**Liver Damage Detection Using DenseNet169 – Technical Report**

**1. Project Overview**

This project aims to classify liver histopathology images into three categories:

* **HCC** (Hepatocellular Carcinoma)
* **CC** (Cholangiocarcinoma)
* **Normal** liver tissues

The goal is to assist hepatologists in early and accurate liver damage diagnosis using deep learning models.

**2. Dataset Description**

* **Total Images**: 150 Each Class
* **Classes**: HCC, CC, Normal
* **Format**: JPEG/PNG images
* **Split**:
  + Train: 70%
  + Validation: 15%
  + Test: 15%

**Preprocessing:**

* Verified images using TensorFlow I/O.
* Resized all images to **224×224 pixels**.
* Applied **ImageDataGenerator** for real-time augmentation:
  + Rotation, flipping, zooming, contrast adjustment.

**3. Model Architecture**

* Base Model: **DenseNet169** (pre-trained on ImageNet)
* Layers:
  + Global Average Pooling
  + Dense layer (512 units, ReLU)
  + Dropout (0.5)
  + Output: Dense (3 units, Softmax)

**Transfer Learning:**

* First few layers frozen.
* Final layers fine-tuned for liver classification.

**4. Training Configuration**

* **Optimizer**: Adam
* **Loss Function**: Categorical Crossentropy
* **Metrics**: Accuracy
* **Batch Size**: 32
* **Epochs**: 30–50 (with early stopping and ReduceLROnPlateau)

**Callbacks Used:**

* ModelCheckpoint (monitor val\_accuracy)
* EarlyStopping (patience=5)
* ReduceLROnPlateau (factor=0.2, patience=3)

**5. Performance Evaluation**

* **Test Accuracy**: 95%
* **Precision/Recall/F1-Score** (per class)
* **Confusion Matrix** analysis

**Visualization:**

* Training & validation accuracy/loss plots
* Grad-CAM for explainable predictions

**6. Tools & Environment**

* **Google Colab Pro**
* **TensorFlow & Keras**
* **Matplotlib, Seaborn, NumPy, Pandas**
* **Data stored in Google Drive**

**7. Challenges Faced**

* Class imbalance (mitigated using augmentation)
* Low contrast in histopathology images
* Need for interpretability: Added Grad-CAM

**8. Future Improvements**

* Use domain-specific models like HoVer-Net
* Integrate clinical metadata
* Explore multi-modal learning
* Deploy model via Streamlit web app for real-time usage

**9. Conclusion**

The DenseNet169-based model demonstrated strong potential in detecting liver damage from histopathology images. With further optimization and clinical integration, it can serve as a valuable tool for liver disease diagnosis.