameras, which with the inspection method, the figure digitalization helps to determine where and in what measure differs the computerized model from the real object.

These differences may serve as a guide to modify the development processing until the model and the real object are acceptable [3]. The optoelectronic system was developed in the “Noninvasive methods for the stomatologic diagnosis laboratory”, which is based on the reflectometry method [4], that is used to acquire the data (voltage) on the surface of the dental enamel, and this is found within the acquisition methods of active range, of no contact, reflected and optic [5]. In the defects detection, the specialist goes through a diagnosis consisting in objective and subjective methods.

2 METHODOLOGY

The main problem of this project is to find micrometric defects on the dental enamel surface; for which it has to developed the reconstruction of the surface topography using topological techniques.

To make the images digitalization of the surfaces, it will be taken the data matrix as binary images of the five faces of the tooth. A digital processing of images will be used with whiteness, blackness filters, edges, and a reconstruction of the dental piece volume will be done from images of the surface of each tooth face. The aforementioned will let to observe the defects on the dental enamel surface. The defects investigated are: demineralization zones, fractures and incipient caries. The beginning of the carious processing may happen through dimples, fissures due to accumulation of dentobacterial plate, having a demineralization as a preamble .

2.1 Automatic Device

This system is based on the reflectometry method which is based on making a light ray to fall on a surface and by the intensity of the reflection it can be measured the ruggedness of the surface of the sample. The system consist in a laser as a transmitter and a photodiode as a receiver, this tracto transmitter-receiver is placed on a automatic device which makes a sweep in a cartesian plane X- Y, the sweep is done in different distances 25, 50, 100, 150 micras. The previous allows a precise analysis of the ruggedness in the surface of the dental pieces.

The angles implemented for the ruggedness analysis were made in an experimental way which consists in sweeping the surface and for every analyzed point the angle of the transmitter as of the receiver and the distance between the E-R tract and the dental piece is changed, since the ruggedness of a dental piece is anisotropic.

2.2 Data Acquisition

Figure 1, shows a flow chart of the system of acquisition data, which starts with the optoelectronic device already described. This system gives as a result a reflected light and the reception device makes a conversion to analogical voltage in the order of milivolts, that is why an amplifier of voltage is used to transform them into volts. By using a data acquisition card a conversion of analogical voltage to digital voltage is made and the result is sent to the computer.

The results are stored in a data file under a matrix form, this data come in the order of 0 to 5 volts.

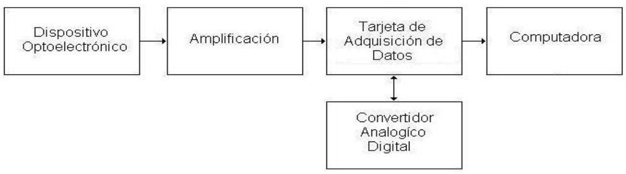

Figure 1. Flow Chart

2.3 Elimination of outlier data

To the data acquired by the system of acquisition a conversion to the RGB image in a scale on grays to 256 colors, is made; to this images Fourier and Wotherford Transforms filters will be applied, that allows to correct some data abnormalities such as: noise, outliers data or interference due to the device , a discrete transform was applied to analyze the frequencies and to watch the pass down , pass high, pass band and if an anomaly would exist, a modification in the image of the discrete Fourier transform can be done. By doing the experiment with this method it was observed that the data doesn't have many alterations and if it is applied to the image the modifications are minimal or none that is why it was applied only to guarantee that there were no abnormalities.

2.4 Interpolation Method

To the data already treated it was applied an interpolation algorithm so the curve is smoother and when it is traced the form is observed. This method consists in evaluating the points of the n x m storage points and to obtain its metric with the four neighbor points. Figure 2 shows the points analyzed. This metric is the media between two points and the matrix of the data is increased to the double of the original matrix and this is done so the defect may be observed better, if this does not exit, then, the behavior of the dental enamel ruggedness is observed.

	P(x, y+1)	
P(x-1, y)	P(x, y)	P(x+1, y)
	P(x, y-1)	

Figure 2. Interpolation Method

Interpolation is done to obtain the data according to the distance there is from one point to another, that is, if the data acquisition is made to a 100 micron then the interpolation processing is made three times so the distance is 12.5 micron.

2.5 Ruggedness reconstruction of the dental enamel

To generate the ruggedness topography of the dental enamel an algorithm was developed, see figure 3. Based on topological metrics, the topological metric is the distance that exits between two points; this method consists in obtaining the distances between the initial point and the 8 neighbors that are found around this one.

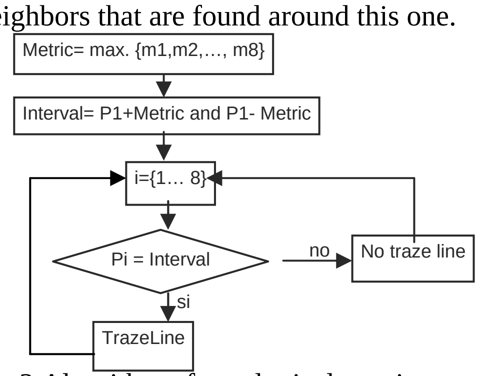

Figure 3 Algorithm of topological metric

Figure 4 shows the neighborhood of the 8 neighbors. Of the 8 metrics obtained, the highest or medium or lowest is taken to do the neighborhood or the connection between the points. The aforementioned is made so the differences between neighborhoods can be seen. With this, the topographic reconstruction of each of the faces of the dental pieces [6] is generated, and figures can be built inside the space, later a checkup can be made and to identify certain forms that fulfill properties in order to know the possible defects in our dental samples.

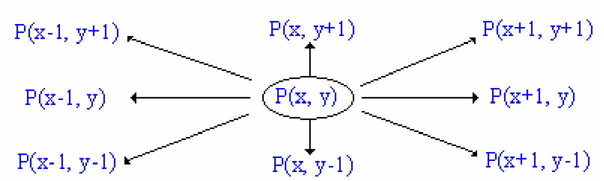

Figure 4.The 8 neighbors of a point

2.6 Reconstruction of the volume of dental pieces

As the images generated by the reconstruction of the ruggedness topology are independent then they are grouped to form the solid [7], it is made through geometry and grouping the edges of each image. This image is incomplete so to be completed the following has to be done, grouping the edges and filling the black gaps. Even this way, this image counts with the characteristics of rotation, scale, translation.

2.7 Computer tools

The software was designed on Delphi, where you can see the principal screen with the data acquisition on the tooth face in a matrix form, the 2 dimensions image on RGB to a 256 colors in a scale of grays. To do this application and to watch the image on three dimensions it was used as a tool an OpenGl. This library belongs to Silicon Graphics, some adaptations were made so it could work on Windows the operating system, thanks to this library animated programs o graphics on three dimensions can be done, utilizing the methodologies in the graphics area.

3 EXPERIMENTS AND RESULTS

The acquired data was used and presented on [4], which was used on a non automatic mechanism, it can be appreciated that the data is wrong but also it is appreciated the form of the dental piece, in figure 5 the data is seen on a form of a matrix the image on RGB of the external face in a scale of grays.

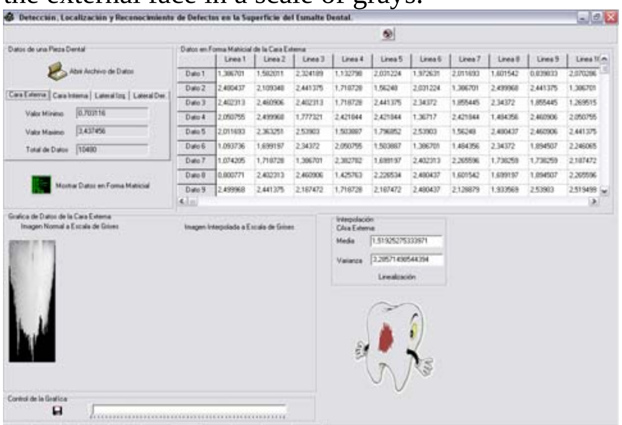

Figure 5. Data acquired by the optoelectronic system and the image is generated from this data.

Figure 6 shows the Fourier transform.

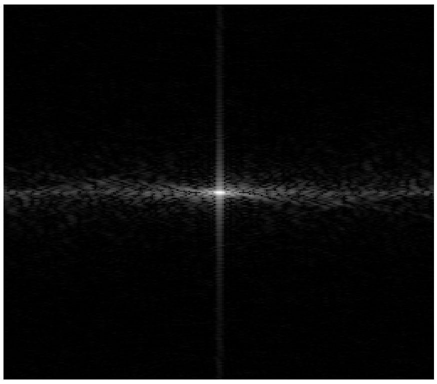

Figure 6.Transformation of the dental piece

Figures 7 and 8 show the image of low pass and band pass.

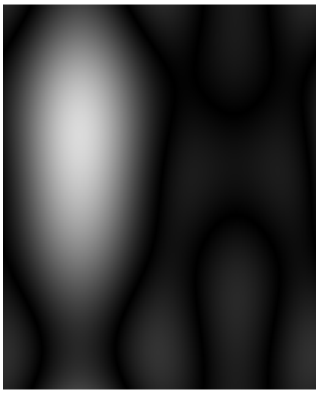

Figure 7. Filtered Image of low pass.

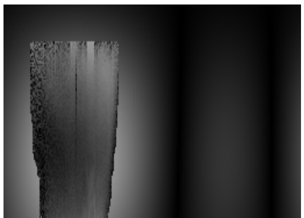

Figure 8. Filtered Image through the band of the dental piece.

Figure 9 shows the image without noise [8], with the Butterworth filter on level 1.

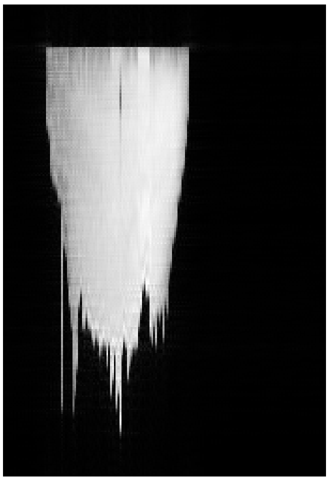

Figure 9. Image with no interference.

Figure 10 shows the interpolated image, with a single interpolation.

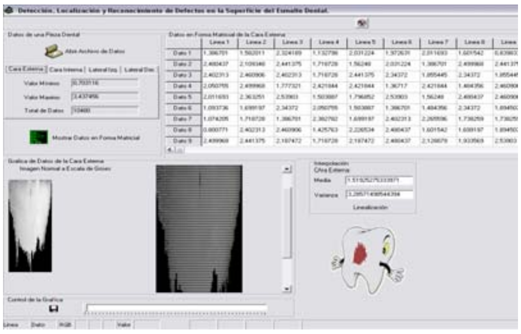

Figure 10. Image with an interpolation

Figure 11 shows the construction of the volume in which the defect can be seen, the defect done manually and validated with a metallographic microscope.

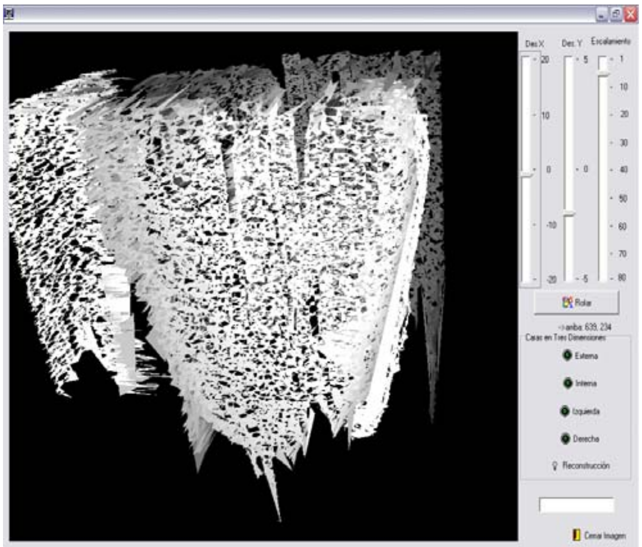

Figure 12. Reconstruction of the volume on 3D.

4 CONCLUSION

A software was obtained that allows to visualize the three dimensions image, as well as the reconstruction of the volume of dental pieces from the data generated by the optoelectronic device APDSED that analyzes the dental enamel ruggedness, from which it gives a diagnosis of the possible surface defects .

The results show that the dental pieces ruggedness varies. Also, it contributes with a methodology and software for the preventive diagnosis on the stage of defects in the dental enamel, based on the noninvasive technique of no contact that will allow to do the physical study of the dental ruggedness in a visual way.

5 ACKNOWLEDGMENTS

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