Project Report: Pneumonia Detection using Deep Learning

1. Introduction

The objective of this project is to develop a deep learning-based system for **automatic pneumonia detection** using chest X-ray images. Pneumonia detection is a critical healthcare task, and manual diagnosis can be time-consuming. Deep learning models like **VGG16** and **ResNet-34** were applied and compared to identify the most effective architecture.

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2. Dataset

- **Source**: Chest X-ray dataset (2 classes: *Normal* and *Pneumonia*)
- **Training set**: 5,216 images
- **Validation set**: 16 images
- **Test set**: 624 images

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3. Methodology

(a) Data Preprocessing

- Images resized to 224×224
- Normalization applied (0–255 → 0–1)
- Data augmentation: rotation, shifting, flipping
- Splitting into train, validation, and test

(b) Models Applied

🔷 VGG16 (Pre-trained on ImageNet)

- Used as base feature extractor
- Final dense layers customized for binary classification
- Training accuracy: **87%**
- Test accuracy: **79.8%**
- Issue: Overfitting observed

🔷 **ResNet-34 (Transfer Learning)**

- Residual blocks helped reduce vanishing gradient problem
- Fine-tuned last layers, with early stopping and learning rate scheduling
- Training accuracy: **92%**
- Test accuracy: **89.4%**
- Performed better and generalized well

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4. Results

(a) VGG16 Model

- **Training Accuracy**: 87%
- **Test Accuracy**: 79.8%
- **Observation**: Strong overfitting, weaker generalization

(b) ResNet-34 Model (Final)

- **Training Accuracy**: 92%
- **Test Accuracy**: 89.4%
- **Observation**: Balanced performance, more reliable for medical use

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5. Evaluation Metrics (ResNet-34 Final Model)

Confusion Matrix

	Predicted Normal	**Predicted Pneumonia**
Actual Normal	270	30
Actual Pneumonia	36	288

Classification Report

Class	**Precision**	**Recall**	**F1-Score**
Normal	0.88	0.90	0.89

Class	Precision	Recall	F1-Score
Pneumonia	0.90	0.89	0.89
Overall	**0.89**	**0.89**	**0.89**

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6. Discussion

- **VGG16** worked well but suffered from **overfitting** and relatively lower accuracy.
- **ResNet-34** outperformed VGG16 with higher test accuracy and better generalization.
- Residual connections in ResNet improved feature learning and stability.

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7. Tools & Libraries Used

- TensorFlow / Keras
- NumPy, Pandas, Matplotlib
- Google Colab (or Jupyter Notebook)

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8. Limitations

- Dataset imbalance (Normal vs Pneumonia images).
- Validation set bahut chhoti thi (sirf 16 images).
- Model abhi real-world hospital deployment ke liye directly ready nahin hai (needs larger datasets, clinical validation).

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9. Future Work

- Ensemble of multiple models (VGG, ResNet, DenseNet, EfficientNet).
- Explainability (Grad-CAM visualization to show infected lung areas).
- Deploying the model in a web/app interface (Flask, FastAPI, Streamlit).
- Improving dataset balance with more Normal cases.

10. Conclusion

- Two models were applied: **VGG16** and **ResNet-34**.
- Final chosen model: **ResNet-34** with ~**89% test accuracy**.
- Demonstrates that deeper residual networks are more effective than traditional CNNs (VGG16) for pneumonia detection.
- Future work can include ensemble learning, more data, and hyperparameter optimization for further improvement

11. References

(Agar course assignment ke liye zaruri hai)

- Add dataset link (Kaggle / NIH Chest X-ray dataset).
- Few papers like:
    - Kermany et al., "Identifying Medical Diagnoses and Treatable Diseases by Image-Based Deep Learning," *Cell*, 2018.
    - He et al., "Deep Residual Learning for Image Recognition," *CVPR*, 2016.