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DENTAL DISEASE DETECTION USING DEEP LEARNING

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ABSTRACT— Dental illness most prevalent common, non-communicable diseases that affects the people health resulting in pain, discomfort and even death. Various tumor mimics the clinical type of cyst. Classification of diseases is very important for diagnosis and proper management of the patient. So, our project aims to develop a system for the detection of dental diseases using deep learning for 3 types of dental diseases- periodontal, carries and cysts using CNN, Feature extraction, Softmax. The diagnosis requires the use of dental radiography, the dataset (radiographic images) are collected from different clinics.

Keywords: CNN: Convolutional layer, FC: Fully connected layer, OCC: Oral Cavity Cyst.

1. INTRODUCTION:

According to the most recent survey, dental caries is expected to affect about 48% of the population, or over 3.6 billion individuals, in their permanent teeth. Dental caries is typically considered the most prevalent illnesses in all ages and stages of life. Dental caries, according to the WHO, is a significant a world health issue and is a rising problem. a developing condition that can destroy other teeth severely if left untreated, which may be the major causes for further tooth loss. And The failure to properly brush your teeth, munching frequently, bacteria in our young people, and drinking sugary beverages are all factors that contribute to caries.

However, the main cause is the bacteria that live in our mouths, which create white acids that can dissolve tough tissues like dentin, enamel, and cementum. Cool-colored black and yellow are good indicators of caries. Caries symptoms might include tooth pain, tooth loss, and inflammation. It illustrates the distinction between teeth and those who have no caries. In undeveloped nations like India, dental caries is still seen as a serious condition. This disease has deep-seated roots in areas that are thought to lack enough resources and treatment options, particularly in the field of dentistry. Nowadays, a big worry is the lack of appropriate knowledge and motivation combined with the rising consumption of carbs. Therefore, identifying dental cavities becomes a crucial duty. The diagnosis of dental illnesses requires the use of dental radiography. Due to the wide range of dental features, positioning mistakes, and the sizeable number of radiographs are required to be investigated, radiograph analysis is time-consuming and frequently error-prone. A system that automatically highlights anomalies and identifies serious diseases in dental radiographs is necessary to improve detection accuracy and decrease the cost of misdiagnosis. This paper focuses on using ML to bridge the research gap and find and validate such a solution by creating a software prototype which enables computers to recognize normal anatomical components and distinguish between small anomalies in radiograph systems by employing digital picture providing in CNN for self-identifying the caries for treatment. misdiagnosis in medicine is a common occurrence nowadays, and it affects many people either directly or indirectly. Misdiagnosis's consequences are brought on by improper drug care releasing diseases and incorrect analyses of medical conditions. As a result, methods for soft computing including neural networks, computer learning methods, and CNN are providing an effective answer pertaining to dentists. It's used in the deep learning method self-learning back-propagation technique lead to enhance results obtained from the given dataset while boosting computational performance. The CNN method is therefore most

frequently used in real time situations in medical field. Convolutional neural networks are essentially neural networks with one or more levels of convolution. These layers are made of multiple neurons with the ability to learn.

1.1 Radiographs: The term “Various exams that require the use of x-rays to see the internal organs of the body are referred to as "medical radiography.".

X-Ray methods:

a) Bitewing radiography: This method is used to look at the interproximal surfaces of teeth and find cavities while tracking dental caries development. Finding secondary caries behind repairs assessing periodontal health.

b) Occlusal Radiography: This technique is utilized to look at the upper and lower jaws' broad surfaces. to look for salivary stones in the submandibular gland's duct. to identify and assess the severity of lesions (such as cysts) in the mandible or maxilla. To determine the maxillary sinus's border. to assess maxillary and mandibular fractures

c) Panoramic radiography: This technique creates just one image including the maxilla and mandible, which make up the facial structure. The panoramic radiographs display typical landmarks. The shadows of hard tissues the base of the skull, the orbital rim, the mandible, the maxilla, and the teeth. Earlobes, lips, and cheeks are examples of soft tissue shadows.

2. RELATED WORK:

In this section, several studies on the diagnosis of oral disorders are discussed. A Survey on Dental Disease Detection Based on Deep Learning Algorithm Performance using Various Radiographs [2] developed Namrata Ansari & Tilottama Dhake tells us that dental disease is a significant problem in humans and deep learning is increasingly being used in the field of dentistry. The purpose of this literature review is to identify dental problems such as tooth identification, caries, treated teeth, dental implants, and endodontic treatment using deep learning approaches in dental image analysis which help dentists in their decision-making process. Dental radiographs are essential for the diagnosis and detection of dental issues. The study focuses on the development and use of several image segmentation/ classification algorithms in the extraction of regions of interest from dental radiographs. To predict different forms of impacted teeth, a convolutional neural network is trained, validated, and tested using dental images with labelled images datasets. Our research suggests that Hybrid models such as CNN-SVM, CNN-KNN or CNN-LSTM or K-mean can be trained over mixed data sets to produce excellent results whereas compared to other image segmentation algorithms, UNet architecture performs better at segmenting dental Xray images.

The experimental results for various types are discussed. precision as a whole was 88.46%. Abdullah S. AL-Malaise ALGhamdi, Mahmoud Ragab SaadAbdulla AlGhamdi, Amer H. Asseri, Romany F. Mansour, and Deepika Koundal's paper, Detection of dental diseases through X-Ray images using Neural Search Architecture Network, proposes a technique for performing multiclass classification through x-ray images using neural network with transfer learning approach, Nasnet. Three distinct types of classes were used: cavities, fillings, and implants. Image processing steps are applied to neural networks with multiple max-pooling layers, dropout layers, and activation functions. Multiclass categorization will soon be possible on sizable datasets with numerous classes. To enhance current performance, it is feasible to implement brand-new, cutting-edge deep learning methods based on hybrid deep learning. It has been addressed how the dentist has outperformed ML in Justin Ker, Lipo Wang, Jai Ra, and Tchoyoson Lim's Deep Learning Applications in Medical Image Analysis (2018). Shashikant Patil developed an algorithm for spotting tooth cavities in 2019. The multilinear principal component analysis is employed during the feature extraction procedure.

The Neural Network (NN) classifier and the Adaptive Dragonfly algorithm (DA) algorithm are used for classification. In addition to False Positive Rate (FPR), False Negative Rate (FNR), Negative Predictive Value (NPV), False Discovery Rate (FDR), F1-Score, and Matthews Correlation Coefficient, the accuracy, sensitivity, specificity, and precision of the caries detection model are also evaluated (MCC). Aarushi Tetarbe et al. (2017) proposed a method to identify oral cancer using different data mining techniques. Health institutions use data mining methods to categorise fatal diseases like cancer, dengue, and tuberculosis.

The output is calculated and collected using WEKA (Waikato System for Knowledge cross-validations). Algorithms for data extraction and machine learning are included in WEKA. The system first categorises oral cancer in the dataset, and afterwards

WEKA is used to apply various data mining approaches. The primary objective is to classify the dataset's data and select an appropriate algorithm from it for an accurate prognostic model. Thanks to all the paperwork and finished work, we were able to upgrade our system. It was also very helpful to think about how we could increase the precision of our system, datasets, and expertise.

3. PROPOSED METHODOLOGY

In order to identify dental disorders such Dental Caries, Periodontal, and Cysts, this work provides a multi-input CNN architecture analysis in advance and deep convolutional neural networks. The panoramic raw images are clarified by filters during the pre-processing phase. Eventually, a deep model-based multi-input convolutional neural network model that has already been trained is created. Figure 1 depicts the proposed system's overall structure, which includes each of these phases. The general architecture of the proposed system is represented in figure 1.

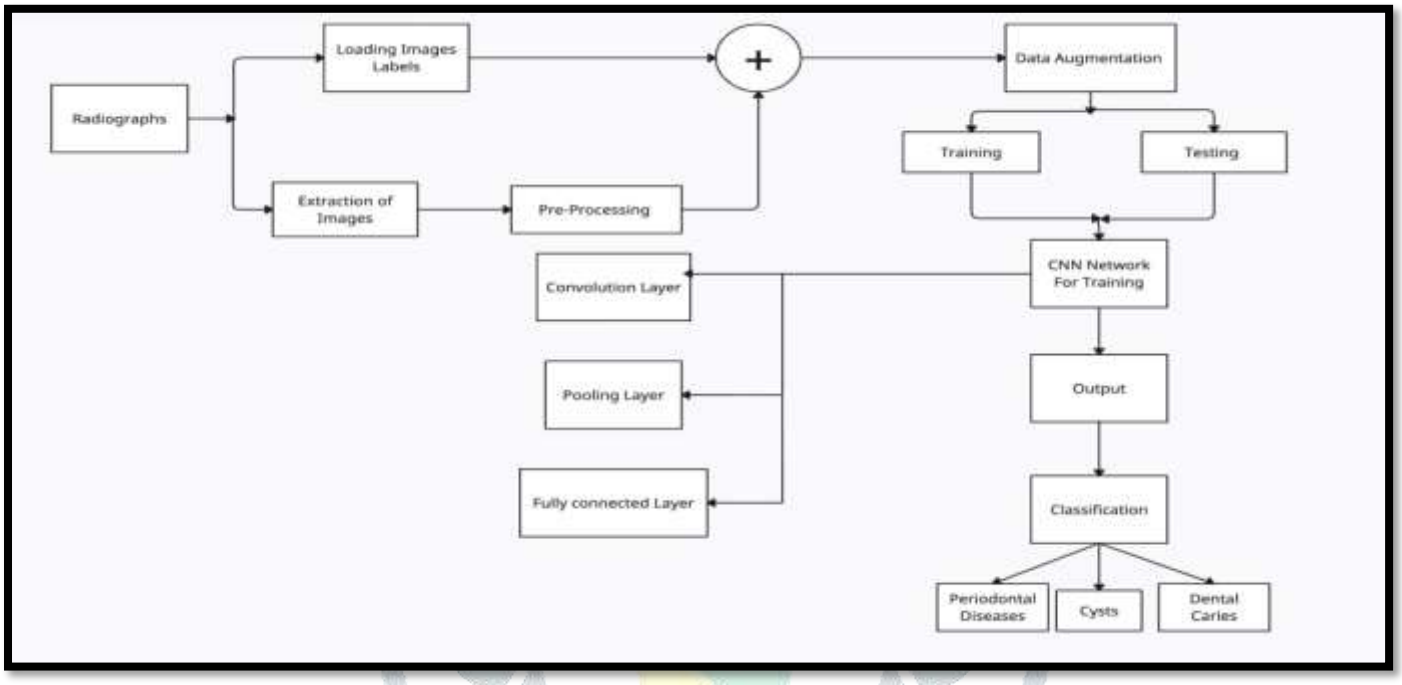

Fig 1: System architecture of proposed system

3.1 DEEP CONVOLUTIONAL NEURAL NETWORK:

A Convolutional Neural Network (CNN) consists of multiple layers of a network. which has been taught in a particular system to extract and classify features. It replaces the use of labor-intensive classical feature extraction and categorization techniques. A simple CNN structure consists of an input layer, an output layer, and several hidden levels. In the hidden layer convolutional, fully connected and pooling layers are also included. The high-level features that were acquired by filtering the input images are processed by convolutional and pooling layers. CNN architectures often use a number of convolution filters that are applied to the raw picture in order to extract a lot of information, mostly from images.

Numerous convolution modules that are stacked one on top of the other make up a typical CNN architecture. The convolutional layer is the first layer in every module of the CNN architecture, and it is followed by the pooling layer, a crucial building element. The pooling layer's primary task on an image set is feature extraction. The data is down sampled as the primary function. As a result, the network's level of computing is reduced. This supports and aids in the management of over fitting. A thick layer or often more make up the final convolutional module. These thick layers only perform classification. In this instance, the CNN model, which includes

three convolutional layers, is first modified for learning, and we then added max pooling layers for subsampling. Two thick layers are finally flattened on top of one another.

1**) Pooling Layer**: Similar to Convolutional Layer, this layer is responsible for reducing the spatial extent of the Convolved property. The amount of computing power needed to process the information is decreased through dimensionality reduction. It also aids in identifying dominant features that are rotationally and spatially invariant and making it easier to prepare the model. The number of these layers may be raised to capture the low-level characteristics much more efficiently, but this would require more computing work depending on how complex the images are.

2) **Fully Connected Layer:** The addition of a Fully Connected layer makes it simple to learn non-linear combinations of the high-level data from the convolutional layer. The Fully Connected layer is currently acquiring a possibly non-linear capability in that area. Now that the structure of our input photos has been modified to be appropriate for our multi-Level, we will smooth the picture into a column vectors. A feed-forward neural system and a back-propagation structure are used to handle the flattened yield for each preparation focus. An image's low-level characteristics can be recognized by the model, which can then be grouped over various epochs.

3.2 PRE-PROCESSING:

Panoramic images will be used in this study to identify cyst, periodontal disease, and tooth caries. These raw images will have undergone various image processing procedures. The carious areas in the dental photos have been made clearer, and the classification performance has improved. For panoramic raw images, an intensity colour map and sharpening filter will be applied. As a result, new images will be the same size that they had before. The updated image will now have greater contrast as a result. The caries zone will eventually be seen to sharpen in images produced as a result of modification procedures.

3.3 DATASET:

Using Kaggle (Planmeca Intra, Helsinki, Finland), MyRay, and other software, photos from private dental and oral health clinics were gathered assessed. There were 980 patients and a total of 1181 periapical pictures that were examined. 101 pictures, some of which were blurry or showed fractures, cysts, and infections the study's exclusion. The study only contained a few periapical pictures out of 1181 total photos. It was done to establish a dataset of patient-provided periapical radiography images. Under the supervision of a dentist, this dataset was collected. Gray channels with different sizes were present in these photos. Dental periapical pictures from the dataset are shown in samples in Figures 2, 3, and 4 referred for this study.

Fig 2: Dental Caries

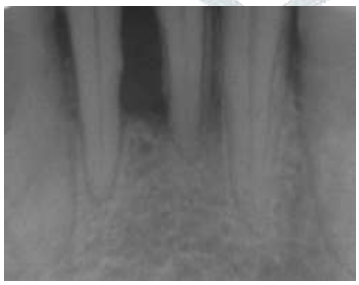

Fig 3: Periodontal Disease

Fig 4: Dental Cyst

4. DATASET TABLE:

Diseases	Type of Radiograph used	Description	Dataset no
Dental Caries	Occlusal	A tooth may sustain damage when the enamel of your teeth is attacked by acids produced by microorganisms in your mouth that cause decay.	1026
Periodontal Disease	Periapical	Mostly brought on by inflammation and bacterial infections of the bone and gingiva that cover and anchor the teeth.	100
Dental Cyst	Panoramic	Cyst originates from tissue that surrounds a tooth before it erupts into the mouth.	50

Table 1: Dataset

4. SCOPE:

The goal of the study is to help dentists identify problems such cysts, periodontal disease, and dental caries. Deep learning and the CNN algorithm are utilized. Since this approach may be used effectively and on a wide scale by someone who is familiar with websites, we tend to receive more accurate findings.

5. DISCUSSION:

The study aimed to develop an automation system, to predict dental caries from radiographs with reasonable clinical accuracy. For the purpose, the top CNN object detection algorithm, with highest precision used. Mean precision is a metric used to evaluate the correctly identify and locate objects within an image by considering both precision and recall, highlighting the improvement areas or improvement. The foundation of automatic caries detection is established on approached that generates AI model which is more efficient in diagnosis of caries than human prediction.

6. APPLICATIONS.

1. discovery and annotating of teeth
2. identification of dental disease, plaque, and caries
3. identification of periodontally damaged teeth
4. Osteoporosis
5. Detection of anatomical objects and oral lesion pathology
6. forensic software
7. Reconstruction and enhancement of dental images

8. CONCLUSION.

Around the world, there are now sporadic, uncoordinated initiatives being made to apply machine learning to the dental industry. This study described a method for classifying dental problems and diagnosing dental diseases using dental radiographies. Based on

periapical pictures, this study suggests a system for the automatic identification of dental caries. A deep convolutional neural network with several inputs is the foundation of the suggested method. Images from different dental hospitals and clinics were gathered in order to get the required results. Multiple metrics are used to assess the implemented solution, and it is contrasted with related methods. This will make disease diagnosis easier for those without dental experience. The diagnosis of dental illnesses benefits from early disease identification, which is a crucial step.

As a result, we're planning to put in place a website where dentists may upload or drag-and-drop their radiographs and get the findings. Using the ensemble learning method, the final classification procedure identifies whether the illness is cyst, periodontal, or dental caries. Therefore, the research increases the likelihood of a correct diagnosis by identifying disorders before they spread to other regions of the maxilla and mandibular area.

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