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Enhancement Panoramic Image Based on Principal Component Analysis (PCA) and SURF Algorithm

Tamara A. Anai [(1)]
Omar B. Taha Al-Tekreeti [(2)]
Rajaa S. Najim [(3)]
Muthenna Sh. Rajab [(4)]
Intesar J. Mohammed [(5)]

[(1)] Department of Basic Sciences, Computer Sciences, [(2)] Department of Oral and Maxillofacial Radiology[(3)] Department of Basic Sciences, Medical Physics, [(4)] Department of Conservative, [(5)]Department of Oral Diagnosis. [(1,2,3,4,5)]College of Dentistry, University of Tikrit, Iraq.

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Corresponding Author:
Name:
(1)Tamara Afif Anai
(2)Omar B. Taha Al-Tekreeti
(3)Rajaa S. Najim
(4)Muthenna Sh. Rajab
(5)Intesar J. Mohammed
E-mail:
tamsamka@tu.edu.iq
Tel: 77077328026
Affiliation:
(1)Assistant Lecturer, Department of Basic Sciences, Computer Sciences,
(2)Lecturer, Department of Oral and Maxillofacial Radiology
(3) Prophesier, Department of Basic Sciences, Medical Physics,
(4)Prophesier, Department of Conservative Dentistry,
(5)Ass. Prophesier, Department of Oral Diagnosis

Abstract

Image upgrade is essential for giving improved data to other image handling methods. Also, the requirement for differentiation improvement to all-encompassing image is a usually performed examination by dental specialists and oral specialists in regular practice and is a critical indicative apparatus. It covers a more extensive zone than a traditional intraoral x-beam and, subsequently, gives important data about the maxillary sinuses, tooth situating and other bone variations from the norm. Thusly, it is anything but difficult to distinguish and perceive valuable data. In this pursuit was utilized the calculation of Principle Component Analysis (PCA) to upgrade the subtle elements of images and enhance the quality the image, by its joining with strategy for difference improvement, and highlights extraction that take from the upgrade technique to limit mistakes in images, along these lines enhance the execution of the framework, image upgrade strategies used to deliver more reasonable images for identification and extraction. Three principle computerized image process strategies: Contrast Stretching, Histogram Equalization and, Contrast Limited Adaptive Histogram Equalization , were considered to build the improvement image, and evacuate clamor, separately however low quality and the image is light angle in hues and less clear . In this exploration we will, pre-prepared images were assessed utilizing current image recognition and highlight extraction techniques Speeded Up Robust Features (SURF) calculations after go in improvement strategies. After that PCA embed the yield vector from SURF. Gotten results demonstrated that upgrade image expanded after number of separated highlights and diminished mistakes amid info image in PCA. Therefore, the impacts of various pre-process procedures were thought about in the paper and the assessment parameters are figured which demonstrate that proposed work gives better execution from the image broke down under PSNR to enhance the dependability of proposed strategy from the outcomes.

Introduction:

Image improvement is a technique to upgrade the nature of image. Image overhaul is a system to improve the idea of image. "Image gets ruined in the midst of the strategy of obtainment because of light power, edge of catch and inadequacies of recognizing contraption. Redesign gives better commitment to robotized image taking care of", for instance, change of multifaceted nature, sharpening, noising and improving the shading precision [(1)]. Two primary classes of image differentiate improvement are spatial area and recurrence Domain [(2)]. Spatial space strategies manage coordinate control of pixels and therefore enhance the general differentiation of image while recurrence area techniques take a shot at Fourier change of an image. Major Spatial space techniques incorporate Intensity Transformation and Filtering. Power change comprises of splendor control, extending the difference and histogram balance, extends the differentiation by redistributing the dim level qualities. These systems break the histogram into and afterward perform adjustment. Channels are straight and nonlinear. Direct channels are low pass channel, honing channel, High lift channel Median, Min and Max Filters [(3)]. Customary strategies used to enhance fluctuation in our examination, we utilized three conventional techniques that are thought to be the most unmistakable strategies used to enhance the differentiation in images, and we additionally utilized SURF to extraction the highlights from image upgrade strategies in view of PCA. Here are the conventional techniques utilized in this examination, specifically, Contrast Stretching (CS) [(4)], Histogram Equalization (HE) [(5)] and Contrast Limited Adaptive Histogram Equalization (CLAHE) [(6)]. Highlights, which were recognized in the isolated images were gained by SURF methodologies. SURF have their own exceptional parameters that can change area happens. To grasp the effects of the parameter regards on feature distinguishing proof, SURF calculations were associated with the photos with different parameter regards. Considered parameters of SURF locator are according to the accompanying: Limit: Empowers most grounded incorporate edge that takes out direct features. Octaves: Characterize number of octaves that resize the principal image to half size. Scale: Characterize number of scale levels, which deliver legitimately clouded out images per octave. The blend of the update methodology and SURF discoverer make the best results. Higher number of the octave and scale bolster quality by utilizing PCA. Besides, minor limit diminishes in SURF don't yield terrible yields. PCA likewise are vital to get stronger coordinated image changing sweep and sum [(7)]. The Principal Component Analysis (PCA) is a champion among the best procedures that have been used as a piece of image affirmation and weight. PCA is a quantifiable procedure under the far reaching title of factor examination. The motivation behind PCA is to decrease the huge dimensionality of the information space (watched factors) to the littler characteristic dimensionality of highlight space (autonomous factors), which are expected to depict the information financially. This is the situation when there is a solid connection between watched factors. The employments which PCA can do are expectation, excess evacuation, highlight extraction, information pressure, and so forth. Since PCA is an established strategy which can accomplish something in the straight space, applications having direct models are reasonable, for example, flag handling, image preparing, framework and control hypothesis, interchanges, and so forth. The most helpful applications contain swarm reconnaissance, video content ordering, individual recognizable proof (ex. driver's permit), shots coordinating, entrance security, and so forth. The guideline thought of using PCA for go up against affirmation is to ex press the tremendous 1 - D vector of pixels created from 2 - D facial image into the moderate focal parts of the segment space. The proposed procedure will take three distinctive approaches to upgrade the photos and test them on the photo and note

the rate change, by then endeavor the features isolated in the photos and coordination with PCA, this gives better results, less time and precision in the results. The other key ideal position of PCA is that once you have found these models in the data and you pack the data i.e. by reducing the image weight. To upgrade the photo quality image change is a basic development. As a fundamental low-level image dealing with procedure, discretionary uproar ejection has been extensively thought about and various update designs have been proposed [8-10], based systems, lacking portrayal [11]. An all-encompassing radiograph is an all-encompassing filtering dental x-beam of the upper and lower jaw. It exhibits a two-dimensional point of view of a half-float from ear to ear. All-encompassing radiography is a kind of focal plane tomography; thusly, photos of various planes are taken to make up the composite panoramic image, where the maxilla and mandible are in the focal trough and the structures that are shallow and significant to the trough are darkened. Other nonproprietary names for an all-encompassing radiograph are dental all-encompassing radiograph and pantomogram, and through the significance of all encompassing " [12] , must be a first rate image to be examined by the authorities must be improved in the best courses for this suggested proposed system will be recorded resulting to talking about PCA. Whatever remains of the paper is organized as pursues. Segment II presents foundation ideas for hunt. Area III proposed strategy. Segment IV Implementation paper and quickly audits the trial results. Segment V Concludes the paper.

Background Concepts

2.1 Digital Image

The image implies a two dimensional limit *f (x, y)* where *x* and *y* mean the spatial headings and the estimation of f whenever *(x, y)* is with respect to the intensity of the image by at that point. "A propelled image can be created as a cross section whose line and fragment records perceive a point in the photo and whose regard orchestrates with the level of light power by at that point". Each part of the bunch identifies with a segment in the photo and is called pixel [13]. The accompanying Equation beneath show of directions broadly of image lattice, where the image has M lines and N sections deciding the beginning at the point *f (0, 0)*.

$$f(x,y)=\begin{bmatrix} f(0,0) & f(0,1) & \dots & f(0,N-1) \\ f(1,0) & f(1,1) & \dots & f(1,N-1) \\ \vdots & \vdots & \ddots & \vdots \\ f(M-1,0) & f(M-1,1) & \dots & f(M-1,N-1) \end{bmatrix}$$

2.2 Panoramic Image

"All encompassing imaging (called pantomography) is a system for delivering a solitary image of the facial structures that incorporates both the maxillary and the mandibular dental curves". "This methodology conveys a tomographic image in that it particularly images a specific body layer. In all encompassing radiography, x-beam source and an image receptor turn around the patient's head. All-encompassing images are most important clinically for definite issues requiring wide extent of the jaws. All-encompassing imaging is regularly used as the hidden evaluation image that can give the required comprehension or help with choosing the prerequisite for various projections. All-encompassing imaging are also useful for patients who don't continue intraoral methodologies well. The essential injury of all-encompassing radiology is that the image does not demonstrate the fine anatomic detail open on intraoral periapical radiographs. In this way, it isn't as useful as periapical radiography for recognizing minimal carious injuries, fine structure of the minor periodontium, or periapical disease. The proximal surfaces of premolars in like manner consistently cover. The availability of an all-encompassing radiograph for an adult seeing habitually does not obstruct the necessity for intraoral films for the investigations of most by and large experienced dental afflictions. Exactly when a full-mouth

game plan of radiographs is open for a patient requiring simply expansive dental consideration, typically alongside zero additional supportive information is gotten from a simultaneous panoramic examination. Diverse issues related with all-encompassing radiography consolidate unequal enhancement and geometric twisting around the photo. Sometimes, the proximity of covering structures, for instance, the cervical spine, can stow away odontogenic bruises, particularly in the incisor locale. Clinically basic things may be orchestrated outside the focal trough and may appear deformed or not be seen at all"[12, 14].

2.3 Image Enhancement Techniques

To upgrade an image, where "improve" can be portrayed impartially or abstractly. "For instance, image upgrade methods can expand the flag to-commotion proportion of an image, or they can make certain highlights less demanding to see by changing the hues or forces. By and large, there is no broad bringing together hypothesis of image improvement at present in light of the fact that there is no broad standard of image quality that can fill in as an outline model for an image upgrade processor". Target of image upgrade – process the image (e.g. differentiate change, image sharpening...). Image brightness and contract affect image abstract quality discernment [15, 16]. In our exploration, we utilized three customary techniques.

2.3.1 Contrast Stretching Method (CS)

Contrast Stretching Method (also called Normalization) enhancing an image by extending the scope of power esteems it contains to make full utilization of conceivable qualities. Unlike histogram equalization, "contrast stretching is limited to a direct mapping of contribution to yield esteems". The outcome is less sensational, yet has a tendency to stay away from the occasionally fake appearance of adjusted pictures. The initial step is to decide the cutoff points over which picture power esteems will be broadened. These lower and maximum points of confinement (for standard 8-bit grayscale pictures, these limits are usually 0 and 255) [4].

2.3.2 Histogram Equalization Method (HE)

The histogram of an image is the representation of the number of pixels that have every value of color. In a greyscale image, it is typically spoken to as a realistic of the dark qualities, and in RGB pictures, the portrayal is finished with three designs, one for each shading segment (red, green and blue). "To avoid dependence between the quantity of pixels or the quantity of quantization levels and the extent of the histogram, more often than not the histogram hub are standardized in the vicinity of 0 and 1. This is the reason that the tomahawks units did are appear "[5].

2.3.3 Contrast Limited Adaptive Histogram Equalization Method (CLAHE)

This strategy that has shown itself to be valuable in allocating showed power levels in therapeutic image. "The technique is intended to enable the eyewitness to effectively observe, in a solitary picture, all complexity of clinical or research intrigue. The technique looks at a histogram of forces in a relevant locale focused at every pixel and sets the showed power at the pixel as the rank of that pixel's force in its histogram. That histogram is an adjusted type of the conventional histogram in which the complexity upgrade actuated by the technique at every force level is constrained to a client selectable maximum [6].

2.4 Speed-Up Robust Feature (SURF)

First exhibited by Herbert Bay, 2006 in gathering in European on PC vision. SURF relies upon multi-scale space theory and the segment discoverer relies upon Hessian lattice. It has awesome execution and exactness. In image I, $x=(x,y)$ is the given point, the Hessian network $H(x,\partial)$ in x at scale ∂ , it very well may be characterize as following Equation:

$$H(x, \partial) = \begin{bmatrix} Lxx(x,\partial) & Lxy(x,\partial) \\ Lyx(x,\partial) & Lyy(x,\partial) \end{bmatrix}$$

Where *Lxx(x, ∂)* is the convolution results. "SURF counts use to some degree one of a kind techniques for recognizing highlights". In key point organizing advance, the nearest neighbor is described as the key point with least Euclidean separation for the invariant descriptor vector. Lowe used an all the more convincing estimation that obtained by taking a gander at the division of the closest neighbor to that second-closest neighbor [17, 18].

2.5 Principle Component Analyses (PCA)

PCA is a simple yet popular and useful linear transformation technique that is used in numerous applications, such as stock market predictions, the analysis of gene expression data, and PCA is used to reduce the dimensionality of training data ,Haykin, [19], and Fukunaga[20]. Table(1), show the algorithm of PCA.

Proposed Method

Proposed method integration enhancement methods based on PCA and SURF algorithms.

Begin

Step 1: Input: read the origin image (x) of dimension M*N.

Step 2: Convert (x) to gray image.

Step 3: Calculate PSNR (Peak Signal to Noise Ratio) from the MSE (Mean Square Error) for origin (x) according to the formula.

$$MSE = \frac{1}{M \times N} \sum_{i=1}^{M} \sum_{j=1}^{N} (x_{ij} - y_{ij})^2$$

$$\text{PSNR} = 10 \log_{10} \frac{L^2}{\text{MSE}}$$

Where x is the original image and y is the distorted image. M and N are the width and height of an image. L is the dynamic range of the pixel values.

Step 4: I-Apply Contrast Enhancement methods →

a- (CS) (Umbaugh, 1998)[4].

b- (HE)(Rafael et al., 2004)[5].

c- (CLAHE) (Zuiderveld, 1994)[6].

.

II-Generate image histogram→ (a,b,c).
III-Show image enhanced → (a,b,c).
IV-Output: Enhanced image (a`,b`,c`)

Step 5: Calculate PSNR for (a`,b`,c`).

Step 6: Apply SURF to extraction features from (a`,b`,c`).

Input→(a`,b`,c`)

Output→features extraction for (a",b",c")

Step 7: Find vector for three method.

Output vector:

[a"] =SURF-CS, [b"] =SURF-HE,
[c"] =SURF-CLAHE

Step 8: Do the PCA transform of output vectors from **Step 7** as input vector for PCA.

Step 9: Apply the steps of PCA in Table (1).

Step 10: Show modify image enhanced.

x`(a")= SURF-CS-PCA
x`(b") =SURF-HE- PCA
x`(c") =SURF-CLAHE- PCA

Step 11: Calculate PSNR as step 3. x`(a"), x`(b") , x`(c").

End.

Experimental Results and Discussions

The experiments were performed using the sample image taken from dentistry of Tikrit University Fig. (1), shows the original image, and histogram. In order to evaluate the performance of proposed method we tested proposed in three method of enhancement method and compare the results of the proposed method in (PSNR). So a higher PSNR value indicates the higher quality of the image. Table (2), results of PSNIR details. After image filtering, object features were detected using different parameters of (SURF) algorithms to features extraction from image that very useful to enhance image and give accuracy result to extract vector of image for PCA. Fig. (2), (a) (b)

(c) shows the (CS), (HE), and (CLAHE) and histogram for image. Fig. (3), (a) (b) (c) shows the features extraction for SURF-CS, SURF-HE, and SURF-CLAHE. Fig. (4), (a) (b) (c) shows the proposed method (SURF-CS-PCA), (SURF-HE-PCA), and (SURF-CLAHE-PCA) proposed method. Fig. (5), (a) (b) (c) illustrates the results of change detection using image enhance- principal components for three methods.

Conclusion

A proposed method enhance quality and Elucidation the images by integration with contrast enhancement. It overcomes the noise of image based on PCA after using the features extraction SURF from enhancement methods and enhances the image to correct extent. SURF is great with PCA to extricate upgrade image. Furthermore, see the distinction of value between three contrast enhancements method .Experimental results show that proposed method better than the enhancement methods. Using PSNIR the quality of proposed method, the errors have been less, to diagnose panoramic image for doctor. Further works will be extended to detect an enhancement images using PCA by hybrid it with met heuristic algorithm.

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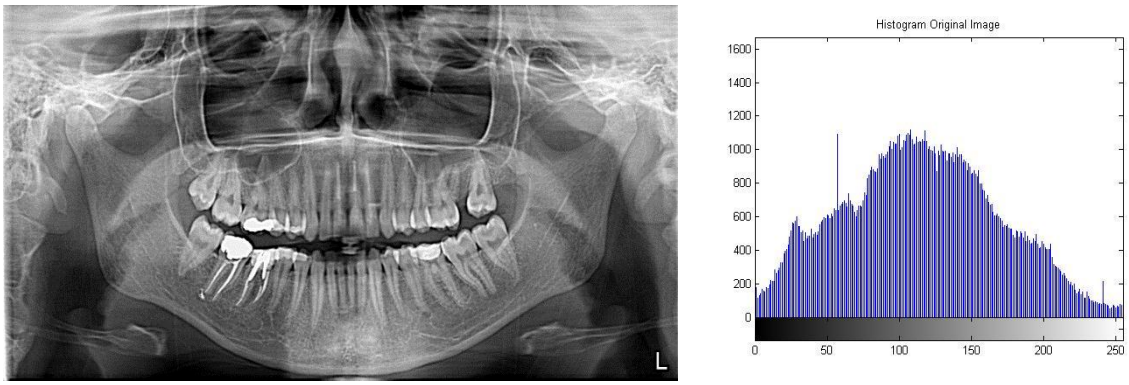
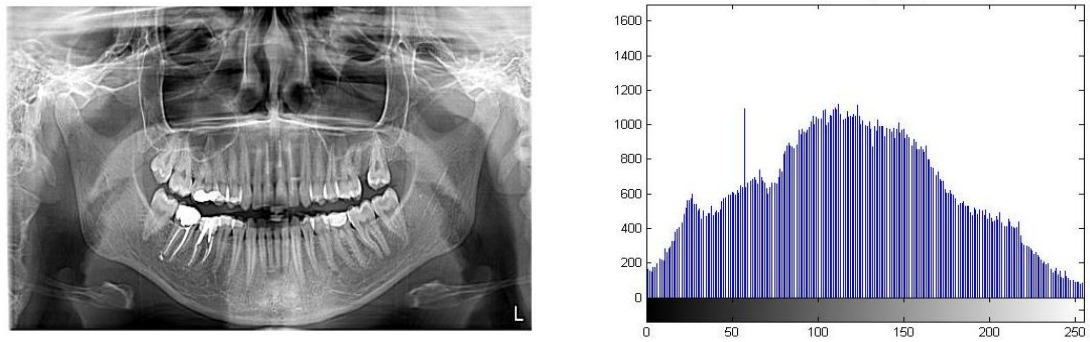
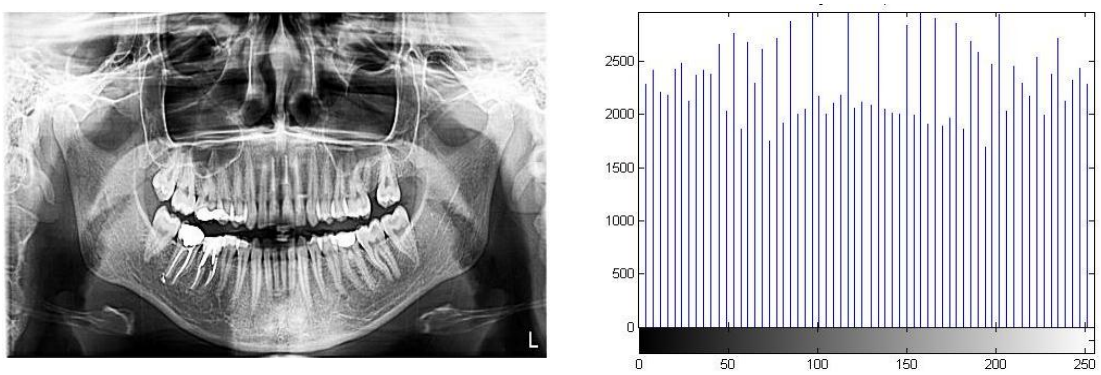


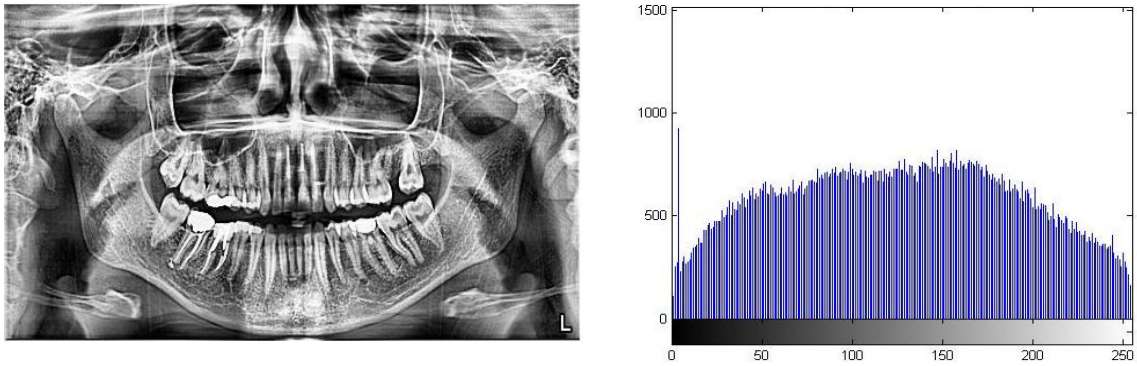
Fig. (1): The Original image.



(a)

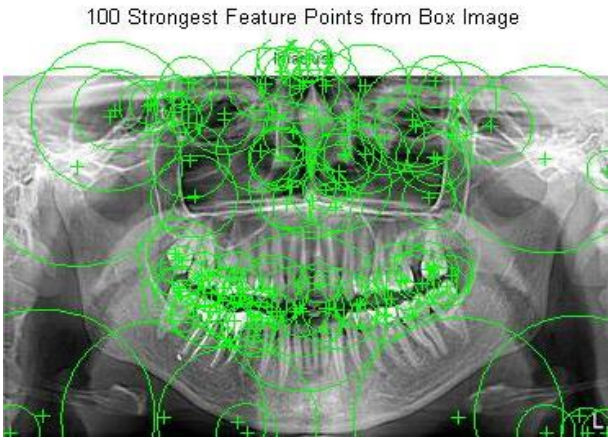


(b)

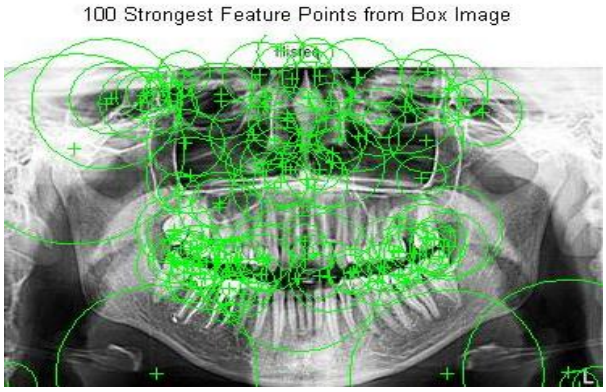


(c)

Fig.(2): (a) Contrast Stretching (CS) method. (b) Histogram Equalization method (HE). (c) Contrast Limited Adaptive Histogram Equalization method (CLAHE).



(a)



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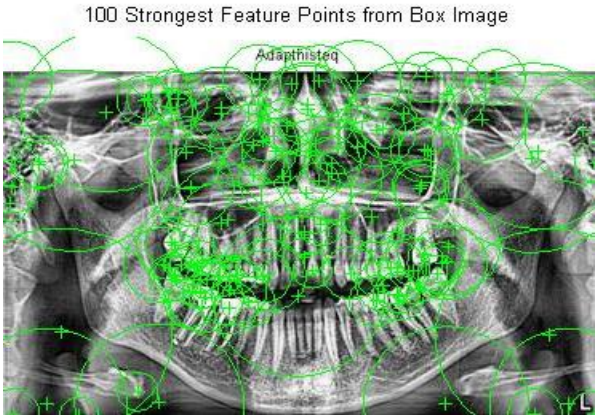
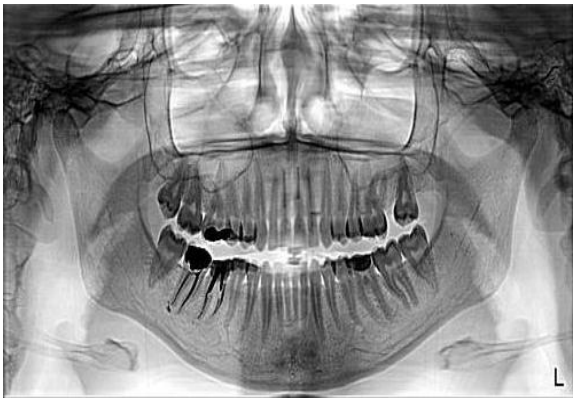


(c)

Fig. (3):(a)The features extraction for SURF-CS.(b) The features extraction for SURF-HE.(c) The features extraction for SURF-CLAHE.



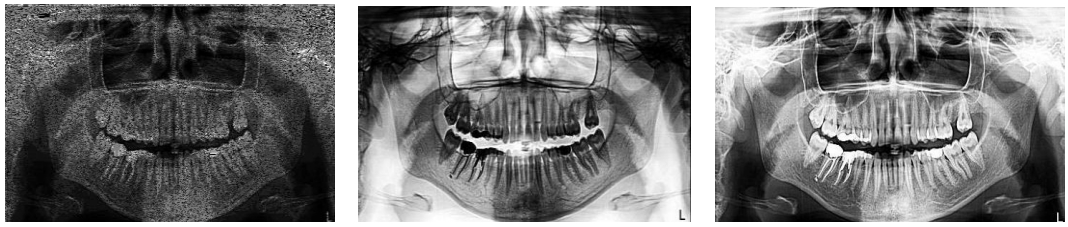
(a)

(b)

(c)

Fig.(4):(a)Contrast Stretching-SURF-PCA (SURF-CS-PCA) proposed method.(b) Histogram Equalization-SURF-PCA (SURF-HE-PCA) proposed method.(c) Contrast Limited Adaptive Histogram Equalization-SURF-PCA (SURF-CLAHE-PCA) proposed method.

(a)



(b)

(c)

Fig. (5):(a) The results of change detection using image enhance- PCA- CS.
(b) The results of change detection using image enhance- PCA- HE.
(c)The results of change detection using image enhance- PCA- CLAHE.

Table (1): PCA algorithm.

1. Compute the mean feature vector

   $\mu = \frac{1}{p}\sum_{k=1}^{p} x_k$, where, x_k is a pattern (k = 1 to p), p = number of patterns, x is the feature matrix
2. Find the covariance matrix

   $C = \frac{1}{p}\sum_{k=1}^{p}\{x_k - \mu\}\{x_k - \mu\}^T$ where, T represents matrix transposition
3. Compute Eigen values λ_i and Eigen vectors v_i of covariance matrix

   $Cv_i = \lambda_i v_i$ (i = 1, 2, 3,....q), q = number of features
4. Estimating high-valued Eigen vectors
   (i) Arrange all the Eigen values (λ_i) in descending order
   (ii) Choose a threshold value, θ
   (iii) Number of high-valued λ_i can be chosen so as to satisfy the relationship

   $\left(\sum_{i=1}^{s}\lambda_i\right)\left(\sum_{i=1}^{q}\lambda_i\right)^{-1} \geq \theta$, where, s = number of high valued λ_i chosen

   (iv) Select Eigen vectors corresponding to selected high valued λ_i
5. Extract low dimensional feature vectors (principal components) from raw feature matrix.

   $P = V^T x$, where, V is the matrix of principal components and x is the feature matrix

Table (2): The result of PSNIR .

Images	**PSNR**
Original image	25.36
Contrast Stretching method(CS)	31.11
Histogram Equalization method(HE)	31.25
Contrast Limited Adaptive Histogram Equalization method(CLAHE)	31.16
SURF-CS-PCA Proposed method	42.70
SURF-HE-PCA Proposed method	**46.79**
SURF- CLAHE -PCA Proposed method	42.77

References:

1- Lee C, Lee Ch ,Young L, & Chang-Su K, Power-constrained contrast enhancement for emissive displays based on histogram equalization, IEEE TRANSACTIONS ON IMAGE PROCESSING ,21(1)(2012),80-93.

2- Cheenu S & Manshi S, Methods for Image Enhancement: A review, International Journal of Computer Science and Mobile Computing, ISSN 2320–088X, 3(8) (2014) ,602–606.

3- Nirmala S , Dongale T, & Kamat R, Review on image enhancement techniques: FPGA implementation perspective, International Journal of Electronics Communication and Computer-Technology(IJECCT),2(6)(2012),270-274.

4- Umbaugh C E, Computer vision and image processing practical approach using CVIP tools, Practice Hall PTR,(1998).

5- Rafael C G, Richard E W , & Steven L, Digital image Processing using matlab ,Prentice Hall, New jersey,(2004).

6- Zuiderveld K, Contrast limited adaptive histograph equalization,graphic gems IV, San Diego: Academic Press Professional, (1994), 474–485.

7- Akcaya E O,& Avsara O, The effect of image enhancement methods during feature detection and matching of thermal images. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLII-1/W1(2017).

8- Donoho D L, De-noising by soft thresholding, IEEE Transactions on Information Theory ,41(1995),613–627.

9- Coifman R R, Donoho D L, Translation-invariantde-noising,in: A.Antoniadis,G. Oppenheim (Eds.), Wavelet and Statistics, Springer,Berlin, Germany,(1995).

10- Pizurica A& Philips W, Estimating the probability of the presence a signal of interest in multire solution single and multi-image denoising, IEEE Transaction on ImageProcessing,15(3)(2006),654–665.

11- Elad M & Aharon M, Image denoising viasparse and redundant representations over learn eddiction aries, IEEE Transaction on Image Processing, 15(12) (2006),3736–3745.

12- Allan G F, Panoramic radiology: seminars on maxillofacial imaging and interpretation,Springer Science & Business Media, (2007).

13- Rafael C & Richard E, Digital image processing, 3rd , Pearson Education, Inc, (2008),36-96.

14- Stuart C W & Micheal J P, Oral radiology and interpretation mosby, (2005).

15- Kim Y,Contrast enhancement using brightness preserving bi-histogram equalization, IEEE Transactions on Consumer Electronics ,43(1)(1997),1-8.

16- Chen S et al. ,Contrast enhancement using recursive mean-separate histogram equalization for scalable brightness preservation, IEEE Transactions on Consumer Electronics,49(4)(2003),1301-1309.

17 -Jingxin H, Wu L, Hao Z, & Lin L, Image mosaic based on SURF Feature matching, ICISE '09 Proceedings of the 2009 First IEEE International Conference on Information Science and Engineering, (2009),1287-1290.

18- Lowe D, Distinctive image features from scale-invariant key-points, IJCV, 60(2) (2004),91–110.

19- Haykin S, Neural net works: A comprehensive foundation, 2nd ed. Englewood Cliffs,NJ:Prentice-Hall,(1999).

20- Fukunaga K, Introduction to statistical pattern recognition. 2nd ed. New York: Academic,(1991).