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DIABETIC RETINOPATHY ANALYSIS

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ABSTRACT
Agreatchallengeinthebiomedicalengineeringisthenon-invasiveassessmentofthephysiologicalchangesoccurringinsidethehumanbody.Specifically,detectingthe abnormalitiesinthehumaneyeisextremelydifficultduetothevariouscomplexitiesassociatedwiththeprocess.Retinalimagescapturedbydigitalcamerascanbeusedtoidentifythenatureoftheabnormalitiesaffectingthehumaneye.Conventionaldiseaseidentificationtechniquesfromretinalimagesaremostlydependentonmanualintervention.Humanobservationishighlypronetoerror,thesuccessrateofthesetechniquesisquitelow.DiabeticRetinopathyisonesuchdiseaseofretinawhichoccursinpeoplesufferingfromlongstandingdiabetes.It isamultistageprogressingdiseasenamelyNDPR andPDR. Microaneurysms,hemorrhages andexudatesaretheabnormalfeaturescommonlyobservedintheretinalimageofapersonaffectedbydiabetic retinopathy.Imageprocessingtechniquesareusedtopre-processthefundusimage,whichisfollowedbysegmentationofanomalies.Featureextractionisdoneandthedetectedfeaturesareusedtoclassifythedifferentstagesofdiabeticretinopathy.Theclassificationtechniqueusedis Fast Regional convolutional Neural Network,andtheaccuracyobtainedis98.9%.

INTRODUCTION
DiabeticRetinopathy(DR)isacomplicationofDiabeteswhichaffectstheeye.Itiscausedbydamagetotheblood vesselsoftheretina–thelight-sensitivetissueatthebackoftheeye.Atfirst,diabeticretinopathymaycausenosymptomsoronlymildvisionproblems.Eventually, itcan causeblindness.It isoneoftheleadingcauses ofblindnessintheworld.Around80percentofpopulationhavingdiabetesformorethan10ormoreyearshassomestageofthedisease. This disease specifically targets the retina, the light-sensitive tissue at the back of the eye responsible for transmitting visual information to the brain. Over time, high levels of sugar

in the blood can damage the blood vessels that nourish the retina, leading to a range of vision-related problems. The condition develops gradually and often without noticeable symptoms in its early stages. However, as diabetic retinopathy progresses, it can lead to vision impairment and, in severe cases, even blindness. Early detection and management are crucial to preventing or minimizing the impact of diabetic retinopathy. There are two primary forms of diabetic retinopathy: non-proliferative (also known as background) and proliferative. Non-proliferative diabetic retinopathy involves weakening and

swelling of the retinal blood vessels, which can result in leakage of fluid and blood into the retina. In proliferative diabetic retinopathy, new, abnormal blood vessels may grow on the retina, potentially leading to more severe complications. Regular eye examinations are vital for individuals with diabetes, as they enable early detection of diabetic retinopathy and the initiation of appropriate treatments to preserve vision. The management of diabetes through blood sugar control, blood pressure management, and other lifestyle changes is also crucial in preventing or slowing the progression of this condition.Almosttwo-thirdofallType2andalmostallType1diabeticsareexpectedtodevelopDRoveraperiodoftime.

a b

Figure1. VisionAffectedbyDiabeticRetinopathy.a.NormalVisionb.VisionaffectedbyDiabeticRetinopathy

Diabeticretinopathyisclassifiedintotwotypes:
Non-proliferativediabeticretinopathy(NPDR)istheearly stageofthediseaseinwhichsymptomswillbemildornonexistent.InNPDR,thebloodvesselsintheretinaareweakened.Tinybulgesinthebloodvessels,calledmicroaneurysms,mayleakfluidintotheretina.Thisleakagemayleadtoswellingofthemacula.
Proliferativediabeticretinopathy(PDR)isthemoreadvancedformofthedisease.Atthisstage,circulationproblemsdeprivetheretinaofoxygen.Asaresult,new,fragilebloodvesselscanbegintogrowintheretinaandintothevitreous,thegel-likefluidthatfillsthebackoftheeye.Thenewbloodvesselsmayleakbloodintothevitreous,cloudingvision.
OthercomplicationsofPDRincludedetachmentoftheretinaduetoscartissueformation.InPDR,newbloodvesselsgrowintotheareaof theeyethatdrainsfluidfromtheeye.Thisgreatlyraisestheeyepressure,whichdamagestheopticnerve.Ifleftuntreated,PDRcancauseseverevisionlossandevenblindness.
Itistheimageoftheinternalstructureoftheeyecapturedusingspecializedfunduscameras that consistofan intricatemicroscopeattached toaflashedenabledcamera. Themainstructuresthatcanbevisualizedonafundusimagearethecentralandperipheralretina,opticdisca

ndmacula.
ThecommonabnormalitiesfoundinthehumanretinaareMicroaneurysms,HemorrhagesandExudatesas showninFigure.2

Figure.2Fundusimagewithabnormalities

Asmallswelling thatformsontheendsoftinybloodvessels.Thesesmallswellingsmaybreakandallowbloodtoleakintonearbytissue.Theearliestvisibilityofdiabeticretinopathyisthemicroaneurysms.Retinalhemorrhageisadisorderoftheeyeinwhichbleedingoccursintotheretina.Retinalhemorrhagesthattakeplaceoutsideofthemaculaifleftundetectedformanyyears,andmaysometimesonlybe pickedupwhen the eyeisexaminedin detailbyophthalmoscopyorfundusphotography.Someretinalhemorrhagescancausesevereimpairment ofvision.
AsDiabeticRetinopathyprogresses,afluidrichinproteinandcellularelementsthatoozesoutofbloodvesselsduetoinflammationandisdepositedinnearbytissues.Exudatesaremanifestedasspatially randomyellowishorwhitishpatchesofvaryingsizes,shapesandlocations.Thesearethevisiblesignof DRandamajorcauseofvisuallossinnon-proliferativeformsofDR.

LITERATURESURVEY

ImageProcessingforIdentifyingDifferentStagesofDiabeticRetinopathy

Inthiswork,analgorithmhasbeendevelopedfortheidentificationofthedifferentstagesofDiabeticRetinopathy(DR).Theirregularitiesintheretinalbloodvesselssuchaschangesintheperimeter,areaofspreadareconsideredasameasureofseverityofDR.TheinputfundusimagesareobtainedfromtheMESSIDORDatabase.Atotalof100imagesareanalyzedinthepresentstudy.Theseimagesaregradedintofoursubsetsas Grade0,1,2and3.Grade0correspondstonormalretinalimagesornoDR.Grade1imagescorrespondtoMildNon-ProliferativeRetinopathy.Grade2imagescorrespondtoModerateandSevereNon-ProliferativeRetinopathy.Grade3imagescorrespondtoProliferativeRetinopathy.Thisalgorithmprovides85%accuracy.

BPand SVM basedDiagnosisof DiabeticRetinopathy

Thisworkproposesanalgorithmforidentificationofthedifferentstagesofdiabeticretinopathy.TheearlysignsofDRMicroaneurysmsareconsideredforclassifyingthedifferentstagesofthedisease.Theinputfundusimageispre-processedusingmedianfiltertoremovesaltandpeppernoise.MAslooklikeisolatedpatternsandaredetachedfromthevessels.Basedontheshape,intensitylevelandsizethefeaturesof Microaneurysmscanbeextracted.AfterthedetectionofMicroaneurysms,Dependingonthecountofdetected Microaneurysms,theimagesareclassifiedwhetheritisnormal,mildmoderateandseverebyusingSVM.Thismethodprovides83%accuracy,74%sensitivityand100%specificity.

DiabeticRetinopathy:PatientIdentificationandMeasurementoftheDiseaseUsingANN

Inthissystem,fundusretinalimageisusedtodiagnosediabeticretinopathypatient.Developedsystemusedgreenplaneoutof RGBcomponentofimageduemoreclarity.Green planeisselectedbecauseredplaneshavesaturatedfeaturesandblueplane haslowintensity

featureswhilecontoursareeasily viewedingreenplaneduetoproperintensityfeatures.MedianfilteringoperationandhistogramequalizationoperationsisperformingonagreenplanetoanalyzevariousfeaturesinDRpatient.Inthegivensystemdefectsboundariesarecreatedaroundtheaffectedareasoftheretinaimageandcalculatingtheareas.AccordingtotheareaofDR feature component and with thehelpANNbytraininganddefiningweightstothepreviouslayer.Severityofthediseasecanbeanalyzed. Achievedanaccuracyof86.36%.

DiabeticRetinopathyDetectionusingFast Recurrent Neural Network

Thissystemproposesclassificationoffundusimagesusing Fast Recurrent Neural Networkalgorithm.Fromthetotal778images287featuresareextracted.Afterextractionclassesareformedasclass0,class1,class2,class3having360,88,142,188respectively.TheFast Recurrent Neural Networksalgorithmisoneofthebestamongclassificationalgorithms-ableto classifylargeamountsofdatawithaccuracy.Fast Recurrent Neural Networksareanensemblelearningmethodforclassificationandregressionthatconstructanumberofdecisiontreesattrainingtimeandoutputtingtheclassthatisthemodeoftheclassesoutputbyindividualtreeswhereeach tree depends on the values ofa randomvector sampledindependentlywiththesamedistributionforalltreesintheforest.Thebasicprincipleisthatagroupof“weaklearners”cancome togetherto form a “stronglearner”.Achievedanaccuracyof 74.93%.

AutomaticDetectionofMicroaneurysmsandClassificationofDiabeticRetinopathyImages usingSVM Technique

Themainobjectiveofthisworkistodetecttheearlystageof DRusingthefeaturesextractedfromthepre-processedimage.Theimageobtainedfromthedatabaseissubjectedtothepre-processingstepssuchasgreenchannelextraction,contrastenhancement,medianfilteringandhistogramequalization.Afterpre-processing,theimageismorphologicallyoperatedbyadiskshapedstructuringelement.Connectedcomponentanalysismethodisusedfortheremovalofopticdisk.Thisimageisthenutilizedforfeatureextraction.ThefeatureslikeMicroaneurysmsarea,homogeneityandtexturepropertiesareextracted.Theappropriatefeaturesforclassificationareselected.SupportVectorMachinetechniqueisusedforclassifyingtheinputimagesasnormalandDRbasedimageaswellasdetectingtheearlierstageofDRusingtheextractedfeatures.

PROPOSEDSYSTEM

TheProposedsystemisamultistageclassifierofDiabeticRetinopathy.Thissystemovercomesthedrawbacksoftheexistingsystembyclassifyingthediseaseintofourstages,namely,Normal,NPDR1,NPDR2andPDR.Thismultistageclassificationisimportantbecausethediseaseitselfprogressesinmultiplestages.Thereoccurrenceofthediseasedependsonthestageinwhichthetreatmentisprovide,soitisnotenoughtoclassifytheimageasnormalandabnormal. Thepre-processingpartofboththeexistingandproposedsystemremainsimilar,thedifferencecomesinthesegmentationandfeatureextractionstages.Existingsystemonlysegmentedanomalieslikemicroaneurysms,theproblemwiththisisthisanomaly occursintheinitialstageofthedisease.Treatmentcannotbegivenatthisstage;hencethisisamajordrawback. Theproposedsystemovercomesthisbysegmentinghemorrhagesalongwithmicroaneurysmsandalsobyconsideringalargefeaturesetwhichincludestheareaandcountofthesegmentedanomalies. Thefeaturesetalsoincludestexturalfeatureslikeenergyandcorrelation,andstatisticalfeatureslikemeanandvariance.Thisfeaturesetisthenusedtoclassifytheimageintotherespectiveseverity.

RESULTS

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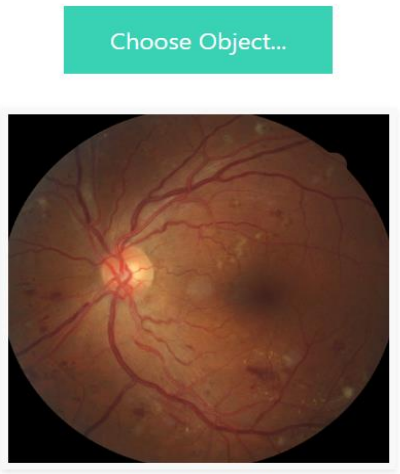

Fig.3 Result Predicting Severe Diabetic Retinopathy

Fig.4 Result Predicting Moderate Diabetic Retinopathy

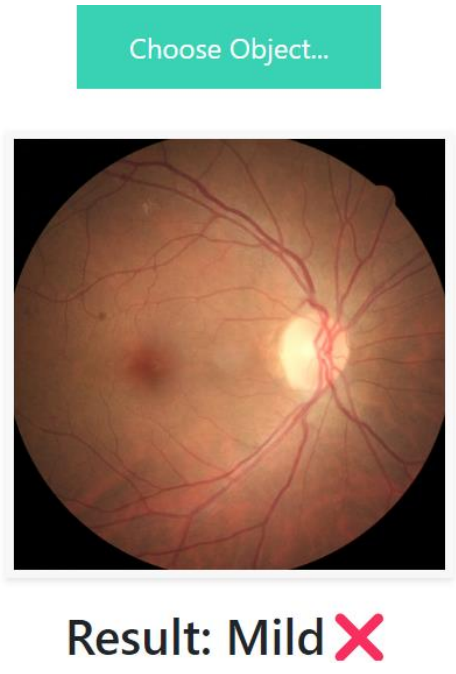

Fig.5 Result Predicting Mild Diabetic Retinopathy

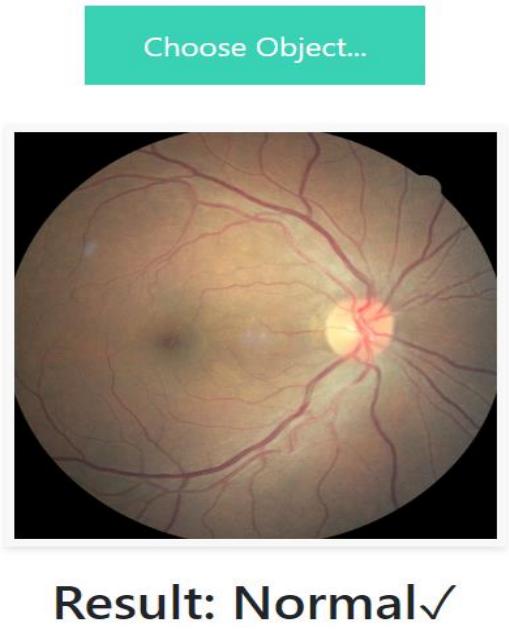

Fig.6 Result Predicting Normal Diabetic Retinopathy

CONCLUSION

ThefastandefficientearlydetectionofDiabeticRetinopathyisonlypossibleifthereisaneffectivemethodfor segmentingthediabeticfeatures inthefundus image.Theproposedsystem presentsafast,effectiveandrobustwayof detecting diabeticfeatures inthefundusimageswhichcanbeusedforclassificationoftheimagesbasedontheseverityofthedisease.Ther etinalimagesaresubjectedtograyscaleconversion,preprocessingandfeatureextractionsteps.Theextracted featuresarefedtoaFast Recurrent Neural Networkclassifierwhichwillclassifytheimagesintodifferentseverity levels.ThusthisFast Recurrent Neural Networktechniquehasgiven a successfulDRscreeningmethod whichhelpstodetectthe disease inmultiplestages.

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