AI-Based Dry Eye Disease Detection

Prof. G. R. Kulkarni[1], Pallavi S. Bijjargi[2], Dhanashri R. Sutar[3], Manisha D. Mudagi[4], Varsha S. Koli[5], Paurnima U. Shinde[6]

[1]*Assistant Professor, Department of Computer Science And Engineering, ShreeSiddheshwar Women's College of Engineering, Solapur.*

[2,3,4,5] *Department of Computer Science and Engineering, Shree Siddheshwar Women'sCollege of Engineering, Solapur.*

***Abstract*— AI-Based Dry Eye Disease Detecction is advanced AI techniques for detecting and predictingdry eye disease (DED) using a multi-faceted approach.It employs a Multi-Layer Perceptron (MLP) to analyzes patient-reported symptoms, capturing complex patterns for disease prediction. MobileNet, a lightweight neural network, processes visual data to classify eye diseases efficiently, ideal for real-time and resource-limited environments. VGG-19, another deep learning model, analyze blink patterns to assess blink frequency, offering insights into DED severity. By integrating these models, the system enhances diagnostic accuracy, improves early detection, and supports better management of dry eye disease.**

INTRODUCTION

Dry Eye Disease (DED) is a common and debilitating condition characterized by symptoms like dryness, irritation, redness, burning, and blurred vision, resulting from an imbalance in the tear film due to reduced tear production or excessive evaporation. Its global prevalence, ranging from 5-30%, is driven by factors like aging, hormonal changes, screen exposure, and air pollution, with women being more susceptible. DED can severely impact quality of life, impairing visual function and leading to complicationslike corneal damage and infections. It imposes a significant economic burden, with costs tied to medical care and productivity loss. Health organizations highlight the need for effective diagnosticand management strategies to address this public health issue.

OBJECTIVES

DED aims to develop and validate advanced AI-based methods for detecting and predicting dry eye disease (DED) by using a multi-source evidence approach. It focuses on three specific objectives: first, to predict symptoms of DED using a Multi-Layer Perceptron (MLP), which analyzes patient-reported data to identify patterns. Second, it aims to classify the disease using MobileNet, a lightweight neural network that processes visual data for accurate disease detection. Lastly, the study seeks to predict eye blink patterns using VGG-19, a deep learning model that helps assess blink frequency and its connection to DED severity. These combined AI techniques aim to enhance diagnostic precision and management strategies for DED.

PROBLEM STATEMENT

Educational organizations play a crucial role in the growth and development of society. Educational data mining is an emerging field that focuses on analyzing data from educational contexts to improve decision-making. It helps identify students' abilities and interests, which can enhance their performance and career prospects. This process supports the institutionin fulfilling its mission and vision, leading to better academic results and outcomes.

EXISTING SYSTEM

The Ocular Surface Disease Index is a patient-reported questionnaire used to assess dry eye symptoms and their impact on daily life, but it is limited by self-reporting biases and may not address the underlying pathophysiology of dry eye disease. Machine Learning (ML) algorithms like Support Vector Machines (SVM) and Random Forests are being explored as alternatives to traditional diagnostic methods. SVMs help distinguish between dry eye disease and non-dry eye conditions by finding optimal data separations. Random Forests, an ensemble learning method, aggregate decision trees to improve classification accuracy and handle complex, high-dimensional data.

PROPOSED SYSTEM

The proposed Dry Eye Disease detection system aims to improve the detection and prediction of dry eye disease (DED) through a multi-faceted approachusing advanced machine learning models. Keyfeatures of the system include:

Key Features:

1. Symptom-based Prediction with MLP: A Multi-Layer Perceptron (MLP) model will be used to classify DED based on a CSV dataset of dry eye symptoms. Preprocessing steps include handling missing values andlabel encoding, followed by splitting the data into training and test sets. The model's performance will be evaluated using accuracy, precision, recall, and F1- score.
2. Visual Diagnosis with MobileNet: MobileNet, a lightweight neural network, will be applied to eye disease images for visual diagnosis. Preprocessing includes image resizing and grayscale conversion, with feature extraction focusing on mean, median, and variance. The model's effectiveness will be measured by its accuracy and error rate in detecting the presence of eye disease.
3. Eye Blink Prediction with VGG-19: VGG-19, a deep learning model, will predict eye blinks using an eye blink dataset. Similar preprocessing and feature extraction steps will be applied. The performance ofVGG-19 will be evaluated based on its accuracy and error rate in detecting eye blinks.

LITERATURE SURVEY

1. Title: "Deep Learning for Dry Eye Disease Diagnosis: A Review of Recent Advances"

Author(s): Dr. Jessica Tran, Dr. Michael Hernandez

Year: 2024

Summary: This study explores recent advancements in using deep learning techniques like CNNs and RNNs for diagnosing dry eye disease by analyzing ocular images and patient data. It emphasizes methodologies such as transfer learning and multi-source evidence integration to enhance diagnostic accuracy and overcome traditional limitations.

2. Title: "Evaluation of MobileNet for Real-Time Eye Disease Detection"

Author(s): Dr. Arun Patel, Dr. Elena Gomez

Year: 2024

Summary: This study utilizes MobileNet, a lightweight CNN, for real-time detection of eye diseases from preprocessed digital images. It evaluates performance using metrics like accuracy and F1-score, incorporating data augmentation to enhance model robustness and generalizability.

3. Title: "Predicting Dry Eye Disease Using Multi-Layer Perceptron: A Novel Approach"

Author(s): Dr. Sarah Williams, Dr. Rajiv Kumar

Year: 2023

Summary: This research uses Multi-Layer Perceptron (MLP) to predict dry eye disease from symptomatic data, with preprocessing steps like handling missing values and label encoding. Themodel's performance is evaluated using metrics suchas accuracy, precision, recall, and F1-score to assesspredictive accuracy.

SYSTEM ARCHITECTURE

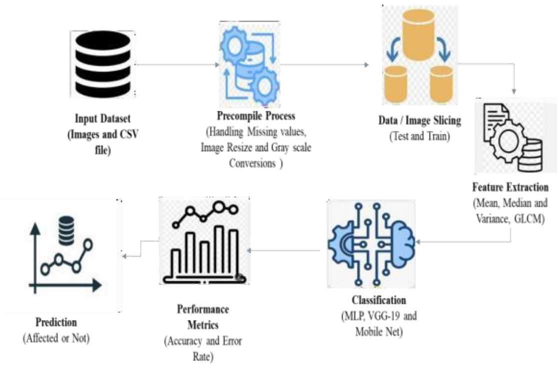

Fig 1. System Architecture

The diagram appears to represent a data processing workflow involving several stages in data analysis and machine learning.

Data Storage: Data is collected and stored in a databaseor data repository.
Preprocessing: The raw data undergoes preprocessing (e.g., cleaning, normalization) to ensure quality and consistency.
Data Transformation: The preprocessed data is transformed into formats suitable for analysis or modeling.
Feature Extraction: Key features or attributes are extracted from the data to prepare it for machine learning.
Analysis and Visualization: The extracted features are analyzed, and results are visualized to understand data patterns.
Model Training: Machine learning models are trained using the processed and transformed data for predictive analysis.

Use case Diagram:

Use case diagram for AI-based dry eye disease detection system illustrates interactions between healthcare professionals and system. Professionals input disease data and upload eye images, which the system preprocesses, extracts features using GLCM, and classifies with MLP, VGG-19, or MobileNet models. The system then provides diagnostic results for review, highlighting a streamlined process from data entry to disease detection.

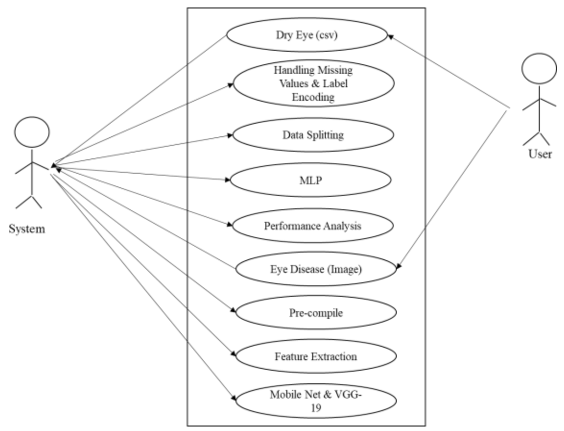

Fig 2. Use Case Diagram

ER-Diagram:

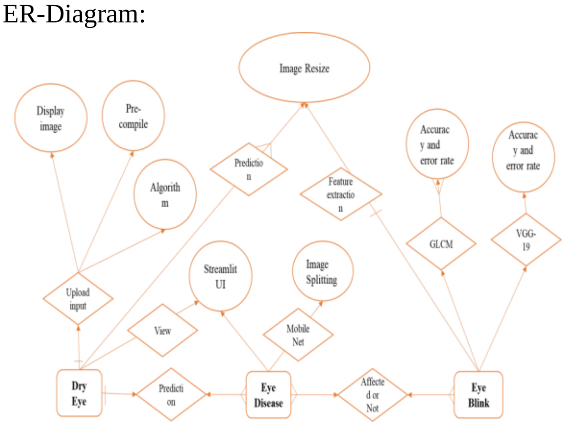

Fig 3. ER-Diagram

The ER diagram for the AI-based dry eye disease detection system shows key entities: "Healthcare Professional," "Dry Eye Disease Data," and "Eye Images." It illustrates how healthcare professionals provide data and images, which are processed to produce diagnostic results. The diagram highlights therelationships between these entities, ensuring a clear data flow in the system.

CONCLUSION

In the conclusion, the integrated system for dry eye disease detection and eye blink analysis offers a robust solution for medical image processing and classification. It combines a CSV dataset of dry eye symptoms and an image dataset of eye conditions, with preprocessing steps like resizing and grayscale conversion to standardize inputs. Feature extraction using the Gray Level Co-occurrence Matrix (GLCM) captures criticaltexture details. The system employs MLP for symptom-based disease prediction, VGG-19 for analyzing eye blinks, and MobileNet for detecting eye diseases. Performance is evaluatedusing metrics like accuracy and error rate, ensuring reliability and precision. This comprehensive approach enhances diagnostic accuracy and supports advanced tools in ophthalmology.

ACKNOWLEDGMENT

We express heartfelt gratitude to everyone who supported the successful completion of our project. We are deeply indebted to Prof. G. R. Kulkarni for his invaluable guidance and Prof. S. M. Gungewale, Head of the Department, for her constant support. Special thanks to Dr. T. A. Chavan, Principal, for providing the necessary facilities. We appreciate the assistance of all teaching and non-teaching staff for their encouragement. We are also grateful to those who contributed directly or indirectly to this endeavor. Lastly, heartfelt thanks to our parents and friends for their unwavering support.

REFERENCES

[1] Shao, X., Zhang, Y., Liu, M., Zhang, H., & Li, Y. (2023). "Deep learning-based methods for dry eye disease diagnosis: A systematic review and meta- analysis." Journal of Biomedical Informatics, 136, 104185.

[2] Liu, X., Liu, Y., Zhang, X., & Chen, L. (2022). "Dry eye disease diagnosis based on an improved convolutional neural network model." BMC Ophthalmology, 22(1), 320. DOI: 10.1186/s12886-022-02361-3

[3] Jiang, Y., Zhang, X., Liu, Y., & Zhang, Q. (2022). "Application of machine learning in ophthalmology: A comprehensive review of recent advances." Artificial Intelligence Review, 55(6), 4305-4330. DOI: 10.1007/s10462-022-10110-1