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# Dental X-Ray Analysis

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**Abstract:** *With advancements in medical field, technology is being applied for ingenious applications that let doctors to use them as tools in beneficial way. Examining dental radiographs by dentists usually fritter away time and also error prone due to its complex structure. The idea is to analyze dental radiographs in easier way by applying neural networks and transfer learning techniques. These intelligence techniques assist for precise results. The novelty is to apply neural networks on those x-rays to analyze them with aid of transfer learning models. For this, radiograph is taken as input for building model using weights and models in transfer learning. Various architectural models from transfer learning are applied for training x-ray data that yields accurate results. Among applied models, MobileNet architecture with some neural network layers gave error-free results. This x-ray analysis will segregate radiographs having caries and gives output as probability value. This application allows dentists for quick and easier outcome of dental x-rays that rescues time.*

**Keywords:** Neural Networks, Transfer Learning, MobileNet Architecture, X-rays**.**

## I. INTRODUCTION

Tooth decay and cavities has become extensive complication over adults aged from 20 to 64 which is being neglected from ages to recent times is report given by National Health and Nutrition Examination Survey. The lessening is notable in all aged subgroups. Despite there is decrease in this it is found immobile among some population. Among adults 20 to 64 this problem made permanent in their teeth.

Radiographs of teeth are necessary for diagnosis of teeth for treatment purposes. But it is often time killing process and may lead to many errors due to its heavy structure for dentists and there will be increase in number for analytics on daily basis for them [5]. For this problem automated tools come to play that supports dentists for treatment and practice which can further improve standard on dental works. Though, automated tools are also challenging to use.

Radiograph Data collected from hospital that can be viewed through using software and converting them using different techniques [8]. Classification and analysis is performed on these radiographs which later makes use of neural networks [1]. Deep Neural networks with transfer learning techniques helps to build a mechanized tool which will be able to detect problem in x-rays and makes work easy [10]. Neural networks are made up neurons interconnected by different layers where these neurons learn by training and acts like perceptron. Neural networks can be used for many applications that can be adopted in many areas. Coming to deep learning it has capacity to work with unstructured data. We designed a model based on transfer techniques which will tell whether teeth in x-rays having cavities or not. Transfer learning is a technique that gains weights which can be applied to others.it is a popular approach where pre-defined weights models are applied to build a new one. This

will help to upgrade the performance of the model and it lessen training period. Here we used four architectures includes VGG16, MobileNet architecture, Residual Neural network architecture and GoogleNet architecture [2],[4]. So, mobile net architecture is used to develop application. VGG Net has more parameters in terms of weight and heavy model takes lot of time for training. Google net is faster than VGG16[7]. ResNet also takes more time for its training which results in not suitable for real time applications easily. MobileNet architecture is effective for web and also for mobile applications and is efficient convolutional neural network where CNN is mostly used for images [6],[9]. The main objective of this is to provide better prediction for its x-ray images this helps dentists as well as to people for verifying results. For this we developed a web application using Flask as framework. Thus, our model takes tooth x-rays for training after training application is developed using web framework that uploads input image x-ray, for results is given as value in form of probability value less than one. Depends on value decides whether patient having caries or not.

Data Flow diagram which lets to know flow of activities involved from giving input x-ray to obtaining probability as output whether having cavities for given teeth.

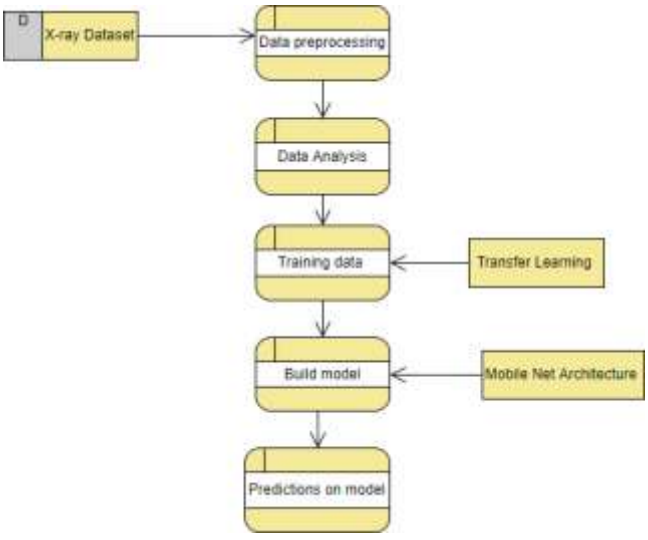


**Figure 1:** Data Flow Diagram

## II. DATA COLLECTION

For dental radiographs, we gathered dataset from Pinnamaneni Medical College that having thousands of x-ray images We obtained dataset of X-rays in form of pano images and a software TWV (Dental Imaging Software) to access the .pano files. Images are later divided based on tooth decay into folders and later being uploaded into drive.

## III.METHADOLOGY AND SOFTWARE USAGE

We used Programming Language Python and Transfer Learning as Technique. Though we have many Neural Networks we prefer to use Transfer learning technique because of having pretrained weights that can be obtained from ImageNet. Main advantage of using Transfer Learning is that it can save time and it leads to good performance. We used Flask as web Framework for developing Web application using Python. In Transfer Learning, among all used architectures MobileNet architecture has given good accuracy compared to all other architectures. Keras is main module used which is imported using pip. This module allows to apply all transfer learning architectures.

Here, analytics was done using keras as backend and we developed a front-end web application using Flask. Initially, dental radiographs are divided into 60,20,20 ratio as Training, Testing and for Cross-validation according to Standard rule of Thumb. Data is being divided into folders having caries and Nocaries for training and now classified data is trained by applying all Transfer learning models among which MobileNet architecture yielded best results where it gives probability between 0 to 1 as output when given x-ray image as input. Google Collab was used as platform for training on data.

Mobile Net is an efficient architecture in Convolution Neural Networks for web and mobile based applications [3]. MobileNet is lightweight in its architecture and have depth wise separable convolution layers. Mobile Net depth wise convolutions use a single filter. The depth wise separable convolution are divided into two layers, a separate layer for filtering and a separate layer for combining. Mobile Net architecture is of 30 layers. Mobile Net is a depth wise convolution, having average pooling layers with SoftMax as classifier. Depth wise convolutions are followed by Pointwise convolutions. Pointwise convolution is 1X1 convolution to change the dimensions.
Along with MobileNet we can use Pooling layers that minimizes computation work in network and it performs dimensionality reduction.

Google Collaboratory is a platform used to train our data that is uploaded to the google drive. Collab is a free Jupyter notebook type environment that requires no setup and runs entirely in the cloud with preinstalled modules in the cloud. In Collaboratory you can directly write the code and execute it. We can train our model and download it for further predictions.

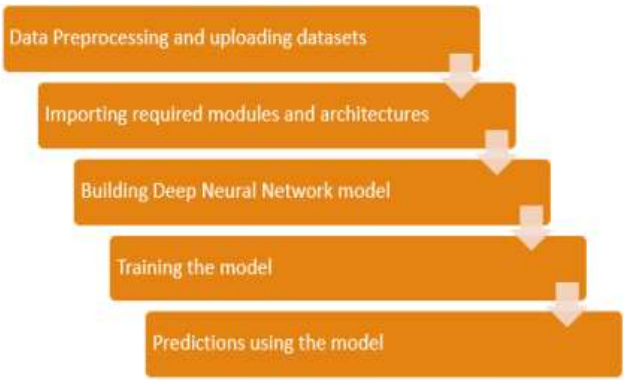


**Figure 2:** Sequence flow of the project

**Step1**- Data Preprocessing and Uploading Datasets

It includes conversion of pano images into .jpg images. Diving the datasets into train, test and validation data. And uploading it to google drive.

**Step2-**Data Preprocessing and Uploading Datasets

Keras is main module used here and all other modules are imported using pip command.

**Step3**-Building Deep Neural model

Our model is build using mobile net architecture from Image net continued with a set of fully connected layers and lastly the classifier SoftMax for classification.

**Step4**-Training the model

Our data is given as input to the model we built previously in step3 and training is done on the Google Collab platform.

**Step5**-Prediction using the model

The trained model i.e., .h5 file is downloaded for further predictions.

# IV. IMPLEMENTATION

### 4.1 Preprocessing on X-ray Images

Using TWV software x-ray images that are in form of. pano are opened and they are converted into .jpg by taking image as per region of interest. Data is being classified into classes of Caries and No caries for further implementation.

### 4.2 Installing Keras

We need to install Keras, TensorFlow module. Keras and the required packages are installed using pip by the following command. Numpy is module for scientific computing and having n-dimensional array object for performing computations.

*Pip install keras*

*Pip install numpy*

### 4.3 Uploading and accessing data

Data is being uploaded into google drive as we used Google Collaboratory as platform for implementation and from google drive data is imported into Google Collaboratory.

Now, data is unzipped and the data is a folder of images in form of.jpg being divided into training and testing and validation folders is shown in the figure 3. Further the data is divided into folders based on images that are having caries and images not having caries.

**Figure 3:** Data classification

### 4.4 Training and Performing Validation on Image dataset

Using Keras module, any architectures can be used by Keras each architecture have their own disadvantages when compared with MobileNet architecture and hence MobileNet architecture is used. When coming to ResNet architecture it takes lesser memory and but it is not feasible for real world application. Due to vanishing gradient problem and long time for training, VGGNet is not used. GoogleNet is comparatively faster than VGGNet, but it gave very less accuracy and incorrect predictions [2],[4]. Finally, MobileNet architecture is applied on dataset among all the architectures. And the model is continued by adding pooling layers for minimizing overfitting by reducing total number of parameters and lastly the fully connected layers with activation function. After training, we got an accuracy of 97% and the output probability value ranges from 0 to 1.

Sigmoid is activation function used that gives the probability between 0 to 1 and image without caries will give value between 0-0.5 and image with caries gives out value between 0.5-1.

Model is saved and testing is done by uploading an image and giving it as input to model. We save the model by the below command.

*model. save('dentalalpha.h5')*

Here, we used modules named IO, PIL, matplotlib for uploading image and testing and predictions are made on it.

### 4.5 Prediction using Web application

Using Flask framework, we created a web interface and deployed our model in it. The web app takes image as input and return the probability value and the final result of the image having/not having caries disease.

## V. RESULT

The output is given in form of probability value where value lies between zero and one. Value less than 0.5 indicates that x-ray that is given is not having caries and value between 0.5 and 1 interprets that x-ray is having cavity. Output will display value along with radiograph image. The output view of the web app is shown in the figure 4.


**Figure4:** View of Web application

And a comparative analysis chart is shown in the figure5 below. The chart includes all other architectures in transfer learning that are applied on to data i.e., VGG net, Mobile Net, Res Net and Google Net architectures. Mobile Net architecture has given good results with high accuracy.

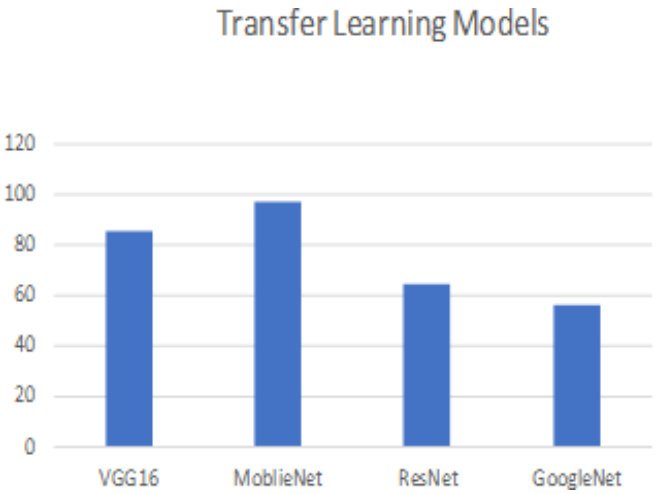


**Figure 5:** Comparative graph of architectures

## VI. CONCLUSION AND FUTURE WORK

Dental cavity prediction is performed by neural networks with transfer learning. Most prevalent diseases i.e., dental cavity or tooth decay are taken into account for the classification by designed models with four different architectures. Transfer learning with MobileNet architecture pretrained model is used to achieve better accuracy among all. Along with model, neural network layers used and classifier plays key role in obtaining precise results. Dataset consisting of 1000 x-ray images is used for training and testing to build model. Experimental results for different models are discussed. The overall accuracy of 97% is achieved with Mobile Net architecture.

As Future work, application can be extended that takes any dental radiograph and predicts any dental diseases that can be found by using x-rays by dentists with better results and even faster.

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