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DETECTION AND CLASSIFICATION OF DIABETIC RETINOPATHY USING YOLO-V8 DEEP LEARNING METHODOLOGY

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ABSTRACT

Diabetic retinopathy (DR) is increasing rapidly. Early detection of DR using computer aided methodology is imperative. This paper aimed to detect various stages of DR meticulously. 60 percent of datasets are considered as trained data sets. 20 percent of datasets are considered as validation datasets. '20' percent of the datasets are considered for testing. YOLOv8 is considered to extract the features and to detect the abnormalities of the fundus images. The edges information of the image is safeguarded with zero padding. Object detection, regression and classification is done with YOLOv8 methodology. The Convolutions apply filters to highlight specific patterns of the image. More spatial information is achieved with a minimum of 29 strides. But to increase the operational speed and to reduce the complexity in computation, the stride value is slightly increased to 31. The performance of the YOLOv8 is evaluated using performance metrics like Train loss function curve, precision recall curve, confusion matrix evaluation and F1 confidence curves. The training loss and validation loss are stabilized with increasing epochs to 25. The YOLOv8 classifier produced micro average precision (mAP) is 0.5 for all sets of results. This proposed methodology is significantly good for detecting diabetic retinopathy. The yolo 8 classifiers produced 0.5 mAP for all sets of results. The mAP value achieved for all classes is 0.5. For no diabetic retinopathy the F1 score value is 0.59 and for all classes F1 Score is 0.31 at 0.113. F1 Score is significantly good for CNN and YOLOv8 classification algorithms. i.e. 0.39 and 0.31. The predicted percentage for no DR is 54%. The predicted percentage for Mild DR is 38%. The prediction rate of proliferate DR is 71%. Based on the performance metrics this deep machine learning algorithm is deliberate as a stand-alone tool to detect the DR images.

Keywords: *Diabetic Macula Edema, OCT Images, Transfer Learning Models, ResNet-50, Diabetic Retinopathy, Medical Image Processing.*

1. INTRODUCTION

One. The blood vessels of the light sensitive tissue of retina are damaged due to complications that occurred with either type1 or type 2 diabetic retinopathy. This led to mild vision disorders and developed dark strings as floaters, vision blurriness, vision fluctuations and dark areas in vision eventually lead to loss of vision. These complications may arise with uncontrolled blood sugar levels [1]. In certain specific cases, growing blood vessels are ceased and walls of the blood vessels in retina might be weaken, often discharging of fluids and blood into the retina is labeled as no proliferative diabetic retinopathy [1][2]. This condition may be severe and may lead

to blindness. Sometimes, the damaged vessels ceased, and new abnormal vessels may grow in the retina. These vessels may leak jelly like material and occupy the middle of the eye. This condition is labelled as proliferative diabetic retinopathy [3]. The prevalence statistics of diabetic retinopathy is 28% and 0.45 million people led to blindness. 19.49% of Ethiopians infected and 32.7% Africans are infected with Diabetic Retinopathy (DR). Meticulous estimation and prediction of diabetic retinopathy is imperative. Ample research is taking place on diabetic research using fundus images. The objective of this paper is to develop a computer aided mechanism for meticulous interpretation of DR. This paper considered various stages of DR. Stage.1 represents No proliferative diabetic retinopathy. Stage.2 represents Mild proliferative diabetic retinopathy, stage.3 represents Moderate proliferative diabetic retinopathy. You Only Look Once (YOLOv8) methodology is applied to classify the DR stages meticulously. 60 percent of the data sets are used for training, 20 percent of the datasets are used for validation and the remaining 20 percent are used for testing.

The performance metrics of the proposed algorithm is validated using train loss curves, precision-recall curves, confusion matrix and F1 confidence curve. The results with YOLOv8 is compared with other classification methods.

This The Diabetic retinopathy data sets are classified as trained data sets, validation datasets and testing data sets. 60% of the data sets are considered as trained data sets. 20% of the data sets are considered as validation data sets and the remaining 20% of the data sets are considered as testing data sets. The trained datasets and validation data sets are given as input to the YOLOv8 algorithm. This supervised learning is used for training purposes. Object Labeling is done for each input image. Modified CSP Darknet 53 is used as backbone of the classifier. This consists of 53 convolution layers. This backbone is pretrained CNN (Convolution neural network) will extract low, medium, and high-level features of the image. The feature map of the CSP Net base layer is decomposed into two parts.

2. METHODOLOGY

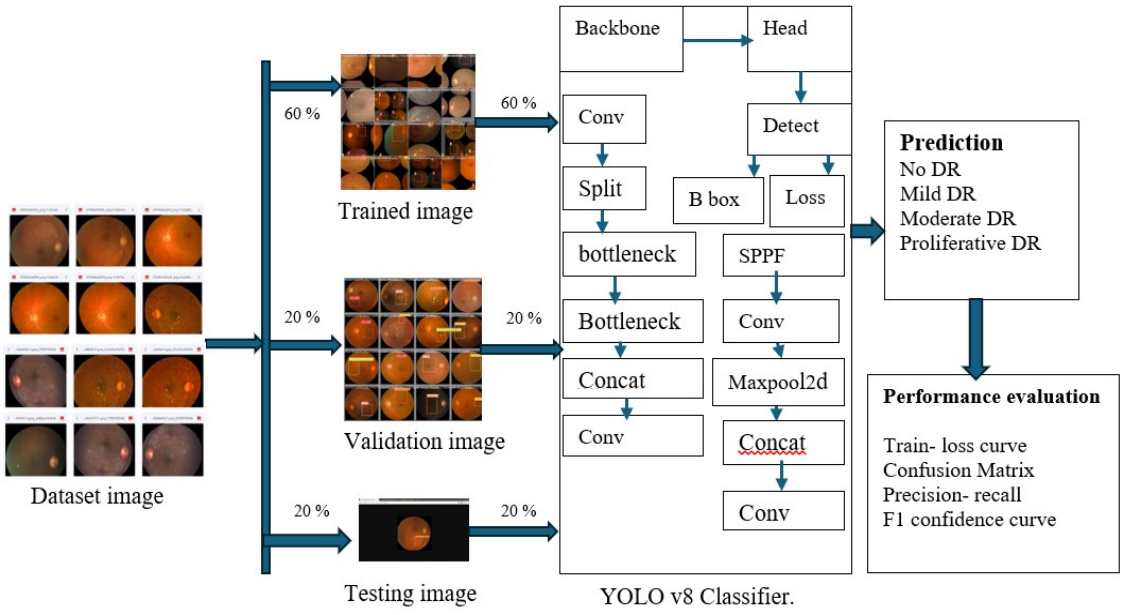
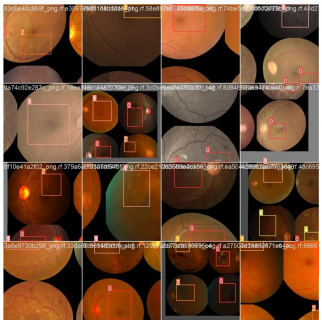


Fig.2.1. Data flow diagram

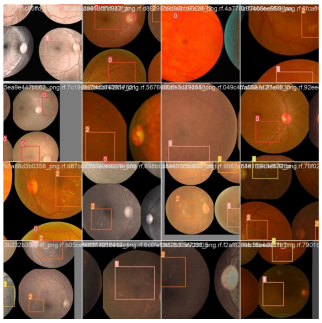
Path aggregation block merges all the features of the image. The splitting and merging will add more gradient flow. Based on the classes of the image, objects are detected, and bounding box coordinates are generated for localization of the image. CSP Darknet 53 is further followed by C2F (course to fine) block. Computational complexity is minimized with factorized convolutions of C2f model. With the C2f model superior gradient flow will be added to the system. YOLOv8 head consists of two distinct heads. These heads perform 1. Objectiveness, 2. Classification, 3. Regression tasks. These tasks are executed in parallel to improve the performance of the system. These two heads process feature maps and generate the final model of bounding boxes. Convolution consists of kernels (filters), Strides, and paddings. These convolutions extract the features of the input image. The Convolutions apply filters to highlight specific patterns of the image [4]. More spatial information is achieved with a minimum of 29 strides. But to increase the operational speed and to reduce the complexity in computation, the stride value is slightly increased to 31. During convolution process zero padding is done at the edges of the image to treat the edges like center of the image. This Zero padding minimizes loss of information at the edges [5]. Max pooling 2D is applied to minimize the spatial dimensions of the feature map. The maximum value of the image is identified while the window is moving the feature map. With max pooling 2D, the complexity of the network is reduced and subsequently, translational invariance of the feature map is achieved with max pooling 2D [6][7]. significant features are extracted during down sampling of the feature map with max pooling and in conjunction with convolution layers. Finally, the input image is classified as no DR, mild DR, moderate DR, and proliferative DR. The performance of the YOLOv8 is evaluated using performance metrics like Train loss function curve, precision recall curve, confusion matrix evaluation and F1 confidence curves.

3. RESULTS AND DISCUSSIONS

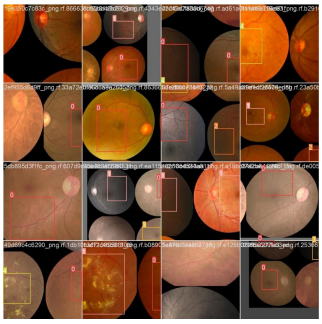
The average precision (AP), Micro average precision (mAP), F-1 Score, precision recall curves and confusion matrix are considered to meticulously determine the state of Diabetic retinopathy. The training images are represented in Fig.3.1., Fig.3.2, and Fig.3.3. The training images are organized as batch '0', batch 1, batch 2. Fig.3.4 and fig.3.5. Images are represented as validation images.



a) Batch (0)



b) Batch (1)



c) Batch (2)

Fig. 3.1: Training images.

The training loss and validation loss is estimated with cumulative errors of the training data set. From Fig.3.6 The train loss and validation loss are decreasing with increasing epochs. These two losses decrease and stabilize at 25 epochs. This

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indicates the YOLO 8 Model is optimally fit to detect various stages of diabetic retinopathy. Fig.3.7. shows the training loss and validation loss are decreasing uniformly and stabilized at 25 epochs. The rate of train loss and validation loss represents the YOLOv8 algorithm is meticulously detecting diabetic retinopathy

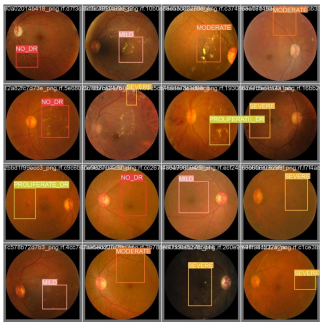

Fig. 3.4. Validation image of Batch 0

Fig.3.8. shows that the train loss is decreasing uniformly and stable with increasing epochs to 10. For data set '1' initially, the validation loss is increased with two epochs and the loss is increased 16.21 percent with two epochs and starts decreasing with increasing epochs

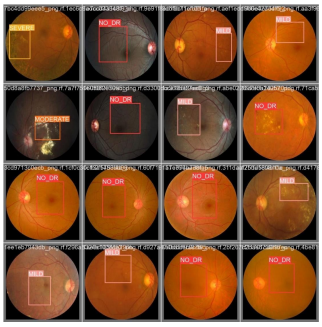

Fig. 3.5. Validation image of Batch 1.

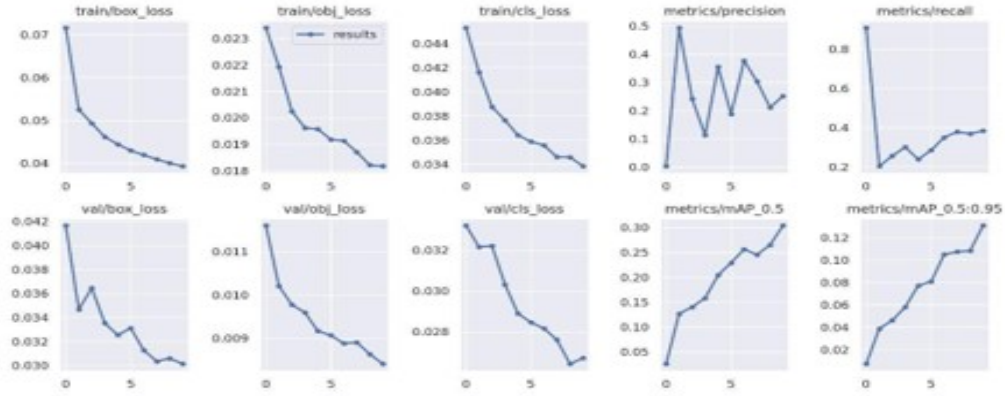

Fig. 3.6: Train-Loss Results For Set1

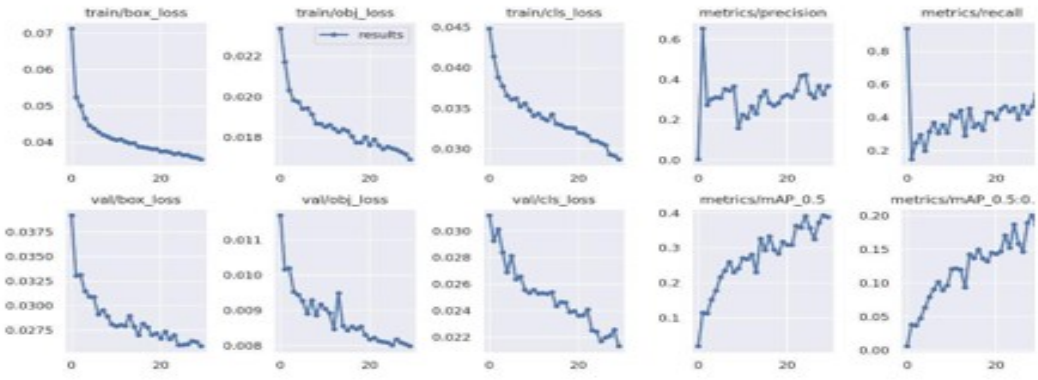

Fig. 3.7: Train-Loss Results For Set2

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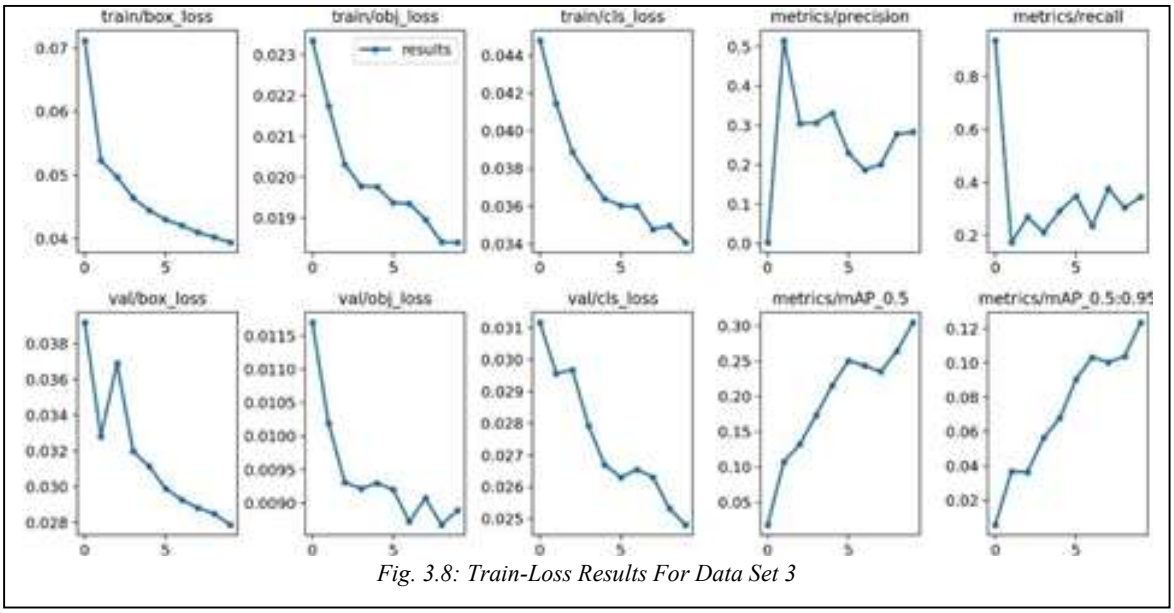


Fig. 3.8: Train-Loss Results For Data Set 3

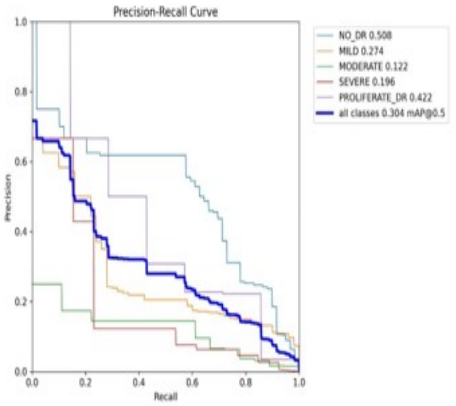


Fig. 3.9: Precision Recall Curve (A).

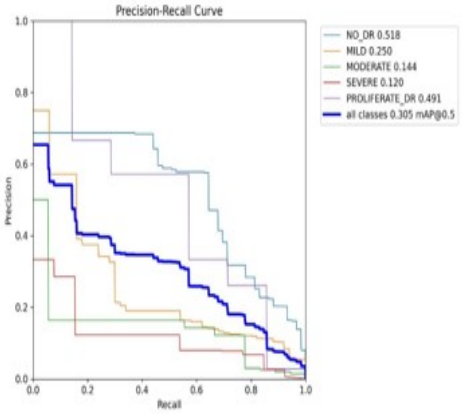


Fig. 3.10: Precision Recall Curve (B).

For dataset 2 the train loss is decreasing uniformly but the validation loss decrease is floating between '0' and 0.0090 but stabilized with increasing epochs. For data set 3 both the train and validation loss are decreasing uniformly and stabilizes with increasing epochs. Precision and recall are two entities in precision recall curve [7][8]. With High precision values low false positive rate is observed and with high recall low false negative rate is observed. The high values of precision and recall under the curve YOLOv8 classifier produce meticulous results and obtain all positive results.

High recall and low precision represent predicted labels that are not correct over training labels [9]. With High precision and low recall, the predicted labels are correct over training labels. With high precision and high recall, the predicted results are all correct. The precision is increased with high classifier threshold value which represents the results are all true positives [10][11]. classifier with low threshold values decreases the precision

and produce false positives and subsequently increase recall value and eventually, the true positive results are increased [12]. The precision levels are floated while lowering the threshold values.

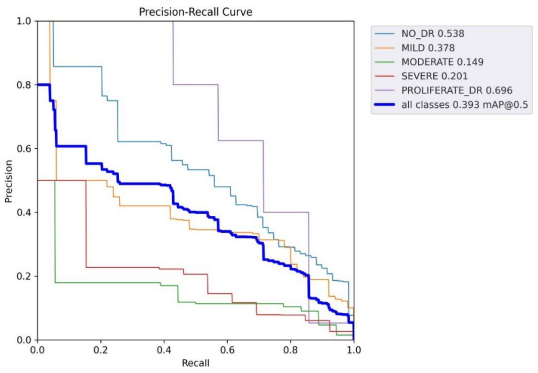


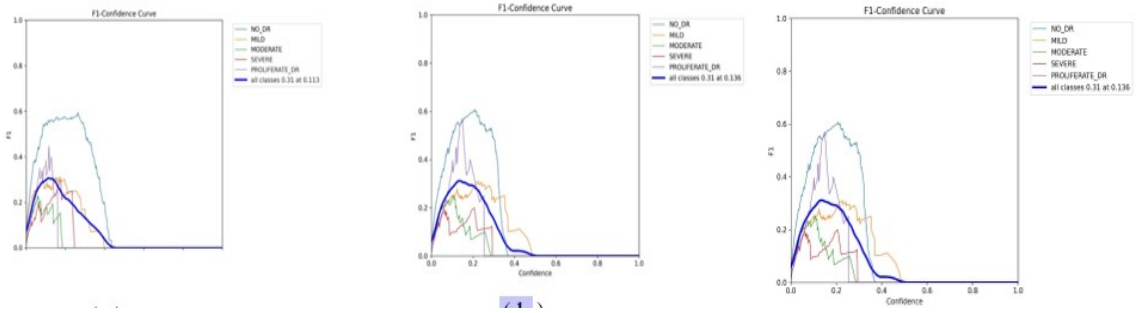
Fig. 3.11: Precision Recall Curve (c).

The precision and recall relationship are observed in the stairstep area of the plot, the precision is significantly dropped at the edges of the steps and recall gain is very small. The ratio of true positives for a single class and total sum of predicted positives of all classes is labelled as micro average precision (mAP)[14]. The optimum value of mAP is '1'. The yolo 8 classifiers produced 0.5 mAP for all sets of results. Fig.3.9. shows that average precision values for No DR, Mild DR, Moderate DR, Severe DR, and proliferate DR values are 0.508, 0.274, 0.122, 0.196 and 0.422 respectively. The mAP value for all classes is 0.5. Fig.3.10 shows that average precision value for No DR, MILD DR, Moderate DR, Severe DR, and proliferate DR are 0.518, 0.250, 0.144, 0.120 and 0.491 respectively. The mAP value for all classes is 0.5.

Fig 3.11. shows that average precision values for No DR, MILD DR, Moderate DR, Severe DR, and proliferate DR are 0.538, 0.378, 0.149, 0.201 and 0.696 respectively. The mAP value for all classes is 0.5. F1 Score indicates the hormonic mean of precision and recall value of YOLO Classification Model. Hormonic means the reciprocal of sum of values of precision and recall. Positive cases are to be recognized and false positives and false negatives are minimized. For no diabetic retinopathy the F1 score value is 0.59 and all classes F1 Score is 0.31 at 0.113. The F1 score value represents the performance of YOLO classifier for detecting the medical images of diabetic retinopathy. Precision recall value, train loss function curves, and confusion matrix surpass the F1 Score and representing the performance index of the YOLOv8 to detect the diabetic retinopathy images. Based on the performance metrics this deep machine learning algorithm is deliberate as a stand-alone tool to detect the DR images.

Correctly predicted results are represented in the diagonal elements. From Fig. 3.13. The predicted percentage for no DR is 54%. The predicted percentage for Mild DR is 38%. The prediction rate of proliferate DR is 71%.

Fig.3.14. Represents the image uploaded for testing is detected as moderate DR. YOLO v8 deep learning algorithms are considered to detect the stage of diabetic retinopathy. The data sets are collected from patients. Some of the data sets are labelled as no DR and the remaining are with DR. Bounding boxes are used to identify the region of interest using YOLOv8.



(a) (b) (c)

Fig.3.12. F1- Confidence Curves

Diabetic retinopathy is detected with YOLOv8 with significantly high precision and recall rates.

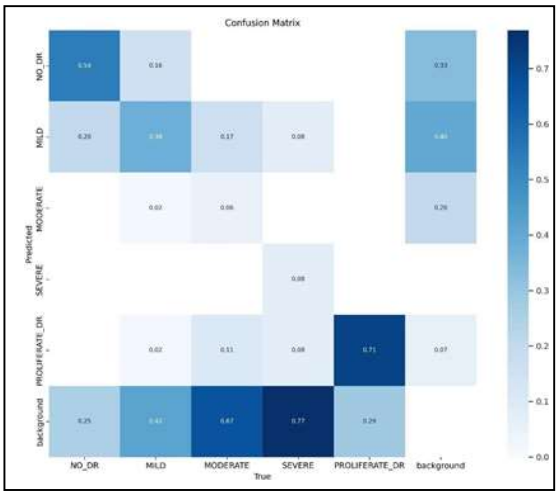


Fig. 3.13: Confusion Matrix

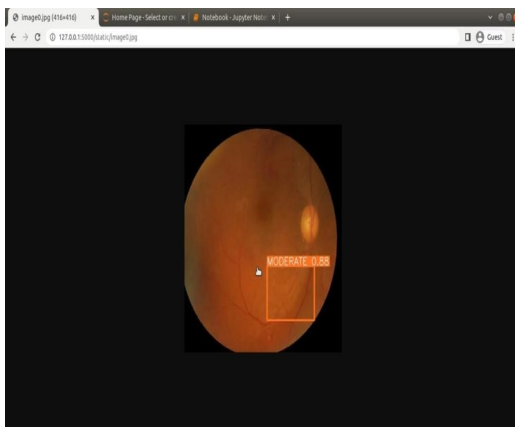


Fig. 3.14. Testing Image With Result

The results shown in Table 3.1 were obtained with CNN, SVM. VGG16, Resnet 50 are authenticated by Aishat Olatunji East Tennessee State University. From table 3.1. and Fig.3.15. YOLOv8 showed better precision value over Resnet 50, VGG 16 classification methodology. But CNN classifier shows superior precision performance over YOLOv8. VGG16 and Resnet50 show outfit performance because the recall value is greater than precision value. The recall value with YOLOv8 has less precision value so the performance of YOLOv8 is significantly better. The training accuracy and validation accuracy of YOLOv8 are 67.72 and 63.30 respectively. These performance metric parameters are approximately like CNN classification. SVM, VGG16 and Resnet50 metric parameters are much inferior over YOLOv8 and CNN classification. F1 Score is significantly good for CNN and YOLOv8 classification algorithms. i.e. 0.39 and 0.31. The SVM classifier produced 0.46. This value is superior to all the classification algorithms, but the remaining performance parameters show inferior results over other classification algorithms. CNN and YOLOv8 show superior results over other classification algorithms to detect diabetic retinopathy.

4. CONCLUSIONS:

Early detection of Diabetic retinopathy is much significant with computer aided technology. To detect the intensity of diabetic retinopathy deep learning algorithms are applied on the fundus images. YOLOv8 is applied on the data sets to detect and classify the images as NO DR, Mild

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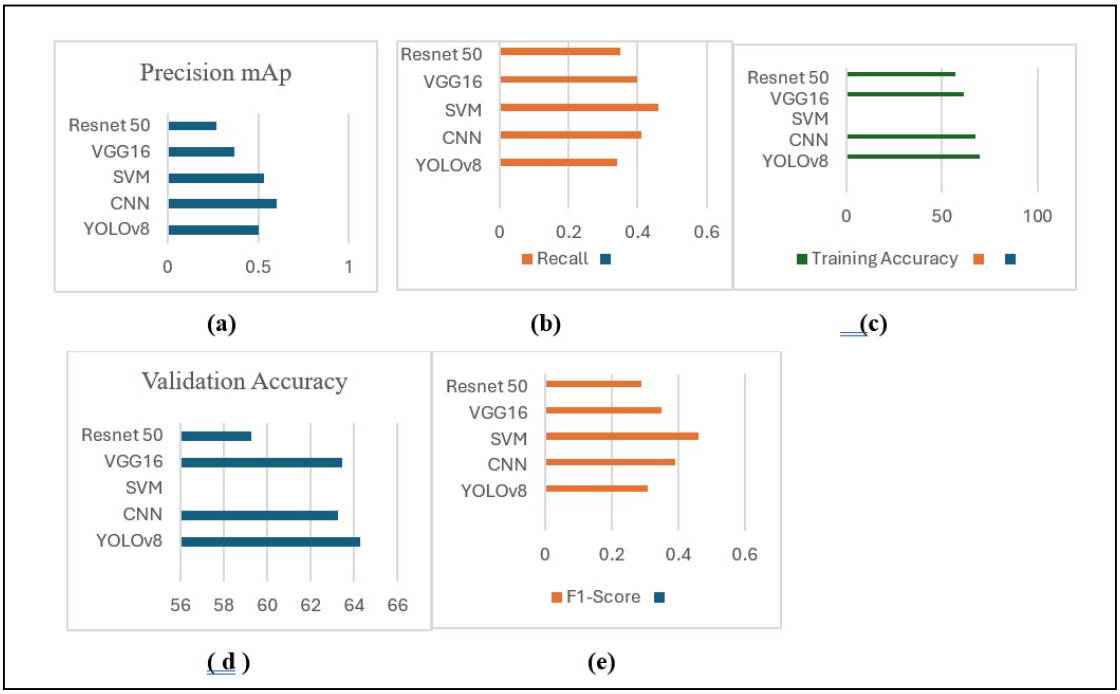

Fig. 3.15. (A) Precision Vs Classifier (B) Recall Vs Classifier (C) Training Vs Classifier (D) Validation Accuracy Vs Classifier (E) F1 Score Vs Classifier

Table.3.1. Comparison Of Different Classifier For DR Detection With Yolov8

Classifier model	Precision mAp	Recall	Training Accuracy	Validation Accuracy	F1-Score
YOLOv8	0.50	0.34	67.72	63.30	0.31
CNN	0.60	0.41	67.64	63.27	0.39
SVM	0.53	0.46	52.39	50.06	0.46
VGG16	0.37	0.40	61.34	63.472	0.35
Resnet 50	0.27	0.35	57.14	59.27	0.29

DR, Moderate DR, and Proliferative DR. The performance of YOLOv8 algorithm is compared with CNN, SVM, Resent50, and VGG16 classifiers. Train Loss curve analysis, precision - recall analysis, Confusion matrix analysis and F1-Confidance Curve are analyzed, and comparative analysis is done with other classification algorithms. The training accuracy and validation accuracy of YOLOv8 are 67.72 and 63.30 respectively. The yolo 8 classifiers produced 0.5 mAP for all sets of results. The mAP value achieved for all classes is 0.5. For no diabetic retinopathy the F1 score value is 0.59 and for all classes F1 Score is 0.31 at 0.113. F1 Score is significantly good for CNN and YOLOv8 classification algorithms. i.e. 0.39 and 0.31. The predicted percentage for no DR is 54%. The predicted percentage for Mild DR is 38%. The prediction rate of proliferate DR is 71%. Diabetic retinopathy is detected with YOLOv8 with significantly high precision and recall rates. VGG16 and Resnet50 show outfit performance because the recall value is greater than precision value. The train loss and validation loss are decreasing with increasing epochs. These two losses decrease and stabilize at 25 epochs. This indicates the YOLO 8 Model is optimally fit to detect various stages of diabetic retinopathy.The optimum value of mAP is '1'. The yolo 8

classifiers produced 0.5 mAP for all sets of results. YOLOv8 and CNN show superior results over other classification algorithms. The proposed YOLOv8 algorithm is best fit to classify diabetic retinopathy.

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