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Detection of Oral Ailments using CNN

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***Abstract:** This paper presents a method developed for oral ailment detection. The paper focuses on the role of neural network in maintaining oral hygiene. The work here presented uses Convolutional Neural Network (CNN) in machine learning to detect oral diseases which incorporates a model of human thinking, such as learning, reasoning based on past experiences. This method uses image detection techniques for Automatic detection of five oral ailments, which familiarizes about their oral conditions and easily evaluates them against disorders. The system has been tested and this paper presents the results obtained shows ailment predictions by feature extraction and aid in an early care.*
***Keywords:** Machine learning, Oral ailments, convolutional neural network.*

I. INTRODUCTION

Oral hygiene is a part of every individual's routine and it is much important to enable prevention of dental disease. The rapid development in medical image processing greatly helps in the detection of abnormalities and cancer in human. Oral problem accounts to millions of investments. Around 80% Americans suffer from cavities and the average adult between the ages of 20 and 64 has three or more decayed or missing teeth. More than 49,000 cases of oral cancer are diagnosed each year in the United States, occurring most often in people over 40 years old. Due to the lack of good oral healthcare facilities and owing to the huge population of the world, cost effective facilities such as computer aided screening and detection of oral cancer is important and so contribution is done in oral ailment detection. The proposed project is an application that accepts input dental and oral images, that can be captured using cell phone by an individual, which helps in self-awareness of oral hygiene. Image detection techniques are used for Automatic detection of five oral ailments, which familiarizes about their oral conditions and easily evaluate them against disorders. The detection is based on Convolutional neural network (CNN). The multi modal approach is used to automatically detect the ailment type. The results show ailment predictions by discriminating visual symptoms and aid in an early care. With the available resources and software packages, it is very much feasible to implement the proposed project. The project is also economically feasible as there is no much to spend except for collecting the datasets. The project will not use x-ray dataset, instead it uses a normal image captured by the smart phone. This image is input to the system which will monitor five oral ailments (Ulcer, Periodontal, Oral cancer, Hyperdontia and Cavity). Deep learning neural network helps in detection of any disease. The proposed project uses CNN (Convolutional Neural Network) since it is a better method for image recognition and image classification

II. BACKGROUND

Artificial Neural Network (ANN) is used for information processing which is inspired by biological nervous systems that is brain. It contains a large number highly interconnected processing elements (such as neurons in brain) working to solve specific problems. Hence, similar to human brain, ANN learns by example. It is used for pattern recognition or data classification, through a learning process. Neuron (Node) is the basic unit of a neural network. It has inputs and a bias value. When a signal (value) arrives, it is multiplied by a weight value. It is shown in equation (1).

$$Y = \sum (weight * input) + bias \quad (1)$$

Equation will be elaborated in equation (2).

$$z = x_1 * w_1 + x_2 * w_2 + \ldots\ldots x_n * w_n + b * 1 \quad (2)$$

Where z is output, w_i is weight, x_i is input, b is bias and i vary from 1 to n.

A. Elements of a Neural Network

Neural network has three elements which are:

1) *Input Layer*: This layer accepts input features. It collects information from the outside world and gives it to the network. No computation takes place at this layer. Nodes pass the information (features) to the next layer i.e. hidden layer.
2) *Hidden Layer:* Nodes of this layer are not exposed to the outside world as they are the part any neural network. It performs all computation that it gets through the input layer and transfers the result to the output layer.
3) *Output Layer:* This layer gives the information learned by the network to the outer world.

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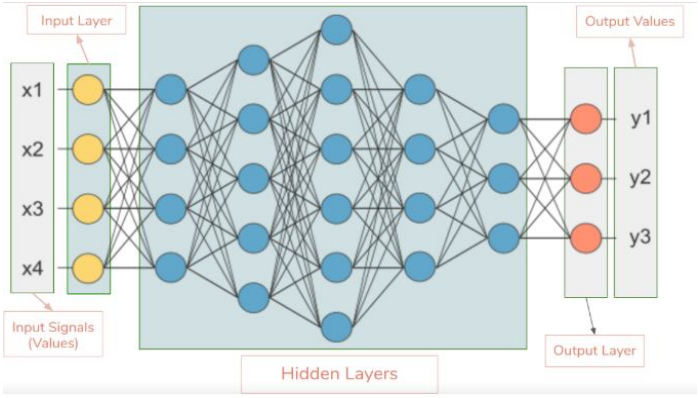

Figure 1 Layers of neural network

Figure 1describes all three layers of neural network. All three layers are interconnected to form a neural network.

III.METHODOLOGY

The detection of oral ailments consists of following steps:

A. Input Dataset

Dataset is created by taking real time images. The data set contains training and testing images. The training dataset is used to train the application and to predict the type of oral ailment and the test dataset is used for testing and find whether the ailments exist or not.

B. Image Processing

An RGB Image consists of three layers and it is a three-dimensional matrix, where as grayscale image is of only two dimensions, and the values ranges between 0–255 (8-bit unsigned integers). For many applications of image processing, color information doesn't help to identify important edges or other features. Hence grayscale conversion is done to identify objects of known hue. Grayscale processing uses single channel for processing rather than starting with full color imaging which uses more number of channels and missing all the important insights.

The images will be of different dimensions. These images are reshaped into one unique size and are converted into gray scale. The image matrices are created from gray scale images and flattened.

C. Neural Network

A neural network is a network or circuit of neurons that may be used for predictive modeling, adaptive control and applications where they can be trained via a dataset. Self-learning resulting from experience can occur within networks, which can derive conclusions from a complex and seemingly unrelated set of information.

Convolutional Neural Network is chosen among several neural networks since it is a better model for image recognition.

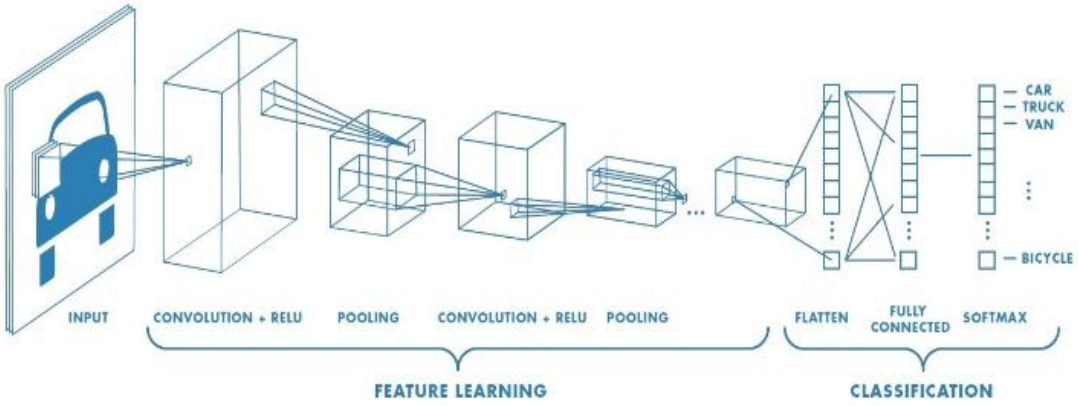

Figure 2 Convolutional neural network architecture

Convolutional Neural Network processes image through several layers as shown in Figure 2, such as:

1) *Convolutional Layer:* Convolution layer is helps to extract features from an input image. Convolution preserves the relationship between pixels in a matrix by learning image features using small squares of input data.
2) *Non Linearity (ReLU):* ReLU stands for Rectified Linear Unit for a non-linear operation. The output expression is shown in equation (3).

$$f(x) = \max(0,x) \quad (3)$$

where output f(x) is obtained using max function for values containing 0 or x. ReLU's purpose is to introduce non-linearity in the ConvNet. There are other non-linear functions such as tanh or sigmoid can also be used instead of ReLU. ReLU function has better performance compared to tanh and sigmoid.

3) *Pooling Layer:* Pooling layers section would reduce the number of parameters when the images are too large. Spatial pooling is done for down sampling which reduces the dimensionality of each map but retains the important information. Three types of pooling are sum pooling, average pooling and max pooling. Implementation uses max pooling. Max pooling take the largest element from the rectified feature map. Taking the largest element could also take the average pooling. Max pooling is used in the project since it is a better pooling technique.
4) *Flattening Layer:* The Flatten Image command merges all the layers of the image into a single layer. The difference is that all the image contents are in a single layer and this operation makes significant changes to the image.
5) *Fully Connected Layer:* The flattened matrix is converted into vector and is fed into a fully connected layer like neural network. Feature map matrix will be converted as vector (x1, x2, x3, ..). With the fully connected layers, features are combined together to create a model.

IV. RESULT AND ANALYSIS

The image is tested by choosing a random image from a testing data set. The test image is compared to the feature extracted training image to obtain the result. The below figure 3-7 shows the image tested with various diseases such as Cavity, Ulcer, Periodontal, Hyperdontia and Oral cancer.

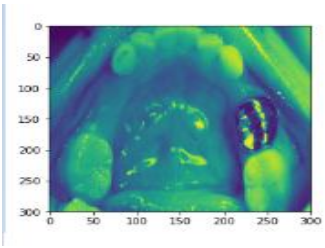

Figure 3 Cavity

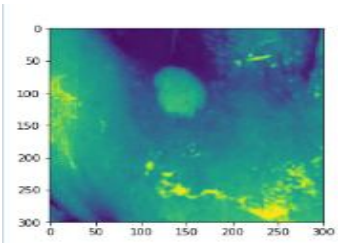

Figure 4 Ulcer

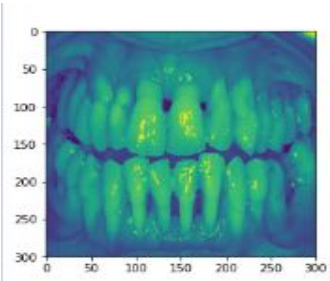

Figure 5 periodontal

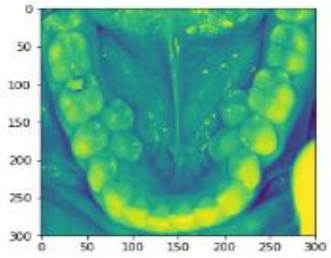

Figure 6 Hyperdontia

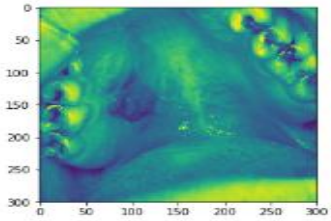

Figure 7 Oral cancer

The tested image shows the accuracy of the result against the training data set. The accuracy of each disease obtained is tabulated in the below Table 1.

TABLE I

Diseases	Accuracy (%)
Cavity	95.2
Ulcer	90.9
Periodontal	95.5
Hyperdontia	90.1
Oral Cancer	90.7

V. CONCLUSION AND FUTURE SCOPE

The implementation is done for detecting five oral ailments where the dataset is built using real time images. Anaconda Navigator with scikit learn, keras, tensrfow is used for the implementation in Python language. CNN algorithm of deep learning is used for training and classifying the different images. Test images are compared against the trained images to detect the disease. The result provides a good accuracy and it uses captured images which are advantageous compared to previous work. The Accuracy obtained is 90.9% for Ulcer, 90.1% for Hyperdontia, 90.7% for oral cancer, 95.2% for cavity, 95.5% for Periodontal disease. Accuracy can be increased by standard and large data set. The different stages of oral cancer can also be detected. More than five diseases can be included for detection.

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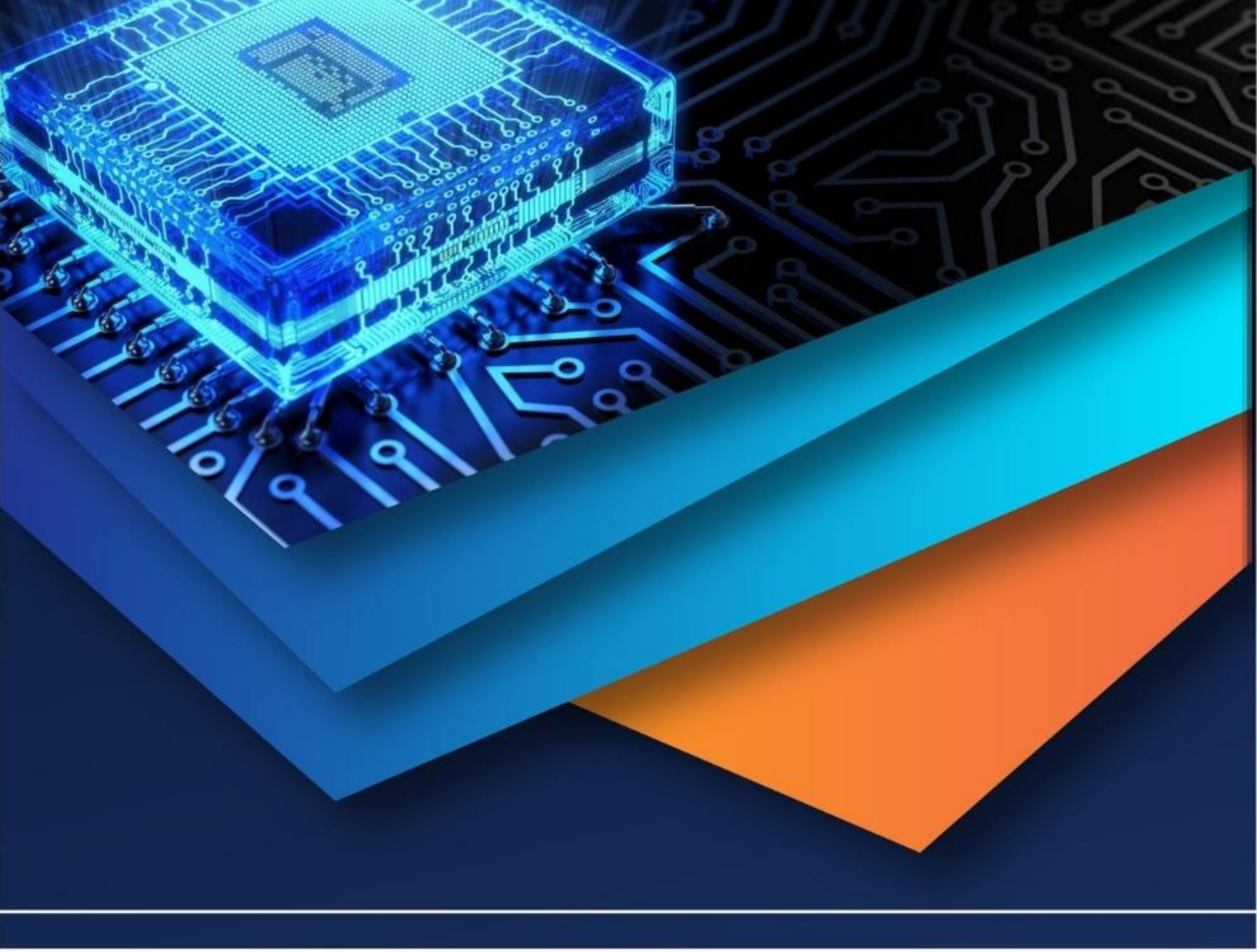

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