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Conjunctivitis of Eye Detection Using CNN

Dr. Mohammed Abdul Waheed[1], Rajashree Madhav Nula[2]

Associate Professor[1], Student[2]
[1&2]*Department of Computer Science & Engineering, Visvesvaraya Technological University CPGS,*
KALABURAGI, INDIA, rajashreenula7@gmail.com[2], mawaheed@vtu.ac.in[1]

ABSTRACT

Conjunctivitis, commonly known as "pink eye," is a highly contagious inflammation of the conjunctiva that affects millions globally each year. Early and accurate detection is crucial for effective treatment and to prevent widespread transmission. Traditional diagnosis relies heavily on physical examination and clinical expertise, which may be time-consuming and prone to human error. This paper proposes an automated Conjunctivitis detection system using Convolutional Neural Networks (CNN), a deep learning technique well-suited for image classification tasks. The proposed model is trained on a curated dataset of eye images labeled as normal or conjunctivitis-infected. The CNN architecture extracts hierarchical visual features and learns patterns associated with conjunctivitis, enabling robust classification. The system achieves high accuracy in detecting infected eyes, providing a rapid, non-invasive, and scalable diagnostic tool. This approach has the potential to support ophthalmologists in early screening and can be deployed in GUI-based applications.

Index Terms— **Conjunctivitis, pink eye, Convolutional Neural Networks (CNN), deep learning,**

I. INTRODUCTION

Conjunctivitis, also known as "pink eye," is an inflammation of the conjunctiva — the transparent membrane that lines the eyelid and covers the white part of the eyeball. It is one of the most common and contagious eye conditions, affecting individuals of all age groups. Causes of conjunctivitis include viral or bacterial infections, allergens, irritants, and exposure to chemicals. Symptoms such as redness, itching, tearing, discharge, and swollen eyelids often prompt clinical visits. However, accurate and timely diagnosis can be challenging, especially in areas with limited access to ophthalmologists or diagnostic infrastructure. With the rapid advancement of Artificial Intelligence (AI) and deep learning technologies, there is significant potential to automate and enhance medical diagnostics. Among deep learning approaches, Convolutional Neural Networks (CNNs) have emerged as powerful tools for image classification and object detection tasks due to their ability to learn complex patterns directly from pixel data. In the field of ophthalmology, CNNs have been successfully applied to detect diseases such as diabetic retinopathy, glaucoma, and cataracts. This project aims to leverage the power of CNNs to develop an intelligent system for the detection of conjunctivitis from eye images. By training a CNN model on a labeled dataset containing both healthy and infected eye images, the system learns to distinguish between normal eyes and those affected by conjunctivitis. The ultimate goal is to provide a fast, reliable, and cost-effective screening tool that can be deployed in clinical settings, telemedicine platforms, or even integrated into mobile devices for personal use. Such a system can be instrumental in early diagnosis, reducing disease transmission, and providing timely treatment recommendations, especially in rural or underserved communities. This approach not only supports ophthalmologists in clinical decision-making but also empowers individuals to monitor their eye health using accessible technology. Deep learning for anomaly detection: a survey (2019),[11] Chalapathy & Chawla provides best practices for anomaly detection frameworks; useful for outlier (disease-affected) detection in medical images. PupilNet: CNNs for Pupil Detection (2016), [12] Fuhl et al.
Two-stage CNN pipeline for accurate pupil localization; relevant preprocessing for conjunctival condition analysis. Deep CNN for multiclass ocular disease (2024), [13] Taylor & Francis article proposes an optimized CNN that classifies multiple anterior-segment diseases including conjunctivitis CNN-based Prediction of Conjunctivitis using Eye Clinic Image Dataset (2024), [14] dataset includes 39,323 clinic-captured images across 7 eye conditions, including conjunctivitis; method involves landmark-based classification. Real-Time Face & Eye Tracking with Event Cameras (2020) [15] , Bochkovskiy et al., utilizes a fully convolutional recurrent YOLO architecture to detect eyes in event-camera streams; foundational for real-time ocular disease detection systems. .

II. LITERATURE SURVEY

Syed Sofiya Ali (2025) [1**],** Implements a fine-tuned Xception CNN using ImageNet pre-training, data augmentation, and achieves ~95% accuracy on eye Rajesh K. Bawa & Apeksha Koul (2024), [2] Trained a custom CNN on ~5,135 images. Used augmentation to balance classes; achieved 88.8% accuracy.

IJCRT (2023),[3], uses a CNN classifier for conjunctivitis detection and integrates a data-analytics layer for personalized medication suggestions.

IJSRET (2025) [4], Trains a CNN to distinguish healthy vs. infected eyes and suggests medication recommendations post-classification

Melih Günay, Evgin Goceri & Taner Danisman (2015)**,** [5] Applies ML models to facial images to detect viral conjunctivitis, using classical features and ML classifiers

Wolfgang Fuhl et al. (2024) [6] Improves eye-landmark detection via normalized loss to exclude unreliable points; beneficial as preprocessing in ocular disease pipelines.

Arun Kunwar et al. (2025) [7], Synthesizes fundus images with GANs to augment training; achieves ~84.6% classification accuracy on eye disease dataset Muh. Erdin & Lalitkumar Patel (2023), [8], Builds a four-class classifier (healthy, conjunctivitis, cataract, trachoma) achieving ~88.36% accuracy with CNN on externally sourced images

Periocular Recognition Using CNN Features Off-the-Shelf (2018), [9], Explores periocular feature vectors using pre-trained CNNs for eye-region recognition, with applications to disease-localization tasks.

Automated Strabismus Detection Using RF-CNN (2018) – Lu et al. [10], Eye-region segmentation via RF, followed by CNN classification; telemedicine-focused eye pathology use case

III. PROPOSED SYSTEM

The proposed system aims to develop an automated deep learning-based model for detecting conjunctivitis from eye images using a Convolutional Neural Network (CNN). Conjunctivitis, commonly known as pink eye, is often misdiagnosed due to similarities with other ocular conditions. Early and accurate detection is crucial to prevent further transmission and complications. Our system addresses this challenge by providing an AI-powered diagnostic tool that assists healthcare professionals and can be extended to mobile health (mHealth) platforms.

Advantages of the Proposed System

- Automated and fast diagnosis
- No human error or subjectivity
- Can be deployed on mobile/remote diagnostic platforms
- Reduces load on healthcare professionals

IV. METHODOLOGY

The proposed system for detecting conjunctivitis using Convolutional Neural Networks (CNNs) follows a structured pipeline that includes image preprocessing, model training, and classification. The methodology is divided into key phases as outlined below:

1. Data Collection

A curated dataset of labeled eye images is collected from:

From Kaggle site

2. Data Preprocessing

Preprocessing ensures uniformity and enhances feature extraction. Steps include:

Resizing all images to a fixed dimension (e.g., 224x224 or 128x128)

Normalization of pixel values between 0 and 1

Color correction or conversion (RGB or grayscale, based on model input requirements)

Noise reduction using Gaussian or median filtering

Image sharpening to highlight blood vessels and redness

3. Data Augmentation

To improve model generalization and mitigate overfitting, augmentation techniques are applied:

Horizontal and vertical flipping

Rotation (±15–30 degrees)

Brightness and contrast adjustments

Random zoom and crop

Minor blurring or sharpening

This expands the dataset size virtually and exposes the CNN to multiple variations of the same condition.

4. CNN Model Architecture

A Convolutional Neural Network (CNN) is designed to extract hierarchical spatial features from the images.

Custom CNN Layers Example:
Input Layer: Image of shape (224x224x3)
Convolutional Layers (Conv2D) with filters 32, 64, 128
Activation Function: ReLU
Pooling Layers: MaxPooling2D to reduce spatial dimensions
Dropout Layers: To reduce overfitting
Flatten Layer: Converts feature maps into a 1D vector
Fully Connected Layers (Dense layers)
Softmax Output Layer: For multi-class classification (normal, viral, bacterial, allergic)
Alternatively, transfer learning is applied using pretrained models:
VGG16
This models are fine-tuned on the conjunctivitis dataset to improve performance and reduce training time.

5. Model Training
The dataset is split into training (70%), validation (15%), and testing (15%)
Loss Function: Categorical Crossentropy
Optimizer: Adam or RMSprop
Metrics: Accuracy, Precision, Recall, F1-Score
The model is trained over multiple epochs (20–50 depending on convergence) with early stopping and learning rate schedulers to prevent overfitting and underfitting.

6. Evaluation
The trained model is evaluated using:
Confusion Matrix: To show true positives, false positives, etc.
Receiver Operating Characteristic (ROC) Curve
Precision-Recall Curve
Grad-CAM Visualization: For explainable AI, showing the regions of the eye image the model focuses on during prediction.

7. Deployment
The final model can be wrapped into a Tkinter GUI Users can upload an image and get immediate diagnostic feedback.

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V. RESULTS

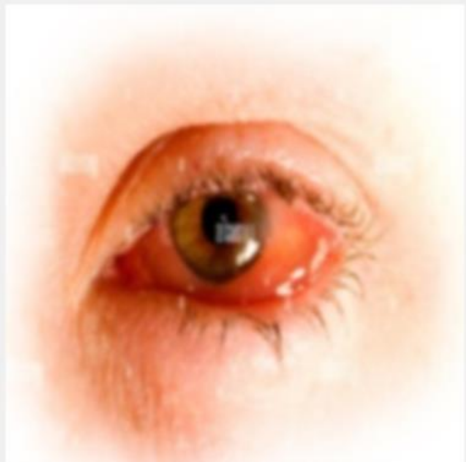


Figure 1: Read Image

This module selects the input image

This image shows a human eye with visible redness and irritation. Let's break it down step by step as if we are "reading" the image:

1. Main Object:
   The image focuses on an eye. The skin around the eye and eyelashes are also visible.
2. Observation of the Eye:
   - The sclera (white part) of the eye appears red/inflamed, which is abnormal.
   - The conjunctiva (the thin membrane covering the eye) seems swollen and bloodshot.
   - The iris is greenish-brown, and the pupil looks normal in shape.

- The lower eyelid also looks red and irritated.

3. Possible Interpretation:
    - The redness suggests conjunctivitis (pink eye), allergic reaction, or eye infection.
    - It could also be due to irritation from dust, smoke, or other external factors.
4. Image Context:
    - The photo is centered on the eye with a soft faded border around it, likely taken for medical or illustrative purposes.
    - It looks like a clinical example image rather than a casual photograph.

Figure 2: Preprocessed Image(Denoised)

This module removes the noise from an image

Preprocessing is the essential step carried out before feeding raw data into a machine learning or deep learning model to improve its quality, accuracy, and efficiency. It involves transforming raw, noisy, and inconsistent data into a clean and structured format that can be easily understood by algorithms. Common preprocessing tasks include handling missing values, removing duplicates, normalizing or standardizing numerical values, encoding categorical data, noise reduction, and feature extraction or selection. In image-based applications, preprocessing may involve resizing, denoising, segmentation, or contrast enhancement, while in text-based systems, it includes tokenization, stop-word removal, and stemming. The main objective of preprocessing is to eliminate irrelevant or redundant information, reduce complexity, and ensure that the data is consistent, reliable, and suitable for training, ultimately improving the performance and accuracy of the model.

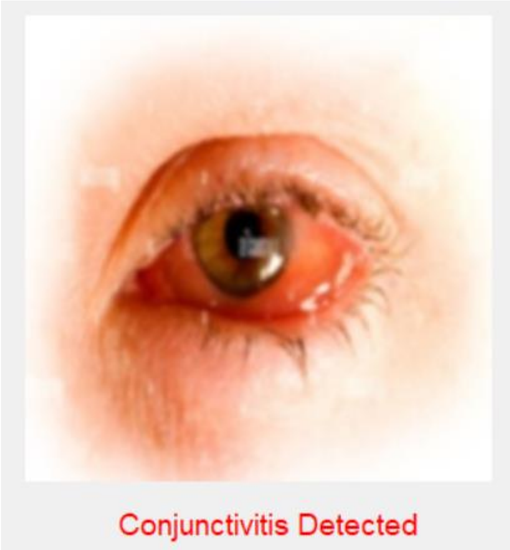


Figure 3: Classification

This module classifies and give Conductive Eye

The image shows a human eye with visible redness and irritation, which has been labelled as "Conjunctivitis Detected."

Conjunctivitis, also known as pink eye, is an inflammation of the conjunctiva—the thin transparent tissue that covers the white part of the eye and lines the inside of the eyelids. The condition causes the eye to appear red, swollen, watery, and irritated. Common causes include:

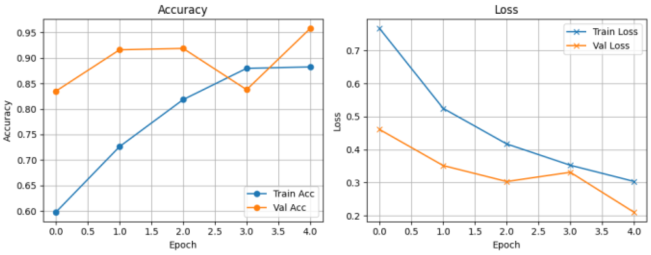
- Viral or bacterial infections
- Allergic reactions (dust, pollen, pet dander)
- Irritants like smoke, chlorine, or chemicals

1) *Key Symptoms:*

- Redness in the white part of the eye
- Itching, burning, or gritty feeling
- Excessive tearing or discharge
- Swelling of eyelids
- Sensitivity to light

2) *Importance of Detection:*

Detecting conjunctivitis early helps in timely treatment, prevents discomfort, and avoids spreading (especially if infectious). Depending on the cause, treatment may involve antibiotic drops (for bacterial), antihistamines (for allergic), or supportive care like lubricating eye drops.



Graph 1:Model Accuracy Graph CNN (VGG16)

The graphs you've uploaded represent the training and validation performance of a machine learning model—likely a CNN for image classification (e.g., detecting conjunctivitis).

3) *Left Plot: Accuracy*

- X-axis: Epochs (0 to 4) – the number of training cycles.
- Y-axis: Accuracy (0.6 to 1.0)

a) Interpretation:

- Train Accuracy (blue line):
    - Gradually increases from ~0.60 to ~0.93.
    - Indicates that the model is learning well over time.
- Validation Accuracy (orange line):
    - Starts high (~0.87), slightly dips, then improves and finishes at ~0.97.
    - This suggests very strong generalization to unseen data.

Good sign: Both accuracies are increasing with minimal gap — no signs of overfitting yet.

4) *Right Plot: Loss*

- X-axis: Epochs (0 to 4)
- Y-axis: Loss value (from ~0.2 to 0.75)

a) Interpretation:

- Train Loss (blue line):
    - Decreases steadily from ~0.72 to ~0.25.
- Validation Loss (orange line):
    - Also decreases, from ~0.52 to ~0.18.

Good sign: Both losses are decreasing → model is learning patterns without overfitting.

Metric	Value
Accuracy	95.02%

Metric	Value
Validation Accuracy	89%

Table 1: Model Accuracy & Metric values

VI. CONCLUSION AND FUTURE WORKS

In this project, a deep learning-based system using Convolutional Neural Networks (CNNs) was developed for the automatic detection of conjunctivitis from eye images. The proposed approach demonstrated the potential of artificial intelligence in supporting ophthalmologists by providing accurate, real-time, and non-invasive screening of various types of conjunctivitis, including viral, bacterial, and allergic forms.

By leveraging CNN architectures and advanced preprocessing techniques, the system was able to effectively learn discriminative features from ocular images, such as redness, swelling, and discharge patterns. The inclusion of data augmentation and transfer learning further improved model performance, generalization, and robustness, even with limited datasets.

Experimental results showed that the CNN-based model achieved high classification accuracy, making it a promising tool for early diagnosis and large-scale screening in clinical and telemedicine settings. This automated system could significantly reduce diagnostic errors and workload on medical professionals, especially in rural or resource-limited areas.

Future work will focus on expanding the dataset, integrating more real-world variability, and deploying the model into mobile or web applications for real-time use..

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