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Report on

"CNN-Based Object Detection for Pneumonia Detection in Chest X-ray Image"

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DEPARTMENT OF ARTIFICIAL INTELLIGENCE & DATA SCIENCE

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CERTIFICATE

This is to certify that the report entitled **"_" submitted by** student_____ is a record of work carried out by him/her, in partial fulfillment of requirement for Third Year of Engineering AI-DS at AISSMS IOIT Pune 411001. This work is done during the academic year 2024-2025, under our guidance.

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Flow of Report

Title page/Certificate/Acknowledgement
Index
Abstract
Hardware /Software Requirement
Methodology
Modules
Working **Features** **Test Cases** **Advantages/Limitation** **Future Scope** **Conclusion** **References**

ABSTRACT

Pneumonia is a serious lung infection that can lead to severe health complications if not diagnosed and treated on time. Chest X-ray analysis is one of the primary diagnostic tools used by radiologists to detect pneumonia. However, manual interpretation of X-rays can be subjective and prone to errors.

This project aims to develop a deep learning-based Convolutional Neural Network (CNN) model to automatically detect pneumonia from chest X-ray images. By leveraging CNN architectures, the model efficiently extracts meaningful features from medical images and classifies them as normal or pneumonia-affected. The project makes use of the Chest X-ray Pneumonia dataset from Kaggle to train and evaluate the model.

Using data augmentation, transfer learning techniques, and fine-tuning, we optimize the CNN model to improve classification accuracy. The final model can be integrated into a web or mobile-based healthcare application, assisting medical professionals in faster and more accurate diagnosis of pneumonia.

Hardware /Software Requirement

Hardware Requirements:

- Processor: Intel Core i5/i7 or higher (for better processing speed)
- RAM: Minimum 8GB (Recommended 16GB)
- GPU: NVIDIA GPU with CUDA support (for accelerated deep learning training)
- Storage: Minimum 10GB free space for dataset and model storage

Software Requirements:

- Operating System: Windows, Linux, or macOS
- Programming Language: Python 3.x
- Libraries Used: TensorFlow, Keras, OpenCV, Matplotlib, Seaborn, NumPy, Pandas
- IDE: Google Colab / Jupyter Notebook
- Dataset: Kaggle’s Chest X-ray Pneumonia Dataset

Methodology

The project follows a structured **deep learning pipeline** to achieve pneumonia detection:

1. **Data Collection:** The dataset is downloaded from Kaggle and consists of labeled chest X-ray images classified into two categories:
    - **Normal (Healthy Lungs)**
    - **Pneumonia (Infected Lungs)**
2. **Data Preprocessing:**
    - Images are **resized to 150x150 pixels** for consistency.
    - **Normalization** is applied by scaling pixel values between 0 and 1.
    - **Data Augmentation** techniques (rotation, flipping, zooming) are used to enhance model generalization.
3. **CNN Model Design:**
    - A **Convolutional Neural Network (CNN)** with multiple layers of convolution, max pooling, dropout, and dense layers is built.
    - The model is trained using **binary cross-entropy loss and Adam optimizer**.
4. **Model Training & Evaluation:**
    - The dataset is split into **training, validation, and testing sets**.
    - The model's performance is evaluated using **accuracy, precision, recall, F1-score, and confusion matrix**.

Modules

The project is divided into several key modules:

1. **Data Loading and Preprocessing Module:**
    - Reads the dataset from the directory.
    - Resizes, normalizes, and augments the images.
2. **CNN Model Training Module:**
    - Defines the architecture of the CNN.
    - Trains the model on the dataset using TensorFlow/Keras.
3. **Evaluation Module:**
    - Tests the model using unseen data.
    - Generates evaluation metrics to assess performance.
4. **Prediction Module:**
    - Takes an input chest X-ray image.
    - Outputs a classification result: **Normal or Pneumonia**.

Working

1. The dataset is downloaded and extracted from Kaggle.
2. The images are preprocessed (resized, normalized, and augmented).
3. A CNN model is designed with convolutional, pooling, and fully connected layers.
4. The model is trained using training and validation data.
5. The trained model is evaluated on a test dataset.
6. A new chest X-ray image is given to the model, which predicts whether the patient has pneumonia or not.

Features

✓ Automated Pneumonia Detection – Reduces dependency on manual interpretation.
✓ Deep Learning-Based Approach – More accurate than traditional methods.
✓ Data Augmentation – Improves model generalization on unseen images.
✓ Transfer Learning Support – Can integrate with pretrained models like VGG16 or ResNet.
✓ Scalability – Can be extended for use in hospitals and healthcare applications.

Test Cases

Test Case	Input	Expected Output	Actual Output
Normal Chest X-ray	**Healthy X-ray**	**"Normal"**	**"Normal"**
Pneumonia Chest X-ray	**Infected X-ray**	**"Pneumonia"**	**"Pneumonia"**
Non-X-ray Image	**Random Image**	**Error Message**	**Error Message**

Advantages & Limitation

Advantages -

- Automates pneumonia detection and assists medical professionals.
- Deep learning-based approach provides high accuracy.
- Scalable for mobile and cloud deployment.

Limitations -

- High dependency on dataset quality for reliable performance.
- Requires GPU for faster training.

Future Scope

- **Pretrained Models:** Improve accuracy using **VGG16, ResNet, or Inception**.
- **Multi-Class Classification:** Extend to detect **other lung diseases**.
- **Mobile Integration:** Develop an **AI-powered healthcare mobile app**.
- **Cloud Deployment:** Make the model accessible on **Google Cloud or AWS**.

Conclusion

This project successfully demonstrates how CNN-based deep learning models can be leveraged for pneumonia detection using chest X-ray images. The model achieves high accuracy through data augmentation and fine-tuning. Future advancements could integrate mobile-based AI diagnostics and real-time cloud processing, making AI-driven pneumonia detection more accessible to healthcare professionals worldwide.

References

- **Kaggle Dataset:** Chest X-ray Pneumonia
- TensorFlow & Keras Documentation
- Research papers on AI in Medical Imaging