Teeth Classification Project Report

Overview:

This project focuses on developing a deep learning model for classifying dental images into seven distinct categories related to oral health conditions. The categories are: ['CaS', 'CoS', 'Gum', 'MC', 'OC', 'OLP', 'OT'].

Data Loading and Preprocessing:

- Loading: using tf.keras.utils.image_dataset_from_directory for train/validation/test splits.
- Preprocessing: through Normalization (by rescaling) and data augmentation (using RandomFlip , RandomRotation , RandomZoom and RandomTranslation).

Visualizations:

- Distribution: MC and OC have the highest number of samples while OC and Gum have the lower number of samples but the training data is reasonably balanced.
- Visualization before and after augmentation: after using the data_augmentation we save each image with its augmented one in a folder in visualization_outputs.
- Histogram of Pixel Intensities for each of the 3 channels (RGB): Distinct color profiles per class , explain the model's effectiveness, as RGB features are discriminative.
- Sobel Edge Maps: method used to identify edges in an image by detecting areas of rapid intensity changes , highlights boundaries between objects or regions with different brightness levels and the outputs are saved in a folder in visualization_outputs.

- Dimensionality Reduction (t-SNE): reduces high-dimensional ResNet features to 2D for visualizing class clusters

Model Training:

- The model was trained for 50 epochs using categorical cross-entropy loss (with label smoothing) and the Adam optimizer. The architecture consisted of X convolutional layers (Conv2D + BatchNormalization + MaxPooling combinations), followed by fully connected Dense layers. A Dropout strategy was applied for regularization (0.5 and 0.3), and L2 weight regularization (tf.keras.regularizers.l2(0.001)) was used on some layers to reduce overfitting.
- A training log file was also generated to record model performance (loss, accuracy, and validation metrics) across epochs for reproducibility and debugging

Evaluation of Test Results:

The model achieved 95% accuracy on the held-out test dataset, which confirms its strong generalization ability.

- Confusion Matrix: showed most predictions aligned with the correct classes (strong diagonal dominance), meaning the model rarely confused different conditions.
- Classification Report: confirmed balanced performance across classes, with precision, recall, and F1-scores all above 0.90 for most categories.

The evaluation highlights the robustness of the model while also pointing out biologically relevant challenges in distinguishing similar oral diseases.

Future Improvements:

- Model Architecture: Experimenting with deeper CNNs.

- Deployment: Building a lightweight web or mobile app to assist dentists in real-time clinical settings.