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Systematic Review of Dental Biometrics Based on Dental Radiographs

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ABSTRACT
Medical image processing is vital in several arenas of medical research and clinical observes. It greatly facilitates early detection and finding of diseases. This paper surveys a supplementary method in the area of medical image analysis for diagnosis of diseases in oral radiology using dental X rays in odontology. Dental X-ray image processing is widely used nowadays for identification of missing individuals or victims. Radiograph is more feasible and retrieved more information for feature extraction as compare to photograph.

Keywords: Dental radiograph (X-ray), dentistry, Computed Axial Tomography (CT Scan or CAT scan) Dental caries, Teeth segmentation, Gap Valley.

INTRODUCTION
In case of medical images human contribution and observation is of major importance. It's indeed a difficult task to grasp fine features in various alteration situations. The data obtained directly from X-ray acquisition device. It's going to yield a fairly poor image quality representation. Due to the role of a person's (dentist) interpretation supported his knowledge, skill and observation which could be vary from doctor to doctor., there are probabilities of error decide the correct medicinal treatment. Software developers together with area specialists have designed various standardized and scientific tools to attenuate the human fault within the case of deciding the proper treatment on the idea of visual opinion. Poor quality of dental images, the primary step is to grow the radiograph, there after segmentation is performed and followed by feature extraction which produces a part of interest which is exclusive for every individual. Feature vector thereby produced is matched with the database images. The image having minimum matching distance is taken into account to be the most effective potential match of the given query image. The primary step in human identification is dental image classification which relies on the way dental features are captured. they're classified as bitewing, periapical and panoramic dental images [5] as shown in figures Bitewing images include the features of both jaws signifying bite. While periapical images include only one jaw either upper jawbone called upper periapical image or mandible called lower periapical image. Panoramic images include features of both jaws including sinuses, nasal area, etc. However, for many dental processing bitewing images are used [6]. The dental radiograph consists of three regions namely background area (having lowest intensity), bone areas (having average intensity) and teeth areas (having highest intensity). In some cases, the intensity of bone area and teeth area are nearly same.
A dental x-ray provides valuable diagnosis information to dentists like passage way treatment, detection of caries and the other anomalies. [1] within the current years, different methods of processing on image are actively used for the finding of oral diseases in odontology. There are various diagnostic methods for odontology which include, Computed Axial Tomography (CT Scan or CAT scan), Ultrasonography (US), Panoramic Imaging, Intra Oral and additional Oral Radiography and MRI. These tomography systems are helpful in confirming the various kinds of dental disease infections. By using the radiographs of teeth, experts can find the Periodontal, Swelling, Interdental bone Loss, Extra Teeth, Impacted teeth, Cysts, Malignancies, Developmental defects, [3] Future Malocclusion

Types of Diseases

Enamel Caries:

In dental x-ray images, enamel caries may be predictable by a loss on the interproximal surfaces of the enamel. To be detectable on a radiographic image there must be a 30% to 50% change within the mineral content of the enamel lesion.

Dentinal Caries

Dentinal Caries is recognized by noting the focal loss of dentinal radiopacity. Dentin caries is also discerned inter- proximally, on the occlusal surface, buccally/lingually, or on root surfaces.

Pulpitis

Dental Caries, commonly referred to as dental caries or cavities extends below the tooth dentin and it affects the nerves or the blood vessels, the it's called the pulpitis.

The Bitewing X-ray

It highlights the crowns of the rear teeth. Dentists take one or two bite-wing X-rays on all sides of the mouth. Each X-ray shows the upper and lower molars (back teeth) and bicuspids (teeth before of the molars). These X-rays are called "bite-wings" because you bite down on a wing-shaped device that holds the film in situ while the X-ray is taken. These X-rays help dentists find decay between back teeth.

Periapical X-ray

It highlights only 1 or two teeth at a time. It shows the whole length of every tooth, from crown to root. This wont to determine teeth caries in an exceedingly particular tooth, because it allows dentist to visualise the entire tooth yet because the teeth surrounding cavities of bone.

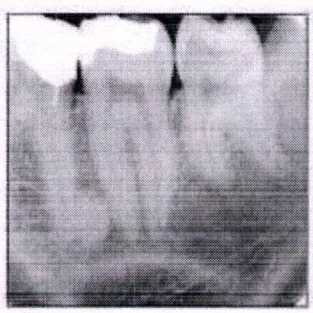
Occlusal View

They are larger than most X-rays. They highlight tooth development and placement in children. Each X-ray shows nearly the total arch of teeth in either the upper or jaw. The film rests on the biting surface of the teeth.

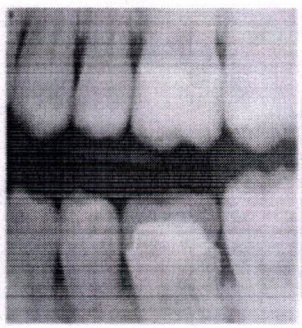
Panoramic View

Panoramic X-rays shows the full teeth structure with jaws and teeth in single view. These types of X-ray are wont to detect different infections or problems present in teeth like cysts, fractures, tumors, impacted teeth and cavity etc.

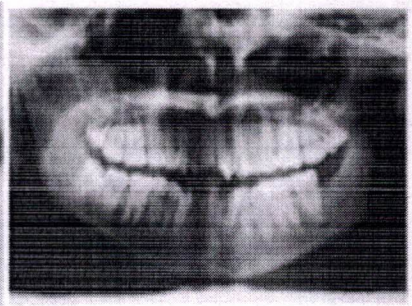
Dental radiograph Dental radiograph is an intra or oral image that's taken using X-ray radiation. Dental radiograph consists of teeth using X-ray radiation. Dental radiograph consists of teeth, bones and surrounding soft tissues. There are three forms of dental radiograph that's commonly employed in dentistry that are periapical, bitewing and panoramic as shown in Fig



Fig(1) Periapical view



Fig(2) Bitewing view



Fig(3) Panoramic view

Literature Review:- Various study has been done by many researcher. Many authors explored the feature extraction and matching techniques based on dental radiograph and photograph in dental biometric. It is an art and science of diagnosis and treatment of diseases and disorders of the oral cavity and its associated structures. The components of dentistry include, periodontics, oral pathology, orthodontics, oral and maxillofacial surgery, pedodontics, prosthodontics, forensic odontology, geriatric dentistry and dental implantology. Periodontics deals with diseased gums, Oral pathology concentrates in the diagnosis, Orthodontics aids in the correction of mal-aligned teeth, oral and maxillofacial surgery is concerned with major surgical procedures related to the dental and associated structures, pedodontics deals with children and prosthodontics accounts for the rehabilitation process. Forensic odontology consists of the gathering and the use of dental evidence in human identification that is primarily documenting and verification of identity. [3] For the automated identification, the dental records are usually available as radiographs .An automated dental identification system consists of two main stages: feature extraction and feature matching. A new semi-aficationutomatic method of human ident cation based on dental radiographs is proposed. This method involves three stages: radiograph segmentation, tooth feature extraction, and tooth feature matching. [4] In this paper, we proposed a teeth segmentation from dental x-ray image. The proposed method consists of three steps: tooth area identification, template matching, and teeth area segmentation. This paper presented a novel teeth detection and dental problem classification

approach using panoramic dental Radiographies. A panoramic dental radiography shows the entire mouth area where all the teeth can be seen.

In 2003, within the Journal of Elsevier, the paper entitled," Matching of dental X-ray images for human identification" has published. during this study, a brand new semi-automatic method of human identi'-cation supported dental radiographs is proposed. This method involves three stages: radiograph segmentation, tooth feature extraction, and tooth feature matching. [6]

The feature removal stage includes the radiograph segmentation and the contour extraction. contour extraction method based on edge detection. Though, the substantial noise that is usually present in radiograph images, the edge-detection-based method does not perform consistently across all the images. Sum the intensities of pixels along each row parallel to the x-axis. The gap between the upper and lower teeth will form a valley in the y-axis projection histogram, which we call the gap valley. Once we get the crown contour and the root contour, we connect them to form the contour of the whole tooth. Once the crown shape is extracted, we traverse from the two ends of the shape boundary to the root boundary. Given a query image generating several sub-images from every database image, each sub-image containing the same number of teeth as the query image. The matching distance between the query image and the open teeth is smaller than that compared to the pretender teeth.

In 2006, within the Journal of Elsevier published entitled "Caries detection and diagnosis: Novel technologies" has published. during this study, a variety of caries detection systems are covered during this review. The pattern of cavity is changing, with an increasing incidence in occlusal surfaces. This shift has rendered traditional detection systems, particularly bitewing radiographs less useful within the diagnostic protocols of clinicians. [7] In this journal Radiographic techniques like Digital radiographs, Subtraction radiology. & Enhanced visual techniques are studied Fibre optic transillumination (FOTI and DiFOTI) Fluorescent techniques Visible light fluorescence QLF Laser fluorescence DIAGNODent Other optical techniques. Ultrasound techniques are studied.

In 2012, within the Journal of IJSR published "A Review of Dental Biometrics from Teeth Feature Extraction and Matching Techniques " During this study, review a task of dental images in human identification and different techniques utilized in dental biometrics. We make comparative analysis of varied methods from this we conclude that almost all of the system used dental radiograph only, while some uses both dental photograph and radiograph within which dental radiograph utilize crown and root contour while dental photograph utilize shape and appearance of teeth structure.

From this study we found that. The matching stage has three sequential steps: tooth-level matching, computation of image distances, and subject identification. In this paper it uses contour and skeleton-based shape extraction as well as matching algorithm for dental images. An active contour model with selective binary and Gaussian filtering regularised level set method. It is used for contour extraction. Shape matching is done by both contour and skeleton-based approaches. Performing a work on Classification and Numbering of Dental Radiographs for an Automated Human Identification System. In this paper they use classification process which aims to classify the extracted tooth into molar or premolar using the binary support vector machine method. numbering process is executed in accordance with molar and premolar pattern. [9]

In 2017 within the journal of IEEE, paper published entitled " Automatic Image Processing Based Dental Image Analysis Using Automatic Gaussian Fitting Energy and Level Sets" During his study, author cited that,, an improved and combinational segmentation approach for tooth extraction from dental radiographs is presented. The dental periapical radiographs are generally of low contrast and poor illumination. the normal average filters may smooth the image but at the identical time it washes out the perimeters. The enhancement part is achieved using bilateral filtering to scale back the contrast variations between teeth, gums and background artifacts. this mixture of contrast enhancement and filtering approach removes the noise and other unwanted background information and at the identical time preserves the perimeters. combination of contrast enhancement and filtering approach removes the noise and other unwanted background information and at the same time preserves the edges. The segmentation using Gaussian fitting energy and independent level sets achieves the segmentation using very less number of iterations. The enhancement filters sometimes washes out the edges therefore this paper uses bilateral and box filtering approach to preserve the edges and at the same time image quality is also improved. The segmentation approach uses the combination of Gaussian distribution fitting energy in combination along with level sets. The local intensities of images are described by Gaussian distributions with different values of mean and variance to handle intensity inhomogeneity.[8]

.In 2018 within the Journal of Biomaterials and Bioengineering in Dentistry Publication Types: Research J Clin Exp Dent "Dental radiography image enhancement for treatment evaluation through digital image processing." during this paper author cited that, Base on the 2 varieties of analysis methods on dental radiography images, both MSE and PSNR statistical methods moreover as in step with expert's observation (dentist).It occurred score difference, that was supported MSE and PSNR statistical scores. Image enhancement method has been conducted in dental radiography by comparing several methods. Such as contourlet transform (CT), wavelet transform, contrast stretching (CS), and contras limited adaptive histogram equalization (CLAHE). For diminishing noise, for optimizing image contrast, and for enhancing brightness of image various methods have been used. In this paper author had evaluated by two methods. Initially it compare between original images and processed images, so that it grew the statistical score. For getting more evaluated methods ,each method was represented by coding format.[10]

In 2020 within the Journal of, IEEE paper published entitled " Classification of Dental Cavities from X-ray images using Deep CNN algorithm" In this paper Existing approach like Mask R-CNN by achieving 82% accuracy and this proposed method of Sobel is best to check other segmentation techniques like Otsu's threshold Watershed.[11] Following are the ways to construct models based on a deep CNN algorithm. The first one is image segmentation using the ROI (region of interest) selection for object detection in mask R-CNN. The second is separate segmentation approaches, comparing analyses to pick effective segmentation methods used to predict dental diseases. Watershed segmentation to distinguish the objects touching the image.

In 2020 within the Journal of , IEEE paper published entitled " Teeth Detection and Dental Problem Classification in Panoramic X-Ray Images using Deep Learning and Image Processing Techniques "In this paper we propose a deep learning solution that helps dentists make the right diagnosis using panoramic dental X rays images. Novel teeth detection and dental problem classification approach using panoramic dental radiographies. We manually annotate panoramic radiographies so as to coach the semantic segmentation CNN. [13]

LITERATURE REVIEW

Journal & Year	Findings
Anil K. Jain Hong Chen 2003 ElSEVIER [6]	A new semi-automatic method of human identification based on dental radiographs is proposed. This method involves three stages: radiograph segmentation, tooth feature extraction, and tooth feature matching.
Iain A. Pretty 1 June 2006 ElSEVIER [7]	A range of caries detection systems have been covered in this review. A summary of their performance is presented. The pattern of dental caries is changing, with an increasing incidence in occlusal surfaces.
Pulkit Pandey, Anupama Bhan, Malay Kishore Dutta Carlos M. Travieso, IEEE 2017 [8]	In this paper, an improved and combinational segmentation approach for tooth extraction from dental radiographs is presented. The dental periapical radiographs are generally of low contrast and poor illumination.
Dr. Ganesh Sable1, Dipali Rindhe2 (2012) [9] IJSR	From this, we found that radiograph is more feasible and retrieved more information for feature extraction as compare to photograph.
Hanifah Rahmi-Fajrin 1, Sartika Puspita 2, Slamet Riyadi 3, Erma Sofiani(2018) Research J Clin Exp Dent [10]	Analysis methods on dental radiography images, both MSE and PSNR statistical methods as well as according to expert's observation (dentist), it occurred score difference that was based on MSE and PSNR statistical scores.
M. Muthu Lakshmi Dr. P. Chitra 2020 IEEE [11]	The Sobel edge detection method is used to implement the classification of dental cavities by Deep CNN is achieved by high accuracy is compared to the existing approach like Mask R-CNN by achieving 82% accuracy. This proposed method of Sobel is best to compare other segmentation techniques like Otsu's threshold Watershed.

CONCLUSION:

Much of the work have been done for teeth segmentation, but very few researchers have applied and realized the methods for diagnosis purpose. Collaborative portions of X-ray selected for further processing specifically

for the purpose of diagnosis is the need of the hour as it would help both doctor and patient to understand the problem and depth of disease. Researchers up till now have been found concentrating on image enhancement or segmentation for extracting features for forensic sciences. No much research has effectively contributed for the analytic methods.

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A Survey of Image Processing and Two Dimension Image Recognition

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ABSTRACT
Computer Vision and Image processing is continually growing. During the past ten years, there has been a significant increase in the level of interest in computer vision, image recognition, soft computing techniques, neural networks etc. This paper reviews different research papers on Digital image, fundamental of digital image processing. Lastly, it focuses on the future scope of the image recognition.

Keywords: Image Recognition, Neural Network, Fuzzy Logic, Genetic Algorithm, Soft Computing.

INTRODUCTION:

Digital Image recognition is the ability of a system or software to identify objects, people, places, and actions in images. It uses machine vision technologies with artificial intelligence and trained algorithms to recognize images through a camera system.

Two dimension digital image is represented as an array of real or complex numbers represented by a definite number of bits. An digital Image is represented as a two dimensional function $f(x,y)$, where 'x' and 'y' are spatial (plane) coordinates and the amplitude of f at any pair of co-ordinates (x,y) represents the intensity or gray level of the image at that point. The digital image is one for which both the co-ordinates and the amplitude value of f are all finite, discrete quantities. Hence, a digital image is composed of a finite number of elements, each of which has a particular location value. These elements are called image elements, picture elements or pixels.

A digital image is discrete in both spatial coordinates and brightness and it can be considered as a matrix whose rows and column indices identify a point on the image and the corresponding matrix element value identifies the gray level at that point.

There are many sensors or devices to acquire images. Most of the device or sensors give a continuous voltage as output, which will be continuous in both amplitude and coordinates. To convert it a digital form, we have to sample this function in both co-ordinates and amplitude. Digitizing the co-ordinate values is called sampling. Digitizing the amplitude value is called quantization. The of sampling and quantization is a matrix of real number.Hence , an image can be represented as shown in figure 1.

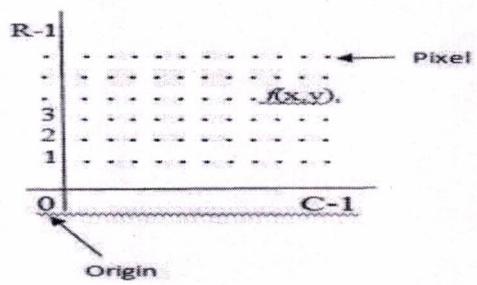

Figure 1

Image Representation

Where the function $f(x,y)$ is assumed to have 'R' rows and 'C' columns. The values of the coordinates are now discrete quantities.

Now, from the above notation, we can write the function $f(x,y)$ as shown in the below

$$f(x,y) = \begin{pmatrix} f(0,0) & f(0,1) \ldots\ldots f(1,C-1) \\ f(1,0) & f(1,1) \ldots\ldots f(1,C-1) \\ . & \\ . & \\ . & \\ f(R-1,0) & f(R-1,1) \ldots\ldots f(R-1,C-1) \end{pmatrix}$$

And the above matrix notation, can be modified as,

$$P = \begin{pmatrix} P_{0,0} & P_{0,1} & \cdots & P_{0,C-1} \\ P_{1,0} & P_{1,1} & \cdots & P_{1,C-1} \\ \cdot & & & \\ \cdot & & & \\ \cdot & & & \\ P_{R-1,0} & P_{R-1,1} & \cdots & P_{R-1,C-1} \end{pmatrix}$$

Where $P_{x1} = f(x=i,y=j) = f(i,j)$

LITERATURE REVIEW

Today, in the 2022th, we are heading into new era of ubiquity, where the user of the internet are counted in trillions and where humans may become the minority as generators and receivers traffic. Instead, most of the traffic will flow between devices and all kinds of "things", thereby creating a much wider and more complex digital image.

It focuses on the recognition of MRF image and FFNN is used to solve the two basic problems of MRF modeling. He uses clean and noisy binary images. The Recognition rate is 100% using Gibbs and Noise Parameters [1].It proposed an EBAM i.e. extended bidirectional associative memory (EBAM) neural network model and MLP NN. He used gray image. In pre-processing filtering, enhancing the image and removing the noise of image, extracting the feature of image and applying EBAM model. The Recognition rate is EBAM is better than MLP NN [2]. It focuses on FL, GA and NN approach. He used NN approach for nature scene image segmentation. The result show nature scene image segmentation efficiency is good using NN approach [3]. The concept of different Edge detection method is focused. The experiment use Noiseless and Noise images [4]. This paper is focused on segmented image using soft computing techniques [5].It is very difficult to recognition degraded image. Outdoor image scenes are degraded due to cloudy medium in the atmosphere (i.e., impurity in air). Such as lack of clarity, fog, and pollution are the phenomena of atmospheric absorption that scatter the image. It focuses on Various Image Dehazing Techniques to remove noise and recognize it [6]. This paper used "LIVE Image Quality Assessment Database", university of Texas. It uses MATLAB to convert colour image to gray scale image. He compares the original and mutilated images using (PSNR), HVS utilizing Fourier Transform, Structural Similarity Index (SSIM), and Universal Image Quality Index (UIQI) measurements. TheComparison result display in tabular format [7].Three Alex Nets, GoogLeNet and ResNet50network are used. CIFAR10,CIFAR100 and MNIST data sets are used. Object detection and object category classification using CNNs. GoogLeNet and ResNet50 network to recognize improved accuracy objects compared to Alex Nets. Performance of CIFAR10 test dataset and CIFAR100 test dataset show in tabular format [8].It focuses on image recognition system structure. The image set of COIL20 is used. Traditional and Improved BP neural network is used to for object recognition and comparison result is shown [9].

Fundamental steps in Digital Image Processing [10]:

Figure bellow shows fundamental steps in digital image processing.

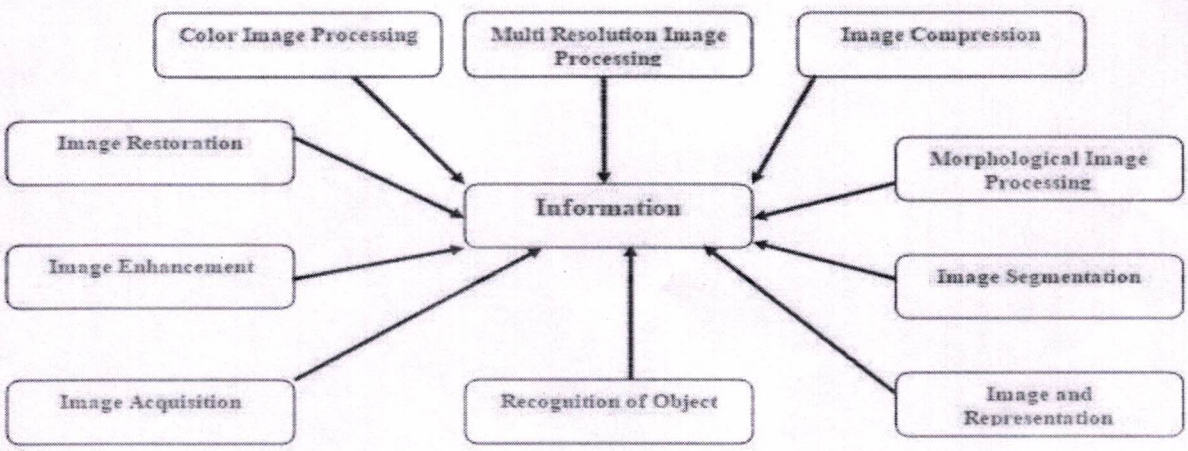

Figure 2

FUNDAMENTAL STEPS IN DIGITAL IMAGE PROCESSING

These steps are briefly discussed bellow.

1. Image Acquisition

This is the first step and fundamental step of digital image processing. Image acquisition could be as simple as being given an image that is already in digital form. Main task performed in the Image acquisition step is pre-processing such as scaling etc.

2. Image Enhancement

Image enhancement is among the simplest and most tempting area of digital image processing. Basic idea behind enhancement techniques is to bring out detail that is disguised, or simply to highlight certain features of significance in an image such as changing brightness & contrast of the image etc.

3. Image Restoration

Improving the appearance of an image is achieved by Image restoration. However, unlike enhancement, which is subjective, image restoration is objective, in the sense that restoration techniques tend to be based on mathematical or probabilistic models of image degradation.

4. Color Image Processing

Color image processing is an area that has been gaining its importance because of the significant increase in the use of digital images over the Internet. It includes color modelling and processing in a digital domain etc.

5.Multi Resolution Image Processing

Multi Resolution offers an capable outline for extracting information from images at various levels of resolution.

6. Image Compression

Image Compression deals with technique for reducing the storage size required to save an image or the bandwidth to transmit it. Particularly data compression is very significant in the data transmission through internet.

7. Morphological Image Processing

Morphological Image processing deals with tools for extracting image components that are useful in the representation and description of shape.

8. Segmentation

Segmentation partitions an image into its ingredient parts or objects. Autonomous segmentation is one of the most difficult tasks in digital image processing. A rugged segmentation procedure brings the process a long way toward successful solution of imaging problems that require objects to be identified individually.

9. Image and Representation

Image and Representation almost always follow the output of a segmentation stage, which usually is raw pixel data, constituting either the boundary of a region or all the points in the region itself. Choosing a representation is only part of the solution for transforming raw data into a form suitable for subsequent computer processing. Image deals with extracting attributes that result in some quantitative information of interest or are basic for differentiating one class of objects from another.

10. Recognition of Object

Recognition is the process that assigns a label, such as, "motor vehicle" to an object based on its descriptors.

11. Information:

Information may be as simple as detailing regions of an image where the information of interest is known to be located, thus limiting the search that has to be conducted in seeking that information. The Information base also can be quite complex, such as an interrelated list of all major possible defects in a materials inspection problem or an image database containing high-resolution satellite images of a region in connection with change-detection application

Future scope of image recognition Two and Three dimensional digital image recognition has a large scope in the future research. It will help to monitor the different two and three dimension image. Unpredictable development might be occurring using soft computing. It will also help with recognize different category of image. It is useful to convenient to computer security, human security etc.

Conclusion It is our opinion that research on the image recognition is an exciting area for many year to come and will keep many scientists and engineers, researcher busy. This paper introduces Digital image and fundamental of digital image processing. It studied so many different techniques for image recognition. Lastly, it focuses on the future direction of the image recognition & the topic is open to further research.

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