<center>**Review on Classification of Dental Diseases**</center>

1. A Comprehensive Deep Learning Framework for Dental Disease Classification

<u>Problem Statement</u>

- Dental diseases are a significant global health challenge that often leads to serious complications if not identified. Early diagnosis is crucial to prevent the progression of these diseases.
- The five classes were **caries**, **gingivitis**, **hypodontia**, **mouth ulcers**, **tooth discoloration**.

<u>Approach</u>

- A five-layer convolutional neural network (CNN) along with Residual Networks (ResNet) and Vision Transformer (ViT) models to analyze dental images and classify them into five prevalent conditions. The ensemble model also uses data augmentation to enhance generalization.
- 5-fold cross-validation and hyperparameter tuning using grid search.
- To enhance generalization, additional evaluation metrics were used such as specificity and sensitivity, offering deeper insights into model performance across different dental conditions.
- To handle ambiguous cases, the model applies a minimum confidence threshold of 30%.

<u>Preprocessing</u>

- Images resized to 224 x 224.
- Augmentation: applied on the minority classes to avoid unbalanced data.

Table 1. Augmentation summary

Augmentation Type	Parameter Used
Rotation	±20°
Width Shift	±20%
Height Shift	±20%
Horizontal Flip	50% probability
Normalization	Pixel values scaled [0,1]
Brightness Adjustment	±20%
Contrast Enhancement	Controlled variation

<u>Model Architecture</u>

- Input Layer
- First Layer (64 filters): Detected basic features (edges and textures).
- Second Layer (128 filters): Combined lower-level features.
- Third Layer (256 filters): Captured intermediate patterns (cavity sizes and gum-line structures).
- Fourth Layer (512 filters): Identified complex relationships between teeth and disease patterns.
- Fifth Layer (1,024 filters): Integrated global features for final classification.
- Max-pooling layers and dropout were used.

<u>Results</u>

- Grad-CAM heatmaps were generated to understand the model's reasoning.
- The mean accuracy obtained across folds was 87.6%

Table 5. Comparative performance of different models

Model	Accuracy (%)	Precision (%)	Recall (%)	F1-Score (%)	Inference Time (ms)
5-Layer CNN	87.6	86.2	85.4	85.8	120

2. Mouth and oral disease classification using InceptionResNetV2 method

Problem Statement

Classification of 7 mouth and oral diseases using deep learning.

Approach

- InceptionResNetV2 Method was used to identify diseases such as gangivostomatitis (**Gum**), canker sores (**CaS**), cold sores (**CoS**), oral lichen planus (**OLP**), oral thrush (**OT**), mouth cancer (**MC**), and oral cancer (**OC**).

Preprocessing

- Images were resized to a size of 224 x 224.
- Augmentation

Transformations	Setting
Scaling	Ranged from 0 to 1
Rotation	25o
Zooming	0.2
Horizontal flipping	True
Shear	20o

Model Architecture

- Models based on transfer learning.
- InceptionResNetV2 model.

Results

- Average accuracy is 99.51%.

InceptionResNetV2 Model Confusion Matrix on Test Set

accuracy=0.9951; misclass =0.0049
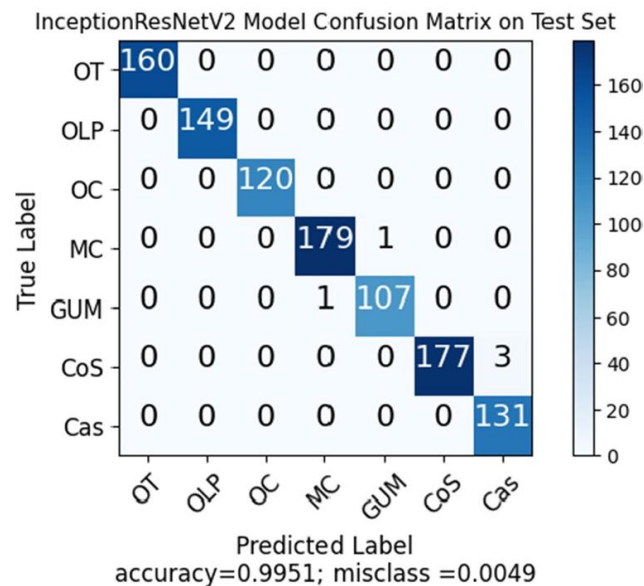
References

[1] P. Parkhi et al., "A Comprehensive Deep Learning Framework for Dental Disease Classification," *Journal of Engineering Science and Technology*, vol. 58, no. 3, pp. 123-134, 2023. doi: 10.18280/jesa.580309.

[2] J. Rashid et al., "Mouth and Oral Disease Classification Using InceptionResNetV2 Method," *Multimedia Tools and Applications*, 2023. doi: 10.1007/s11042-023-16776-x.