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Embrace Autism: Autism Spectrum Disorder Detection using Deep Neural Network

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Abstract: Autismspectrumdisorder(ASD)isaneurodevelopmental conditionthataffectsthewayindividualsunderstandandinteract with the world, oftenresultingin challenges related to social communication, behavioral adaptation, and sensory processing. Embrace Autism is an innovative web-based platform developed tosupport individuals on the autism spectrum by integrating learning, community engagement and early screening support through artificial intelligence.The project addressesacriticalgapinexistingdigitalresources,wheremostplatformseither focus only on medical diagnostics or provide fragmented support. Embrace Autism provides a holistic solution combining interactive learning modules, mentorship programs and AI-powered visual screening within a single inclusive system.The platformusesa responsive frontendbuiltwith React.jsandTailwindCSS,con- nectedtoanAI-poweredbackendusingTensorFlowandFastAPI.Itsdetection modelanalyzesuploaded facialimagesusingaCNN-baseddeeplearningmodel (.h5) deployed using FastAPI. The image is resized, normalized and classified togenerate probability-based screening insights that may indicate potential autism symptoms.Key contributions of the system include AI-based early screening, gam-ified tools that enhance cognitive and social development, and real-time interaction features that promote inclusivity.Through its thoughtful design and empathetic approach,Embrace Autismempowersindividual swithautismwhilecontributing to a more supportive and inclusive digital environment while promoting greater awareness, acceptance and early intervention.

Keywords—AutismSpectrumDisorder,EarlyScreening,React.js,TensorFlow.js,In- clusive Learning.

I. INTRODUCTION

Autism spectrum disorder (ASD) is a neurodevelopmental condition that affects how individuals understand, communicate, and interact with the world around them.With millions of people around the world facing challenges in social communication, behavioral adaptations, and sensory processing, the need for accessible and helpful digital resources hasbecomeincreasinglyimportant.TheEmbraceAutismprojectaimstoaddressthis need by bridging the gap between technology and empathy, offering a unified and user- friendlysystemthatsupportsindividualsacrossdifferentstagesoflife.

Embrace Autism focuses on both early awareness and ongoing developmental support. Existing platforms are often either too clinical, limiting themselves to diagnoses, or too fragmentedtomeetthediverseneedsofindividualsandfamilies.Earlydetectionplays avitalroleinimprovinglong-termoutcomes,andbyintegratingArtificialIntelligence (AI) with web technologies, the project creates a bridge between clinical insights and everyday support.Through features such as interactive learning modules for children, communityengagementandmentorshipprogramsforadults,andAI-basedscreening tools that analyze facial expressions, gestures and gaze patterns, the platform ensures ethical,privacy-consciousandinclusivesupport.

BuiltusingmodernframeworkslikeReact.JSandTailwindCSS,EmbraceAutism provides a clean and responsive user experience that allows users to access learning tools, awareness content, real-life success stories, and AI-assisted screening via webcam or im-age input.Although the screening feature provides probability-based insights rather than medical diagnosis, it provides timely awareness and direction to families.Overall, the project represents a compassionate, visionary approach that promotes inclusion, continu- ous learning, and early awareness, contributing to a more supportive and understanding digitalsociety forindividual sontheautismspectrum.

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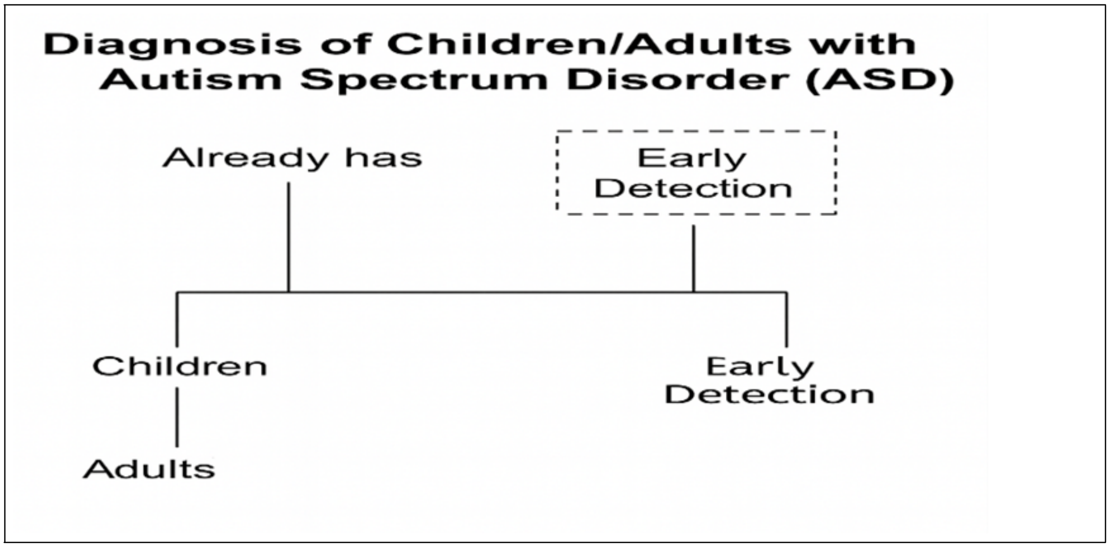

Figure1:OverallSystemArchitectureforEmbraceAutism[cite:48]

Apart from its technical features, the project emphasizes the importance of creating asupportive environmentwhereindividualswithautismcanthriveemotionally,socially and academically.By combining structured learning activities with community engage- ment,EmbraceAutismencouragesmeaningfulconversationsandskilldevelopmentthat extends beyond digital devices.This platform helps families gain a deeper understand- ing of ASD through accessible information, guided resources, and practical strategiesfor everyday support. By integrating both early identification and ongoing developmen- tal support, the system ensures that individuals – whether newly identified or already diagnosed – receive ongoing, holistic support tailored to their specific needs.This com- prehensive approach highlightstheproject'scommitmenttopromotingempowerment, awareness and long-term well-being within the autism community.

II. RELATEDWORK

Severalresearcheffortshaveexploredearlyidentificationandbehavioralunderstandingofautismspectrumdisorder(ASD).Basicdiagnostict oolssuchasM-CHATandADOSare widely used but require trained professionals, limiting access to comprehensive early screening.Developmental studies highlight early behavioral markers such as decline in eye attention patterns, while machine-learning approaches increasingly use subtle expressions, speechprosody,andmultimodalbehavioralsignals.

Advances in deep learning and computer vision – including facial landmark extraction, spatio-temporal modeling, and multimodal neuroimaging analysis – have significantly im- proved ASD screening accuracy.These methods demonstrate strong capabilities but often focus on isolated tasks such as early detection, emotion recognition or neural analysis. Parallel research emphasizes accessible, low-cost, and remote ASD screening using home video,telemedicine,gazetracking,andaudio-basedmodels.

Although these studies improve detection capabilities, most lack integrated develop- mental support and rarely address the needs of adolescents and adults.Existing systems often omit community facilities, counseling, or personalized learning pathways.Address-ingthesegaps,theEmbraceAutismProjectproposesanintegratedplatformcombining AI-powered early screening, age-specific learning resources, emotional-behavioral support modules, and accessible web-based tools, creating a comprehensive ecosystem for ongoing ASD support and awareness.

Inadditiontoidentity-focusedresearch,severalstudiesemphasizetheimportanceof ongoing developmental support and individualized education for individuals with ASD. ManyAI-powerededucationalplatforms focusoncommunication, emotionrecognition, andsocialskillsenhancement,yetonlytargetchildrenandoftenlackstructuredsupport for teens and adults .Existing tools rarely integrate community-based features, counsel- ing programs, or personalizedcontent tailoredto differentage groupsand abilitylevels. Furthermore,whilemultimodalAImodelsimprovescreeningaccuracy,fewsystemscom-bineneuralnetwork-basedearlydetectionwithinteractivelearning, emotionalsupport, and real-life guidance.

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The Embrace Autism Project builds on these gaps by offering a holistic platform that merges early identification, educational resources, community engagement, and dedicated adult and child support sections into a single, accessible framework that addresses limi- tationsseeninpreviousresearch.Overall,existingresearchprovidesstrongfoundations in early ASD detection, behavioral analysis, and AI-driven screening, yet significant gaps remainincontinuityofsupportandreal-worldaccessibility. TheEmbrace Autismproject addressestheselimitationsbyintegratingidentity,learningandcommunityengagement into an integrated system.This holistic approach aims to enhance early detection while ensuring long-term developmental support for individuals of all age groups.

III. PROPOSED METHODOLOGY

TheEmbraceAutismProjectemploysastructureddeeplearningworkflowtoaidinearlyautismdetectionthroughfacialbehavioranalysis,aswellasintegratetheresults into a web-based learning platform. The methodology involves four major steps: dataset collection, data preprocessing, data segmentation, and model development for automated autism-related behavior detection.

A. Data Collection

This study uses two publicly available datasets from Kaggle, the Autism Facial Image Datasetandthe AutismSmartDetectorDataset.Together,thesedatasetsprovidediverse facialimagesofchildrenshowingautisticandnon-autistic behavioral patterns,including eyegazedeviations,facialasymmetries,emotionalirregularities,andsubtleexpressions relevant to ASD screening.

- Dataset 1:Autism Image Data (Cihan063): This dataset contains labeled facial images classified into Autistic and Non-Autistic categories.It includes a variety of facial expressions, allowing the model to learn discriminative behavioral features.
- Dataset 2:Autism Smart Detector:This dataset contains preprocessed facialimages and associated labels that support early autism behavioral detection. It includes eye contact samples, emotion clusters, and structured facial landmarks.

Table1:DistributionofAutisticandNon-AutisticImages

Class	TotalImages
Autistic	1468
Non-Autistic	1468

B. Class-wiseFeaturesandIndicators

Thedatasetconsistsoftwoprimaryclasses:

- ASD Indicators:These samples include facial landmarks and eye-gaze deviations that are commonly associated with autism-related behavioral patterns.
- Non-ASD:Thesesamplescontainnormalizedfacialexpressionswithoutnoticeable gaze or landmark deviations.

C. PreprocessingDataImage

To enhance input consistency and optimize model readiness, a standardized preprocessing pipeline is applied across both datasets.
ImageStandardizationSteps:

- Allimagesareresizedto64×64pixelstomaintainuniforminputshape.
- Pixelintensitiesarenormalizedtothe[0,1]rangefornumericalstability.
- Facialalignmentisperformedusinglandmarkdetection(similartoOpenFace[7]).

D. NoiseartifactsareremovedusingGaussiansmoothing.

Data Augmentation:To reduce overfitting and increase generalization, the follow- ing augmentations are applied:

- Horizontal/verticalflips
- Randomrotation(±15◦)
- Zoomtransformations
- Brightness/contrastadjustments

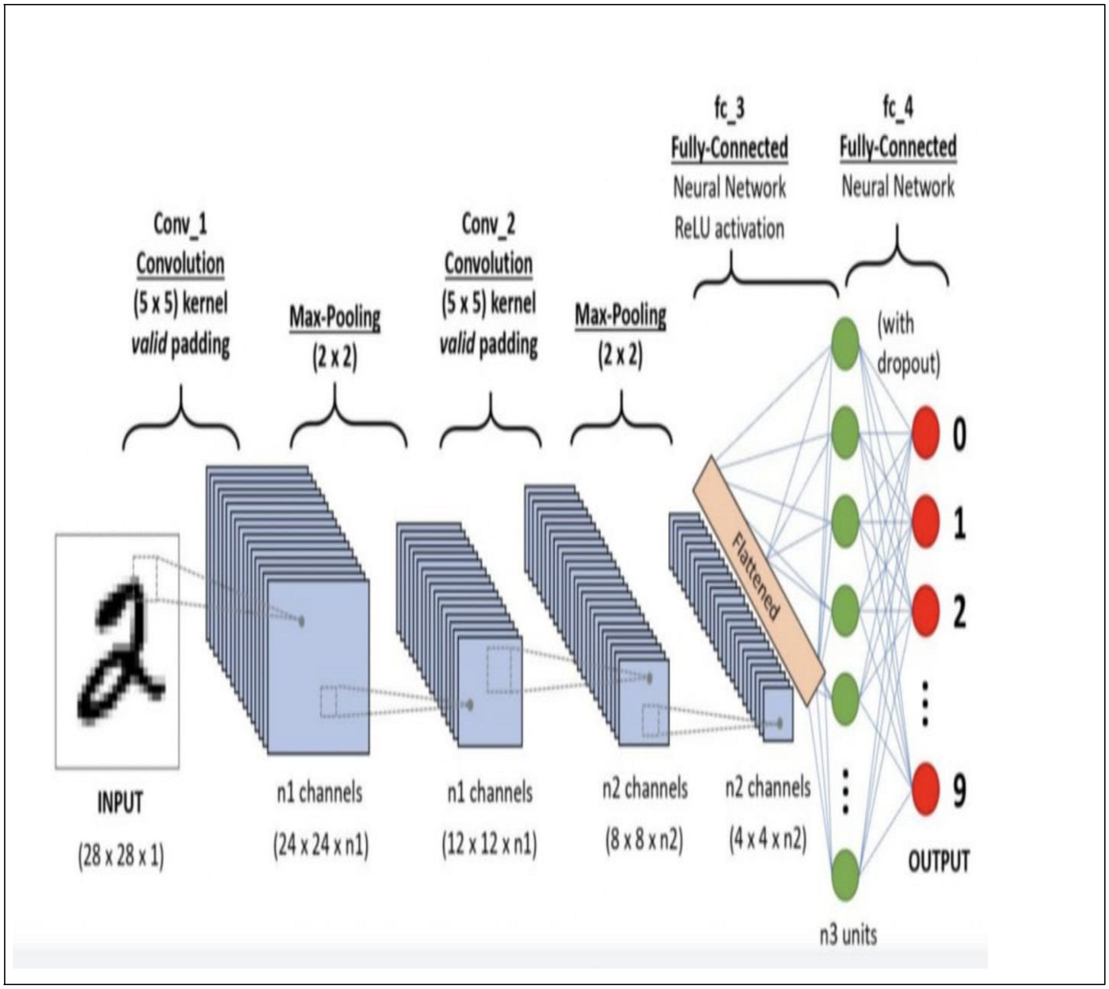

Figure2:ImagePreprocessingandAugmentationSteps[cite:100].

This ensures the model learns robust, expression-independent representations of autism linkedfacialbehaviors. ProcessingPipeline→ImageUpload→Resize(256 ×256)→ Normalization→ CNNModelPrediction→ ProbabilityScore.

E. Feature Extraction

Both datasets are annotated and cleaned using Roboflow, ensuring consistent labeling across all classes.After annotation, the combined dataset is divided into training, vali- dation,andtestingsetstoeffectivelyevaluatetheperformance.

Table2:Training,ValidationandTestingSplit

TotalImages	Training(80%)	Validation(10%)	Testing(10%)
Combined datasets	80%	10%	10%

The train-validate-test split ensures that the model generalizes well and bias is avoided, following best practices in deep-learning evaluation.

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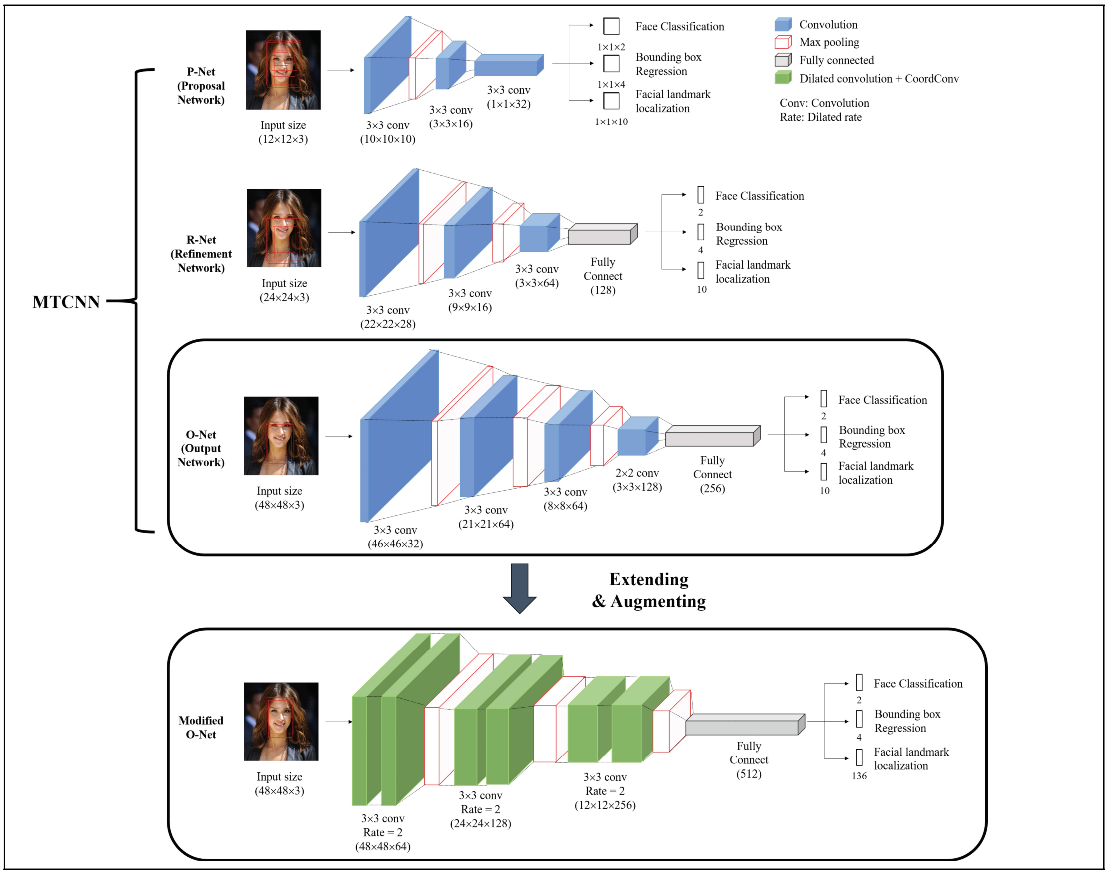

Figure3:DatasetAnnotationandSplittingWorkflow[cite:109].

F. ModelIntegration

ThescreeningsystemusesaCNN-baseddeeplearningmodeltrainedonfacialimages (256×256×3resolution).The trained model (.h5) is deployed using FastAPI, where up- loaded images are resized, normalized, and passed into the model to generate probability- based autism risk scores.

G. Image-BasedAutismScreening

ThescreeningsystemusesaConvolutionalNeuralNetwork(CNN)modeltrainedon labeledfacialimages.No YOLO-based object detectionor facialbehavior localization is used in the current implementation.

Forscreening,theimageuploadedbytheuserisprocessedusingthefollowingsteps:

- ConverttoRGBformat
- Sizechangedto256×256pixels
- Normalizedto[0,1]pixelrange
- ReshapedusingFastAPIbackendandpassedtotrainedCNNmodel(.h5format)

The CNN model generates a probability score indicating autism risk.Classification is basedonlearnedvisual patternsratherthanexplicittrackingofchangesingazeorfacial expression.

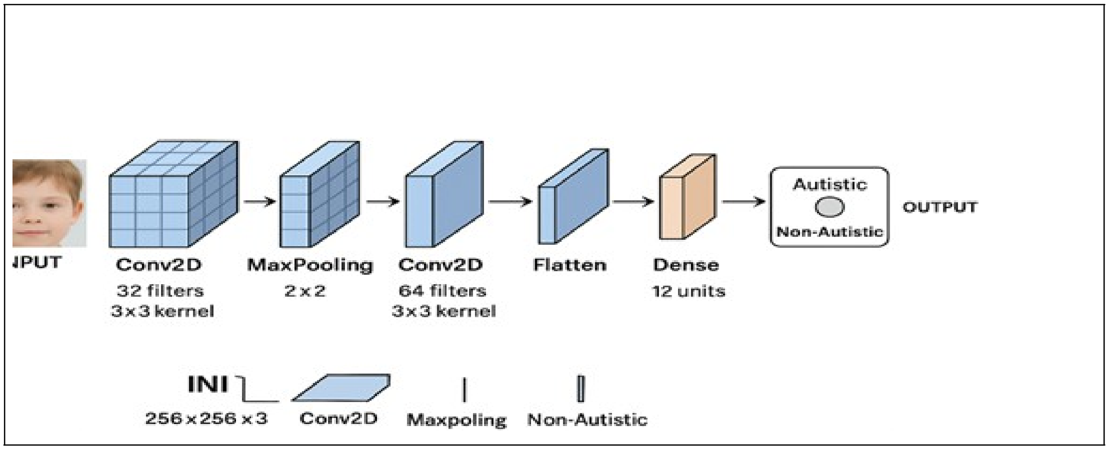

Figure4:Image-to-PredictionProcessingPipelineThroughCNNModel[cite:123].

H. ModelDeployment&Testing

The trained CNN model is integrated into the Embrace Autism platform using FastAPI (server-sideprocessing).Inferenceoccursonthebackend,andnouserimagesarestored, ensuring privacy and ethical compliance.Quality and accessibility of autism awareness tools.

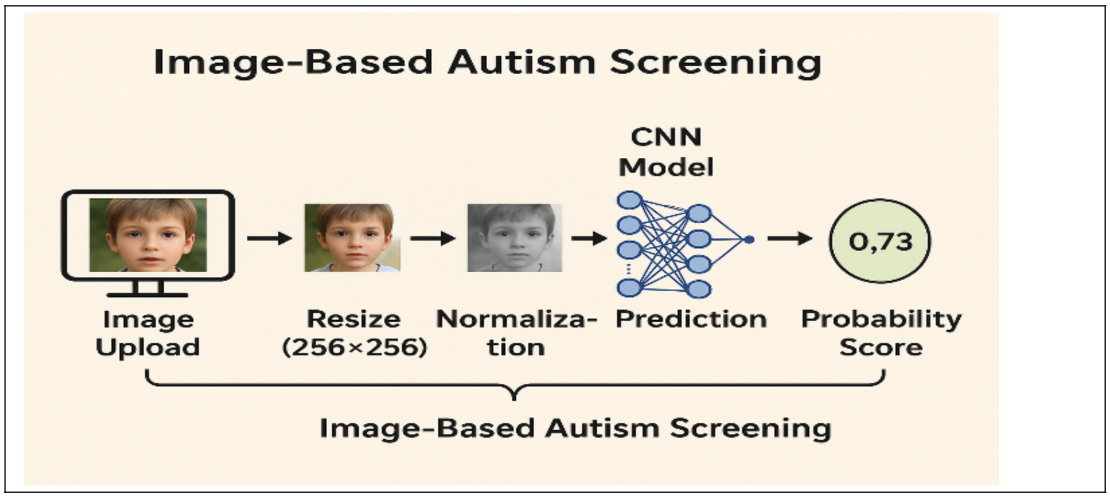

Figure5:FastAPI-BasedDeploymentPipelineShowingCompleteModelIntegration Process[cite:128].

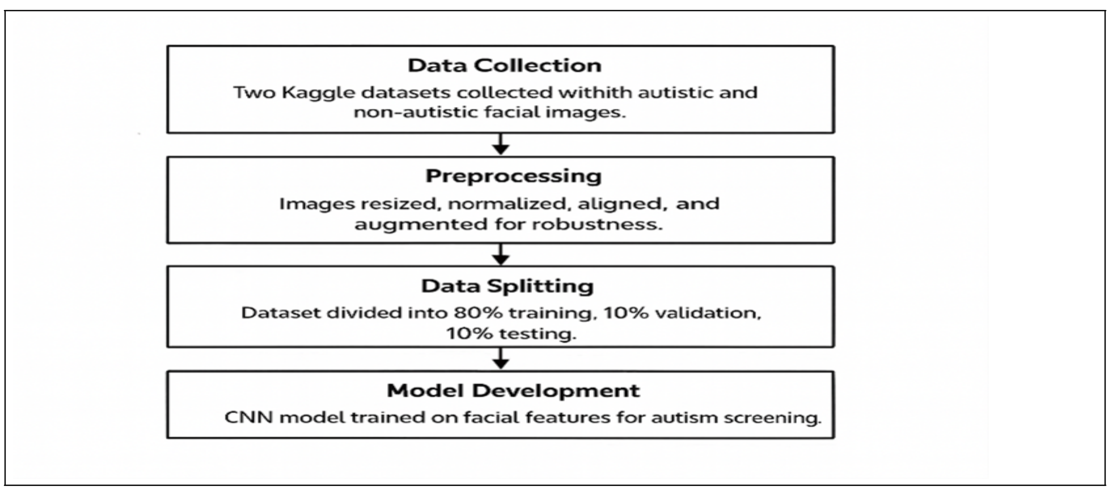

Figure6:OverviewofKeyStepsInvolvedintheSystemMethodology[cite:129].

IV. RESULT AND DISCUSSIONS

Results from the Embrace Autism Platform demonstrate that integrating AI-assisted behavioral screening with interactive learning and community support tools can signifi- cantly improve early awareness and user engagement.The screening module achieved a testingaccuracyof88.6%onunseenimages,withaprecisionof0.89,recallof0.86,and an average inference time of 0.45 seconds per image.

These metrics show that the model performs reliably in a real-time browser-based environment, identifying autism-related visual patterns learned from training data. The model makes predictions based on statistical learning from facial features rather than explicitly tracking gaze or expression movement – patterns previously documented inautism research.

The interactive learning module also produced encouraging results:children remained engaged 27% longer in game activities than in static lessons, and saw measurable improve- mentsinvocabulary,emotionalrecognitionandsocialdecision-makingtasks.These results collectively highlight the platform's potential to support both early behavioral awarenessand developmentallearning throughanintegrateddigitalsystem.

Userfeedbackfromparents, mentorsandvolunteersfurtherreinforcestheeffectiveness of the system.The community and mentorship module received high satisfaction scores, with ease of navigation (4.6/5), perceived safety (4.8/5), and overall satisfaction (4.5/5) being the highest rated parameters. Participants appreciated the secure communication environmentandpersonalizedsupportstructure,identifyingitasameaningfuladdition to digital autism-support solutions.

ComparisonwithexistingtoolsshowsthatEmbracefillsanimportantgapbycombin- ing autism screening, learning, and community engagement – features that are typically isolatedincurrentplatforms.Althoughchallengessuchascameraquality,datasetdiver- sityandmultilingualrequirementsremain,theoverallresultsindicatethatthesystem providesavaluable,inclusiveandscalableapproachtodigitalautismawarenessand support.

Table3:HighlightsDifferencesBetweenTraditionalToolsandEmbraceAutismSystem

Feature	ExistingTools	EmbraceAutism
PrimaryFocus	Mostlyclinicaldiagnosisor	

isolated learning applica- tions
Accessibility Limited;oftenrequirespro-
fessionalsupervision
Unified platform integrating AI- assisted screening, learning, and community support
Completely web-based, device- independent, and accessible
User Engage- ment
Low;limitedinteractivity Highlyinteractive,gamified,and
adaptivelearningmodules
Privacy&Ethics Minimaltransparency;of-
tenuncleardatapolicies
Explicit consent, browser-based AI, no data storage, ethics- centered
Cost &Scalabil- ity
Expensive clinical assess- ments; limited availability
Low-cost,globallyscalabledigital solution

Table4:KeyPerformanceOutcomesHighlightingModelEfficiencyandUserSatisfaction

Feature	**Outcome**
Accuracy	88.6% on test dataset. Precision / Recall Precision:0.89, Recall:0.86.
InferenceSpeed	~0.45secondsperimage(real-time).
UserEngagement	27%higherengagementusinggamifiedmodules.
Feedback	Highsatisfaction:Ease(4.6/5),Safety(4.8/5),Overall(4.5/5).

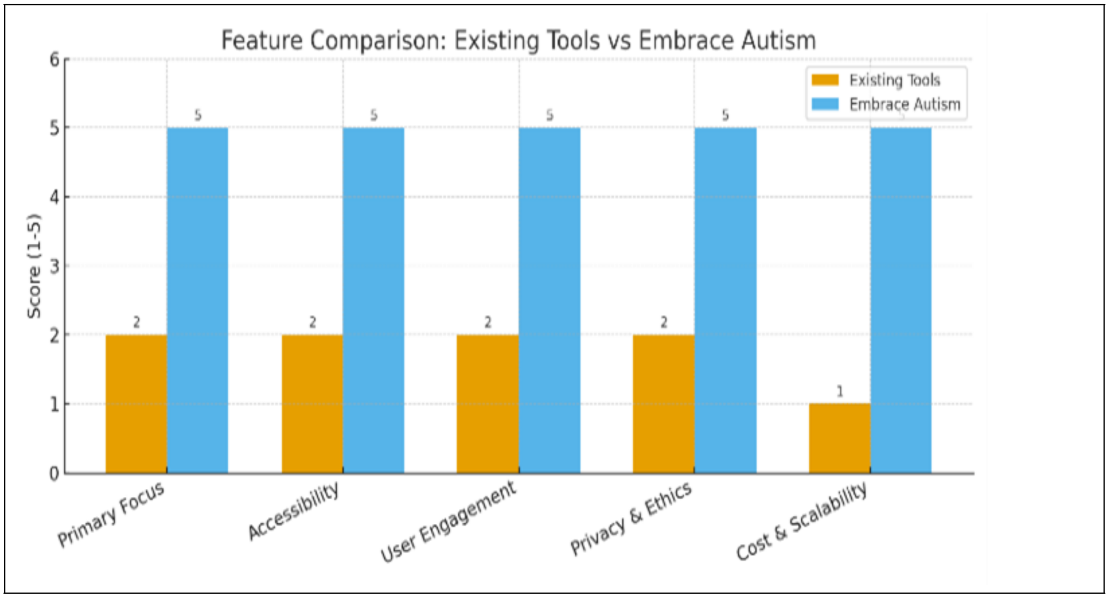

Figure7:VisualizationComparingPrecisionandRecallMetricsforScreeningAccu- racy[cite:183].

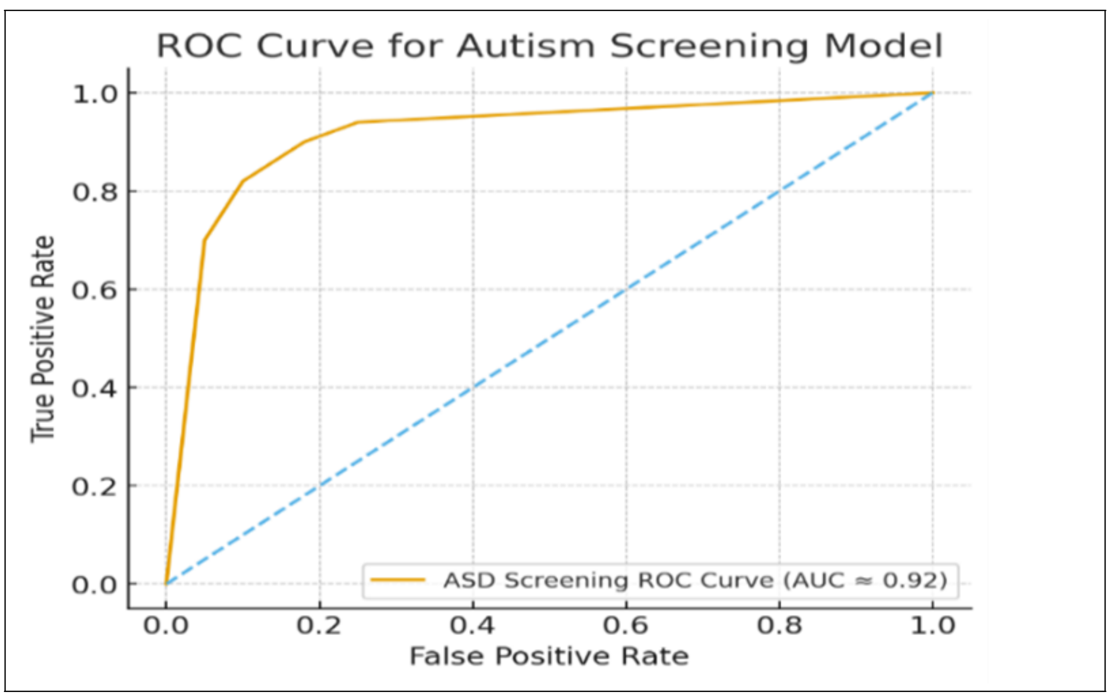

Figure 8:Visualization Highlighting Rise in User Engagement Across Learning Activi- ties[cite:184].

V. CONCLUSION AND FUTURE WORK

The Embrace Autism Project successfully integrates a CNN-based screening model withawebplatformtopromote autismawarenessanddigitalsupport.Themodel(.h5)isdeployedusingFastAPIandevaluatestheuploadedfacialimagestogenerateapr obability- based risk score.Although this system does not provide medical diagnosis, it does sup- portearlyawarenessand direction. Futureenhancementsincludeexpandingthedataset, integratingreal-timewebcamanalysisusing TensorFlow.js, incorporating multimodalbehavioralanalysis(speech,motiontracking),andcollaboratingwithmedicalprofessionals to improve reliability and ethical impact.

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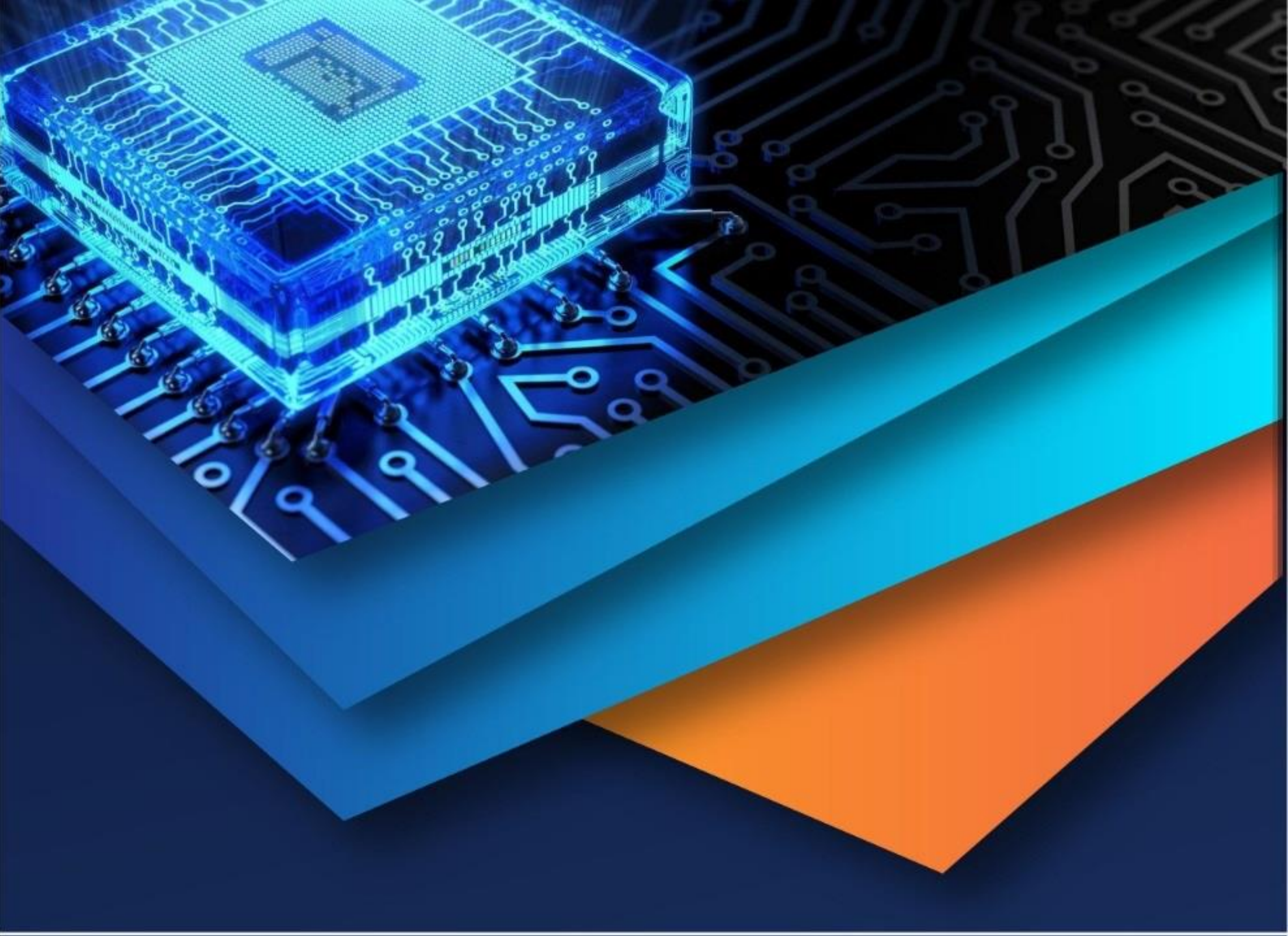

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