



International Journal of Marketing Management

ISSN 2454 - 5007



www.ijmm.net

Email ID: editor@ijmm.net , ijmm.editor9@gmail.com

Digital Dental X-Ray Image Classification using Machine Learning

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Abstract

Dental problems, such as periapical and dental caries, as well as dental malformations, are on the rise among both adults and children. The use of neural networks and artificial intelligence in medical imaging is changing the face of healthcare. The most typical method for detecting dental problems is X-ray imaging. The use of neural networks for the segmentation and categorization of various dental abnormalities has been very beneficial to the area of dentistry. The use of neural algorithms helps improve the detecting accuracy of photos. Automated detection and correct categorization lighten a dentist's duty. Using machine learning to categorize dental X-ray pictures is advantageous since it can be more deeply integrated into these procedures. In order to detect and categorize the dental anomalies, several machine learning methods are used.

Keywords

Machine learning, neural networks, dental X-ray, classification

I. INTRODUCTION

The human body's solid structure, the tooth, decays for a variety of causes. Radiographs can reveal a wide variety of dental problems, including cavities, periodontal disease, mesioangular impaction, peripheral abscess, horizontal and vertical bone impaction, apical periodontitis, overhanging restoration, irreversible pulpitis, cast post restoration, radiopaque restoration, proximal caries, and more. The study of medical image analysis has recently seen a surge in interest in digital photographs of the human body. A plethora of image processing methods are mushrooming in an effort to solve the mysteries of human illness. It is challenging to identify human organs due to their complexity. [1]

When it comes to imaging dense structures in the body, X-ray is one of the simplest options. Bone scans made possible by these rays help doctors diagnose conditions. The doctor may diagnose the condition and recommend treatment if an X-Ray reveals abnormalities. A digital radiography image is a high-tech X-ray evaluation method that generates pictures digitally and displays them on a computer screen instantly. X-ray sensitive plates snap pictures while the examination is underway and send them straight to a computer. A detector-sensor transforms the incident x-rays into a digital picture and an electric charge. The advent of digital X-ray pictures has simplified the recognition and interpretation of dental imaging. 31.00 \$978-1-6654-4126-1/21 ©2021 IEEE When various X-ray machines are used to take pictures, the results vary in terms of contrast, brightness, noise, and resolution. An essential part of treatment planning is the analysis of dental imaging, which may be accomplished by segmenting the tooth. Many methods exist for segmenting dental pictures, such as kmeans and dual clustering, background removal, histogram-based approaches, region-growing methodologies, etc., all of which aid in distinguishing between healthy and diseased tooth tissue. [2] Segmenting and classifying dental pictures is becoming simpler with the use of machine learning principles. Images from dental data sets are processed using a handful of potential classification methods, such as SVM, ANN, and KNN, based on their efficiency and performance.

II. LITERATURE SURVEY

Bhadauria, Anuj S., and Kumar, Anuj To identify the dental restoration in an X-ray picture, Nitin Kumar suggested a method that combines Fuzzy Clustering with iterative level set active contour, also known as Fuzzy Clustering with Level Set Segmentation [4]. Here, we use a median filter to preprocess the picture and apply fuzzy clustering to the segments. Using complete threshold segmentation, the Grab Cut method [5] was introduced by Jiafa Mao, Kaihui

Wang, Yahong Hu, Weiguo Sheng, and Qixin Feng for dental X-ray images. Iwholen and Crowns' outline picture sets were acquired by them. To produce the target tooth picture, the synthetic image of the contour and crown is subjected to a morphological open operation and median filtering. The resulting image is then processed using a Mask for Grab Cut. In order to assess the efficacy of dental treatments, researchers Jie Yang, Yuchen Xie, and Lin Lui devised a system to automatically analyze pre- and post-operative periapical dental X-ray pictures using deep learning techniques applied to small datasets. Clinicians relied on them to categorize disorders as improving, deteriorating, or showing no change at all. Using mathematical morphology, Said.E.H., Dias.E.M., and Nasar.G.F. presented a technique for teeth segmentation in digital dental X-ray images. To enhance the efficiency of teeth segmentation, a grayscale contrast stretching transformation is used. Along with being able to handle bitewing and periapical dental radiograph images, they also found that their technique had the lowest failure rate[7][8].

III. METHODOLOGY

Dental X-ray pictures collected from various sources, including online databases, dental clinics, and hospitals, make up the image collection used in this study. Images of normal teeth and various types of dental caries are collected and saved in a database. Figure 1 shows the steps used to process and analyze digital X-ray pictures of dental caries. Improving pictures and removing redundancy are part of the pre-processing steps after retrieving the raw image from the dataset. The next step is to resize the photographs so they are less distorted, and then to convert them to grayscale as processing colored images would not provide clear data. [9]

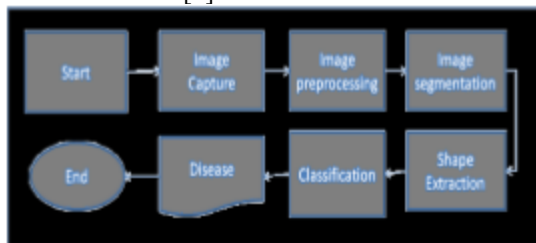


Fig. 1. Basic Block Diagram of process

Based on the image's unique pixels and other comparable features, the scaled and pre-processed

pictures are divided into homogenous non-intersecting sections. By using segmentation, one may locate and identify picture boundaries, such as lines and curves. Additionally, it establishes how precise the computer-generated results are. Feature extraction simplifies processing of huge datasets by producing a smaller collection of features. In most cases, the chosen characteristics include all the necessary information, and the extracted data may be used to accomplish the requested goal. In order to extract features, this study use GLCM. By creating a GLCM and extracting statistical measures from it, the GLCM function characterizes the texture of an image by counting the frequency with which pairs of pixels with certain values and in a given spatial relationship exist in the picture. In addition, the dataset used for training and testing is used to categorize the photos. [10] the eleventh Using classification, we may more easily distinguish between different types of dental illnesses and make an informed diagnosis. The presence of pathological indications of dental illnesses may be detected in the examined picture using a classification method such as KNN (Kernal Nearest Neighbor), Artificial Neural Network (ANN), or Support Vector Machine (SVM). Using information from a previously trained set, SVM created a top-notch classification model. An exciting new direction in image analysis has emerged from the dental industry's use of artificial neural networks (ANN) to categorize impacted teeth and dental caries. To simplify things, supervised classification algorithms like KNN look for the greatest possible match between incoming records and an existing trained record system. [12] The most recent neighbor is located using the formula for the geometric distance, which aids in the classification process.

IV. RESULTS AND DISCUSSIONS

Here we detail the experimental outcomes of the strategies for classifying various dental illnesses using digital X-ray pictures of the mouth. The dental image database stores pictures of teeth that have different dental problems, such as vertical impaction, periapical abscess, distal pulp horn caries, missed canal in root canal, and so on. The photographs were gathered from medical facilities and dentistry offices. The 500 pictures that make up our work are from a variety of dental cavities and healthy tooth sets. We trained with half of the photographs and tested with

the other half. The system is pre-processed using digital X-ray pictures of the problematic teeth.

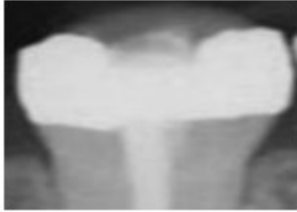


Fig.2. Input Image of teeth

The purpose of pre-processing is to enhance certain visual qualities that are crucial for further processing and to decrease or remove undesirable distortions from the image data. In order to improve the photos' representation, median filters are used for preprocessing in this study, followed by scaling to a specific dimension and grayscale conversion.

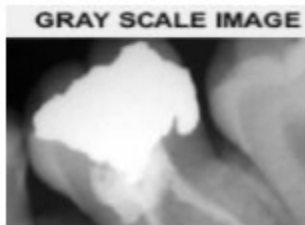


Fig.3. Gray Scale Dental X ray Image

The process of segmentation[13] is carried out by using Region of Interest (ROI), which distinguishes between interesting and uninteresting pixels and gives intensity values of 0 or 1 to the former, correspondingly, to indicate whether they are needed or not.



Fig.4. Segmented dental X ray Image

Extracting useful features from images is the primary goal of feature extraction. In order to extract the features, a Gray Level Co-occurrence Matrix (GLCM) is executed. It takes pictures and pulls out info about textures at the second order. [14] [15] From the pictures included in the dataset, the following attributes were extracted: shape, geometry, skewness, smoothness, energy, entropy, homogeneity, performance, contrast, and correlation.

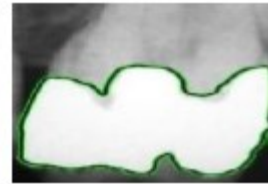


Fig.5. Featured Extracted Image

The Table 1 below gives the extracted feature of some of the dental diseases TABLE I. EXTRACTED FEATURE VALUES OF DISEASED TEETH

Disease	Skewness	Smoothness	Energy	Entropy	Homogeneity	Performance	Contrast	Correlation
Dental caries under restoration	2.6047	0.9999	0.81	0.4796	0.9954	0.4044	0.0071	0.9614
Mesioangular impaction	5.3254	0.9999	0.9372	0.2039	0.9952	0.6339	0.0016	0.9743
Proximal caries	6.4644	0.9993	0.9555	0.1544	0.9996	0.4289	0.0065	0.9804
Vertical impaction	2.5354	0.9999	0.8025	0.4621	0.9963	0.2681	0.0074	0.9613
Dental caries involving distal pulp	2.1802	0.9999	0.7618	0.5617	0.995	0.2006	0.01	0.9563

The images are trained according to the dataset that is been stored.

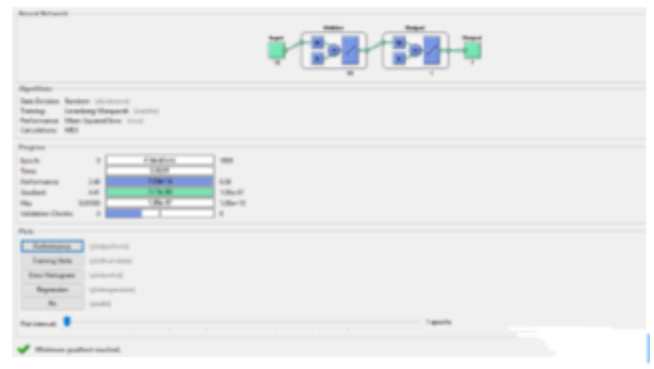


Fig.6. Training of images

Classification methods like SVM, ANN, and KNN are used to the dataset of dental pictures. Figure 7 displays the segmented and classed pictures obtained from the various classifier methods.



Fig.7. a) SVM Output b) ANN output c) KNN output

V.CONCLUSION

An improved method for distinguishing dental caries-affected teeth from healthy teeth is proposed in this study using GLCM features in conjunction with SVM, KNN, and ANN classifiers. By automatically segmenting and classifying teeth, radiologists may evaluate medical pictures more quickly and get a second opinion, which improves the sensitivity of disease diagnosis. Because of this, it can swiftly and precisely deliver outcomes.

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