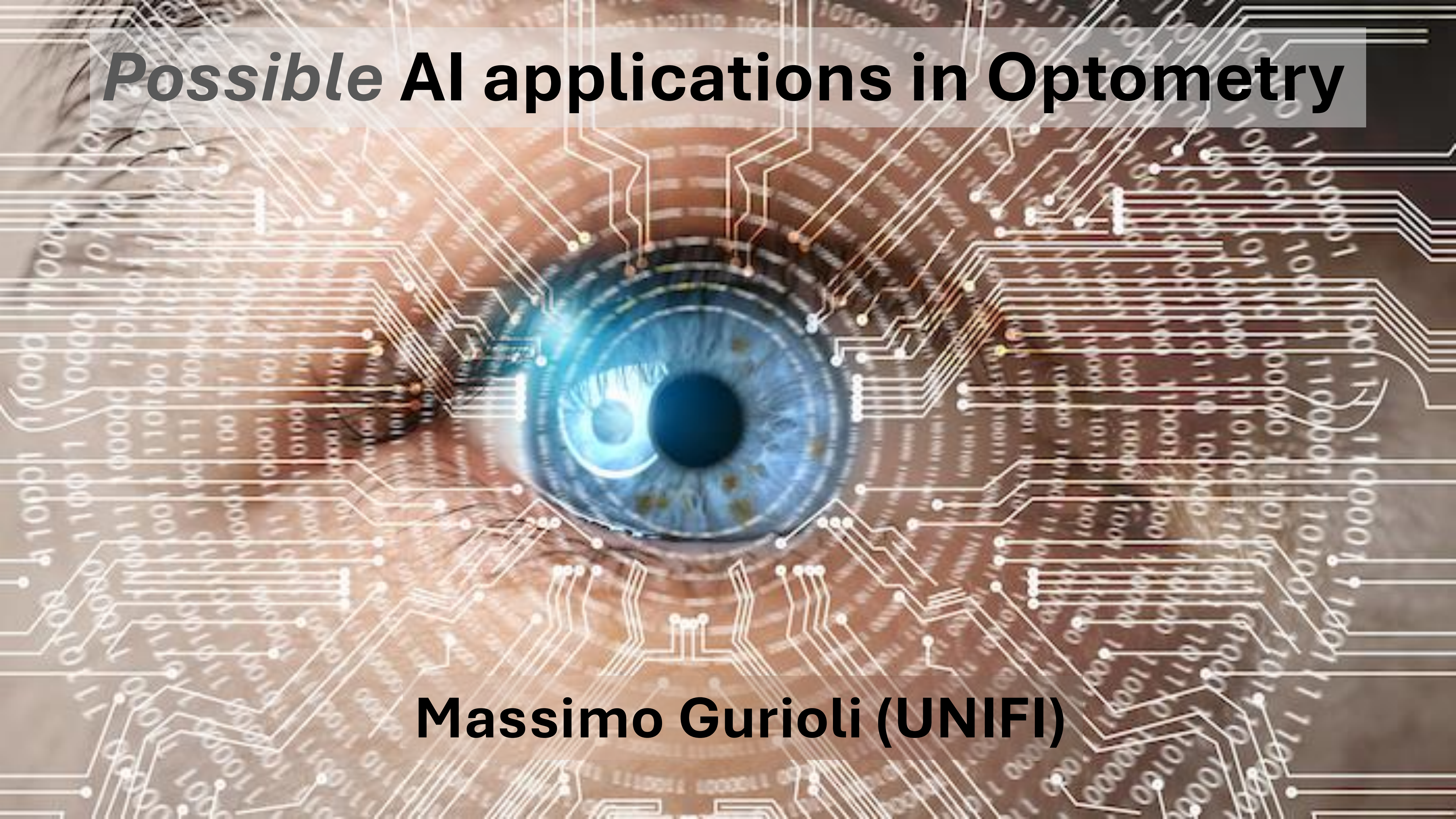


Possible AI applications in Optometry

Massimo Gurioli (UNIFI)

Ophthalmol Ther (2023) 12:1439–1455
https://doi.org/10.1007/s40123-023-00690-4

REVIEW

Artificial Intelligence for Anterior Segment Diseases: A Review of Potential Developments and Clinical Applications

Zhe Xu · Jia Xu · Ce Shi · Wen Xu · Xiuming Jin · Wei Han · Kai Jin · Andrzej Grzybowski · Ke Yao

Deep Learning Classifiers for Automated Detection of Gonioscopic Angle Closure Based on Anterior Segment OCT Images

Benjamin Y. Xu, MD, PhD[1], Michael Chiang, PhD[2], Shreyasi Chaudhary, BS[3], Shraddha Kulkarni, BS[3], Anmol A. Pardeshi, MS[1], Rohit Varma, MD, MPH[4]

Applications of Artificial Intelligence in Myopia: Current and Future Directions

*Chenchen Zhang, Jing Zhao, Zhe Zhu, Yanxia Li, Ke Li, Yuanping Wang and Yajuan Zheng**

Department of Ophthalmology, The Second Hospital of Jilin University, Changchun, China

Open Access

Corneal power evaluation after myopic corneal refractive surgery using artificial neural networks

Robert Koprowski[1*], Michele Lanza[2,3] and Carlo Irregolare[3]

REVIEW ARTICLE

OPEN

Artificial Intelligence for Cataract Detection and Management

Jo… ha Anees, MSc¶,

diagnostics

Systematic Review

Keratoconus Diagnosis: From Fundamentals to Artificial Intelligence: A Systematic Narrative Review

Sana Niazi [1], Marta Jiménez-García [2,3], Oliver Findl [4], Zisis Gatzioufas [5], Farideh Doroodgar [1,6,*], Mohammad Hasan Shahriari [7] and Mohammad Ali Javadi [8]

Int J Ophthalmol, Vol. 16, No. 9, Sep.18, 2023 www.ijo.cn
Tel: 8629-82245172 8629-82210956 Email: ijopress@163.com

· Intelligent Ophthalmology ·

Bibliometric analysis of artificial intelligence and optical coherence tomography images: research hotspots and frontiers

Hai-Wen Feng[1], Jun-Jie Chen[1], Zhi-Chang Zhang[2], Shao-Chong Zhang[3], Wei-Hua Yang[3]

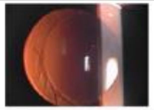
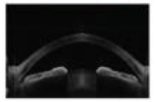
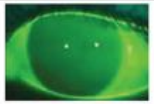
OUTLINE (ideas for AI application on open items in our group):

1. ***Diagnostic Assistance:*** *AI algorithms can help in detecting various eye conditions*
2. ***TeleRefraction:*** *AI-powered device can perform automatic refraction tests*

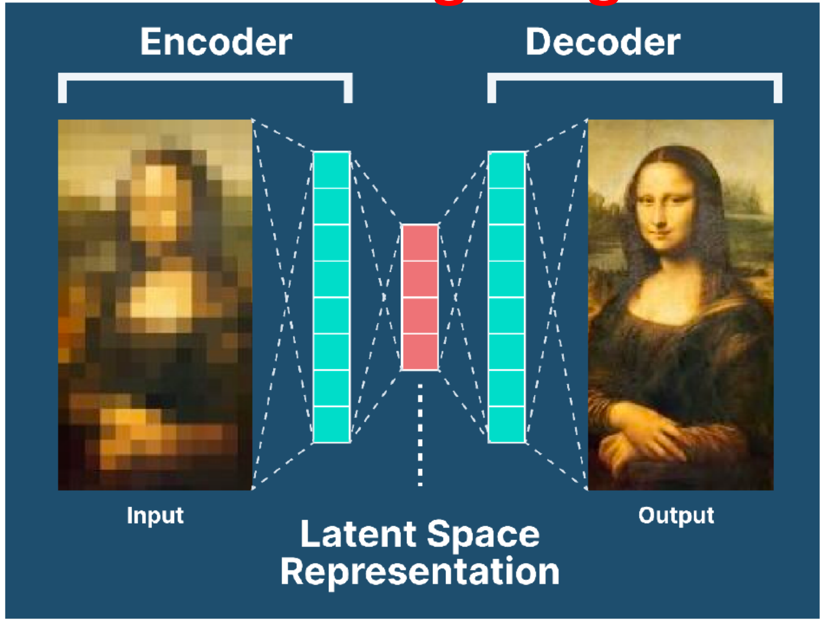
3. ***Hybrid image designs for screenings****: ?May AI optimize them?*

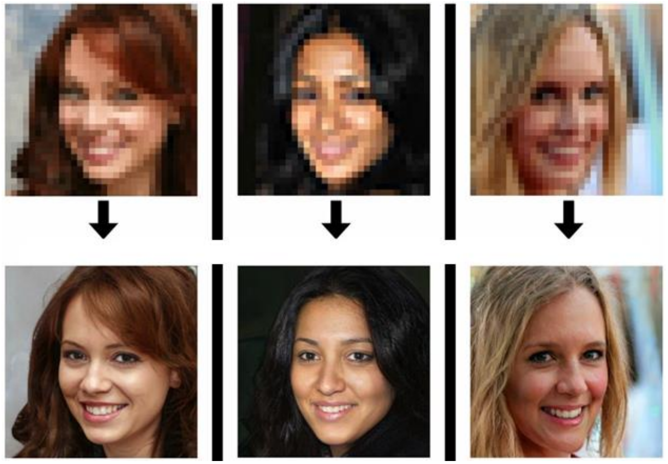
4. ***Understanding human colour perceptions: ??*** *May AI help in understanding human brain??*

Optometry is based on images

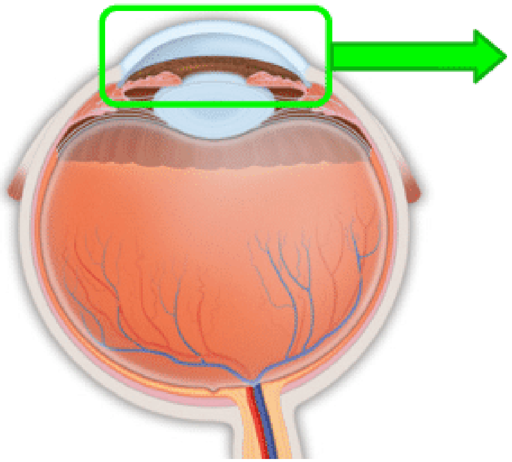
Imaging modalities	Image features		Application
Slit-lamp images	Slit light		Cataract detection and grading
	Diffuse light		Conjunctival hyperemia grading Cataract detection and grading High intraocular pressure detection Identification, localization of conjunctiva, cornea and lens diseases
	Retro-illumination		Posterior capsule opacification progress prediction
AS-OCT images			Angle-closure detection
Tear film lipid layer interference images			Tear Film Lipid Layer Classification Dry eye diagnosis
Frontal eye videos after fluorescein instillation			Dry eye detection, BUT calculation
Retinal fundus images			Cataract grading
Visible wavelength image by digital camera			Corneal arcus and cataract detection

AI is very efficient «denoising images»

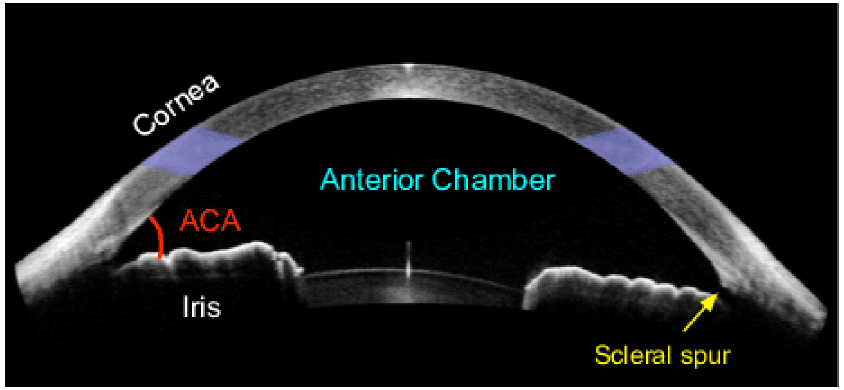




Research @ UNIFI



(A) Anterior segment of eyeball



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Ministero dell'Università e della Ricerca

Segretariato Generale

Direzione Generale della Ricerca

PRIN: PROGETTI DI RICERCA DI RILEVANTE INTERESSE NAZIONALE – Bando 2022
Prot. 2022E3W8KE

PART A

1. Research project title

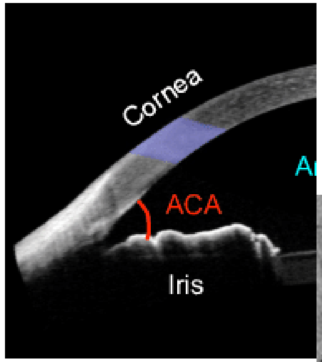
Anterior Eye Normative data from new technologies of imaging to improve primary Eye Assistance Services (AENEAS) \bold(A)

Tomography of anterior eye by OCT e Scheimpflung

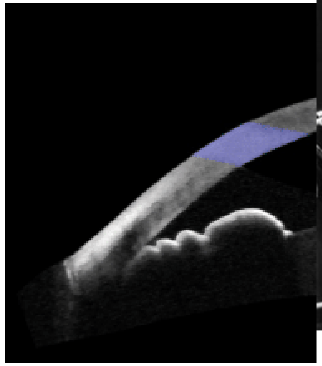
Anterior Eye Normative data from new technologies of imaging to improve primary Eye Assistance Services (AENEAS)

help in detecting various eye conditions

Closure of a



(B)



(C) Angle-closure

ORIGINAL ARTICLE · Volume 119, Issue 11, P2231-2238, November 2012

Download Full Issue

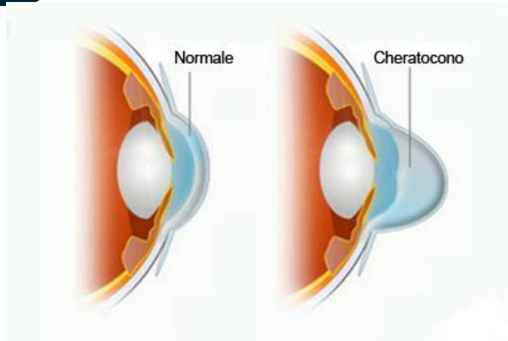
Use of a Support Vector Machine for Keratoconus and Subclinical Keratoconus Detection by Topographic and Tomographic Data

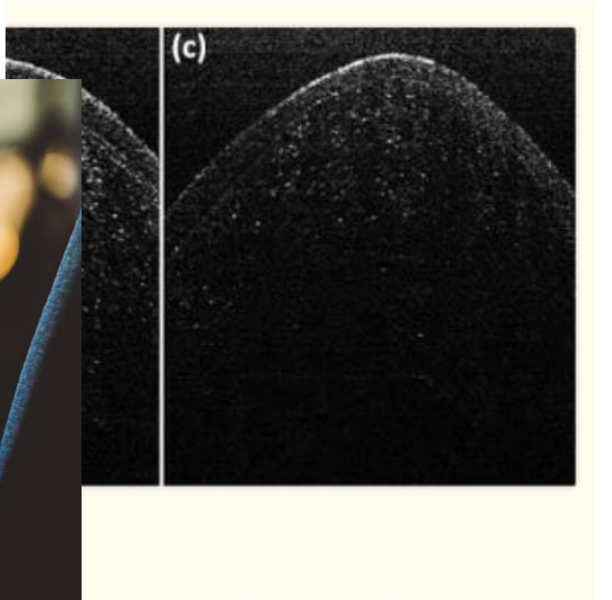
Maria Clara Arbelaez, MD [1] · Francesco Versaci, MSE [2] · Gabriele Vestri, MSE [2] ·
Piero Barboni, MD [3] · Giacomo Savini, MD [4]

Purpose: To define a new classification method for the diagnosis of keratoconus based on corneal mea-

92.8% to 95.0% in eyes with keratoconus, 75.2% to 92.0% in eyes with subclinical keratoconus, and 93.1% to 97.2% in normal eyes.

s





keratoconus (c) severe keratoconus.

2- Telerefraction (PhD. Founded by ESSILORLUXOTTICA)

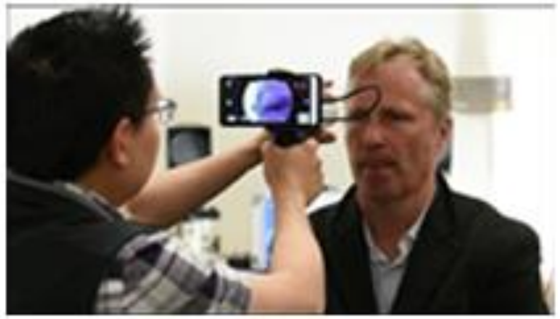
The ROYAL COLLEGE of OPHTHALMOLOGISTS
www.nature.com/eye

ARTICLE

Check for updates

Deep learning for predicting uncorrected refractive error using posterior segment optical coherence tomography images

Tae Keun Yoo[1,2,3], Ik Hee Ryu[1,3], Jin Kuk Kim[1,3] and In Sik Lee[1,3]

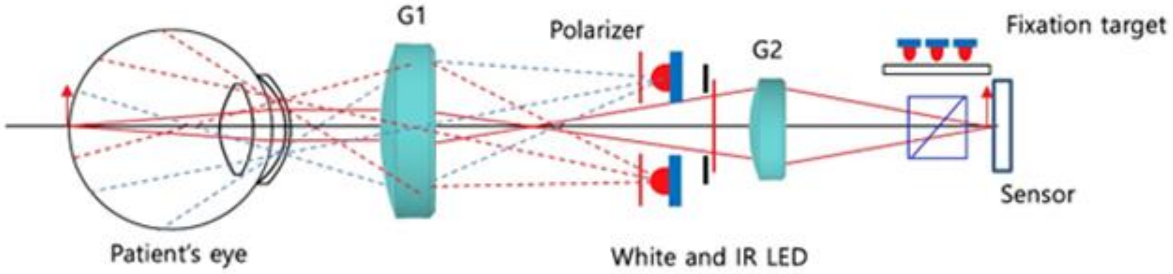


diagnostics
MDPI

Article

Automatic Refractive Error Estimation Using Deep Learning-Based Analysis of Red Reflex Images

Glenn L
Scott Da



Sphere value: −8 (myopic) | Sphere value: 0 (normal vision) | Sphere value: +10 (hyperopia)

KJO
pISSN: 1011-8942 eISSN: 2092-9382
Korean J Ophthalmol 2023;37(2):95-104
https://doi.org/10.3341/kjo.2022.0059

Original Article

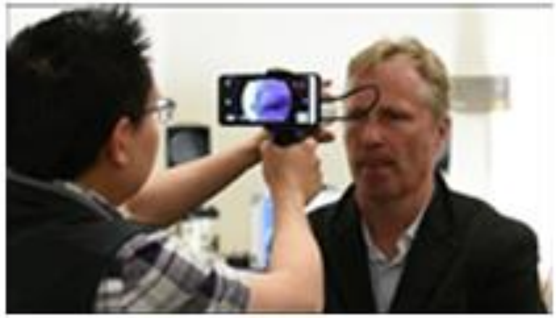
Deep Learning-based Prediction of Axial Length Using Ultra-widefield Fundus Photography

Richul Oh[1], Eun Kyoung Lee[1,2], Kunho Bae[1,2], Un Chul Park[1,2], Hyeong Gon Yu[1,2], Chang Ki Yoon[1,2]
Department of Ophthalmology, Seoul National University Hospital, Seoul, Korea
Department of Ophthalmology, Seoul National University College of Medicine, Seoul, Korea

diagnostics MDPI

Article

Automatic Refractive Error Estimation Using Deep Learning-Based Analysis of Red Reflex Images



Abstract: Purpose: We evaluate how a deep learning model can be applied to extract refractive error metrics from pupillary red reflex images taken by a low-cost handheld fundus camera. This could potentially provide a rapid and economical vision-screening method, allowing for early intervention to prevent myopic progression and reduce the socioeconomic burden associated with vision impairment in the later stages of life.

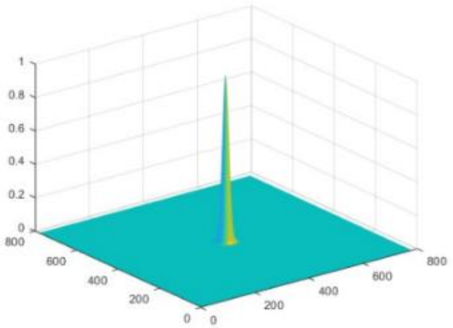
Results: The best-performing trained model achieved an overall accuracy of 75% for predicting spherical power using infrared images and a multiclass classifier.

Sphere value: −8 (myopic) | Sphere value: 0 (normal vision) | Sphere value: +10 (hyperopia)

Hybrid images designs for optometric screenings

How we do hybrid images

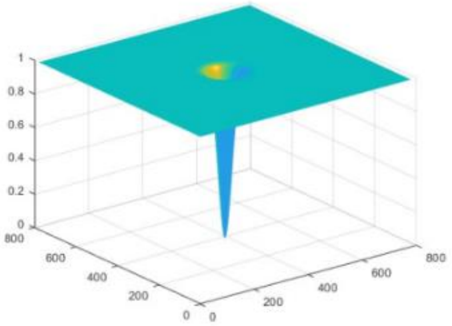
(a) Original image of a dog I_1



(b) Low pass filter G_1

(c) Filtered image I_L

(d) Original image of a sheep I_2



(e) High pass filter $(1 - G_2)$

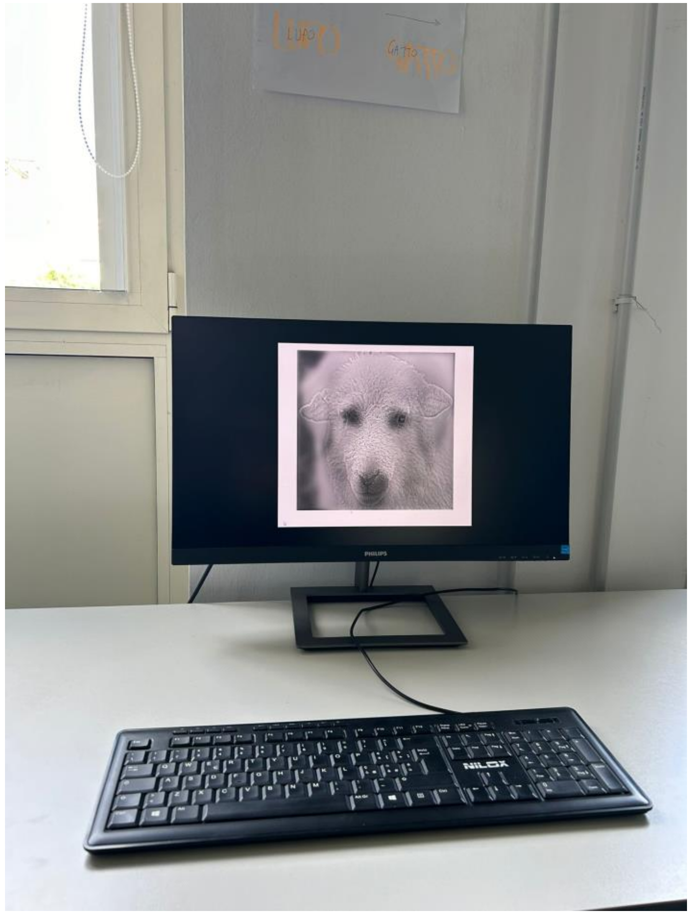
(f) Filtered image I_H

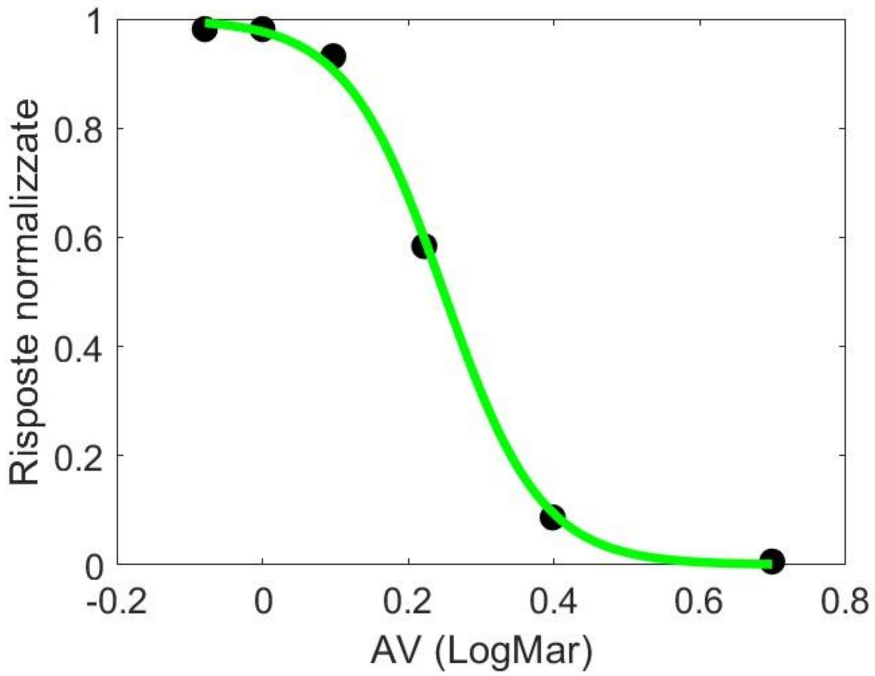
IMPORTANT PARAMETERS

- **Selecting images**
- **Selecting cut off frequencies**

Tests of the screening

1. Miopization
2. Hybrid Image
3. Psychometric response





Optometric Screening

<u>suitable for non specialists for testing very small kids for</u>

control of miopic progression

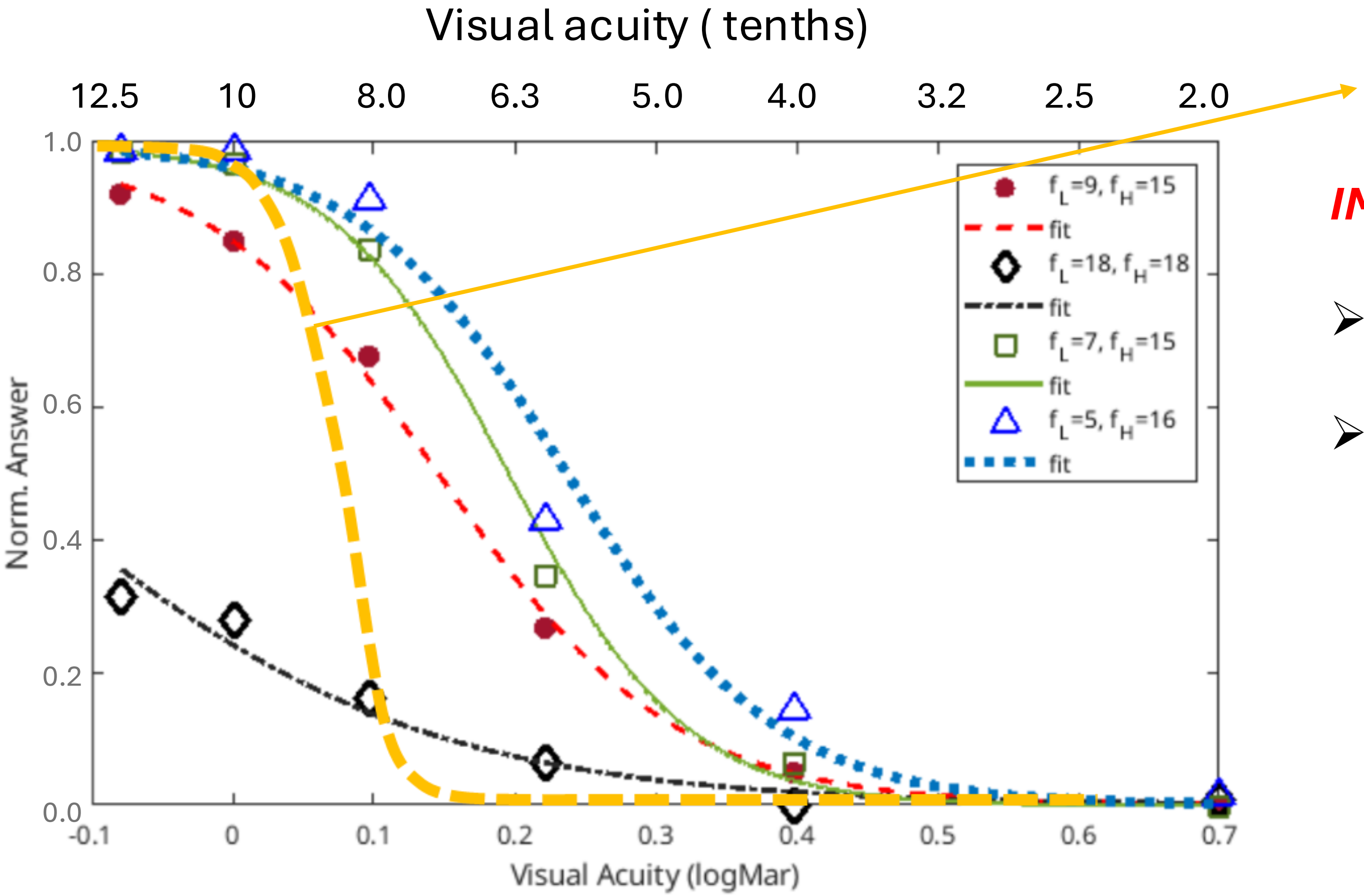


Figure 3. Psychometric fit of four versions of the "sheep-dog"-HI. The cutoff frequencies in the legend are expressed in cycles/set.

Ideal psychometric

IMPORTANT PARAMETERS

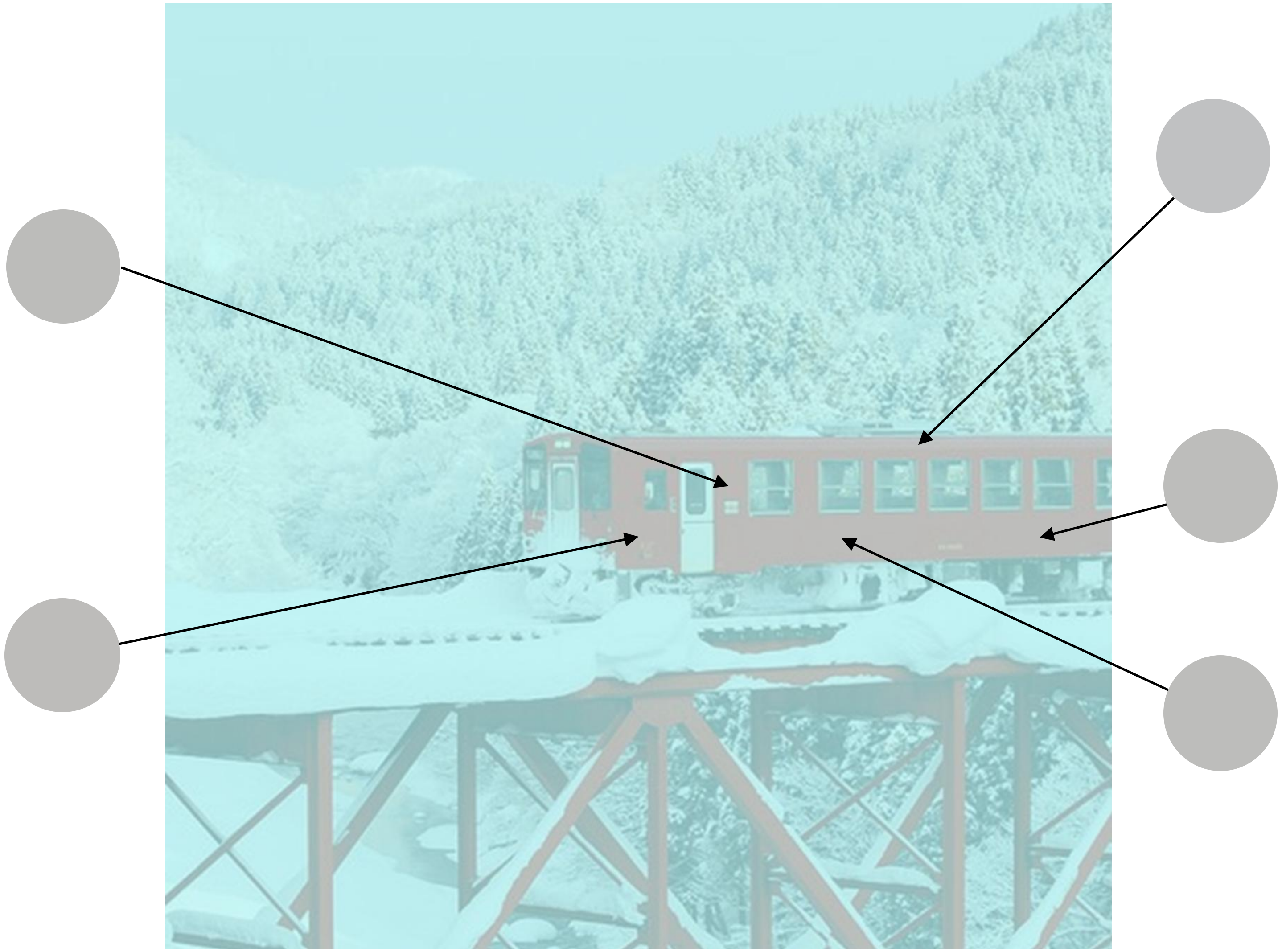
- **Selecting images**
- **Selecting cut off frequencies**

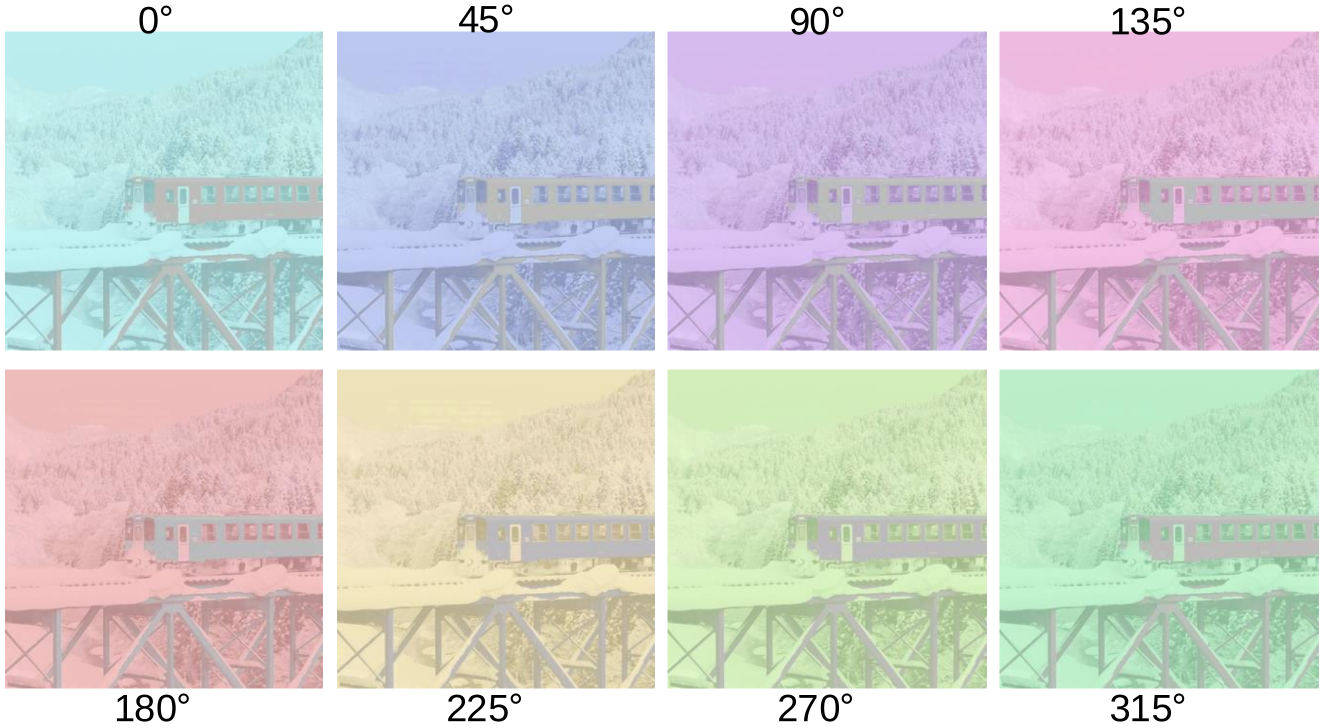
May AI optimize a hybrid image to get an almost ideal psychometric reponse?

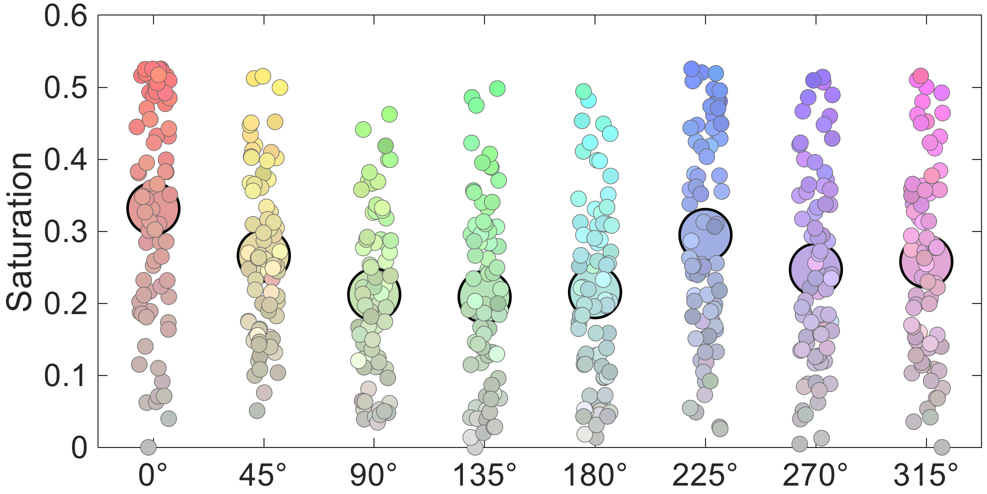
Chromatic illusion

https://www.giannisarcone.com/

Gray looks reddish

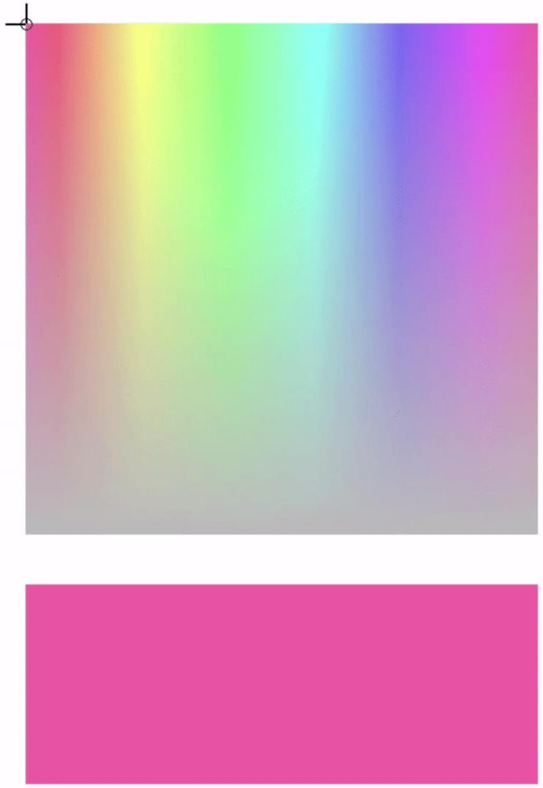






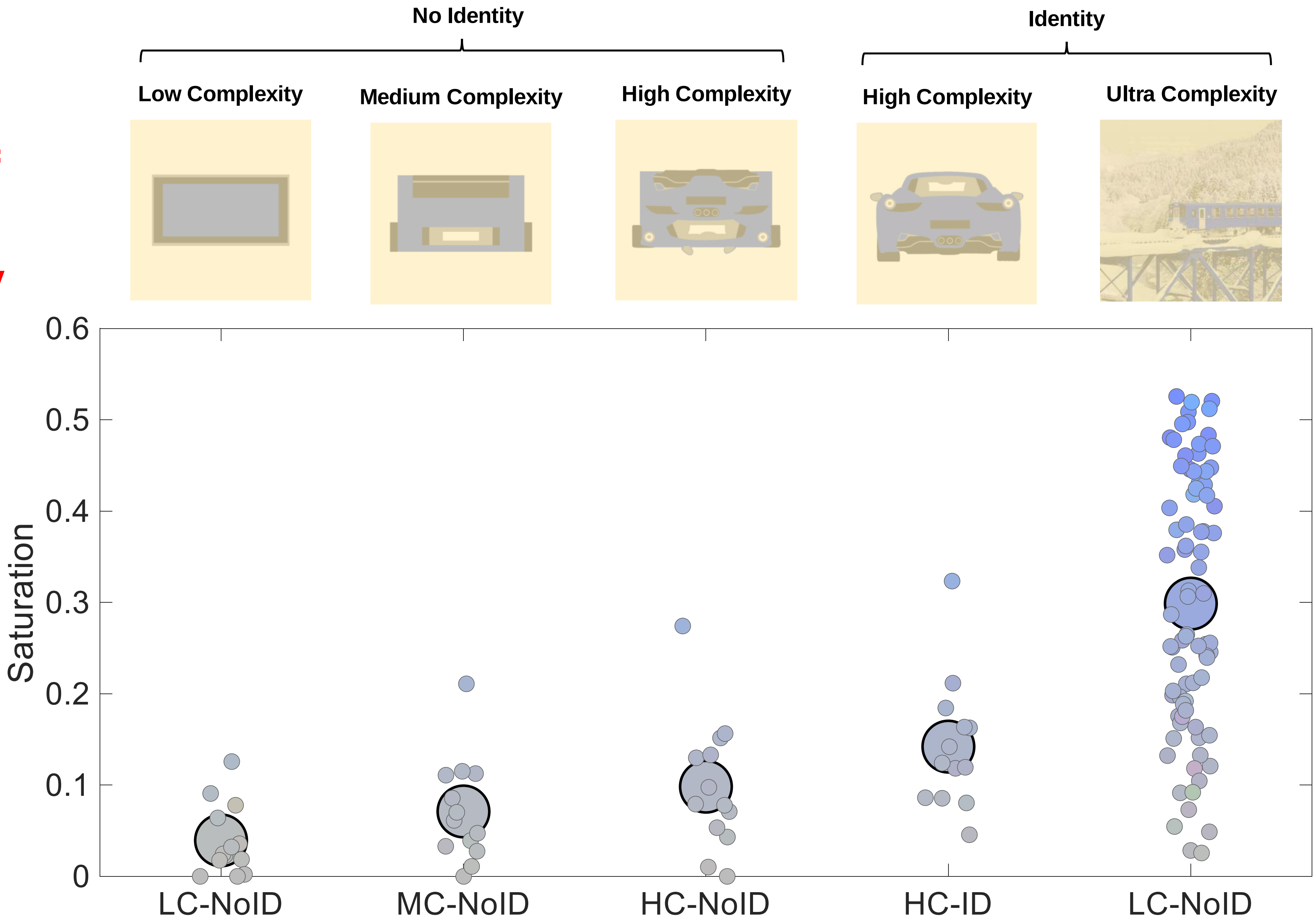
Test on many people

Selection of the colour



Selection of the colour

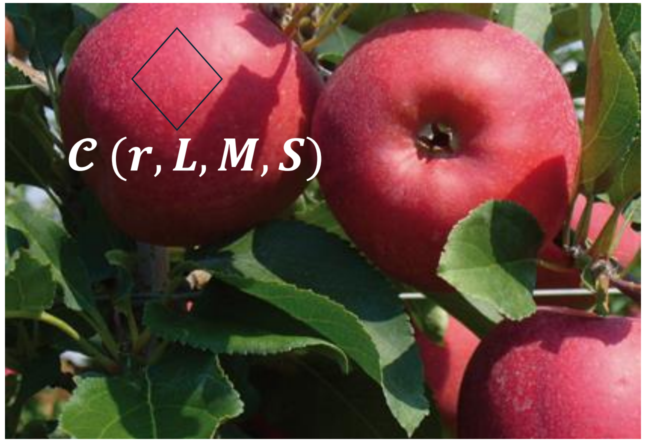
Test as a function of image complexity



«NORMAL» COLOURS

$$\mathcal{C}(r, L, M, S) = \mathcal{C}'(r, L, M, S)$$

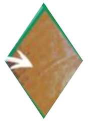
$\mathcal{C}'(r, L, M, S)$



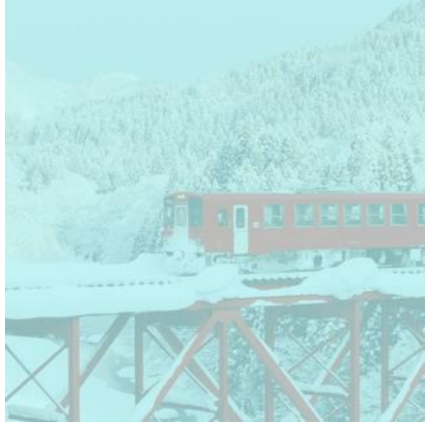
«ILLUSION» COLOUR

$$\mathcal{C}(r, L, M, S) \neq \mathcal{C}'(r, L, M, S)$$

$\mathcal{C}'(r, L, M, S)$



The brain does a lot of operation for presenting us the chromatic perception of the world.



«ILLUSION» COLOUR

$$\boldsymbol{\mathcal{C}(r; L, M, S) \neq \mathcal{C}'((r; L, M, S)}$$

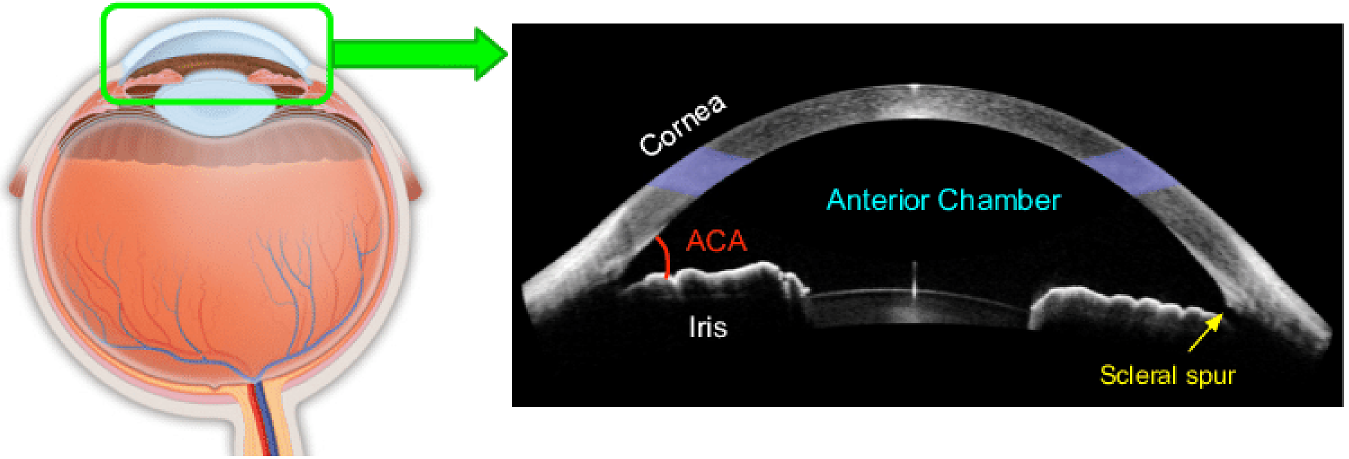
In summary: **chromatic perception is non-local**

$$\boldsymbol{\mathcal{C}(r; L, M, S) = \int dr'\, K(r - r')\mathcal{C}'((r'; L', M', S')}$$

?? May AI help us in understanding the shape of the kernel $\boldsymbol{K(r - r')}$ **??**

1a. Increasing OCT resolution

STRADA STANDARD:
La risoluzione assiale di OCT dipende dalla larghezza spettrale della sorgente luminosa



(A) Anterior segment of eyeball

$$\Delta z = \frac{2 \ln 2}{\pi} \frac{\lambda^2}{\Delta\lambda}$$

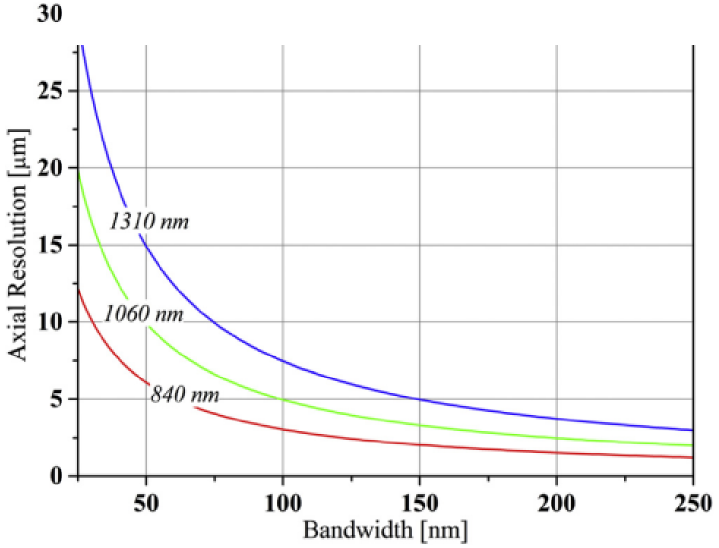


Fig. 2. Axial resolution vs. bandwidth for the typical optical coherence tomography light source center wavelengths of 840, 1060, and 1310 nm.

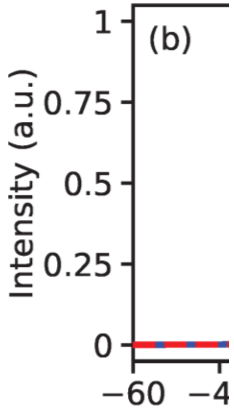
Ti-Sapphire fs laser

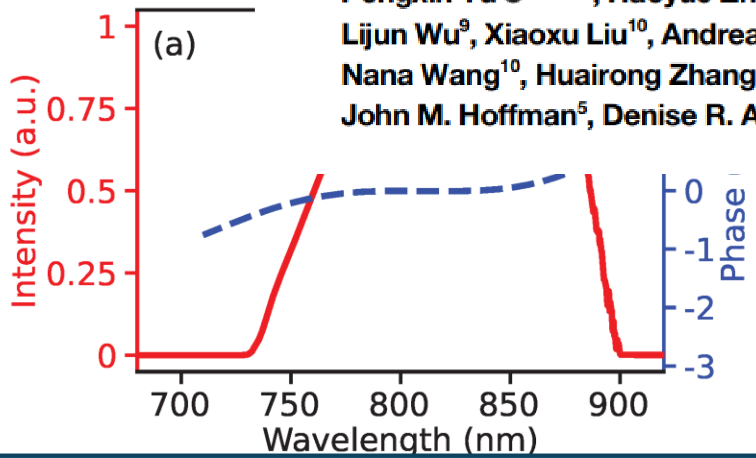
Clinical Trials

Measurement of Te
Resolution Optical

René M. Werkmeister,[1] Aneesh
Jasmin Riedl,[1] Michael Bronhagl
Gerhard Garhöfer,[2] Wolfgang Dr
and Leopold Schmetterer[1,2]

[1]Center for Medical Physics and Biomedica
[2]Department of Clinical Pharmacology, Me
[3]Institute





npj | digital medicine
Article
Published in partnership with Seoul National University Bundang Hospital
https://doi.org/10.1038/s41746-024-01338-8

Spatial resolution enhancement using deep learning improves chest disease diagnosis based on thick slice CT

Check for updates

Pengxin Yu[1,2,3,16], Haoyue Zhang[4,5,16], Dawei Wang[3], Rongguo Zhang[6], Mei Deng[7], Haoyu Yang[8], Lijun Wu[9], Xiaoxu Liu[10], Andrea S. Oh[5], Fereidoun G. Abtin[5], Ashley E. Prosper[5], Kathleen Ruchalski[5], Nana Wang[10], Huairong Zhang[11], Ye Li[12], Xinna Lv[12], Min Liu[13], Shaohong Zhao[9], Dasheng Li[10], John M. Hoffman[5], Denise R. Aberle[5], Chaoyang Liang[14], Shouliang Qi[1,2] & Corey Arnold[15]

Vol. 54 | No. 8 | 5579

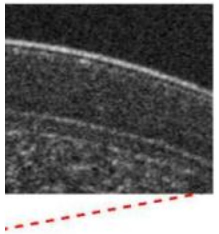


Figure 1. Sample measurement of human precorneal tear film using ultrahigh-resolution OCT. TF, tear film; EP, corneal epithelium; BL, Bowman's layer; ST, corneal stroma; DM, Descemet's membrane; ED, corneal endothelium.

Risoluzione del film lacrimale, lamina di Bowman, membrana di Descemet.....