Using CUDA GPU: NVIDIA GeForce RTX 3050

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Training efficientnet_b0 for Chest X-Ray Classification
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Loading data...
Loading data from:
  Train: data/raw/chest_xray/train
  Val: data/raw/chest_xray/val
  Test: data/raw/chest_xray/test
/home/user/miniconda3/envs/dl_env/lib/python3.10/site-packages/albumentations/core/validatio
n.py:114: UserWarning: ShiftScaleRotate is a special case of Affine transform. Please use Affine
transform instead.
  original_init(self, **validated_kwargs)
Train samples: 5216
Validation samples: 16
Test samples: 624

Train distribution - Normal: 1341, Pneumonia: 3875
Imbalance ratio: 2.89:1

Creating efficientnet_b0 model...
Model parameters: 4,664,446
Trainable parameters: 4,664,446

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STAGE 1: Baseline Training (Frozen Backbone)
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Trainable parameters: 656,898

Training stage: baseline
Epochs: 15, Learning rate: 0.001

Epoch 1/15

Training: 100%|██| 163/163 [00:27<00:00,
5.86it/s, loss=0.299]

Evaluating:

100%|██| 1/1

[00:00<00:00, 2.46it/s]

Train Loss: 0.2575, Train Acc: 0.8955

Val Loss: 2.0019, Val Acc: 0.5000, Val AUC: 0.9531

Epoch 2/15

Training: 100%|██████████████████████████████| 163/163

[00:27<00:00, 5.99it/s, loss=0.21]

Evaluating:

100%|██| 1/1

[00:00<00:00, 2.99it/s]

Train Loss: 0.2115, Train Acc: 0.9199

Val Loss: 2.1892, Val Acc: 0.5000, Val AUC: 0.9531

Epoch 3/15

Training: 100%|██████████████████████████████| 163/163 [00:26<00:00,

6.06it/s, loss=0.297]

Evaluating:

100%|██| 1/1

[00:00<00:00, 2.99it/s]

Train Loss: 0.2046, Train Acc: 0.9174

Val Loss: 1.8932, Val Acc: 0.5000, Val AUC: 0.9531

Epoch 4/15

Training: 100%|██████████████████████████████| 163/163

[00:26<00:00, 6.14it/s, loss=0.1]

Evaluating:

100%|██| 1/1

[00:00<00:00, 2.99it/s]

Train Loss: 0.1793, Train Acc: 0.9275

Val Loss: 2.6331, Val Acc: 0.5000, Val AUC: 0.9688

Epoch 5/15

Training: 100%|██████████████████████████████| 163/163 [00:27<00:00,

6.01it/s, loss=0.294]

Evaluating:

100%|██| 1/1

[00:00<00:00, 2.99it/s]

Train Loss: 0.1702, Train Acc: 0.9310
Val Loss: 2.2129, Val Acc: 0.5000, Val AUC: 0.9531

Epoch 6/15

Training: 100%|███████████████████████████| 163/163 [00:26<00:00, 6.05it/s, loss=0.197]
Evaluating:
100%|███████████████████████████████████| 1/1 [00:00<00:00, 3.00it/s]
Train Loss: 0.1745, Train Acc: 0.9342
Val Loss: 2.7763, Val Acc: 0.5000, Val AUC: 0.9531

Epoch 7/15

Training: 100%|███████████████████████████| 163/163 [00:26<00:00, 6.11it/s, loss=0.107]
Evaluating:
100%|███████████████████████████████████| 1/1 [00:00<00:00, 3.00it/s]
Train Loss: 0.1702, Train Acc: 0.9354
Val Loss: 1.3797, Val Acc: 0.5000, Val AUC: 0.9844

Epoch 8/15

Training: 100%|███████████████████████████| 163/163 [00:27<00:00, 6.00it/s, loss=0.0688]
Evaluating:
100%|███████████████████████████████████| 1/1 [00:00<00:00, 2.96it/s]
Train Loss: 0.1698, Train Acc: 0.9314
Val Loss: 1.5406, Val Acc: 0.5000, Val AUC: 0.9844

Epoch 9/15

Training: 100%|███████████████████████████| 163/163 [00:27<00:00, 5.98it/s, loss=0.0745]
Evaluating:
100%|███████████████████████████████████| 1/1 [00:00<00:00, 2.98it/s]
Train Loss: 0.1602, Train Acc: 0.9394
Val Loss: 2.0385, Val Acc: 0.5000, Val AUC: 0.9844

Epoch 10/15

Training: 100%|███████████████████████████████| 163/163 [00:26<00:00, 6.05it/s, loss=0.106]

Evaluating:

100%|██| 1/1 [00:00<00:00, 2.99it/s]

Train Loss: 0.1687, Train Acc: 0.9363

Val Loss: 1.8817, Val Acc: 0.5000, Val AUC: 1.0000

Epoch 11/15

Training: 100%|███████████████████████████████| 163/163 [00:26<00:00, 6.11it/s, loss=0.104]

Evaluating:

100%|██| 1/1 [00:00<00:00, 2.98it/s]

Train Loss: 0.1582, Train Acc: 0.9362

Val Loss: 2.4513, Val Acc: 0.5000, Val AUC: 0.9375

Epoch 12/15

Training: 100%|███████████████████████████████| 163/163 [00:26<00:00, 6.05it/s, loss=0.0569]

Evaluating:

100%|██| 1/1 [00:00<00:00, 3.00it/s]

Train Loss: 0.1538, Train Acc: 0.9375

Val Loss: 2.7536, Val Acc: 0.5000, Val AUC: 0.9219

Early stopping triggered at epoch 12

Best Validation AUC: 1.0000

Baseline model saved to models/efficientnet_b0_baseline.pth

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STAGE 2: Progressive Unfreezing - Stage 1

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Unfrozen last 20 layers

Trainable parameters: 2,009,010

Training stage: stage_1
Epochs: 15, Learning rate: 0.0001

Epoch 1/15

Training: 100%|███████████████████████████████████| 163/163 [00:26<00:00, 6.14it/s, loss=0.058]
Evaluating:
100%|██| 1/1 [00:00<00:00, 2.80it/s]
Train Loss: 0.1331, Train Acc: 0.9482
Val Loss: 2.8514, Val Acc: 0.5000, Val AUC: 0.9688

Epoch 2/15

Training: 100%|███████████████████████████████████| 163/163 [00:26<00:00, 6.07it/s, loss=0.0837]
Evaluating:
100%|██| 1/1 [00:00<00:00, 2.80it/s]
Train Loss: 0.0975, Train Acc: 0.9655
Val Loss: 2.1211, Val Acc: 0.5000, Val AUC: 1.0000

Epoch 3/15

Training: 100%|███████████████████████████████████| 163/163 [00:26<00:00, 6.12it/s, loss=0.026]
Evaluating:
100%|██| 1/1 [00:00<00:00, 2.79it/s]
Train Loss: 0.0995, Train Acc: 0.9649
Val Loss: 1.7621, Val Acc: 0.5625, Val AUC: 1.0000

Epoch 4/15

Training: 100%|███████████████████████████████████| 163/163 [00:27<00:00, 6.04it/s, loss=0.253]
Evaluating:
100%|██| 1/1 [00:00<00:00, 2.81it/s]
Train Loss: 0.0807, Train Acc: 0.9680
Val Loss: 1.4582, Val Acc: 0.5625, Val AUC: 1.0000

Epoch 5/15

Training: 100%|████████████████████████████████████| 163/163 [00:28<00:00,
5.69it/s, loss=0.014]
Evaluating:
100%|██| 1/1
[00:00<00:00, 2.78it/s]
Train Loss: 0.0758, Train Acc: 0.9714
Val Loss: 1.4219, Val Acc: 0.5625, Val AUC: 1.0000

Epoch 6/15

Training: 100%|████████████████████████████████████| 163/163 [00:27<00:00,
5.90it/s, loss=0.00478]
Evaluating:
100%|██| 1/1
[00:00<00:00, 2.75it/s]
Train Loss: 0.0680, Train Acc: 0.9743
Val Loss: 1.6328, Val Acc: 0.5625, Val AUC: 1.0000

Epoch 7/15

Training: 100%|████████████████████████████████████| 163/163 [00:28<00:00,
5.75it/s, loss=0.0561]
Evaluating:
100%|██| 1/1
[00:00<00:00, 2.64it/s]
Train Loss: 0.0798, Train Acc: 0.9699
Val Loss: 1.5325, Val Acc: 0.5000, Val AUC: 1.0000

Epoch 8/15

Training: 100%|████████████████████████████████████| 163/163 [00:29<00:00,
5.50it/s, loss=0.137]
Evaluating:
100%|██| 1/1
[00:00<00:00, 2.42it/s]
Train Loss: 0.0644, Train Acc: 0.9737
Val Loss: 1.0270, Val Acc: 0.6250, Val AUC: 1.0000

Epoch 9/15

Training: 100%|████████████████████████████| 163/163 [00:28<00:00,
5.76it/s, loss=0.00475]
Evaluating:
100%|███████████████████████████████████████| 1/1
[00:00<00:00, 2.75it/s]
Train Loss: 0.0646, Train Acc: 0.9747
Val Loss: 0.4041, Val Acc: 0.8750, Val AUC: 1.0000

Epoch 10/15

Training: 100%|████████████████████████████| 163/163 [00:28<00:00,
5.69it/s, loss=0.0075]
Evaluating:
100%|███████████████████████████████████████| 1/1
[00:00<00:00, 2.78it/s]
Train Loss: 0.0564, Train Acc: 0.9783
Val Loss: 0.7801, Val Acc: 0.6875, Val AUC: 1.0000

Epoch 11/15

Training: 100%|████████████████████████████| 163/163 [00:28<00:00,
5.81it/s, loss=0.0837]
Evaluating:
100%|███████████████████████████████████████| 1/1
[00:00<00:00, 2.78it/s]
Train Loss: 0.0548, Train Acc: 0.9787
Val Loss: 0.3359, Val Acc: 0.8750, Val AUC: 1.0000

Epoch 12/15

Training: 100%|████████████████████████████| 163/163 [00:27<00:00,
5.86it/s, loss=0.0162]
Evaluating:
100%|███████████████████████████████████████| 1/1
[00:00<00:00, 2.65it/s]
Train Loss: 0.0477, Train Acc: 0.9816
Val Loss: 0.5186, Val Acc: 0.8750, Val AUC: 1.0000

Epoch 13/15

Training: 100%|████████████████████████████| 163/163 [00:27<00:00,
5.86it/s, loss=0.00431]

Evaluating:

100%|██| 1/1
[00:00<00:00, 2.60it/s]
Train Loss: 0.0503, Train Acc: 0.9810
Val Loss: 0.2264, Val Acc: 0.9375, Val AUC: 1.0000

Epoch 14/15

Training: 100%|████████████████████████████████| 163/163 [00:27<00:00,
5.84it/s, loss=0.00353]
Evaluating:
100%|██| 1/1
[00:00<00:00, 2.71it/s]
Train Loss: 0.0448, Train Acc: 0.9831
Val Loss: 0.2577, Val Acc: 0.9375, Val AUC: 1.0000

Epoch 15/15

Training: 100%|████████████████████████████████| 163/163 [00:27<00:00,
5.93it/s, loss=0.0078]
Evaluating:
100%|██| 1/1
[00:00<00:00, 2.69it/s]
Train Loss: 0.0393, Train Acc: 0.9849
Val Loss: 0.1028, Val Acc: 1.0000, Val AUC: 1.0000

Best Validation AUC: 1.0000

Stage 1 model saved to models/efficientnet_b0_stage1.pth

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STAGE 3: Progressive Unfreezing - Stage 2
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Unfrozen last 50 layers
Trainable parameters: 3,296,706

Training stage: stage_2
Epochs: 15, Learning rate: 1e-05

Epoch 1/15

Training: 100%|███████████████████████████████| 163/163 [00:27<00:00, 5.91it/s, loss=0.126]

Evaluating:

100%|██| 1/1 [00:00<00:00, 2.76it/s]

Train Loss: 0.0399, Train Acc: 0.9854

Val Loss: 0.1354, Val Acc: 0.9375, Val AUC: 1.0000

Epoch 2/15

Training: 100%|███████████████████████████████| 163/163 [00:26<00:00, 6.12it/s, loss=0.0922]

Evaluating:

100%|██| 1/1 [00:00<00:00, 2.79it/s]

Train Loss: 0.0389, Train Acc: 0.9868

Val Loss: 0.1628, Val Acc: 0.9375, Val AUC: 1.0000

Epoch 3/15

Training: 100%|███████████████████████████████| 163/163 [00:26<00:00, 6.09it/s, loss=0.0872]

Evaluating:

100%|██| 1/1 [00:00<00:00, 2.89it/s]

Train Loss: 0.0331, Train Acc: 0.9873

Val Loss: 0.1821, Val Acc: 0.9375, Val AUC: 1.0000

Epoch 4/15

Training: 100%|███████████████████████████████| 163/163 [00:26<00:00, 6.06it/s, loss=0.0344]

Evaluating:

100%|██| 1/1 [00:00<00:00, 2.89it/s]

Train Loss: 0.0297, Train Acc: 0.9881

Val Loss: 0.1531, Val Acc: 1.0000, Val AUC: 1.0000

Epoch 5/15

Training: 100%|███████████████████████████████| 163/163 [00:26<00:00, 6.14it/s, loss=0.0105]

Evaluating:
100%|███| 1/1
[00:00<00:00, 2.86it/s]
Train Loss: 0.0336, Train Acc: 0.9872
Val Loss: 0.2278, Val Acc: 0.8750, Val AUC: 1.0000

Epoch 6/15

Training: 100%|████████████████████████████████████| 163/163 [00:26<00:00,
6.11it/s, loss=0.0091]
Evaluating:
100%|███| 1/1
[00:00<00:00, 2.88it/s]
Train Loss: 0.0311, Train Acc: 0.9887
Val Loss: 0.2167, Val Acc: 0.8750, Val AUC: 1.0000
Early stopping triggered at epoch 6

Best Validation AUC: 1.0000

Final model saved to models/efficientnet_b0_final.pth

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FINAL EVALUATION ON TEST SET
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Evaluating: 100%|██|
20/20 [00:03<00:00, 6.13it/s]

Test Metrics:
 loss: 0.8335
 accuracy: 0.8029
 auc: 0.9761
 f1_score: 0.8635
 precision: 0.7613
 recall: 0.9974
 sensitivity: 0.9974
 specificity: 0.4786

Results saved to results/efficientnet_b0_test_results.txt

Training completed successfully!