Colposcopy image classification for cervical cancer screening using deep learning

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BACKGROUND

• Cervical cancer remains a significant global health challenge, especially in resource-limited settings with limited access to effective screening programs.

• Colposcopy is a highly sensitive method of diagnosing cervical interepithelial lesion(CIN), but it is prone to subjectivity

• Traditional screening methods face challenges in these contexts, leading to delayed diagnoses and poor patient outcomes.

• Deep learning techniques provide a promising solution by utilizing advanced algorithms to analyze colposcopy images for early detection of precancerous lesions.

• This study aimed to evaluate the use of deep learning in cervical cancer classification using precancerous images.

METHODS

• The study used data from the International Agency for Research on Cancer (IARC) containing colposcopy examination with 902 Images extracted.

• A deep learning approach was employed to classify colposcopy images with labels for LSIL, HSIL, and Normal cervix.

• The data set it was split into training and validation sets, followed by data augmentation with random transformations for balancing.

• Transfer learning was utilized, incorporating models such as
  ✓ InceptionResNetV2,
  ✓ InceptionV3,
  ✓ VGG19,
  ✓ EfficientB7,
  ✓ DenseNet121,
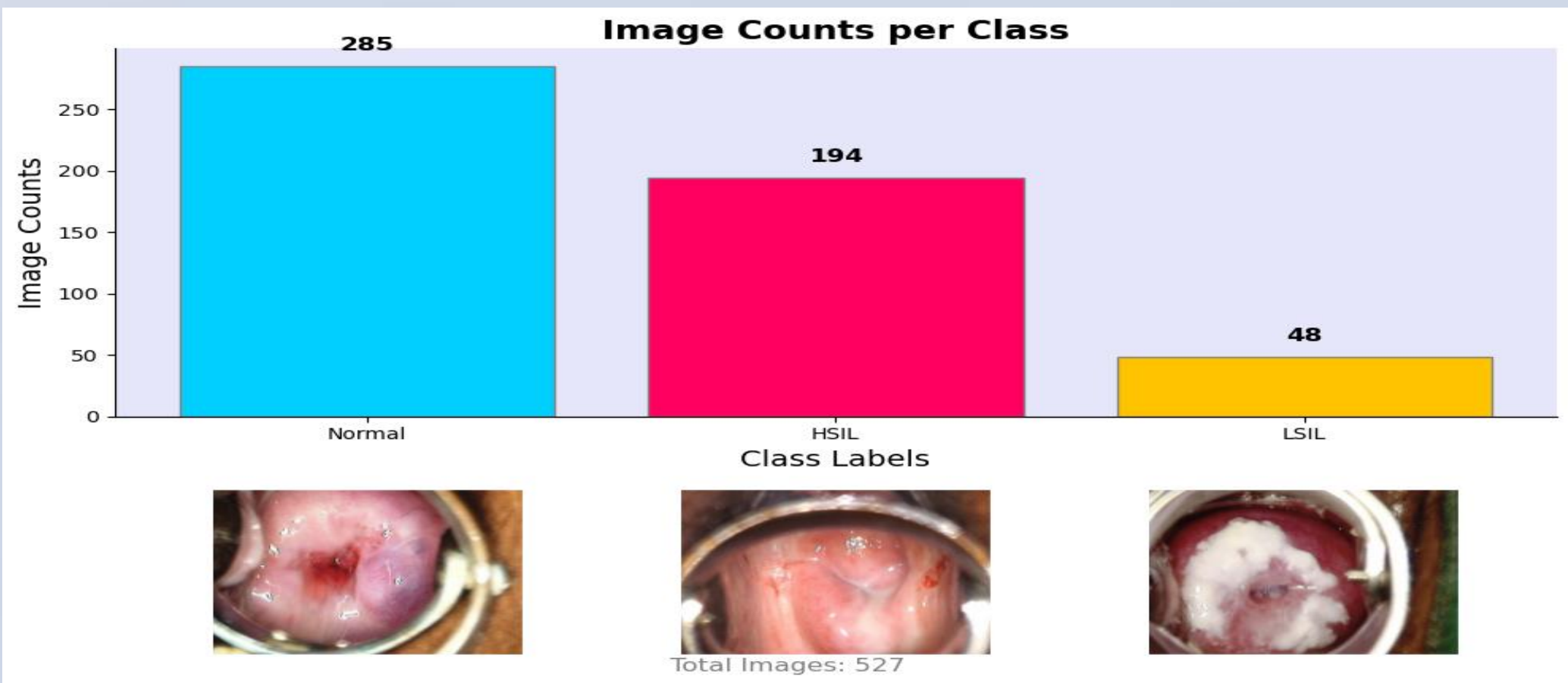 ✓ NasNet Large, and ResNet152

for feature extraction, with fine-tuning applied for three-class classification

• A two-layer neural network with dropout and ReLU activation was added, using categorical cross-entropy As the loss function.

• The Adam optimizer. Hyperparameter tuning (batch size, learning rate, and regularization) with different values was tried,

• The model's performance was evaluated using metrics such as accuracy, precision, recall and AUC.

• Gradient-weighted Class Activation Mapping (Grad-CAM) shows by highlighting which areas of the image are most influential in the model's decision.

• Confusion matrix represents the number of predictions for each combination of true and predicted classes, providing insight into the model's performance across these categories.

RESULTS/FINDINGS

• In this study, a total of 527 cervical images were used after removing images with excessive background noise and benign lesions,

Model	Accuracy (100%)	Precision (100%)	Recall (100%)	AUC (100%)	Loss
Inception ResNet v2	90.00	90.00	90.00	98.32	1.27
ResNet50	60.00	60.00	60.00	78.00	1.4
VGG19	0.00	0.00	0.00	0.00	1.116
InceptionV3	100	100	100	100	0.006
NasNetLarge	100	100	100	100	25.5
EFficientNetB7	37.5	0.00	0.00	63.12	1.07
DenseNet121	90	90	90	98.50	0.30

• This study achieved peak scores on InceptionV3 and NasNet Large.

• However, the results show instability

• unlike InceptionResNetV2 that shows relative stability on validation data showing potential generatability with metrics of 90.00% accuracy, 90.00%precision, 90.00%recall, and 98.32 AUC.

• The model's loss decreased consistently over the epochs without overfitting.

• A confusion matrix demonstrated classification performance.

• Grad-CAM visualizations further highlighted the model's focus on regions of interest in the images.

CONCLUSIONS AND RECOMMENDATIONs

• This study developed and validated a deep learning model for cervical cancer screening using precancerous colposcopy images, using transfer learning model.

We Recommend:

✓ Conduct further validation of the deep learning model across diverse populations

✓ Investigate the integration of the model into routine screening workflows to evaluate its real-world performance and impact on early detection rates.
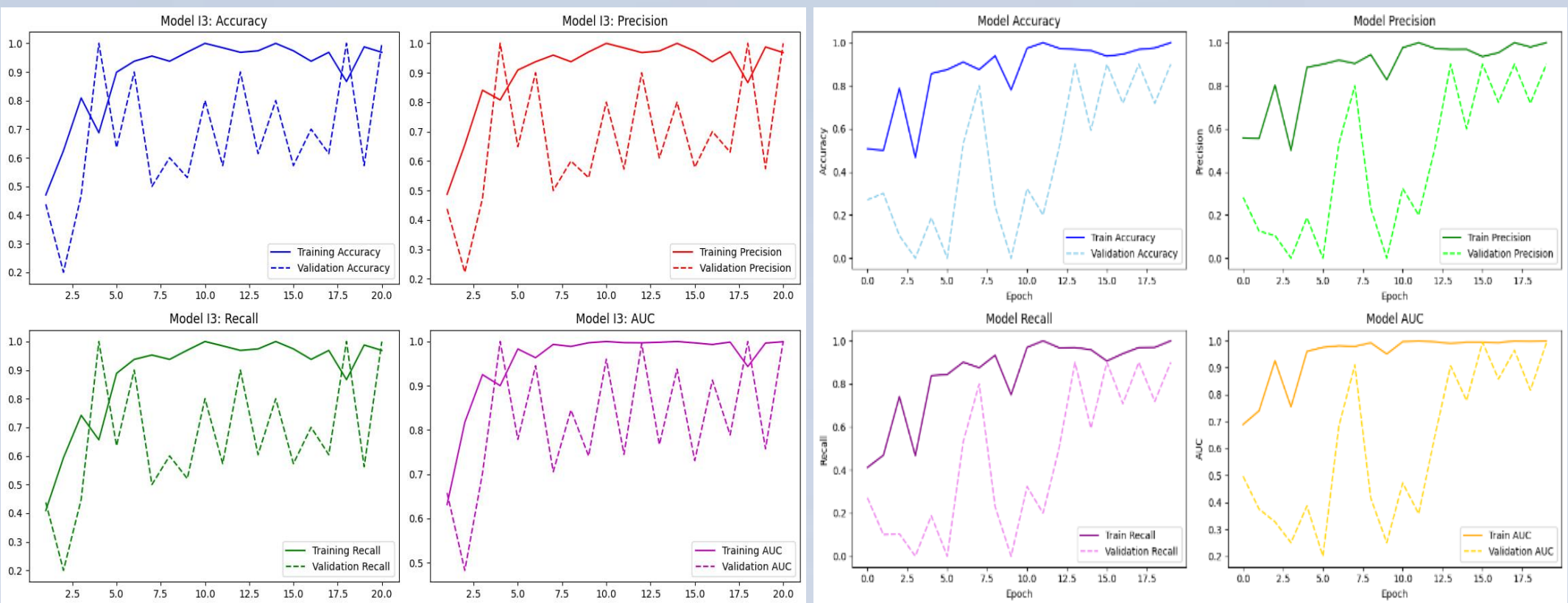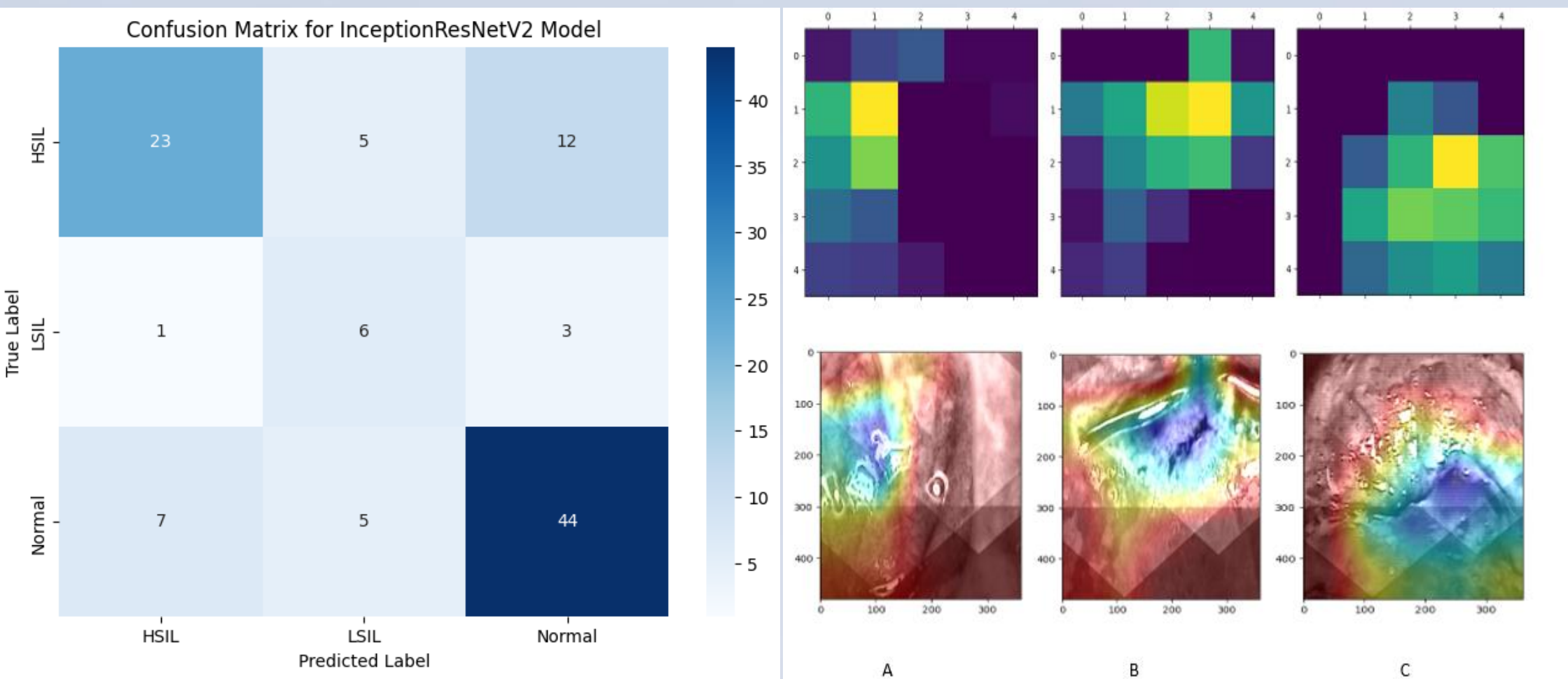
ACKNOWLEDGMENT