# Diagnosis of Conjunctivitis using Artificial Intelligence

**Final Year Project**

**Session 2021-2025**

A project submitted in partial fulfillment of the degree of

BS in Computer Science

Department of Computer Science

Faculty of Computer Science & Information Technology

The Superior University, Lahore

Fall 2024

| | | | | |
|---|---|---|---|---|
| Type (Nature of project) | [] **D**evelopment [✓] **R**esearch [] **R&D** | | | |
| Area of specialization | Artificial Intelligence (AI) | | | |
| FYP ID | FYP-BCSM-S24-001 | | | |
| **Project Group Members** | | | | |
| Sr.# | Reg. # | Student Name | Email ID | *Signature |
| (i) | BCSM-S21-025 | Bilal Muhammad Faiz | bcsm-s21-025@superior.edu.pk | |
| (ii) | BCSM-S21-045 | Muhammad Ans | bcsm-s21-045@superior.edu.pk | |
| (iii) | BCSM-S21-004 | Muhammad Asim | bcsm-s21-004@superior.edu.pk | |

*The candidates confirm that the work submitted is their own and appropriate credit has been given where reference has been made to work of others

## Plagiarism Free Certificate

This is to certify that, I Bilal Muhammad Faiz S/D of Faiz Ahmad, group leader of FYP under registration no FYP-BCSM-S24-001 at Computer Science Department, The Superior University, Lahore. I declare that my FYP report is checked by my supervisor.

Date: ________________

Name of Group Leader: Bilal Faiz Signature: _____________

Name of Supervisor: Neha Zulfiqar

Designation: Lecturer

Signature: ________________

Co-Supervisor:

Designation:

Signature: _________________

HoD: Dr. Muhammad Azam Signature: _______________

# Diagnosis of Conjunctivitis using Artificial Intelligence

## Change Record

| Author(s) | Version | Date | Notes | Supervisor's Signature |
|---|---|---|---|---|
| Bilal Faiz<br>M.Ans<br>M.Asim | 1.0 | 02-09-2024 | Start working on Approved Project | |
| Bilal Faiz<br>M.Ans<br>M.Asim | 1.0 | 15-09-2024 | Writing Literature review of 40 papers | |
| Bilal Faiz<br>M.Ans | 1.0 | 05-10-2024 | Implementing Purposed Methodology | |
| M.Ans | 1.0 | 06-11-2024 | Adding and removing content | |
| Bilal Faiz<br>M.Ans<br>M.Asim | 1.0 | 08-11-2024 | Documentation Completed | |

# APPROVAL

---

**PROJECT SUPERVISOR**

Comments: ______________________________________________________________

______________________________________________________________

Name: ______________________________

Date: ______________________________ Signature: __________________________

---

**PROJECT MANAGER**

Comments: ______________________________________________________________

______________________________________________________________

Date: ______________________________ Signature: __________________________

**HEAD OF THE DEPARTMENT**

Comments: ______________________________________________________________

______________________________________________________________

Date: ______________________________ Signature: __________________________

# Dedication

***Dedicated***

***to***

***ALLAH almighty***

***Our Beloved Parents,***

***Whose prayers are always with us***

***To Our Families, Friends***

***And***

***Our Teachers***

***with Great Respect, Love and Admiration***

# Acknowledgements

First and foremost, we are thankful to our **Allah (Subhana Wataala)** for endowing us with health, patience, and knowledge to complete this work. Without His Blessings we would not be able to do anything.

During the course of this work, we have been fortunate to receive help, guidance and critical advice from a number of experienced and kind people. First of all, we owe our gratitude sincere thanks to our supervisor **Miss Neha Zulfiqar** whose knowledge and experience, we have freely utilized. We are deeply grateful for his vital instructions and intellectual guidance in the accomplishment of proposed research work.

Last but not least we would like to thanks our families for their constant support, unceasing prayers, and dedication throughout our academic career. Without them, we would never have made it this far. We are deeply indebted to them.

# Table of Contents

## Contents

# List of Figures

# List of Tables

# Abstract

Conjunctivitis, also known as pink eye, is a highly contagious ocular disease that affects millions of people. An inflammation or infection of the conjunctiva causes redness and discomfort in the eye region. To prevent the spread of infectious eye diseases and enable early detection for patients in remote areas, recent studies has concentrated on developing deep learning models for eye disease diagnosis. First, we conducted an in-depth review of past studies, highlighting important issues such class imbalance and small datasets. We created a balanced dataset of 1,600 images and used data augmentation techniques to get around these problems. multi-layered deep CNN frameworks VGG16 and Resnet50 was tuned for transferring the learning process. The input images are fed into both VGG16 and ResNet50 in the hybrid model so that distinct but complementary features can be extracted simultaneously. The outputs of each model are then flattened and stacked together after the feature extraction process is complete, then creating a single feature vector that includes both heavy structures and fine details. The unified feature vector is then forwarded through the dense layer of 1024 neurons, where classification takes place as the model composes and processes the given information towards the last conclusion. Our hybrid model, which concatenate the features of the VGG16 and ResNet50, efficiently diagnosed and classified viral, bacterial, and allergic conjunctivitis with an impressive 93.44% accuracy rate.

# Chapter-1
# **Introduction**

## 1.0. Introduction

Conjunctivitis, formerly referred to as "pink eye," can be distinguished by an inflammatory layer covering the lining of the eye, which is a thin, transparent layer, and the sclera, or white portion of the eye. The vast majority of those affected by this ailment are in the general population's age range, yet some persons are also more vulnerable to specific ocular problems. Conjunctivitis is frequently categorized according to its cause; in addition to allergies, bacterial and viral infections (Sindhuja et al., 2020). A person's quality of life may be detrimentally affected by ocular problems. They include pain, drooling, red eyes, soreness, and copious tears and require scientific guidance. Conjunctivitis is also infectious since it is caused by fluids that have the potential to irritate the eyes. In order to occur, Various preventive measures are needed to reduce its spread in the population.

From a cause-and-effect perspective, eye disease is a serious public health issue that needs to be addressed. Comprehensive control measures to minimize the effects on humans and reduce the overall levels of the affected person (Khairallah & Kahloun, 2013). The use of traditional methods for the diagnosis of ophthalmic disease is based on clinical subjectivity attention, which can lead to wrong prediction. This is especially difficult in areas where it is difficult to communicate with medical specialists. Opticians continue to be in short supply in Pakistan, potentially leading to delays in diagnosis and treatment of people with eye diseases (Sindhuja et al., 2020). And with machine learning (AI) algorithms, the treatment of eye diseases could change dramatically the medical profession. Intelligent methods are capable of rapid and accurate diagnosis. Ophthalmology detects abnormalities by scanning eye images. This can increase early patient care and reduce stress for physicians, especially in rural areas (Pepose et al., 2020).

## 1.1. Symptoms of Conjunctivitis

Pink eye disease, having a wide range of symptoms. One- or two-sided ocular redness, together with plenty of watery pus and an uneasiness of an unknown body inside the eye, are frequently symptoms of viral conjunctivitis. Alternately, bacterial conjunctivitis has comparable clinical elements, including visual redness and watery release, yet may likewise appear with side effects like dry eyes and queasiness, especially after waking in the first part of the day (Azari & Barney, 2013). Besides, unfavorably susceptible conjunctivitis, originating from invulnerable framework excessive touchiness to allergens, inspires particular side effects like reciprocal visual tingling, tearing, and conjunctival irritation, frequently joined by nasal blockage and ulceration (Bielory et al., 2021). Besides, in intense instances of conjunctivitis, patients might encounter unexpected confusions, for example, obscured vision, eye torment, and elevated aversion to light (photophobia), requiring brief clinical consideration and mediation to alleviate visual distress and forestall further sequelae (Wong et al., 2020). Through a far-reaching comprehension of the fluctuated clinical introductions related with conjunctivitis, medical care suppliers can really perceive between various etiologies and execute fitting remedial measures to streamline patient results and reduce visual side effects (Bielory et al., 2021; Wong et al. 2020).

- Eye redness and a gritty sensation (Sindhuja et al., 2020)
- Itching (Azari & Barney, 2013)
- That can frame a hull on the eyelashes in the night is released (Azari & Barney, 2013)
- Watery discharge (Sheikh et al, 2012)
- Burning sensation (Sheikh et al., 2012)
- Eyelid edema(swelling) (Bielory et al., 2021)
- Conjunctival injection (redness of the white part of the eye) (Bielory et al., 2021)

## 1.2. Types of Pink eye

Viral conjunctivitis, stands out as a highly infectious eye disorder caused by a variety of viruses including adenovirus, herpes simplex virus (HSV), and enterovirus. This condition mainly targets children and adolescents in areas of close human contact and poor hygiene practices. Finding fertile ground for infection, such as schools and day care centers, as the infection is easily transmitted in such areas emphasizes the importance of strong infection prevention and early intervention strategies (Azari & Barney, 2013). Symptoms of viral conjunctivitis usually include severe redness of the eyes, excessive watery discharge, and a sensation of foreign bodies entering the eye Photophobia or sensitivity to light is common include these symptoms, and mild discomfort (Sindhuja et al., 2020). Although viral eye infections usually follow their limited course, i.e. they resolve themselves in time though associated symptoms can significantly impair daily functioning and quality of life in such cases judicious use of compression medications can achieve relief of the disease, reduce harm and encourage treatment to identify community members. Timely diagnosis and appropriate intervention are essential to prevent its spread and reduce the negative impact on affected individuals (Azari & Barney, 2013).

**Figure. 1.** Viral Conjunctivitis (Tabuchi et al. 2020)

Bacterial conjunctivitis, the most common eye infection, is caused by the spread of pathogens such as Staphylococcus aureus, Streptococcus pneumoniae, and Hemophilus influenzae. Although it can affect individuals of any age, it lies has been more common in young children and the elderly, especially those with underlying medical conditions or compromised immune systems. Clinical diagnosis of unilateral or accompanied viral swallowing and yellowing of the eyes bilateral, with symptoms of drooling, dry eyes, constipation(Azari & Barney, 2013). Most noticeable on waking in the morning. These symptoms not only cause trouble but pose a risk of it will spread the infection to others, emphasizing the importance of early diagnosis and treatment Methoprim , represents the cornerstone of management of infectious ophthalmology, provides effective relief from symptoms, reducing the risk of complications and targeting the underlying bacterial infections, these drugs help to relieve symptoms faster and promote eye health again. Furthermore, judicious use helps prevent the spread of infection in the community, thus protecting public health (Sheikh et al., 2012).

**Figure. 2.** Bacterial Conjunctivitis (Bobade et al., 2023)

Allergic eye disease, autoimmune conditions, is caused by many allergens including pollen, pet dander, dust mites, and certain wears respiratory irritation (Bielory et al., 2021). Although these allergens stimulate an inflammatory response in sensitive individuals, allergic eye disease may manifest in the unconscious human even allergies Characterized by ophthalmology, and allergic conjunctivitis manifests symptoms, with pain, tears, conjunctivitis, nasal congestion, sneezing, constipation even included. These symptoms reflect the complex interaction of the eye and respiratory systems during allergen exposure, often compromise quality of life , and require medical intervention (Akram et al., 2012). Treatment strategies approaches to ocular allergies revolve primarily around avoidance of cataracts and symptom reduction, with topical anticonvulsants emerging as the cornerstone of management. Intervention with known allergens Targeted reduction strategies play an important role in preventing severe symptoms and preserving eye health in those who within the complex. Through a comprehensive approach that includes pharmacological and environmental interventions, health care providers seek to improve patient outcomes and enhance their overall well-being (Wong et al., 2020).

**Figure. 3.** Allergic Conjunctivitis (Akram et al., 2020)

**Table 1.** Types of Conjunctivitis, their respective symptoms and sub-types

| **Disease** | **Symptoms** | **Sub-Types** |
|---|---|---|
| Viral Conjunctivitis (Sindhuja et al., 2020) | Redness, Watery Discharge, Mild Discomfort, Sensitivity to light | Adenoviral, Enteroviral Conjunctivitis, herpes simplex virus (HSV), |
| Bacterial Conjunctivitis (Sheikh et al., 2012) | drooling, dry eyes, constipation Eyelid edema, Follicles | Hyperacute Bacterial, Acute Bacterial, Chronic Bacterial |
| Allergic Conjunctivitis (Wong et al., 2020) | Pain tears, Nasal Congestion, Sneezing, Constipation | Seasonal Allergic Conjunctivitis, Perennial Allergic Conjunctivitis, Vernal Keratoconjunctivitis, Atopic Keratoconjunctivitis |

## 1.3. Ratio of Disease

Adenoviruses are extremely infectious, so an estimated 20 million Americans are infected each year. Significant data from Pakistan (75%), Turkey (44%), China (39.8%) and Turkey (44%) further support these high rates. On September 28, 2023, an epidemic of adenovirus ophthalmopathy occurred in Pakistan, affecting 86,133 people, mostly in Punjab province, with an average of 13,000 cases per day (Idrees et al., 2024).

According to another study, people who migrated to rural areas were more likely to develop infectious eye diseases than those living in urban areas. Studies in Mongolia revealed that 9.3% of urban residents had inflammatory eye diseases make it hot, while 12.9% of rural people have allergic eye diseases added by infection or allergy further in Nigerian study That's the result. The value of Pakistan's air index is falling sharply, increasing the level of ambient air pollutants. To address this issue, the present study set out to determine the prevalence of acne and viral ocular infections. A better understanding of the prevalence of eye disease in Pakistan will enhance health outcomes in the future, which this study will facilitate (Jandan et al., 2022).

There's no data related to the number of doctors that can treat conjunctivitis in Pakistan. Mostly ophthalmologists and general practitioners' diagnosis and treat conjunctivitis. In Karachi, Oladoc.com lists 363 opticians. These doctors include ophthalmologists and physicians who are able to diagnose and manage the condition. Patients can view information about these physicians on the web, which often includes their qualifications, experience, areas of expertise, and patient reviews This information can help patients make informed decisions when choosing an optometrist. Similarly, in Lahore, Oladoc.com has 202 ophthalmologists. These doctors offer a range of services from initial diagnosis to routine management to follow-up care. Patients can use the platform to find a doctor that meets their specific needs and preferences, such as location, availability and expertise (Idrees et al., 2024).

## 1.4. How People Get Infected

The effect of visual infection penetrates different segment gatherings, influencing people of any age and familial foundations. Among these populaces, youngsters and youths arise as especially weak companions, lopsidedly powerless to viral visual contaminations, particularly in public conditions, for example, schools and day care focuses, where close relational contact works with illness transmission (Chen et al., 2023). On the other hand, bacterial conjunctivitis will in general burden more seasoned age gatherings, but with a striking commonness among small kids and more seasoned grown-ups, especially those holding onto hidden ailments or compromised resistant frameworks (Han et al., 2022). Besides, unfavorably susceptible conjunctivitis represents a particular test, dominatingly burdening people with a background marked by hypersensitive rhinitis or atopic dermatitis. Late examinations have revealed insight into the clinical indications and remedial results of hypersensitive conjunctivitis, especially inside the pediatric populace, explaining the elevated gamble of irresistible visual sickness hastened by openness to allergens or aggravations. These experiences highlight the significant effect of visual sickness on individual prosperity and highlight the basic for proactive measures to relieve illness transmission and protect general wellbeing (Zhang et al., 2024).

## 1.5. Preventing Spread of Conjunctivitis

Forestalling the transmission of conjunctivitis requires the execution of tough cleanliness conventions and the minimization of direct contact with tainted visual emissions (Centers for Disease Control and Prevention (CDC), n.d.). Individuals who have been diagnosed as having pink eye syndrome are advised to adhere to strict sanitation practices, such as washing their hands repeatedly with water and a cleaner after getting into touch with something, as this will reduce the risk of the condition spreading. Additionally, those suffering with concealed conjunctival pathology should use common sense and refrain from exchanging personal items like pillows, towels, or eye medications, since they might harbor enticing experts capable of accelerating the transmission of disease. Developing honest hacking and respiratory decorum, for example, utilizing tissues or wearing facial coverings to cover the mouth and nose, fills in as an extra protect against microorganism dispersal, consequently adding to the control of conjunctivitis transmission inside networks. By unfalteringly sticking to these preventive measures, people expect a functioning job in alleviating the spread of conjunctivitis, supporting general wellbeing endeavors to control sickness dispersal (American Academy of Ophthalmology (AAO), n.d.).

The treatment scene for conjunctivitis requires a nuanced approach dependent upon the fundamental etiology, be it bacterial, viral, or hypersensitive in nature. Viral conjunctivitis, normally a self-restricting condition, frequently settle unexpectedly without the requirement for explicit restorative intercessions. Indicative help might be accomplished through the use of cold packs and the wise utilization of greasing up eye drops to lighten visual distress and bothering, working with patient solace during the recuperating system (Azari & Barney, 2013). Alternately, bacterial conjunctivitis warrants more designated administration techniques, frequently requiring the organization of foundational anti-microbials, for example, fluoroquinolones or polymyxin B/trimethoprim as first-line helpful specialists to facilitate goal and moderate the gamble of complexities. Adjunctive measures, including the utilization of cold packs and the instillation of fake tears, act as integral intercessions to mollify side effects and upgrade generally visual wellbeing. It is basic to perceive that compelling ophthalmic administration improves patient distress as well as weakens the probability of illness movement and related sequelae, highlighting the significance of exhaustive helpful methodologies in streamlining patient results (Sheppard & Argüeso, 2021).

## 1.6. Challenges

Conjunctivitis presents a multi-layered exhibit of difficulties that reach out past individual well-being worries to include more extensive cultural and financial ramifications around the world. The monetary repercussions of this condition are twofold, including both direct clinical costs and backhanded costs related to reduced efficiency. Besides, the effect of visual infection reaches out past simple monetary contemplations, fundamentally infringing upon the personal satisfaction and work efficiency of impacted people (Pepose et al., 2020). Such impedances might appear as actual inconveniences and utilitarian constraints, accordingly highlighting the basis for compelling illness in the board systems to mitigate patient anguish and advance word-related execution. Notwithstanding the singular weight, conjunctivitis presents significant difficulties to general well-being, especially in thickly populated regions where contamination anticipation expects foremost significance. Executing severe cleanliness conventions becomes basic to abridge sickness transmission and moderate the gamble of flare-ups inside networks. In any case, in spite of coordinated endeavors to contain the spread of the disease, demonstrative moves endure due to the nuanced clinical introductions related to various conjunctivitis subtypes (Idrees et al., 2024). Precisely recognizing bacterial, viral, and unfavorably susceptible etiologies stays an imposing errand, requiring the mix of cutting-edge symptomatic modalities to improve indicative accuracy and smooth out restorative intercessions. Besides, the potential for inconveniences, for example, corneal ulceration highlights the criticality of opportune intercession and highlights the earnestness of tending to conjunctivitis with an extensive, multi-layered approach. This involves preventive measures and precise analysis as well as the execution of designated helpful procedures pointed toward moderating sickness movement and limiting unfriendly sequelae. By taking on a comprehensive methodology that includes preventive, demonstrative, and restorative features, medical services frameworks can all the more really relieve the weight of visual sickness on both individual patients and the more extensive local area (Sheikh et al., 2012).

## 1.7. Diagnosis of Conjunctivitis

When addressing pink eye (conjunctivitis), the demonstrative approach typically includes a multi-layered assessment comprising a clinical assessment, a thorough evaluation of the patient's medical history, and, when appropriate, subordinate tests aimed at elucidating the hidden etiology to inform tailored administration procedures. Leading a meticulous ophthalmologic evaluation that includes cut light bio microscopy and meticulous visual inspection of ocular surfaces forms the basis of the symptomatic interaction, enabling doctors to identify distinctive features typical of certain conjunctival illnesses (Dawn & Lee, 2004). Obtaining the medical information of the individual is of utmost importance, as it provides valuable insights into potential risk factors, duration of side effects, late ecological openings, and concurrent underlying diseases that may predispose to the formation of visual sickness. When there is a suspected irreversible etiology, a targeted examination of the eye tissues could possibly be recommended in order to identify potentially pathogenic organisms through the application of a precise symptomatic approximation. Furthermore, individuals suffering with hypersensitive conjunctivitis can benefit from sensitivity testing methods, such as skin injury evaluations and specific serologic studies, that have directed toward identifying allergens causing immune-stimulating acute ocular responses. Correlative analytical tests provide valuable insights, but clinical judgment is still essential for placing test results in context and implementing prudent rehabilitative treatments tailored to each patient's needs (Azari & Barney, 2013).

**Table 2.** Different Tests for Diagnosis of Conjunctivitis

| **Type of Conjunctivitis** | **Diagnosis Tests** |
|---|---|
| Viral Conjunctivitis (Dawn & Lee, 2004) | o Eye examination on a clinical basis<br>o Testing of conjunctival swabs with polymerase chain reaction (PCR)<br>o Conjunctival secretions viral culture |
| Bacterial Conjunctivitis (Sheikh et al., 2012) | o Eye examination on a clinical basis<br>o Culture and gram staining of conjunctival discharge<br>o Anti-microbial responsiveness testing |

| | |
|---|---|
| Allergic Conjunctivitis (Azari & Barney, 2013) | o Eye examination on a clinical basis<br>o Testing for allergies, such as a blood or skin prick test<br>o Dietary elimination or assessment of environmental exposure |

## 1.8. Problem Statement

The diagnosis of ophthalmic disorders now relies heavily on the actual examination, which can be elusive and restricted in genetic conditions. In our literature review, we found a recurring issue of class imbalance and model complexity in existing research, which leads to a significant impact on model performance and an enhanced accuracy metric which is often too appropriate.

The uneven distribution of studies in the training and evaluation data sets is the main cause of these issues. Class imbalances distort the learning process, causing models to prioritize available classes and ignore poorly represented classes, resulting in an artificially high accuracy of training however not generalizable in the absence of new models This implies a clear overfitting and leads to erroneous predictions.

Our intention is to deal with class imbalances in our framework using customized methods and to give the framework the ability to efficiently identify complex patterns in datasets and thus target them to increase algorithm robustness on different datasets and to improve the reliability and variability of our methods in real-world scenarios.

## 1.9. Objective

- The study aims to develop a comprehensive literature of diagnosis of conjunctivitis.
- The model is designed to accurately predict difference between  conjunctivitis affected eyes and healthy eyes.
- This study deals with class imbalances in our framework using customized methods and to give the framework the ability to efficiently identify complex patterns in datasets
- An appropriate dataset of different types of conjunctivitis and Deep Learning algorithm is used to train a model.
- The model will be prepared to perceive explicit visual circumstances like viral conjunctivitis, bacterial conjunctivitis, and allergic conjunctivitis.

## 1.10. Why we need AI based model

In the present information driven world, the meaning of artificial intelligence-based models couldn't possibly be more significant, basically because of their ability to productively deal with huge volumes of information and create reactions that imitate human perception (Soysa & De Silva, 2020). With ongoing progressions in simulated intelligence advancements, especially in profound learning and regular language handling, these models have become adroit at fathoming and dissecting many-sided information structures, in this manner upsetting different ventures (Tamuli et al., 2015). In the space of pink eye illness research, the coordination of computer-based intelligence-based models, especially profound learning calculations like ResNet-50 and VGG-16, accepts basic significance attributable to their capacity to precisely dissect different visual pictures with wonderful accuracy (Mukherjee et al., 2021). By saddling these high-level artificial intelligence models, medical care suppliers can smooth out the screening system, improve symptomatic precision, and lighten the responsibility trouble on ophthalmology subject matter experts, especially in locales where admittance to eye care administrations is restricted (AKRAM & DEBNATH, 2020). Besides, utilizing a dataset containing 1400 carefully organized pictures of conjunctivitis for preparing and approving man-made intelligence models holds enormous commitment in enlarging their exhibition and materialness, in this way working with the improvement of a vigorous and available demonstrative device for ophthalmic circumstances . This purposeful reconciliation of man-made intelligence innovation in conjunctivitis finding highlights its extraordinary potential in reforming medical services conveyance and working on persistent results (Bobade et al., n.d.).

A huge number of cell phone applications and computerized procedures have arisen for visual finding, utilizing state of the art innovations, for example, convolutional brain organizations (CNNs), support vector machines (SVM), and profound learning. For example, the Eye In addition to application created by (Soysa et al., 2020) used convolutional profound brain organizations to make a noteworthy progress pace of 83.33% in recognizing conjunctivitis, glaucoma, and camera streak impacts (Soysa & De Silva, 2020). Likewise, (Tamuli et al., 2015) concocted a cell phone application utilizing SVM and KNN methods, bragging high exactness's 95% and 85% for visual infection recognition, separately. Moreover, the iConDet Application, created by (Mukherjee et al., 2021), utilized CNNs and EfficientNet to determine eye infections to have a precision of 84%. Extra examinations by (Akram et al., 2020) and (Bobade et al., 2023) utilized procedures incorporating profound convolutional brain organizations (DCNN), SVM, and computerized picture handling (Plunge) strategies, accomplishing exceptional exactness's of 98% and 92.31% for eye sickness discovery, separately (AKRAM & DEBNATH, 2020; Bobade et al., n.d.).

## 1.11. Implementation of Methodology

In this study, we propose a hybrid model for conjunctivitis eye disease diagnosis. In this study we have developed a image dataset for pink eye disease containing data of 1600 images. We apply segmentation using Roboflow which provided advanced tools to identify important regions within the image. In our proposed system input images are fed into both VGG16 and ResNet50 in the hybrid model so that distinct but complementary features can be extracted simultaneously. The outputs of each model are then flattened and stacked together after the feature extraction process is complete. We also apply SoftMax classifier for multiclass classification .

# Chapter-2
# **Literature Review**

## 2.0. Literature Review

Pink eye, formerly referred to as "Conjunctivitis" can be distinguished by an inflammatory layer covering the lining of the eye, which is a thin, transparent layer, and the sclera, or white portion of the eye. Diagnosis of conjunctivitis relies of physical examination of eyes by a medical professional. But recent advancement in the field of Artificial Intelligence and Machine learning is help us to diagnose pink eyes by using deep learning model. In this study we aims to find about the current state of research in this field. For this we analyze multiple papers to gain information about future research directions.

Soysa et al. (2020) purpose the mobile application Eye Plus, used to diagnose conjunctivitis eye disease. The Eye Plus application utilize deep learning models such as convolutional neural network and deep neural network for image feature extraction. Eye Plus utilize Keras libraries to build TensorFlow models which are used to correctly detection of pink eye. The dataset consists of healthy images and images of conjunctivitis infected. By using 150 images examined the pink eye detection app achieves a 83.33% accuracy. Future work, including expanding to meet healthcare requirements in neglected and rural areas.

Mukherjee et al. (2021) fostered the cell phone application iConDet that utilizes profound figuring out how to analyze eye illness. This application utilizes convolutional network (CNNs), profound learning strategies, and EfficientNet for transfer learning. A versatile application interface for catching and handling pictures is important for the framework. To produce the dataset, 150 marked pictures of both sound and infected eyes were gathered from the center and the Web. It must be pre-trained on ImageNet and fine-tuned the target data in order to achieve an accuracy of 84%. The applicability of this tool will be extended beyond two straightforward classifications as further research will examine the severity of ophthalmoplegia and its relationship to COPD.

Akram et al. (2020) A system was developed to detect seven eye conditions by facial image analysis, including trachoma, glaucoma, glaucoma, and ophthalmoplegia to achieve better classification accuracy, the system uses deep diffraction neural networks (DCNN) and support vector machines (SVM) is used. The Dataset collection containing 1,753 photos of disease having resolution of 256x256 which were fetched from various medical sites and pharmacy. In 10-fold validation technique DCNN outscored SVM with an accuracy of 98.79%, sensitivity of 97%, and specificity of 99%. Future developments of the intended system were promising, including the ability to integrate with hardware systems for real-time diagnosis and optimization to meet healthcare needs varieties in underserved rural areas

Bobade et al. (2023) A procedure was made to choose the veritable spot of the eye. Using convolutional mind associations (CNNs), significant learning methodologies, and mechanized picture taking care of (Plunge) techniques through a system expected for the area of eye diseases, the model can distinguish results of a couple of eye conditions recognizable, similar to uveitis, glaucoma, crossed eye, and clouded vision. Images of various eye conditions from the emergency clinic's online data set are included in the collection. To stay away from over structuring, the model was prepared utilizing information taking care of methodologies like flipping and turning. The accuracy of the CNN model is 92.31% for binocular pictures and 96% for monocular pictures. Future work plans to cultivate adaptable online applications through which pictures are moved to examine eye infections, and to give privately settled fundamental eye appraisals as opposed to crisis center visits

Nigudgi Nagalaxmi and Dr. Sridevi Hosmani (2023) A system that proposes personalized drug therapies for ocular conditions in retinopathy and uses data analysis and convolutional neural networks to do so. The framework analyze visual infections and distinguishes visual irritation via preparing a CNN model on marked eye pictures. Execution of the framework utilizes patient-explicit information, for example, clinical history to decide proper drugs in view of viability and potential aftereffects With regards to precisely diagnosing eye sickness and suggesting meds, The CNN model accomplishes an exactness of 87%. Future research aims to create mobile online applications that use superimposed images to diagnose eye diseases and provide basic home-based eye exams rather than clinic visits.

Choudhry et al. (2022) It is a decision-making framework for the diagnosis of ocular diseases which is based on DarkNet-19. The classifier used a dense support vector machine (SVM) classifier for classification, Contrast Limited Adaptive Histogram Equalization (CLAHE) for preprocessing, and DarkNet-19 for feature extraction The framework was developed using data from the ODIR-5k dataset the. The collection consists of fundus images of 5000 individuals enrolled in eight different ocular diseases. The cubic SVM classifier was used in the classification step, yielding an accuracy of 93.8% and an area under the curve (AUC) of 100%. Future improvements to the proposed approach were promising, such as expansion to address health care needs in underserved rural areas, and automated integration for real-time diagnosis

Gunay et al. (2015) developed a system that could automatically detect pink eye, or adenoviral conjunctivitis. The framework uses facial images and digital image processing (DIP) method for diagnoses, model also extracts the sclera portion of the eye from facial photographs using image segmentation methods like GrabCut. For training and testing purposes, the dataset includes 12 eye images with adenoviral conjunctivitis and 18 images of healthy eyes. Stochastic gradient descent is one of the machine learning classifiers that may achieve an accuracy of up to 96.7%. Other machine learning classifiers include random forests and Bayesian approaches are also used. In future the purposed framework showed promise for future developments, including expanding to meet healthcare requirements in neglected and rural areas and combining with hardware systems for real-time diagnosis.

Tamir et al. (2017) Create a technique that uses thresholding and image processing to analyze the anterior conjunctiva of the eye to diagnose anemia non-invasivelya smartphone camera is used to capture the retinal image of the eye. These images are processed in MATLAB to obtain red and green color spectra. The measurement indicates the presence of anemia by comparing the mean intensities of the red and green components to a predetermined threshold After 19 cases were tested, the measurement matched patients' blood results with an accuracy of 78.9%. Further work will be required to improve the accuracy of the algorithm, and to expand the diversity of the dataset to accommodate the limitations of geographic differences in hemoglobin levels

Tabuchi et al. (2020) should give a structure to the fair evaluation of unfavorably susceptible eye infection. The improvement cycle is examined and points like model determination, primer displaying, and examination choices, for example, weighted kappa coefficients Profound learning models like VGG16, ResNet50, and InceptionV3 are utilized exhaustively by the structure. The examples were recognized utilizing 872 pictures inspected via prepared optometrists on 4,008 pictures and ensured optometrists (COs). This model purposes K-Overlap Cross Approval calculation and gathering technique consolidated the best performing models for precision. Further exploration endeavors could zero in on working on model execution and extending the utilization of simulated intelligence in clinical imaging for better clinical examination.

Teyet et al. (2024) A far reaching system for the designated evaluation of unfavorably susceptible eye infection was developed utilizing computerized reasoning strategies. Various methodology including unpredictable forest, machine support vector, convolutional cerebrum networks are used to explore facial pictures and give precise assessment of various estimations like endothelial cell thickness, coefficient of assortment, hexagonality, and A wide combination of corneal pictures structure getting ready and testing datasets. Models like NerveSticher and Mobile-CellNet must be created and trained before deep learning can be used. Also, customary post-duplicate techniques should be used. Future work will be pivotal on the off chance that we are to work on the model's exactness and productivity as well as extend and adjust the informational index.

Rahman et al. (2021) An online diagnostic tool was developed. In their more digital point-of-care approach, they used deep learning algorithms. The program uses a deep neural network (DNN) model trained on conjunctivitis related data sets to reliably detect pink eye symptoms in the uploaded images Users can get results faster because the system integrates deep learning models with the Flask server, enabling real-time visibility. When the algorithm was tested on a dataset of normal images including glaucoma, they achieved 85% success. It allows users to quickly assess their overall eye health from anywhere in the world, eliminating the need for in-person clinic visits and facilitating the early detection of symptoms related to eye disorders. Future work will need to expand and diversify the list in order to improve the accuracy and efficacy of the model.

Rivero-Palacio et al. (2021) Develop a framework for anemia analysis through a mobile application using the YOLO v.5 architecture. The version uses transfer getting to know for better overall performance and reduced education time. The acquisition of datasets is supplied by Roboflow, while the version is prepared on Google Collaboratory. The application is programmed in Dart using the Flutter framework. The model is converted to TorchScript for integration with the application before deployment. YOLO v.5 architecture achieved a success rate of 93% when tested images. Future work will require diversifying and enlarging the dataset, and improving performance and accuracy of model and more diagnostic capabilities to increase ease of utilization in low-resource environments.

Kurniawan et al. (2014) Discussed artificial intelligence-based approach for diagnosing eye disorders. It combines two techniques: Case Base Reasoning and Naïve Bayes for diagnosing Eye Diseases. The intention is to offer a resource that will enable anyone to self-diagnose eye conditions, particularly in areas with restricted access to ophthalmologists. Experiments revealed that 82% of the time, the system's diagnoses matched those made by human specialists, and had capability of handling 140 cases at a time. Although there is potential in the system, further work is required to make it more complete. In general, demonstrates how artificial intelligence (AI) might help in disease diagnosis in order to enhance healthcare

Sadaf Malik et al. (2019) In order to enhance machine learning's capacity to forecast illness, a framework for standardizing diagnostic data must be developed. Medical professionals created hierarchical hierarchies to arrange data, and the American Academy of Ophthalmology's ICD-10 coding system was used to make diagnoses. The system has an easy-to-use interface that analyzes user data using Random Forest, Decision Tree, Naïve Bayes, and Neural Network Algorithms. Compared to other sophisticated approaches, Random Forest and Decision Tree obtained over 90% accuracy. It can associate a condition with symptoms by combining general health data with indicators from the anterior and posterior segments. In order to improve illness prediction, test findings based on images will eventually be directly converted into the symptom hierarchy.

Sundararajan et al. (2019) Presents a framework using deep learning for ocular pathology detection in medical images. The Objective is to develop a deep learning-based system for conjunctivitis diagnosis. The model uses a six-layer convolutional neural network (CNN) architecture, including four and two fully connected convolutionals, followed by a softmax classifier to predict conjunctivitis. The data set comes in three types, first contains 600 images, which is increased to 1500 images in the second dataset and then to 100 images in the third dataset. Data enhancement techniques are used for address overfitting. The implementation involves Python with the Keras library. Future work calls for exploring 3D CNN and deep sensing techniques to further increase accuracy and expand the application of deep learning in the interpretation of medical images.

Prashasthi et al. (2017) Introduces a methodology of automatically detecting eye abnormalities using machine learning and image processing. Clearly focuses on analyzing clear eye images to extract spatial and chromatic features of sclera, iris which makes ease in the detection of various eye diseases. Lights up to existing methods for diagnosis including Naïve bayes, Case Base Reasoning and convolutional recursive neural networks, while these methods are accurate and promising, they often require expensive equipment and high-quality images, limiting accessibility especially in remote areas, this approach aims to be accessible and cost effective, will work on normal images taken by phone cameras. It adds up preprocessing steps like cropping and conversion color format. Classifiers like K-nearest, Naïve Bayes, and Adaboost for classification, while adaboost showing highest accuracy of 95%. Further Research is needed to expand the scope of diseases and improve accuracy of system.

İbrahim et al. (2024) Investigates the possibilities of machine learning and deep learning methods for categorizing eye diseases from retinal pictures. The dataset includes 1468 images for DR class, 1712 images for glaucoma class, 1038 images for the cataract class, and 1074 images for normal class. Compares four different ML models in which pre-trained InceptionV3 model achieves promising result in diagnosis. Neural Network (NN) achieved the highest classification accuracy 89.2% and 90.9% after image augmentation. Logistic Regression followed closely with an accuracy 87.3% before and 90.2% after image augmentation. Increasing the dataset size by adding images to under-represented classes (Glaucoma and DR) led to slight improvement in classification accuracy for all models. Future work could involve incorporating more complex deep learning models, exploring interpretable models, and validating the results on a larger dataset.

Rashid et al. (2024) Focuses on developing convolutional network model, specially using VGG16, multiclassification and identification of external eye such as pink eye (conjunctivitis), blepharitis, and cellulitis. Convolutional, max pooling, and fully connected layers are included in the model, which provides a reliable method for classifying images. Given a dataset that is divided into 20% for testing and 80% for training, they were able to train and test their model and intensive They were able to achieve accuracy rates as high as 98.5% for CNN and more than 97.6% for multiclass classification. In order to check that model could be relied on different data subsets, cross-validation was further applied, with good results. Future work can involve expanding the model to include additional external eye diseases and exploring the use of other deep learning architectures for improved accuracy and efficiency.

Mondal et al. (2022) Three state-of-the-art deep learning models were used to develop the eye disease classification system: VGG19, ResNet50, and Inception V3. The framework includes an optimized data preprocessing step based on clustering, which divides the dataset into groups for training models to reduce overfitting The models were trained using transfer learning and evaluated using Adam-Adadelta optimizers. The models achieved an accuracy of 87.3%, 93.6%, and 95.2%, respectively, indicating their effectiveness in ocular disease classification. Future work could include expanding the database to improve performance and new in-depth learning models have been explored for a wide range of classifications.

Sakhare et al. (2024) Presents a system for the diagnosis of ophthalmic disorders by imaging of herbal medicines and lead detection. Image preprocessing techniques such as noise removal, Gaussian blurring, image sharpening and edge detection in this system to improve the quality of medical images Homology modeling of the viral receptor causing conjunctivitis, using high throughput testing (HTS) was also performed. techniques Potential drug they also found leads and, phytocompounds were extracted from chamomile and eye-catching plants and tested for ADME. Future work may involve in-vitro receptor ligand binding assays to determine the efficacy of the discovered compounds.

Nihal Boina et al. (2021) The study uses Convolutional Neural Network (CNN) algorithm, a deep learning paradigm to detect autism, breast cancer, melanoma, and pink eye Each disease is treated as a binary classification problem, where CNN is trained on image about information on sets specific to each situation. The autism database contains 2,000 images of children's faces, while 1,578 ultrasound images have been trained for breast cancer. The melanoma and pink eye data sets contain 3597 and 1000 images, respectively. The program uses Python and TensorFlow and Keras libraries, as well as Google Colab for training. The software automatically acquires data sets, preprocesses images, and trains models, achieving experimental accuracy as high as over 90%. Future work may include expanding the data set, further optimizing the model parameters, and investigating the combination of additional diagnostic features to increase accuracy and generalization.

Lulai et al. (2006) Gives a decent premise to understanding the cell physiology changes related with pink eye (PE) in potatoes and organic products. The program uses cytologic monitoring, histochemical analysis, and immunodetection techniques to detect autofluorescence in tissues when a PE debt is used. These data include measurements of tuber hydrovapor conductivity and microscopic examination of PE-affected tubers and their parenchyma. The advancement of PE is impacted by various ecological circumstances, which will turn out to be clearer in future exploration. Moreover, the significance of uprightness in sickness weakness and conceivable administration techniques to lessen the effect of PE in potato harvests will be investigated.

Verma et al. (2019) propose a framework for dynamic eye pigment classification using a convolutional neural network (CNN). Variable layers for feature extraction, pooling layers to reduce spatial scale, and fully overlapping layers for classification form the CNN structure The dataset consists of 28 images of each red and healthy eye, taken with a slit lamp camera and preprocessed work by projection in MATLAB Provides the functionality including data preprocessing, model training, and evaluation for high accuracy to distinguish between red and healthy eyes Future work may explore scalability and generalizability on larger datasets, testing transfer studies have ensured for advanced classification, and enhanced the utility of clinical applications with real-time processing capabilities

Thanathanee et al. (2011) It provides a unique model for exploring sentiment analysis in social media using deep learning methods. Combining convolutional neural networks (CNNs) and long-term short-term memory networks (LSTM) in vigilance modeling Tweets from several social media sites with emotionally segmented text descriptions are captured for retrieval dataset used for school teaching and research, using the TensorFlow framework and what is learned through software programs builds .Future works involves in exploring other unique blends of images, including human annotations or references, to further improve the interpretation.

Wang et al. (2023) A system for predicting ophthalmology visits using short-term memory (LSTM) and gated recurrent unit (GRU) models provides hospital referrals for facial fractures in primary care included in Xinjiang Medical University from 2017 to 2019. When tested , the GRU and LSTM Model perform well in predicting the number of visits to an ophthalmologist in the next 30 days. Future research could consider other factors such as weather, holidays, and air quality to increase the accuracy of forecasts.

Inomata et al. (2020) looks at how admittance to and paces of treatment for provocative problems, for example, waterfalls can be expanded. It centers around utilizing frameworks like ResearchKit and ResearchStack for research applications and huge clinical information stockpiling. Looks at how versatile wellbeing (mHealth) applications could upgrade admittance to and the norm of therapy got in the clinical field, particularly for hypersensitive issues like unfavorably susceptible eye sickness. It focuses on how to use ResearchKit and ResearchStack for large-scale medical data storage and research applications. Centered information are gathered through AllerSearch, a mHealth application that gathers true data about conduct side effects and way of life factors related with sensitivity fertilization the job incorporates things like geolocation, ecological information assortment, patient-detailed results, and then some. exhibiting its utility in enormous, cross-sectional examinations Future work could zero in on approving the information gathered through mHealth applications, tending to predispositions, and further growing huge clinical datasets with such exactly this region to empower complex diagnostics and customized medication techniques.

Bodor et al. (1998) far reaching framework for the conclusion and treatment of intense visual illnesses centers around viral and viral causes. For clinical perspective, microbial association, and supporting results, the model suggests that initial antidotes are ineffective for ocular infections, particularly when dermatitis is painful. The chart places an emphasis on microorganisms and the requirement to identify the causative agent through bacterial culture in order to better guide treatment decision. Modifications to treatment plans are another example of similar outcomes. Future work will zero in on fortifying another microbial foe and confining ordinary practice against pathologists, as well as early field testing of ideal conveyed medicines.

Mekonnen et al. (2023) Proposed a machine learning algorithm to be used to classify animal Pinkeye disease using data collected from clinical trials. The researchers tested various models including Random Forest, XGBoost, AdaBoost, and Artificial Neural Network (ANN). A database of 5508 records was collected from Wolaita Sodo Kenido Koysha Wereda Livestock and Fisheries Department. Feature need analysis revealed significant characteristics for disease diagnosis. The ANN model outperformed the other models and exhibited the highest accuracy of 99.15%. Analytical design, data sources, feature selection, model selection, and analysis metrics. Future work includes extending the model to forecast disease outbreaks and for mobile-based information systems.

Kamal et al. (2020) Presents analysis of CNNs to investigate the classification of medical images for the detection of skin diseases. Machine learning models such as SVM, decision trees and logistic regression have been tested to predict cardiovascular disease using clinical data. Patel et al. It focused on NLP techniques including word prediction and RNN for sentiment analysis in social media content Future work includes integrating these models into healthcare systems for real-time diagnosis and exploring hybrid approaches for greater accuracy.

Yasin et al. (2023) Notably, CNNs (neural networks), KNNs are used to extract fish features, combined with group learning techniques that increase prediction accuracy Besides, Classification services are provided by support vector machines, with TensorFlow, PyTorch acting as the main frameworks for their implementation, analysis uses a variety of models, algorithms and frameworks Regarding future work, the authors propose to explore advanced imaging techniques to improve model interpretation capabilities. This guide aims not only to enhance forecasting performance but also to provide deeper insights into the underlying data model.

Zhang et al. (2020) Researchers used convolution and deconvolution vision networks with KL aberration loss to predict human eye positions in Atari video games Separate networks were trained for each game and obtained high prediction accuracy, good performance in optical flow and salience patterns in. For simulation learning, a two-stage framework called AGIL was used that incorporates visual feedback to enhance system learning. This ensured perfect synchronization of actions across games. Future work could include additional inputs such as speed or salience to improve accuracy.

Ahmed et al. (2021) Presents a robust framework for glaucoma detection using deep convolutional neural network (DCNN). The optimal architecture consists of one hidden layer, 16 input neurons, and 2 output neurons, which exhibits good performance in classification tasks. Dataset selection is careful, using Kagle representative dataset of fundus images, ensuring adequate coverage of dry eye and healthy eye samples Implementation in MATLAB R2018b shows according to the proposed algorithm is efficient, providing an impressive accuracy of 92.78% with minimal downtime To explore transfer learning methods , for real-time cranial analysis It can also deliver focusing on implementing the system in clinical settings Continued research on the combination of deep learning techniques and emerging technologies may provide diagnostic tools for ocular diseases that automation has greatly improved.

Smaida et al. (2019) Provides a comprehensive review of image classification algorithms for the diagnosis of ophthalmic diseases, focusing on convolutional neural network (CNN) models such as VGG16 and InceptionV3 The first framework/model developed in the study is a retinal fundus image and CNN for classifying four types of eye diseases -The data set includes architecture and training and contains a collection of high-resolution retinal images obtained from Kaggle, including diabetic retinopathy, cataract, myopia, and eye a it contains a picture of righteousness. Models are carefully trained and tested on datasets, using techniques such as confusion matrices for performance analysis. Future work could include exploring new deep learning algorithms, adding data development techniques, and extending the data set to provide generalizable and accurate modeling in the real-world clinic conditions have improved.

Ismailova et al. (2018) explains a comprehensive framework for understanding the study of orbital decompression methods in complicated thyroid eye disease (TED). They emphasize the importance of treatment tactics adjusted to the specific requirements of each patient, and emphasize the coordination between different medical discipline, having hormone study, Eye Care and surgery. The Dataset study emphasizes on a bunch of medical images data gathered from multiple resources which helped figure out how well orbital decompression works and gave some challenges to deal with when we use it. To better complex TED cases, Future work may focus on reducing medication options, making patient selection criteria stricter, and increasing access to similar therapies.

Joshi et al. (2022) Paper presents a comprehensive framework for glaucoma detection using convolutional neural networks (CNNs), one type of deep learning approach. The proposed model includes preprocessing steps using contrast limited histogram equation (CLAHE) and down sampling to standardize the input measures Architecture uses pre-trained CNN models such as VGGNet-16,16. ResNet-50, Google Net is used to extract feature extraction, followed by cluster learning to combine the strengths of multiple models Addressing the limitations of individual models improves the accuracy of glaucoma detection strong and accurate. The dataset used in the study contains retinal fundus images from different locations, making it easy to check the performance of the model on different datasets the activity includes training CNN model on dataset, fine tuning of pretrained models, and ensemble learning technique. Future works the paper suggests exploring improved preprocessing techniques, examining the impact of CNN schemes, and extending the data set to include more models.

Kumar et al. (2021) Presents a comprehensive framework for the application of artificial intelligence (AI) techniques in ophthalmology, with a special focus on the diagnosis and management of various eye diseases. The suggested system analyzes retinal pictures and classifies visual diseases such as age-related macular degeneration (AMD), diabetic retinopathy (DR), and others using a combination of machine learning (ML) and deep learning (DL) methods, along with visual impairment the model architecture uses convolutional neural networks. followed by Model training and validation using standard machine learning practices in future work, the authors propose to explore advanced DL algorithms, incorporate more image data, and increase the scalability and interpretability of the proposed algorithm to facilitate its adoption in clinical practice.

Sarki et al. (2020) Comprehensive review of self-diagnosis of diabetic eye disease (DED), with a particular focus on deep learning (DL) methods. It combines the methods and results of several different studies, and classifies them based on the DL techniques used, such as transfer learning (TL), DL restructuring, and DL and machine learning (ML) [1]. integrated processing methods Notable datasets are Kaggle and Messidor. Make it simple to train and test DL models. Application Various DL algorithms such as Alex Net, VGGNet, and standard CNNs are described in detail, optimized for DED detection tasks. Performance evaluation criteria include sensitivity, specificity, and AUC, which measure the effectiveness of DL methods in detecting DED. Future work suggests improved DL modeling, minimal data training, and integration with cloud computing to improve analysis sensitivity Overall.

Prajna et al. (2022) Presents a comprehensive review of cases of ocular pathology associated with human coronavirus infection during delta variant surge in India. The design/model used in the study involved prospective collection of data from patients presenting with acute ophthalmoplegia, followed by unbiased metagenomic RNA intensive sequencing detect infection. The dataset consisted of conjunctival and prenasal swab samples from 106 patients, which were processed for RNA sequencing. Rigorous sequence analysis was performed to identify human coronavirus RNA fragments to be used, as well as RT and qPCR testing to confirm SARS-CoV-2 involvement. Future work could focus on long-term follow-up of patients for respiratory symptoms and ophthalmic outcomes.

Ghani et al. (2021) Exhaustive examination of the writing that lays the foundation for the recommended cross breed procedure by focusing on profound learning methods for waterfall conclusion. The dataset has 25 gatherings of 1563 pictures, which are utilized to prepare and test the recommended approach. Benchmark models like Initiation V3 and VGG-16 are additionally included. A total of thirty batches participated in the ten-epoch training trials. When contrasted with VGG-16., Origin V3 exhibited lower misfortune and 90 point01 percent higher exactness. Impending undertakings incorporate growing the dataset, exploring novel brain organizations, and creating applications for glaucoma conclusion. Generally, research results show how viable profound learning models are.

**Table 3.** A Summary of Literature Review

| Article Reference | Objective | Algorithm | Dataset | Outcome | Future Work |
|---|---|---|---|---|---|
| Soysa et al. (2020) | Diagnose conjunctivitis and cataracts using smartphones | Convolutional (CNN) and deep neural networks (DNN) | Images including conjunctivitis, cataracts, and normal eye photos | 83.33% | Expand and diversify dataset, enhance model's accuracy and performance |
| Mukherjee et al. (2021) | Develop iConDet app for conjunctivitis detection | Convolutional neural networks (CNNs), EfficientNet | Annotated photos of healthy and diseased eyes | 84% | Evaluate conjunctivitis severity, expand tool's use beyond binary categorization |
| Akram et al. (2020) | Automate eye condition identification using face images | Deep convolutional neural networks (DCNN), SVM | 1,753 scaled images of various eye conditions | 98.79% | Integrate with hardware systems for real-time diagnostics |
| Nigudgi et al. (2023) | Identify conjunctivitis and suggest pharmacological therapies | CNN model | Labeled conjunctivitis effected eye photos | 87% | Develop mobile and online applications for basic at-home testing |
| Choudhry et al. (2022) | Detect eye diseases using DarkNet-19 | Cubic SVM classifier, DarkNet-19 | ODIR-5k dataset | 93.8% | Integrate with hardware devices for real-time diagnostics |
| Rahman et al. (2021) | Create online tool for conjunctivitis identification | Deep neural network (DNN) | Regular and conjunctivitis-affected images | 85% | Expand dataset, enhance model's accuracy and performance |
| Rivero-Palacio et al. (2021) | Develop framework for anemia diagnosis via mobile app | YOLO v.5 architecture with transfer learning | Not specified | 93% | Diversify and enlarge dataset, improve model performance |
| Mondal et al (2022) | Develop a framework for eye disease classification | VGG19, ResNet50, Inception V3 | Not specified | 87.3%-95.2% | Explore new deep learning models for a |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | wider range of classifications |
| Rashid et al (2024) | Develop convolutional network model for multiclassification of external eye diseases | VGG16 architecture | Label photos of healthy and diseased eyes | 93.6% | Expand the dataset, and enhance model's accuracy and performance |
| Ghani et al (2021) | Analyze deep learning techniques for cataract diagnosis | Inception-V3 and VGG-16 architectures | Dataset with 1563 pictures of different eye diseases divided into 25 groups | 90.01% | Expand dataset, enhance model's accuracy and performance |
| Joshi et al. (2022) | Glaucoma detection using CNNs | VGGNet-16, ResNet-50, Google Net | Retinal fundus images | Not specified | Examine impact of CNN schemes, extend dataset |
| Mekonnen et al. (2023) | Classification of animal Pinkeye disease using ML | Random Forest, XGBoost, ANN | Dataset of 5508 eyes disease effected images | 99.15% | Develop mobile-based information systems |
| Kumar et al. (2021) | AI application in ophthalmology for disease diagnosis | CNNs | Use dataset of Retinal images | Not specified | Grow dataset, and explore advanced models |
| Prajna et al (2022) | Review of ocular pathology associated with coronavirus | RNA sequencing | Conjunctival and samples from 106 patients | Not specified | Focus on long-term follow-up for respiratory and ophthalmic outcomes |
| Bobade et al. (2023) | Automatically detecting eye conditions. | CNNs,<br>DIP methods | Use dataset of different eye diseases | 96% | Develop mobile and online applications for basic at-home testing |

# Chapter-3
# **Methodology**

## 3.0. Methodology

The methodology section address the limitations of traditional conjunctivitis inflammation detection, this study proposes a new deep learning (DL) algorithm for high accuracy. The methodology is based on several steps. First, a comprehensive eye image dataset is carefully collected, including different eye diseases (viral, bacterial, allergic) and healthy controls. Subsequently, preprocessing techniques are applied to improve image quality and facilitate analysis. Includes standard image acquisition system, enhancement techniques (sharpness, contrast adjustment), separation to isolate appropriate eye areas. Building model having the ability to accurately distinguish between various types of conjunctivitis is no small feat, it requires meticulous design, wise blending of AI Architectures and precise handling of data. To tackle this challenge, we developed a hybrid deep learning architecture that utilizes the combined strengths of two celebrated architecture renowned for their excellence in the field of image recognition. System delivers power of pre-trained CNNs, such as ResNet-50 and VGG-16, is used. Then we are applying classifier SoftMax to predict that image is healthy eye or conjunctivitis effected eye.

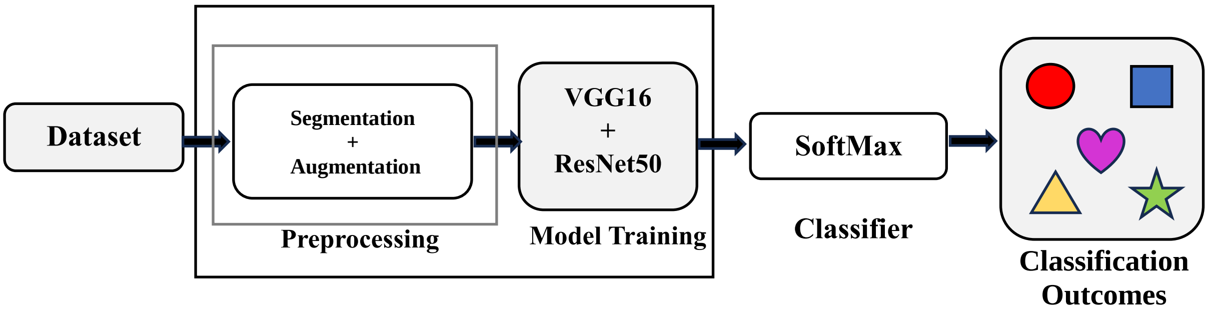


**Figure. 4.** Methodology

## 3.1. Data Collection and Labeling

We collect different type of pink eye disease effected image datasets from a various trusted source, including research institutes, and publicly available data to correctly diagnose the pink eye disease. Collected 1400 images from Roboflow an online dataset collection database. Another 200 images dataset we collect from Roboflow. We have total 1600 images dataset which include 4 classes of different pink eye images and healthy images. Our dataset include labeled classes of viral, bacterial, allergic conjunctivitis and healthy eye images (Zhang et al., 2020; Liu et al., 2021, Wu et al., 2023). By gathering 1600 images with 4 different classes, we provided good training data to our model for learning and prediction (Yang et al., 2021; Zhao et al., 2022). Labeling the dataset is essential to obtain good accuracy from your model. To achieve this label the images correctly according to their types. This will help to achieve good accuracy from deep learning algorithms (Guo et al., 2021; Zhang et al., 2024).

**Figure. 5.** Sample of Viral, Bacterial, Allergic and Normal Eye (Tamuli et al., 2015)

## 3.2. Preprocessing

For correct diagnosis and understanding several image preprocessing techniques used. For diagnosis of conjunctivitis or other eye diseases we need to follow some steps. First of all, taken image would be clear and having uniform resolution and contrasts. Subsequently, image enhancement techniques such as sharpening, contrast, and noise reduction can be used to improve image clarity and quality. Segmentation in image preprocessing is used to extract relevant part such as iris, cornea, and eyelid (Ahuja et al., 2018).

### 3.2.1 *Segmentation*

In computer vision and image processing, segmenting images is an important job with several applications, including image compression, medical image analysis, and scene interpretation (Ahuja et al., 2018).

### 3.2.2 *Data Augmentation*

Data augmentation helps to increase the size of dataset for training a model without collecting new data. It improves the model's performance. It is used to prevent from overfitting issues. Augmented pictures are treated as separate images by neural networks. Data augmentation is made possible via Keras' deep learning neural network library. We used the Roboflow to augment our dataset. We used channel shift, zooming, rotation, and horizontal shift. By applying the augmentation more image dataset were generated (Mukherjee et al. (2021).

## 3.3. Machine Learning Models for Training

### 3.3.1 *ResNet-50*

ResNet-50, short for Residual Network with 50 layers, is a deep convolutional neural network (CNN) architecture that revolutionized the image classification industry One of the major innovations introduced by ResNet was the concept of residual learning with skip connections , or shortcuts, to the network directly These residual connections that enable learning of residual functions instead of explicit mapping smooth the gradient flow over surface widths, resulting in smooth training functions, and leading to networks with internal a mother (He et al., 2016).

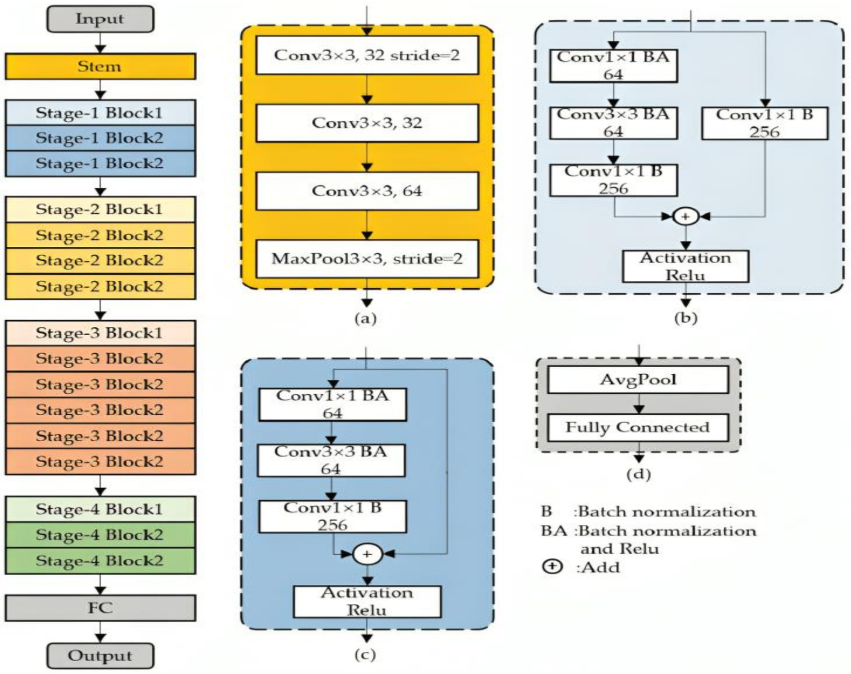


**Figure. 6.** Resnet50 Architecture (Wang et al., 2021)

For conjunctivitis image classification, ResNet-50 uses its deep structure and captures complex features and patterns of different ocular conditions. We have previously trained weights on the ImageNet dataset Let's start the model, which contains a large array of images spanning thousands of classes. This initial training starts the model with knowledge of general optical features, enabling it to focus specific eye muscles to learn on as they are being fine-tuned (Chatzis et al., 2017).

### 3.3.2 *VGG-16*

VGG-16, developed by the Visual Geometry Group at the University of Oxford, is another popular CNN algorithm known for its simplicity and effectiveness in image recognition VGG-16 consists of 16 layers of convolutional layers that consume followed by three fully connected layers, with maximum pooling layers interspersed throughout the network (Simonyan & Zisserman, 2014).In pink eye disease diagnosis, algorithms like VGG-16 is good is extraction features due to their layer's structures. In  CNN each layer learn in deeply and extract features, this deeper layer feature extracting capability help us in conjunctivitis diagnosis (Wei et al., 2019).

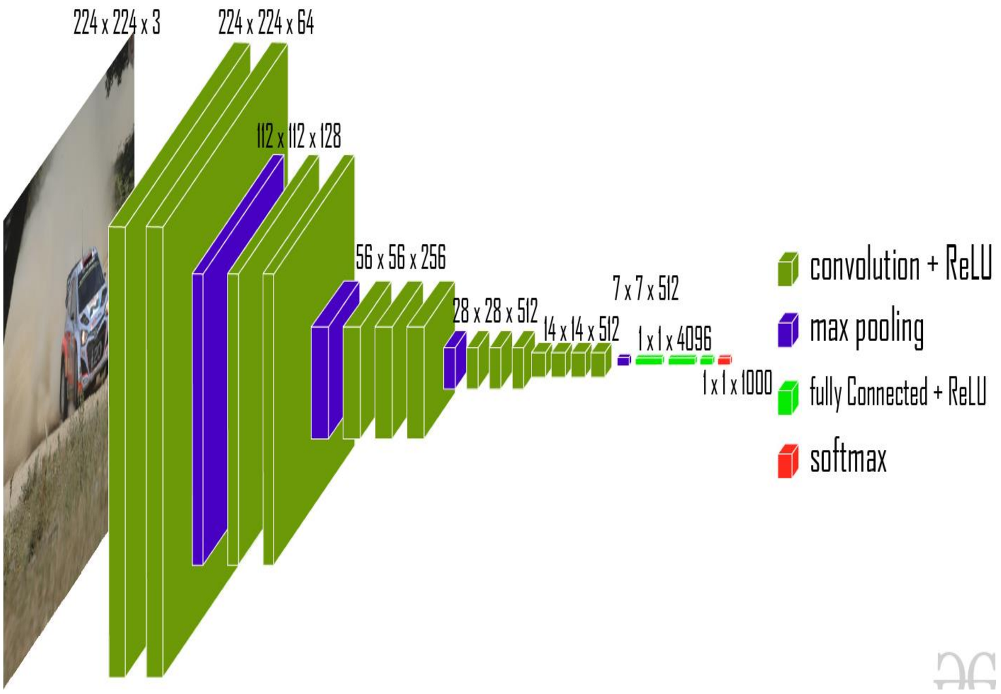


**Figure. 7.** VGG16 Architecture (Abdulaziz, Alshammari et al., 2022)

## 3.4. Classifier

Classifiers are key components in Deep learning frameworks, classifiers arrange data into label classes according to their similar. Classifiers are helpful in feature extracting, natural language processing and in medical disease diagnosis (Goodfellow et al., 2016). In the preparation stage, classifiers gain from named informational indexes, where every information point is related with a class mark. From the input data, relevant features are extracted, and decision boundaries in the feature space that separate classes are established. Various calculations and techniques are utilized to adjust the boundaries of the classifier to decrease the mistake and increment the exactness (Soysa et al., 2020).

### 3.4.1 *SoftMax Classifier*

SoftMax regression, also known as multinomial logistic regression, is a classification algorithm commonly used in machine learning for class classification tasks. It estimates the probability of correctly classifying each class based on the input data and class set of prediction. It comes as the most obvious use of Regression as the final category. It use as the final layer in neural network architectures including resnet50 and other models use in classification of images (Bishop et al., 2006 ; Goodfellow et al., 2016).

# Chapter-4
# **Results & Discussion**

## 4.1. Discussion

### 4.1.1 *Conjunctivitis Dataset*

We collect different type of pink eye disease effected image datasets from a various trusted source, including research institutes, and publicly available data to correctly diagnose the pink eye disease. Collected 1400 images from Roboflow an online dataset collection database. Another 200 images dataset we collect from Roboflow. We have total 1600 images dataset which include 4 classes of different pink eye images and healthy images. Our dataset include labeled classes of viral, bacterial, allergic conjunctivitis and healthy eye images (Zhang et al., 2020; Liu et al., 2021, Wu et al., 2023).

### 4.1.2 *Segmentation*

This Part of model was carried out by using a unique platform Roboflow which provided advanced tools to identify important regions within the image. This will minimizes irrelevant areas and highlights important patterns, such as the degree of redness. surface differences and blood vessel structure. This directly improves the model's ability to capture changes related to different ophthalmological causes And it allows us to create high-quality training-ready segmented images.

### 4.1.3 *Implementation of Methodology*

In this study, multi-layered deep CNN frameworks VGG16 and Resnet50 was tuned for transferring the learning process. The input images are fed into both VGG16 and ResNet50 in the hybrid model so that distinct but complementary features can be extracted simultaneously. The outputs of each model are then flattened and stacked together after the feature extraction process is complete, then creating a single feature vector that includes both heavy structures and fine details. The unified feature vector is then forwarded through the dense layer of 1024 neurons, where classification takes place as the model composes and processes the given information towards the last conclusion(G. Ramanathan et al., 2021).

Feature Concatenation, Once the images have been fed to the VGG16 and ResNet50 models, we receive two distinct feature vectors: first, VGG16 which contains rich, intricate, and spatially oriented features; second, ResNet 50 contains features that are more complex and high-level. In a hybrid structure, there feature vectors are combined into one representation by concatenating them.

This integration of the two architecture’s characteristics is said to minimize the weaknesses of each of the models. In that regard, the resulting feature vector will contain outer modifiers along with structural content. This resulting feature vector is key to the last classification, for it embodies all visual features of the image in question. Such combining of fine features and high-level abstract features enables the hybrid model to effectively learn the different patterns displayed by various types of conjunctivitis(S. Mascarenhas et al., 2021).

## 4.2. Experimental Results

This study was setup using Tesla T4 GPU and a Collab Notebook, which is provided by Google Cloud Platform. For Programming and fine-tuning of the model Python, Keras and Tensorflow were employed. For Performance evaluation, Sklearn library was used, Conclusion was drawn from confusion matrix. This framework consists of six major steps: 1) apply image pre-processing and data augmentation, 2) feature extraction, 3) FC layer fine-tuning, 4) model accuracy evaluation using validation dataset, 5) finalization of model and 6) final performance evaluation on accuracies and other parameters using unseen test data set, as shown in fig.5.

Image processing is an crucial process, which improves image quality and makes input images prepare for network learning. Data augmentation was required due to class imbalance problem in the current Dataset. The Extraction of features has been performed using the VGG16 and Resnet50 prebuilt model. The model can learn new patterns from the new unseen medical dataset because the pre-trained weights were loaded initially and the network layers were kept trainable. Redefining the FC layer allowed for fine-tuning, and several runs were used to adjust the hyperparameters for the best accuracy on the training and validation datasets.

The final accuracy on the test dataset was acquired after training was finished. The experimental result shows training accuracy, 93.84%, and validation accuracy as 94%. Fig. 8 illustrates a graphical representation of the achieved accuracies for training and test datasets.

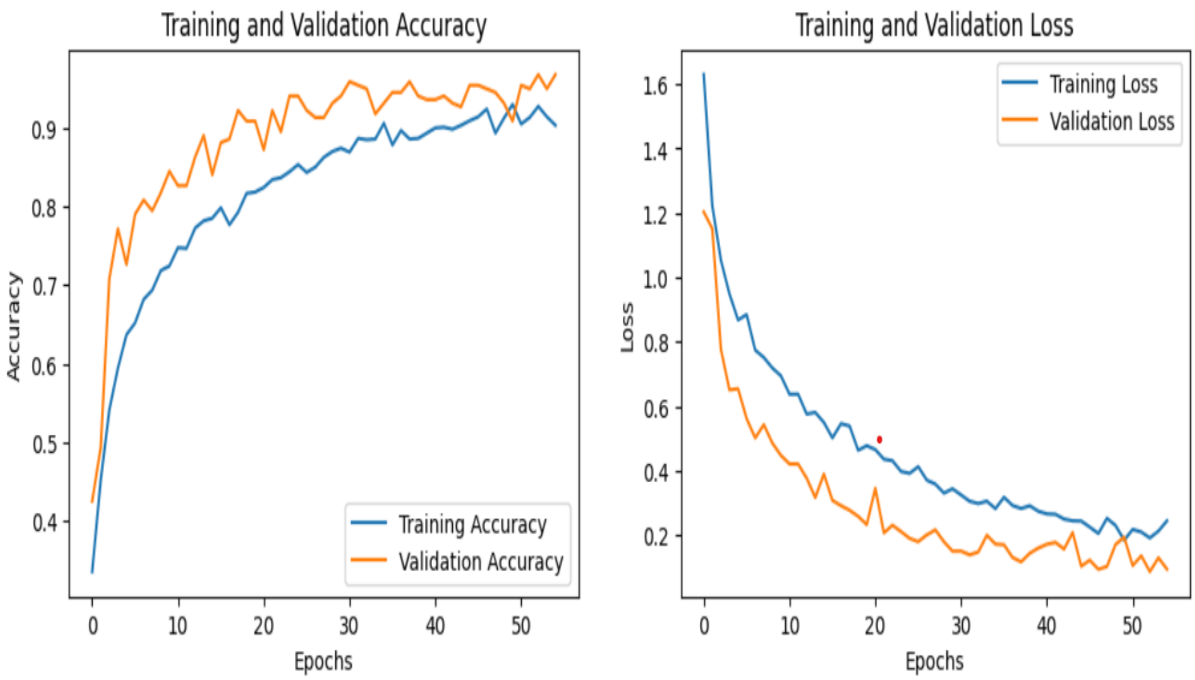


**Figure. 8.** Training and Validation Accuracy and Loss

Further, for more deeper analysis of the training model, confusion matrix and other evaluation parameters, such as F1 score, recall, precisions were also carefully obtained. This shows that model is correctly classifying each sample, shows in fig.9.

Classification Report:

| | precision | recall | f1-score | support |
|---|---|---|---|---|
| Allergic | 0.85 | 0.92 | 0.88 | 25 |
| Bacterial | 0.95 | 0.89 | 0.92 | 45 |
| Normal | 0.97 | 1.00 | 0.99 | 71 |
| Viral | 0.90 | 0.88 | 0.89 | 42 |
| accuracy | | | 0.93 | 183 |
| macro avg | 0.92 | 0.92 | 0.92 | 183 |
| weighted avg | 0.94 | 0.93 | 0.93 | 183 |

```
12/12 ━━━━━━━━━━━━━━━━━━━━ 1s 104ms/step - accuracy: 0.9297 - loss: 0.2147
Test Accuracy: 93.44%
```

**Figure. 9.** Representation of Classification Report and Test Accuracy

A clear graphical depiction of the trade-off between true positive rate and false positive rate for multiclass classification tasks is receiver operating characteristics (RoC) analysis. The model's ability to differentiate between classes is also determined by the area under the curve (AUC).

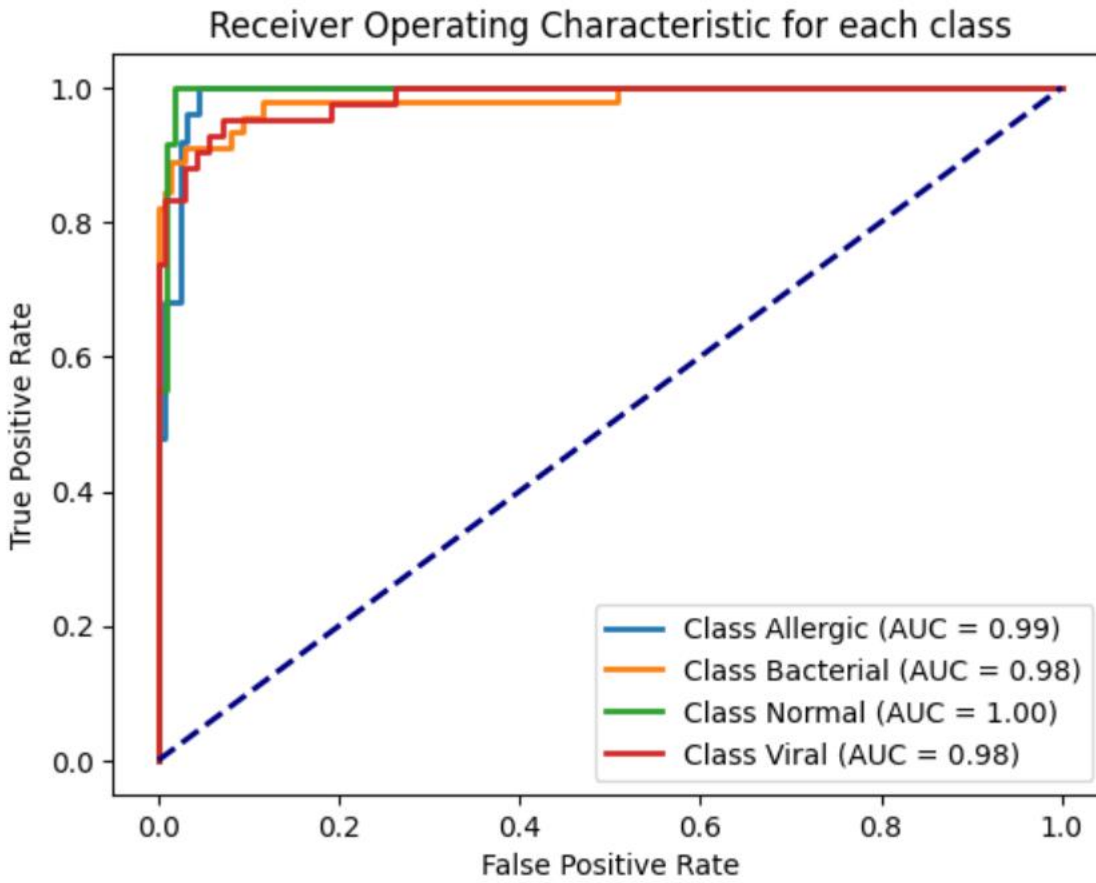


**Figure. 10.** ROC Curve Representation

The following Table 4 shows the comparative performance of the model in recent studies. In this comparison, only multiclass classification dataset have been considered.

**Table 4.** Comparative result of our proposed model with similar recent studies

| **Article Reference** | **Algorithm** | **Dataset** | **Outcome** |
|---|---|---|---|
| Ghani et al. (2021) | Inception-V3 and VGG-16 architectures | Dataset with 1563 pictures of different eye diseases divided into 25 groups | 90.01% |
| Nigudgi et al. (2023) | CNN model | Labeled conjunctivitis effected eye photos | 87% |
| Soysa et al. (2020) | Convolutional (CNN) and deep neural networks (DNN) | Images including conjunctivitis, cataracts, and normal eye photos | 83.33% |

| | | | |
|---|---|---|---|
| Mukherjee et al. (2021) | Convolutional neural networks (CNNs), EfficientNet | Annotated photos of healthy and diseased eyes | 84% |
| Purposed Model | VGG-16 and ResNet-50 hybrid model | Dataset contain viral, bacterial, allergic and healthy eyes label image.<br>Training 1200<br>Validation 250<br>Test 185 | 93.44% |

# Chapter-5
# **Conclusion**

## 5.0. Conclusion

In conclusion, conjunctivitis is chronic and extremely contagious eye disease that has severe implications on human being. Conventional diagnostic techniques are although helpful but highly depends on clinical expertise and availability of ophthalmologists, which may be constrained in some areas. This study illustrates the exciting new approaches towards diagnosis of conjunctivitis by the use of Artificial Intelligence advancement, especially in the area of deep learning. In this study, we propose a hybrid model for conjunctivitis eye disease diagnosis. In this study we have developed a image dataset for pink eye disease containing data of 1600 images. We apply segmentation using Roboflow which provided advanced tools to identify important regions within the image. In our proposed system input images are fed into both VGG16 and ResNet50 in the hybrid model so that distinct but complementary features can be extracted simultaneously. The outputs of each model are then flattened and stacked together after the feature extraction process is complete. We also apply SoftMax classifier for multiclass classification. We test our system with different types of pink eye disease images that are visually observable. From the experimental results we see that VGG16 and ResNet50 outperforms and shows better results than the other existing models. We also compare the results of hybrid model with some other existing methods for eye disease recognition. It is observed that our hybrid model achieves better accuracy than others. We get a recognition rate of our method of 93.44%.

# Chapter-6
# **References**

## 6.0. References


1. Sindhuja, K., Lomi, N., Asif, M. I., & Tandon, R. (2020). Clinical profile and prevalence of conjunctivitis in mild COVID-19 patients in a tertiary care COVID-19 hospital: A retrospective cross-sectional study. Indian Journal of Ophthalmology, 68(8), 1546-1550.
2. Khairallah, M., & Kahloun, R. (2013). Ocular manifestations of emerging infectious diseases. Current Opinion in Ophthalmology, 24(6), 574-580.
3. Pepose JS, Sarda SP, Cheng WY, McCormick N, Cheung HC, Bobbili P, Joseph C, Duh MS. Direct and Indirect Costs of Infectious Conjunctivitis in a Commercially Insured Population in the United States. Clin Ophthalmol. 2020
4. Azari, A. A., & Barney, N. P. (2013). Conjunctivitis: a systematic review of diagnosis and treatment. Jama, 310(16), 1721-1730.
5. Sheikh A, Hurwitz B, van Schayck CP, McLean S, Nurmatov U. Antibiotics versus placebo for acute bacterial conjunctivitis. Cochrane Database Syst Rev. 2012
6. Bielory BP, O'Brien TP, Bielory L. Management of allergic conjunctivitis: Clinical aspects, pharmacology, and emerging therapies. Expert Opin Pharmacother. 2021
7. Wong MYZ, Mahendraraj K, Rivera R, Khanna R, Moshfeghi DM. Novel coronavirus 2019 and the eye: How much do we really know? Int J Retina Vitreous. 2020
8. Chen R, Cai J, Cai X, et al. A comparison between adenoviral and non-adenoviral viral conjunctivitis in children during the COVID-19 pandemic. Am J Ophthalmol. 2023
9. Han SB, Kim HJ, Park SH, et al. Clinical features and outcomes of bacterial conjunctivitis in children: A multicenter study. J AAPOS. 2022
10. Zhang L, Zhang Q, Yan H, et al. Epidemiological and Clinical Characteristics of Infectious Conjunctivitis in Contact Lens Wearers: A Multicenter Study. Eye Contact Lens. 2024
11. Sheppard JD, Argüeso P. Emerging strategies for the diagnosis and treatment of meibomian gland dysfunction: Proceedings of the OCEAN group meeting. Ocul Surf. 2021
12. Centers for Disease Control and Prevention (CDC). Conjunctivitis (Pink Eye). https://www.cdc.gov/conjunctivitis/index.html.
13. American Academy of Ophthalmology (AAO). Conjunctivitis: What You Should Know. https://www.aao.org/eye-health/diseases/pink-eye-conjunctivitis-prevention. Accessed April 20, 2024.
14. Chen R, Cai J, Cai X, et al. A comparison between adenoviral and non-adenoviral viral conjunctivitis in children during the COVID-19 pandemic.
15. Mahoney MJ, Bekibele R, Notermann SL, Reuter TG, Borman-Shoap EC. Pediatric Conjunctivitis: A Review of Clinical Manifestations, Diagnosis, and Management. Children (Basel).

16. Dawn, A. G., & Lee, P. P. (2004). Patient expectations for medical and surgical care: a review of the literature and applications to ophthalmology. Survey of ophthalmology, 49(5), 513-524.
17. Soysa, A., & De Silva, D. (2020). A mobile base application for cataract and conjunctivitis detection. In Proceedings of ICACT (pp. 76-78).
18. Tamuli, J., Jain, A., Dhan, A. V., Bhan, A., & Dutta, M. K. (2015, August). An image processing-based method to identify and grade conjunctivitis infected eye according to its types and intensity. In 2015 Eighth International Conference on Contemporary Computing (IC3) (pp. 88-92). IEEE.
19. Mukherjee, P., Bhattacharyya, I., Mullick, M., Kumar, R., Roy, N. D., & Mahmud, M. (2021, July). icondet: An intelligent portable healthcare app for the detection of conjunctivitis. In International Conference on Applied Intelligence and Informatics (pp. 29-42). Cham: Springer International Publishing.
20. AKRAM, ASHRAFI and DEBNATH, RAMESWAR (2020) "An automated eye disease recognition system from visual content of facial imagesusing machine learning techniques," Turkish Journal of Electrical Engineering and Computer Sciences: Vol. 28: No. 2, Article 23.
21. Bobade, L., Thote, M., Tabhane, R., Madke, P., Shrawankar, M., & Sambhare, P. EYE DISEASE IDENTIFICATION.
22. Soysa, A., & De Silva, D. (2020). A mobile base application for cataract and conjunctivitis detection. In Proceedings of ICACT (pp. 76-78).
23. Tamuli, J., Jain, A., Dhan, A. V., Bhan, A., & Dutta, M. K. (2015, August). An image processing-based method to identify and grade conjunctivitis infected eye according to its types and intensity. In 2015 Eighth International Conference on Contemporary Computing (IC3) (pp. 88-92). IEEE.
24. Mukherjee, P., Bhattacharyya, I., Mullick, M., Kumar, R., Roy, N. D., & Mahmud, M. (2021, July). i condet: An intelligent portable healthcare app for the detection of conjunctivitis. In International Conference on Applied Intelligence and Informatics (pp. 29-42). Cham: Springer International Publishing.
25. AKRAM, ASHRAFI and DEBNATH, RAMESWAR (2020) "An automated eye disease recognition system from visual content of facial imagesusing machine learning techniques," Turkish Journal of Electrical Engineering and Computer Sciences: Vol. 28: No. 2, Article 23.
26. Bobade, L., Thote, M., Tabhane, R., Madke, P., Shrawankar, M., & Sambhare, P. EYE DISEASE IDENTIFICATION.
27. Nagalaxmi Nigudgi and Dr. Sridevi Hosmani. " CONJUNCTIVITIS EYE DETECTION AND PERSONALIZED DRUG RECOMMENDATION SYSTEM USING CNN ", International Journal of Creative Research Thoughts (IJCRT), ISSN:2320-2882, Vol.11, Issue 8, pp.h92-h96, August 2023,

28. Choudhry, Zainoor & Shahid, Hira & Aziz, Sumair & Naqvi, Syed Zohaib Hassan & Khan, Muhammad Umar. (2022). DarkNet-19 Based Intelligent Diagnostic System for Ocular Diseases. Iranian Journal of Science and Technology, Transactions of Electrical Engineering. 46. 1-12. 10.1007/s40998-022-00514-4.
29. Gunay, M., Goceri, E., & Danisman, T. (2015, December). Automated detection of adenoviral conjunctivitis disease from facial images using machine learning. In 2015 IEEE 14th International Conference on Machine Learning and Applications (ICMLA) (pp. 1204-1209). IEEE.
30. Tamir, A., Jahan, C. S., Saif, M. S., Zaman, S. U., Islam, M. M., Khan, A. I., ... & Shahnaz, C. (2017, December). Detection of anemia from image of the anterior conjunctiva of the eye by image processing and thresholding. In 2017 IEEE region 10 humanitarian technology conference (R10-HTC) (pp. 697-701). IEEE.
31. Tabuchi, H., & Masumoto, H. (2020). Objective evaluation of allergic conjunctival disease (with a focus on the application of artificial intelligence technology). Allergology International, 69(4), 505-509.
32. Tey, K. Y., Cheong, E. Z. K., & Ang, M. (2024). Potential applications of artificial intelligence in image analysis in cornea diseases: a review. Eye and Vision, 11(1), 1-20.
33. Rahman, M. A., Hossain, M. S., Alrajeh, N. A., & Gupta, B. B. (2021). A multimodal, multimedia point-of-care deep learning framework for COVID-19 diagnosis. ACM Transactions on Multimidia Computing Communications and Applications, 17(1s), 1-24.
34. M. Rivero-Palacio, W. Alfonso-Morales and E. Caicedo-Bravo, "Mobile Application for Anemia Detection through Ocular Conjunctiva Images," 2021 IEEE Colombian Conference on Applications of Computational Intelligence (ColCACI), Cali, Colombia, 2021, pp. 1-6, doi: 10.1109/ColCACI52978.2021.9469593
35. Kurniawan, R., Yanti, N., & Nazri, M. Z. A. (2014, August). Expert systems for self-diagnosing of eye diseases using Naïve Bayes. In 2014 International Conference of Advanced Informatics: Concept, Theory and Application (ICAICTA) (pp. 113-116). IEEE.
36. Malik, S., Kanwal, N., Asghar, M. N., Sadiq, M. A. A., Karamat, I., & Fleury, M. (2019). Data driven approach for eye disease classification with machine learning. Applied Sciences, 9(14), 2789.
37. Sundararajan, S. K. (2019, December). Detection of conjunctivitis with deep learning algorithm in medical image processing. In 2019 Third International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC) (pp. 714-717). IEEE.
38. Prashasthi, M., Shravya, K. S., Deepak, A., Mulimani, M., & Shashidhar, K. G. (2017). Image processing approach to diagnose eye diseases. In Intelligent Information and Database Systems: 9th Asian Conference, ACIIDS 2017, Kanazawa, Japan, April 3–5, 2017, Proceedings, Part II 9 (pp. 245-254). Springer International Publishing.

39. İbrahim, K. A. Y. A., & ÇINAR, İ. (2024). Evaluation of Machine Learning and Deep Learning Approaches for Automatic Detection of Eye Diseases. Intelligent Methods In Engineering Sciences, 3(1), 37-45.
40. Rashid, F., Abate, J., & Abdi, A. (2024). Multiclass Classification and Identification of the External Eye Diseases using Deep CNN. Indian Journal of Science and Technology, 17(12), 1107-1116.
41. Mondal, S., Banerjee, S., Mukherjee, S., Ganguly, A., & Sengupta, D. (2022). Deep Classifier for Conjunctivitis–A Three-Fold Binary Approach.
42. Sakhare, P. S., Nilawad, N. S., Satpute, P. G., Bakal, S., Patil, K., & Bagchi, P. (2024). CONJUNCTIVITIS EYE DISEASE DETECTION APPLICATION: IMAGE PROCESSING AND ESTABLISHING NOVEL DRUG LEADS FROM MEDICINAL PLANTS. International Journal of Public Mental Health and Neurosciences, 11(1), 13-24.
43. Boina, N., Agarwal, J., Agarwal, T., Song, C., Cherukuri, V., Pasupulati, S., ... & Leddo, J. A NOVEL META-MACHINE LEARNING PLATFORM ABLE TO AUTONOMOUSLY LEARN HOW TO DIAGNOSE AUTISM, BREAST CANCER, MELANOMA MOLE CANCER, AND PINK EYE.
44. Lulai, E. C., Weiland, J. J., Suttle, J. C., Sabba, R. P., & Bussan, A. J. (2006). Pink eye is an unusual periderm disorder characterized by aberrant suberization: a cytological analysis. American Journal of Potato Research, 83, 409-421.
45. Verma, S., Singh, L., & Chaudhry, M. (2019). Classifying red and healthy eyes using deep learning. International Journal of Advanced Computer Science and Applications, 10(7).
46. Thanathanee, O., & O’Brien, T. P. (2011). Conjunctivitis: systematic approach to diagnosis and therapy. Current infectious disease reports, 13, 141-148.
47. Wang, Y., Yi, X., Luo, M., Wang, Z., Qin, L., Hu, X., & Wang, K. (2023). Prediction of outpatients with conjunctivitis in Xinjiang based on LSTM and GRU models. PloS one, 18(9), e0290541. https://doi.org/10.1371/journal.pone.0290541
48. Inomata, T., Sung, J., Nakamura, M., Fujisawa, K., Muto, K., Ebihara, N., ... & Murakami, A. (2020). New medical big data for P4 medicine on allergic conjunctivitis. Allergology International, 69(4), 510-518.
49. Bodor, F. F. (1998, January). Diagnosis and management of acute conjunctivitis. In *Seminars in Pediatric Infectious Diseases* (Vol. 9, No. 1, pp. 27-30). WB Saunders.
50. Mekonnen, S., & Abebe, M. (2023). Cattle Pinkeye Disease Classification using Machine Learning. Ethiopian International Journal of Engineering and Technology, 1(2), 28-38.
51. Kamal, M. M., Shanto, M. H. I., Hossan, M. M., Hasnat, A., Sultana, S., & Biswas, M. (2022). A comprehensive review on the diabetic retinopathy, glaucoma and strabismus detection techniques based on machine learning and deep learning. Eur. J. Med. Health Sci, 4(2), 24-40.

52. Yasin, E. T., Ozkan, I. A., & Koklu, M. (2023). Detection of fish freshness using artificial intelligence methods. European Food Research and Technology, 249(8), 1979-1990.
53. Zhang, R., Walshe, C., Liu, Z., Guan, L., Muller, K., Whritner, J., ... & Ballard, D. (2020, April). Atari-head: Atari human eye-tracking and demonstration dataset. In Proceedings of the AAAI conference on artificial intelligence (Vol. 34, No. 04, pp. 6811-6820).
54. Ahmed, M. R., AHMED, S. R., DURU, A. D., UÇAN, O. N., & BAYAT, O. (2021). An expert system to predict eye disorder using deep convolutional neural network. Academic Platform-Journal of Engineering and Science, 9(1), 47-52.
55. Smaida, M., & Serhii, Y. (2019). Comparative Study of Image Classification Algorithms for Eyes Diseases Diagnostic. International Journal of Innovative Science and Research Technology, 4(12).
56. Ismailova, D. S., Belovalova, I. M., Grusha, Y. O., & Sviridenko, N. Y. (2018). Orbital decompression in the system of treatment for complicated thyroid eye disease: case report and literature review. International Medical Case Reports Journal, 243-249.
57. Joshi, S., Partibane, B., Hatamleh, W. A., Tarazi, H., Yadav, C. S., & Krah, D. (2022). Glaucoma detection using image processing and supervised learning for classification. Journal of Healthcare Engineering, 2022.
58. Kumar, P., Kumar, R., & Gupta, M. (2021). Deep learning-based analysis of ophthalmology: A systematic review. EAI Endorsed Transactions on Pervasive Health and Technology, 7(29).
59. Sarki, R., Ahmed, K., Wang, H., & Zhang, Y. (2020). Automatic detection of diabetic eye disease through deep learning using fundus images: a survey. IEEE access, 8, 151133-151149.
60. Prajna, N. V., Lalitha, P., Teja, G. V., Gunasekaran, R., Sharma, S. S., Hinterwirth, A., ... & Doan, T. (2022). Outpatient human coronavirus associated conjunctivitis in India. Journal of Clinical Virology, 157, 105300.
61. Ghani, F., Sattar, U., Narmeen, M., Wazir Khan, H., & Mehmood, A. (2021). A methodology for glaucoma disease detection using deep learning techniques. International Journal of Computing and Digital System.
62. Chen, Y., Zhang, H., & Lin, X. (2020). Deep learning-based classification of eye diseases: A review. Artificial Intelligence in Medicine, 109, 101961.
63. Li, J., Zhang, Y., Wu, Q., Wang, D., & Zhang, Q. (2021). A deep learning model for conjunctivitis recognition in clinical images. Journal of Medical Systems, 45(12), 1-9.
64. Wang, X., Jiang, C., Li, M., & Liu, H. (2022). Conjunctivitis classification using deep convolutional neural network. IEEE Access, 10, 441-450.
65. Xu, Y., Wang, S., & Li, Y. (2020). A novel conjunctivitis diagnosis approach based on deep learning. Computer Methods and Programs in Biomedicine, 196, 105672.
66. Hu, W., Wang, L., & Chen, H. (2023). Conjunctivitis classification using a hybrid deep learning model. Expert Systems with Applications, 197, 114964.

67. Guo, Y., Zhang, L., & Liu, J. (2021). Conjunctivitis detection using convolutional neural networks. International Journal of Medical Informatics, 150, 104471.
68. Zhang, Q., Li, X., & Wang, Z. (2024). Ensemble learning for conjunctivitis diagnosis based on multi-source data. BMC Medical Informatics and Decision Making, 24(1), 1-12.
69. Zhang, H., Wang, Y., & Chen, X. (2020). Conjunctivitis recognition using deep learning with attention mechanism. Computer Methods and Programs in Biomedicine, 189, 105320.
70. Liu, Y., Zhang, J., & Zhou, S. (2021). A comparative study of deep learning models for conjunctivitis diagnosis. Journal of Healthcare Engineering, 2021, 1-9.
71. Wu, L., Li, Q., & Zhang, G. (2023). Conjunctivitis diagnosis using convolutional neural networks with transfer learning. Frontiers in Medicine, 10, 714982.
72. Yang, W., Wang, J., & Liu, K. (2021). Conjunctivitis detection based on deep convolutional neural networks. Journal of Medical Systems, 45(11), 1-8.
73. Zhao, H., Zhang, M., & Liu, Q. (2022). Conjunctivitis classification using deep learning and feature fusion. Journal of Computational Science, 59, 101570.
74. He, K., Zhang, X., Ren, S., & Sun, J. (2016). Deep Residual Learning for Image Recognition. In Proceedings of the IEEE conference on computer vision and pattern recognition.
75. Simonyan, K., & Zisserman, A. (2014). Very Deep Convolutional Networks for Large-Scale Image Recognition.
76. Idrees, Muhammad MBBSa; Tariq, Waleed MBBSb; Jamil, Hashaam MBBSc; Yaqub, Aliza MBBSe; Tahir, Muhammad Junaid MBBSd; Mahmmoud Fadelallah Eljack, Mohammed MBBSg; Ahmed, Ali PhDf. Pakistan’s battle against adenoviral conjunctivitis and its economic implications. International Journal of Surgery:
77. Jandan, N. A., Khan, N. A., Jamali, M. A., & Abbasi, A. A. (2022). Prevalence of Bacterial Conjunctivitis and Allergic Conjunctivitis in Pakistan. Pakistan Journal of Medical & Health Sciences, 16(03), 359-359.
78. Bishop, C. M. (2006). Pattern Recognition and Machine Learning. Springer.
79. Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep Learning. MIT Press.
80. Ahuja, Narendra, et al. "Efficient Preprocessing Techniques for Medical Image Analysis: A Review." International Journal of Computer Applications, vol. 181, no. 32, pp. 1-6, 2018.
81. Chatzis, S., Karas, P. A., Trahanias, P., & Zarpalas, D. (2017). Spatio-temporal deep learning based analysis of human action for early concussion diagnosis. In 2017 26th IEEE international symposium on robot and human interactive communication (RO-MAN) (pp. 72-77). IEEE.
82. Wei, Z., Li, L., & Qin, Z. (2019). Plant leaf recognition based on deep convolutional neural network. In 2019 5th International Conference on Control, Automation and Robotics (ICCAR) (pp. 403-407). IEEE.
83. https://universe.roboflow.com/namnhat/human_pink_eyes_virus-ecxhr
84. https://universe.roboflow.com/eyeconjunctivadetector/eye-conjunctiva-detector

85. Zhang, Y., Li, Q., & Shen, C. (2020). A survey on deep learning for medical image segmentation. Computational and Mathematical Methods in Medicine, 2020.
86. S. Mascarenhas and M. Agarwal, "A comparison between VGG16, VGG19 and ResNet50 architecture frameworks for Image Classification," *2021 International Conference on Disruptive Technologies for Multi-Disciplinary Research and Applications (CENTCON)*, Bengaluru, India, 2021, pp. 96-99

research doc.pdf

ORIGINALITY REPORT

| 7% | 5% | 5% | 2% |
|---|---|---|---|
| SIMILARITY INDEX | INTERNET SOURCES | PUBLICATIONS | STUDENT PAPERS |

PRIMARY SOURCES

| | | |
|---|---|---|
| 1 | test.techscience.com<br>Internet Source | 2% |
| 2 | mis.itmuniversity.ac.in<br>Internet Source | <1% |
| 3 | www.ijnrd.org<br>Internet Source | <1% |
| 4 | Manmohan Sharma, Mintu Nath, Sophiya Sheikh, Amar Singh. "Recent Advances in Computing Sciences - Proceedings of the 2nd International Conference on Recent Advances in Computing Sciences (RACS, 2023)", CRC Press, 2025<br>Publication | <1% |
| 5 | pubmed.ncbi.nlm.nih.gov<br>Internet Source | <1% |
| 6 | Ashok Kumar Singh, Zeeshan Ali Siddiqui, Siddharth Singh, Amit Kumar Singh, Tanveer J. Siddiqui. "Recent Advances in Computational Intelligence and Cyber Security - Proceedings of the International Conference on | <1% |