AI for Tele-Dermatology (Case Study)

Course: Applied Computer Vision

Program: B.Tech III Year

Mode: In-Class Case Study + Hands-on Lab (Google Colab)

Total Duration: Two Weeks (6 Classes + 2 Lab Sessions)

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1. Introduction

Tele-dermatology enables remote diagnosis and monitoring of skin diseases using images captured through mobile devices. Real-world tele-dermatology images suffer from illumination variation, skin-tone diversity, noise, and device-dependent artifacts. Among computer vision tasks, classification and segmentation play complementary roles: classification supports clinical decision-making, while segmentation enables precise lesion assessment.

This two-week case study focuses on building and critically evaluating classification and segmentation models under real-world variability.

2. Learning Objectives

At the end of this module, students will be able to:

- Design and train deep learning models for skin disease classification
- Develop pixel-level lesion segmentation models
- Evaluate robustness under brightness and skin-tone variations
- Perform misclassification and segmentation error analysis
- Critically interpret model performance for tele-dermatology deployment

3. Datasets (Public and Open-Access)

Use one or more of the following datasets:

1. ISIC 2018 Challenge Dataset (images + segmentation masks)
2. HAM10000 Dataset (multi-class skin disease classification)
3. Derm7pt Dataset (Optional – advanced clinical annotations)

All datasets are freely available and compatible with Google Colab.

Two-Week Execution Plan

Week 1: Skin Disease Classification

Class 1: Problem Understanding & Dataset Exploration

- Tele-dermatology workflow overview
- Disease classification problem formulation
- Dataset exploration and class distribution analysis
- Train-validation-test split

Class 2: Classification Model Design

- CNN architectures (VGG16 / ResNet / MobileNet)
- Loss functions and evaluation metrics
- Training a baseline model without data augmentation

Lab Session 1:

- Train baseline classification model
- Report Accuracy, Precision, Recall, and F1-score
- Generate confusion matrix
- Identify top misclassified disease classes

Analysis Tasks:

- Analyze possible causes of misclassification
- Evaluate effect of brightness variation on classification performance
- Examine classification accuracy across different skin tones

Deliverables (End of Week 1):

- Confusion matrix
- Metric comparison tables
- Short misclassification analysis report

Week 2: Lesion Segmentation

Class 3: Segmentation Fundamentals

- Importance of lesion segmentation in dermatology
- Medical image segmentation concepts
- U-Net and U-Net++ architectures
- Loss functions: Dice Loss, Binary Cross-Entropy

Class 4: Segmentation Training & Evaluation

- Training segmentation model using lesion masks
- Visualizing predicted masks and overlays
- Computing Dice, IoU, Precision, and Recall

Lab Session 2:

- Train segmentation model with and without brightness augmentation
- Perform class-wise segmentation analysis (melanoma, eczema, psoriasis, acne)
- Identify segmentation errors:
  - Over-segmentation
  - Boundary leakage
  - Missed lesion regions

Deliverables (End of Week 2):

- Segmentation overlay images
- Metric comparison tables
- Error analysis report

Integrated Analysis Component

Answer the following question:

Q: "How do brightness variation and skin-tone diversity affect both classification accuracy and segmentation quality in tele-dermatology images? Which task is more sensitive, and why? Support your answer with experimental results."

Expected Length: 300–400 words

Evaluation Rubric (Total: 40 Marks)

- Classification Model Implementation & Analysis: 15 Marks
- Segmentation Model Implementation & Analysis: 15 Marks
- Integrated Interpretation & Reporting: 10 Marks

Expected Learning Outcomes

- Hands-on experience with medical image classification and segmentation
- Understanding robustness and bias in healthcare AI systems
- Ability to analyze real-world failure cases
- Preparation for final-year projects and research in medical imaging