Title Page:

A Novel Breakthrough in AI-Enabled Ophthalmology using Support vector machine algorithm Compared with K-Nearest Neighbor algorithm in Detecting Glaucoma from Retinal Fundus Images.

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Keywords:Support Vector Machine algorithm,K-Nearest Neighbor algorithm , eye treatment, glaucoma, detection.

ABSTRACT

Aim: The purpose of this research is to investigate a new advancement in employing artificial intelligence in ophthalmology. Specifically, it compares two machine learning techniques (SVM and K-Nearest Neighbor) for detecting glaucoma in retina images. **Materials and Methods:** The SVM is employed on a glaucoma detection dataset of 145461 records. This paper compares the machine learning methods SVM and KNN and proposes and implements a standard module for glaucoma detection. Each group provided 1010 sample records for evaluation purposes. The sample records were measured using clinical analysis; the evaluation's enrollment ratio is one, its confidence percentage is ninety-five percent, its pretest power percentage is eighty percent, and its alpha and beta values are 0.05 and 0.5. For accuracy, the obtained significance value (p), which is less than 0.05, is 0.001. The overall accuracy of both processes was calculated and reported. **Results:**On the given dataset, the SVM classifier machine learning algorithm predicts glaucoma diagnosis with 92.00% accuracy, whereas the K-Nearest Neighbor classifier predicts the same event with 90.00% accuracy.**Conclusion:** The Support Vector Machine (SVM) algorithm surpasses the K-Nearest Neighbor approach in predicting glaucoma, according to the study.

Keywords:Support Vector Machine, algorithm,K-Nearest Neighbor, eye treatment, glaucoma, detection.

INTRODUCTION:

Glaucoma is a prevalent cause of blindness that can lead to progressive vision loss. Early identification of glaucoma is crucial for preserving vision and can be accomplished with noninvasive retinal fundus imaging screening. The development of artificial intelligence (AI) into strong medical image analysis has the potential to profoundly change how glaucoma is diagnosed.

This study looks into the development of a novel AI-powered glaucoma screening tool based on retinal fundus photos. We assess the effectiveness of two machine learning techniques used to evaluate these images: a support vector machine (SVM) and a K-Nearest Neighbor . We compared the method's ability to distinguish between eyes with and without glaucoma to determine which is better suited for this application.

Glaucoma detection includes 105 scientific publications published in IEEE Xplore, 165 scientific articles in Google Scholar, and 34 items found in ScienceDirect. Because the ideal depiction of glaucoma detection can be challenging to accomplish, Bayesian approach offers an additional method for incorporating prior data into detection models. To forecast a circumstance in which foresight is either untrustworthy or worthless. As a result, everything appears to be stable. This study compares two machine learning algorithms, K-Nearest Neighbor (KNN) and support vector machine (SVM), to see if artificial intelligence might help with glaucoma diagnosis. We use retinal fundus images to assess how well these algorithms distinguish between healthy and glaucomatous eyes.The analysis highlighted a research gap: while numerous approaches to glaucoma detection have been developed, the majority of these technologies have low accuracy. Many research have demonstrated that the K-Nearest Neighbor (KNN) performs poorly and with low accuracy in glaucoma identification. Analyzing and comparing them is the best technique to determine which categorization algorithm is most accurate. This study examines the accuracy and precision of the K-Nearest Neighbor (KNN) and Support Vector Machine (SVM) methods.

MATERIALS AND METHODS:

The data analytics lab at Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, where this study was conducted, has incredibly well-configured technologies that aid in producing reliable results. There were two groups in total that were taken into consideration for the research: group 1 had ten sample sizes, and group 2 also had ten sample sizes. G-power 0.95, alpha value 0.005, beta value 0.95, and confidence interval 95% are used in the computation. Kerneler (2019) obtained the dataset for the study from the Kaggle website.

Pseudocode for Support Vector Machine(SVM) Algorithm:

Step 1: Preparing the data

1.1 Load the collection of fundus pictures 1.2 Prepare the photos (resize, normalize, sharpen contrast, etc.)

1.3 Take relevant features (such as texture, optic disc, and cup-to-disc ratio) and extract them from photos.

Step 2: Divide Information

2.1 Separate the dataset into testing and training sets (for example, 30% testing and 70% training).

Step 3: SVM Model Training

3.1 Initialize the SVM model using the preferred kernel (radial, polynomial, or linear basis function, for example).

3.2 Use the training dataset to train the SVM model.

3.2.1 Feed the SVM with the retrieved features and the associated labels (glaucoma positive or negative).

3.2.2 If necessary, use cross-validation to modify model parameters (such as kernel parameters and regularization parameter C).

Step 4: Model Evaluation

4.1 Predict labels for the test dataset using the trained SVM model

4.2 Evaluate the model performance using appropriate metrics (e.g., accuracy, precision, recall, F1-score)

4.3 Visualize the results (e.g., confusion matrix, ROC curve)

Step 5: Fine-tuning (optional)

5.1 If performance is not satisfactory, fine-tune the model by adjusting parameters or exploring different kernels

5.2 Re-train and evaluate the model iteratively until desired performance is achieved

Step 6: Deployment (optional)

6.1 Once satisfied with the model's performance, deploy it for glaucoma detection in real-world scenarios

6.2 Implement necessary integration with existing healthcare systems if applicable

Support vector machine:

The sklearn.linear_model library of the SVM class was used for the data training in this investigation. Read Glaucoma Detection.csv by opening the file. Eighty percent of the dataset is utilized for training, and the remaining twenty percent is used for testing. The dataset's data records are distributed randomly. Three of the 10 SVM classifiers are created using the training dataset after the output variable has been defined. The testing dataset is estimated using the training dataset. Accuracy is obtained after the SVM classification design is tested.

Pseudocode for K-Nearest Neighbor (KNN) Algorithm:

Step 1: Preparing the Data

- Load the Fundus Image Dataset.
- Preprocess fundus images by resizing, normalizing, and denoising them.

Step 2: Feature Extraction

- Extract relevant features from the preprocessed fundus images.

Step 3: Dataset Splitting

- Split the dataset into training and testing sets (e.g., 70-30 split).

Step 4: Model Training

- Define the KNN algorithm.
- Train the model using the training data.

Step 5: Prognosis and Assessment

- For each image in the testing set:
    - Find the k nearest neighbors from the training set.
    - Use a voting mechanism to determine the class label for the test image (e.g., 'Glaucoma' or 'Non-Glaucoma') based on the majority class among the k neighbors.
    - Evaluate the predicted class label against the true label.
- Calculate evaluation metrics such as F1-score, recall, accuracy, and precision to assess the classifier's performance.

Step 6: Deployment and Iterative Improvement

- Refine the model iteratively based on performance evaluation.
- Tune parameters such as the value of k.
- Consider other feature extraction techniques or preprocessing methods if necessary.
- Use the improved classifier for glaucoma detection tasks in real-world scenarios if performance is satisfactory.

K-Nearest Neighbor (KNN):

The K-Nearest Neighbor (KNN) algorithm is a simple and effective method for classification and regression tasks. It belongs to the family of instance-based learning algorithms, where the model is built upon the training instances themselves. KNN classifies new instances based on their similarity to known instances in the training data.

This study was implemented using Google collab and SPSS software, and hardware specifications needed in a system for evaluation is an intel i3 processor, 50GB Hard Disk Drive, 4GB and Random Access Memory (RAM) and software specifications needed is a windows operating system.

STATISTICAL ANALYSIS

The SPSS tool is used to statistically assess the work in addition to experimental analysis. The mean, standard deviation, accuracy, and standard error mean were the research objectives. The SVM and KNN algorithms were compared using an independent sample T-Test.

RESULTS

Table 1:shows the accuracy findings derived from contrasting the Support Vector Machine (SVM) and K-Nearest Neighbor (KNN) for analysis with various iterations.

Table 2: This table displays the various parameters for each of the two groups. The accuracy, recall, F1 Score, and support for SVM and KNN have been calculated. A comparison between the two groups shows that SVM performs better in terms of accuracy (92.00%) thanK-Nearest Neighbor (KNN).

The statistical analysis of K-Nearest Neighbor (KNN) and Support Vector Machines (SVM) using various test datasets is displayed in Table 3.

Table 3:The table shows that when compared to K-Nearest Neighbor (KNN) , Support Vector Machines (SVM) yield higher accuracy.

Table 4:The statistical analysis of the Significant values for both groups is shown in Table 4. The accuracy between the two groups differs by a very little amount (0.001). That is why K-Nearest Neighbor (KNN) is inferior than Support Vector Machine (SVM).

Figure 1:The mean accuracy of K-Nearest Neighbor (KNN) K-Nearest Neighbor KNN and Support Vector Machine (SVM) was deduced in Figure 1. The outcomes demonstrated that the SVM's accuracy (92.00%) is higher than the KNN 's accuracy.

DISCUSSION:

Two groups of people experimented with K-Nearest Neighbor (KNN) and Support Vector Machines (SVM) by varying the test size. As per the SPSS testing data (Figure 1), the accuracy of SVM is 92.00%, whereas the accuracy of KNN is 90%. This demonstrates why Support Vector Machine (SVM) outperforms K-Nearest Neighbor (KNN) . The developed SVM algorithmic classification model performed better than the KNN in terms of comparison accuracy (92.00%), according to the SPSS.

Despite the good results that the provided technique achieved, there are still several limitations to the study. The findings obtained by assessing accuracy on huge datasets may not be sufficient. Furthermore, it is undesirable that the mean error in SVM is higher than in KNN.

final result. Reducing the mean error considerably improves the current study effort. One possible way to increase accuracy and reduce mean error in the algorithms is to apply optimization algorithmic approaches to them. There is also the option of applying feature selection techniques before dataset classification to improve classifier accuracy and get desired outcomes.

CONCLUSION:

A machine learning classifier known as Support Vector Machine (SVM) uses K-Nearest Neighbors to improve accuracy. According to the study, the Support Vector Machine (SVM) approach appears to be more accurate in detecting glaucoma than

K-Nearest Neighbor (KNN). It has been shown that SVM outperforms KNN in detecting glaucoma. According to the study's findings, the Support Vector Machine (SVM) strategy outperforms the K-Nearest Neighbor (KNN) approach in terms of accuracy (90.00%).

DECLARATION:

Conflicts of Interests:

No conflicts of interest in this manuscript.

Author Contributions:

Author Y. Yamini Reddy played a key role in collecting and analysing data as well as writing the manuscript. Additionally, Y. Yamini Reddy contributed significantly to conceptualization, data validation and providing critical feedback during manuscript reviews.

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REFERENCES:

1) 3-LbNets: Tri-Labeling Deep Convolutional Neural Network for the Automated Screening of Glaucoma, Glaucoma Suspect, and No Glaucoma in Fundus Images. S. Puangarom; A. Twinvitoo; S. Sangchocanonta; A. Munthuli; P. Phienphanich; R. Itthipanichpong; K. Ratanawongphaib.

Published In: https://ieeexplore.ieee.org/xpl/conhome/10339936/proceeding

DOI: https://doi.org/10.1109/EMBC40787.2023.10340102.

2) Glaucoma progression detection using variational expectation maximization algorithm. Akram Belghith; Madhusudhanan Balasubramanian; Christopher Bowd; Robert N Weinreb; Linda M. Zangwill

Published In: https://ieeexplore.ieee.org/xpl/conhome/6548349/proceeding

DOI: https://doi.org/10.1109/ISBI.2013.6556615.

3) Glaucoma Detection Using Fundus Images of The Eye

Juan Carrillo; Lola Bautista; Jorge Villamizar; Juan Rueda; Mary Sanchez; Daniela rueda

Published In: https://ieeexplore.ieee.org/xpl/conhome/8719845/proceeding

DOI: https://doi.org/10.1109/STSIVA.2019.8730250.

4) A Novel Prediction Method for Glaucoma Detection Using Retinographies

Bengie L. Ortiz; Lance McMahon; Peter Ho; Jo Woon Chong

Published In: https://ieeexplore.ieee.org/xpl/conhome/10436122/proceeding

DOI: https://doi.org/10.1109/C358072.2023.10436242

5) Review of Machine Learning techniques for glaucoma detection and prediction Tehmina Khalil; Samina Khalid; Adeel M. Syed

Published In: https://ieeexplore.ieee.org/xpl/conhome/6901367/proceeding

DOI: https://doi.org/10.1109/SAI.2014.6918224

6) Application of Deep Learning and Virtual Reality in Ophthalmology for Detection of Glaucoma Zuha Khan; Mohammad Areeb Akhter

Published In: https://ieeexplore.ieee.org/xpl/conhome/9456097/proceeding

DOI: https://doi.org/10.1109/INCET51464.2021.9456136

7) Convolutional Neural Networks for Automated Glaucoma Detection: Performance and Limitations Akash Bayyana; Jeyanand Vemulapati; Sai Hemanth Bathula; Gangula Rakesh; Srilatha Tokala; Murali Krishna Enduri

Published In: https://ieeexplore.ieee.org/xpl/conhome/10306338/proceeding

DOI: https://doi.org/10.1109/ICCCNT56998.2023.10307182

8) Glaucoma Disease Detection Using Deep Learning G. Viswa Datta; S. Ravi Kishan; A. Kartik; G. Bhargava Sai; S. Gowtham

Published In: https://ieeexplore.ieee.org/xpl/conhome/10179605/proceeding

DOI: https://doi.org/10.1109/ICECCT56650.2023.10179802

9) Experimental Approach to Identify the Optimal Deep CNN Models to Early Detection of Glaucoma from Fundus CT-Scan Images S Sumitha; S Gokila

Published In: https://ieeexplore.ieee.org/xpl/conhome/10142228/proceeding

DOI: https://doi.org/10.1109/ICICCS56967.2023.10142248

10) Transfer Learning for Early and Advanced Glaucoma Detection with Convolutional Neural Networks Ali Serener; Sertan Serte

Published In: https://ieeexplore.ieee.org/xpl/conhome/8886343/proceeding

DOI: https://doi.org/10.1109/TIPTEKNO.2019.8894965

11) Early Detection of Glaucoma using Transfer Learning from Pre-trained CNN Models Amer Sallam; Abdulguddoos S. A. Gaid; Wedad Q.A Saif; Hana'a A.S Kaid; Reem A. Abdulkareem; Khadija J.A Ahmed

Published In: https://ieeexplore.ieee.org/xpl/conhome/9406508/proceeding

DOI: https://doi.org/10.1109/ICTSA52017.2021.9406522

12) Detection and Classification of Closed Angle Glaucoma Using Optical Coherence Tomography Images Fatih Teke; Oğuz Kaynar; Yasin Görmez

Published In: https://ieeexplore.ieee.org/xpl/conhome/10296537/proceeding

DOI: https://doi.org/10.1109/ASYU58738.2023.10296

TABLES AND FIGURES

Table 1: Accuracy values of SVM and KNN algorithms obtained for each iteration while evaluating the dataset for various test sizes.

GROUP	ACCURACY
SVM	92.00
SVM	96.00
SVM	94.00
SVM	95.00

SVM	93.00
SVM	96.00
SVM	92.00
SVM	95.00
SVM	94.00
SVM	92.00
KNN	90.00
KNN	88.00
KNN	89.00
KNN	87.00
KNN	90.00
KNN	86.00
KNN	87.00
KNN	89.00
KNN	88.00
KNN	86.00

GROUP STATISTICS

	GROUP	N	Mean	Std. Deviation	Std. Error Mean
ACCURACY	SVM	20	93.6500	2.00722	.44883
	KNN	20	86.3000	3.06251	.68480

Table 2: Group Statistics Results-SVM and K-NEAREST NEIGHBOR algorithm

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
ACCURACY	Equal variances assumed	2.496	.122	8.977	38	.000	7.35000	.81878	5.69247	9.00753
	Equal variances not assumed			8.977	32.781	.000	7.35000	.81878	5.68376	9.01624

Table 3: Independent sample test for significance and standard error determination. P-value is less than 0.00 considered to be statistically significant and 95% confidence intervals were calculated.

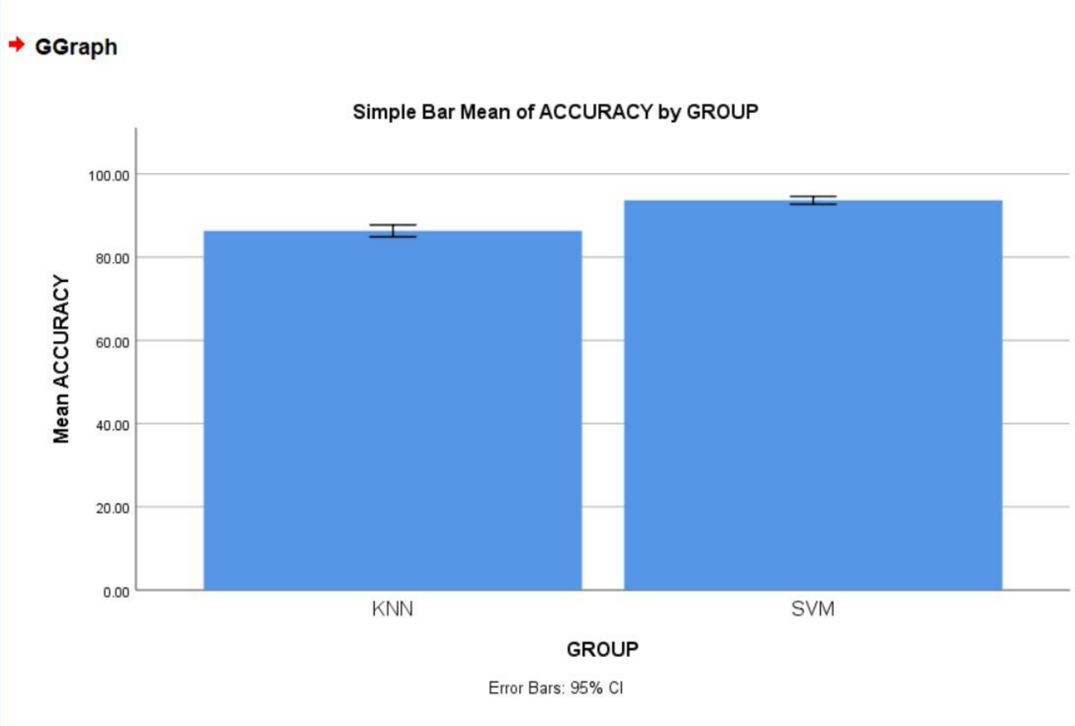

Fig.1. These results underscore SVM superior predictive performance and its potential to enhance traffic evaluation.This comparison is graphically represented with the X-axis denoting "SVM vs KNN algorithm," while the Y-axis represents "Mean Accuracy."The Error bar is represented by ± 2.