



Opinion

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Thoughts on AI's Future in Ophthalmology

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Opinion

Andrew Ng, cofounder and head of Google Brain and was the former Chief Scientist at Baidu, building the company's Artificial Intelligence Group into a team of several thousand people: "When anyone goes to see a doctor, I want AI to help that doctor provide higher quality and lower cost medical service. I want every five-year-old to have a personalized tutor" [1].

At this point in time in ophthalmology, AI, which can analyze fundus photos and OCT images and can uncover early disease patterns that may escape human's notice, is poised to become a near

expert diagnostic medical tool [2,3].

By automating complex and redundant tasks that may incur human error, AI will have a streamlining effect on medical diagnosis and treatments. That is not to say that there will be no errors in the system. There will be a need for critical guardrails in the AI systems to ensure high quality and accuracy.

Table 1: illustrates some AI methods, their definitions, and their accuracy in making the diagnosis of glaucoma.

Table 1: AI methods, definitions, and accuracy.

Ai Method	Definition	% Diagnostic Accuracy for Glaucoma Diagnosis
Regression	A statistical method that models the relationship between a dependent variable and one or more independent variables.	>.97 AUC (R. Hemelings) [4] in detecting glaucoma using a regression model for automated fundus photos screening
Random Forest	An ensemble learning method that constructs multiple decision trees and outputs the mode of their predictions.	92% accuracy (R Raman) [5] in identifying glaucoma with fundus images using random forest.
Gradient Boosting	An ensemble technique that builds models sequentially, each correcting errors made by the previous ones.	98% accuracy (C Huang) [6] glaucoma boost, glaucoma risk stratification.
Neural Networks	Computational models inspired by the human brain that can learn from data through multiple layers of processing.	AUC .98 (D Bizios, et al.) [7] in diagnosing glaucoma from retinal nerve fiber thickness from OCT images Neural network vs Support vector machines
Generative AI	AI systems that can generate new content based on learned patterns from existing data, useful in image synthesis.	98% accuracy (A Shoukat, et al.) [8] in automatic diagnosis of glaucoma from retinal images using Deep Learning

Table 2: illustrates the method of implementation of the AI tool analysis, patient privacy, meticulous data pick up and transfer and its setting as well as the necessary guardrails to ensure image

Table 2: AI method and setting for Implementation.

Method And Setting of Implementation	Guardrails For Methods of Implementation
Image Analysis	- Uniformity of Image Capture: Ensure excellent image visualization for accurate comparisons.
Predictive Analytics	- Comprehensive Medical History: Include thorough history, physical exam, and labs: get to know the patient for better predictions; meticulous rigors to protect data privacy
Robotic Assistance	- Review Outcomes: Conduct careful assessments of complication risks to improve surgical safety and effectiveness.
Telemedicine	- Well-Trained LLMs, large language models and VLMs, Visual language Models: Ensure accurate data transfer with built-in potential error checks to enhance reliability and privacy.
Efficient Data Handling	- Check Accuracy: Regularly verify the comparability and reproducibility of datasets to avoid acquisition and transfer errors.
Predictive Maintenance	- Frequent Equipment Checks: Maintain reliable standard records to ensure equipment functionality and reduce downtime and avoid inadequate addition of requisite new data to avoid LLM hallucinations.

From keratoconus, in which AI models have detected with accuracy of 98%, to corneal biomechanics to cataract surgery, IOL formulas, to diabetic retinopathy, detected above 95%, to age related macular degeneration, AUC >.90, to strabismus detection, amblyopia risk, myopia progression risk, to facial analysis, the richness of images tied to texts has catapulted ophthalmology into a vaulted place for AI applications [9-11].

Moving through entry level image/text analysis of these and other subcategories of ophthalmology will require careful applica-

tions of privacy guards, both for in house clinical work and items shared between centers that share clinical trial data sets [12].

Agentic AI, systems capable of autonomously executing tasks formerly performed by human researchers and office workers, non-human computer groups carrying out medical office and patient care initiatives, LLMs providing rapid generation of educational materials, computer opinion analysis of resident's and attending's level of care and suggested adjustments are either all in the works or have begun to see real time applications [11,13].

Table 3: AI Role in Ophthalmology and Method of Implementation.

#	Role In Ophthalmology	Method Of Implementation
1	Early Detection and Diagnosis	- Image Analysis: AI analyzes retinal images and OCT scans for early disease detection. - Predictive Analytics: Identifies likelihood of developing eye diseases for proactive management.
2	Personalized Treatment Plans	- Tailored Interventions: Recommends personalized treatment options based on individual patient data. - Monitoring Progress: Adjusts treatment plans in real-time based on responses.
3	Enhanced Surgical Precision	- Robotic Assistance: AI-driven systems assist in performing surgeries with higher precision. - Surgical Planning: Analyzes outcomes to help plan complex surgeries effectively.
4	Improved Patient Engagement	- Virtual Assistants: Provides information about conditions and treatments through AI-powered chatbots. - Telemedicine: Enhances remote monitoring and consultations for better access to care.
5	Data Management and Workflow	- Efficient Data Handling: Manages and analyzes large volumes of data, streamlining workflows. - Predictive Maintenance: Anticipates equipment needs to ensure operational readiness.

Conflict of Interest

None.

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