

Telemedicine: How Glaucoma Care is Reaching Out to the Community

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Rutgers-New Jersey Medical School

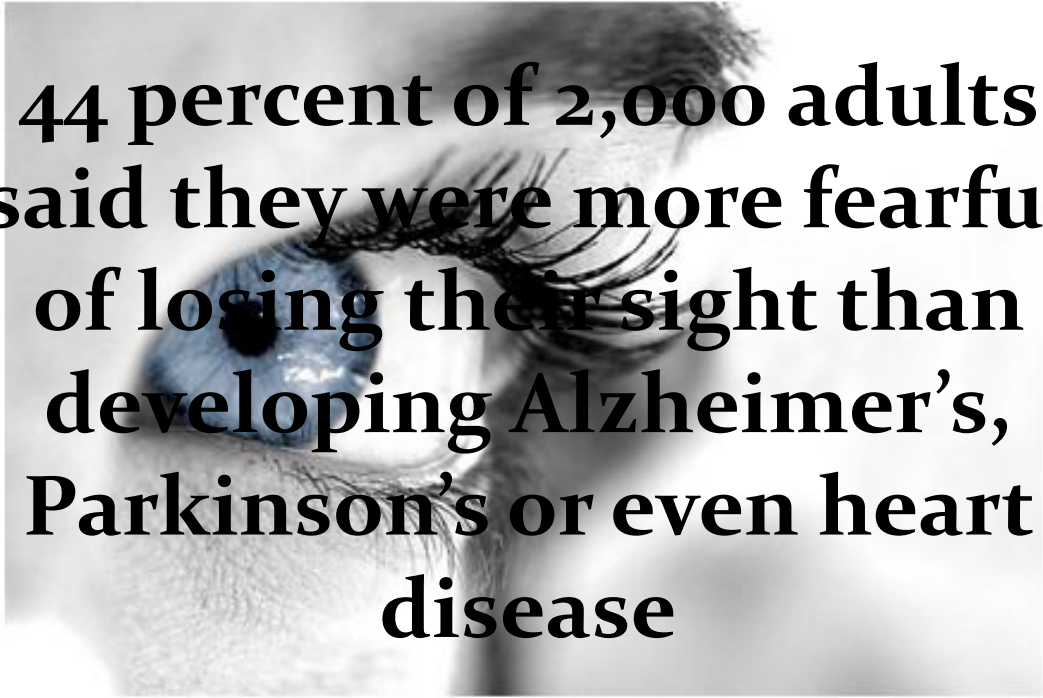


Important Sa

Do not take FARXIGA to dapagliflozin or an. Symptoms of a serio include: skin rash, red swelling of the face.

Keep an Eye on Your Eyes

Four major eye issues and how to treat – and prevent – them.



44 percent of 2,000 adults said they were more fearful of losing their sight than developing Alzheimer's, Parkinson's or even heart disease

A recent survey found 44 percent of 2,000 adults said they were more fearful of losing their sight than developing Alzheimer's, Parkinson's or even heart disease.

Visual Impairment Numbers

- 1 in 28 Americans ages 40+ suffers from low vision
- This number is guaranteed to grow in coming years as the population ages.
- Every day an estimated 10,000 baby boomers turn 65, making them members of a very vulnerable group

- US News March 2015

Glaucoma

- NEI reports that 3 million people in the U.S. have glaucoma- expected to grow to 4 million by 2030
- Glaucoma is the second most common cause of blindness worldwide. It is estimated that 4.5 million persons globally are blind due to glaucoma¹ and that this number will rise to 11.2 million by 2020²

- US News March 2015
- 1. World Health Organization data from www.who.int/blindness/causes/priority/en/
- 2. Quigley et al. Br J Ophthalmol 2006; 90:262-267

Telemedicine

- Benefits

- Enhancing screening for VTD
- Bring subspecialty expertise to underserved communities
- Other...

- Strouthidis NG, et al. Br J Ophthalmol 2014
- Kassam F, et al. Middle East Afr J Ophthalmol 2013



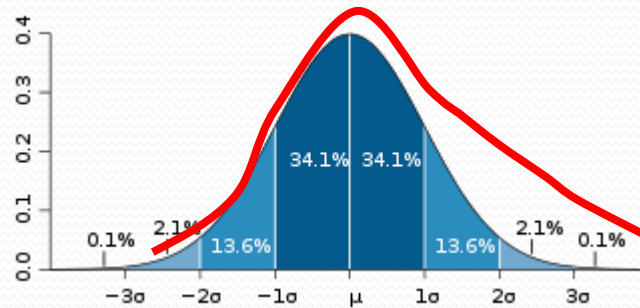
Tele-Glaucoma

- Part of Telemedicine
- Yet, poses distinct challenges:
 - Glaucoma is a group of diseases
 - Slowly progressive optic neuropathy
 - Visual field loss is elusive
 - IOP is extremely variable
 - **PAINLESS**



Challenges to Diagnosis

Flaws in IOP definition



IOP in general pop is not gaussian: skewed



Screening using IOP will miss many patients

Is there a better way?



NJ Glaucoma

Glaucoma

- Structure vs Function testing
- Is there a best test(s) for diagnosis?

What shows first ?

- Studies have found optic disc and RNFL damage often precede detectable visual field loss

Sommer A, et al. *Arch Ophthalmol* 1991; 109:77.

Tuulonen A, and Airaksinen PJ. *Am J Ophthalmol* 1991; 111: 485.

Johnson CA, et al. *Am J Ophthalmol* 2003; 135: 148.

One way...



or
the better way...

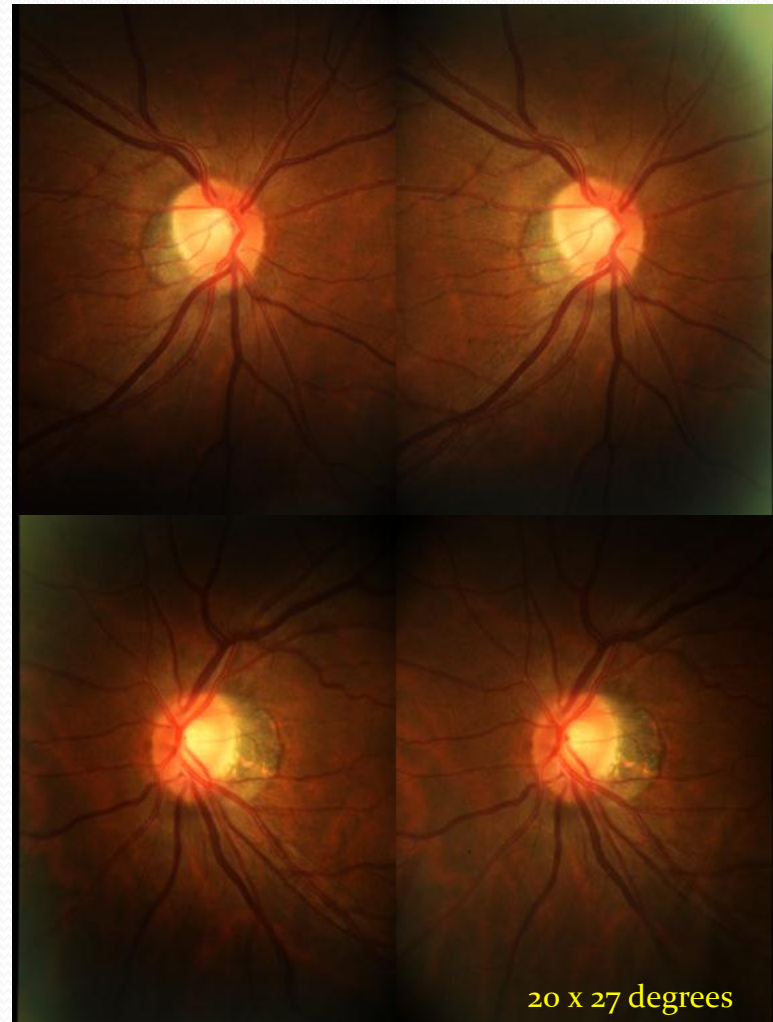


NJ Glaucoma

Digital Imaging



Non-Myd Simultaneous Stereo >4mm



Ophthalmology Telemedicine at New Jersey Medical School

- Telemedicine Outreach Program (TOP) Services established at NJMS in 2005
 - The Student Sight Savers Program in 2009 joined TOP Services in tele-screening



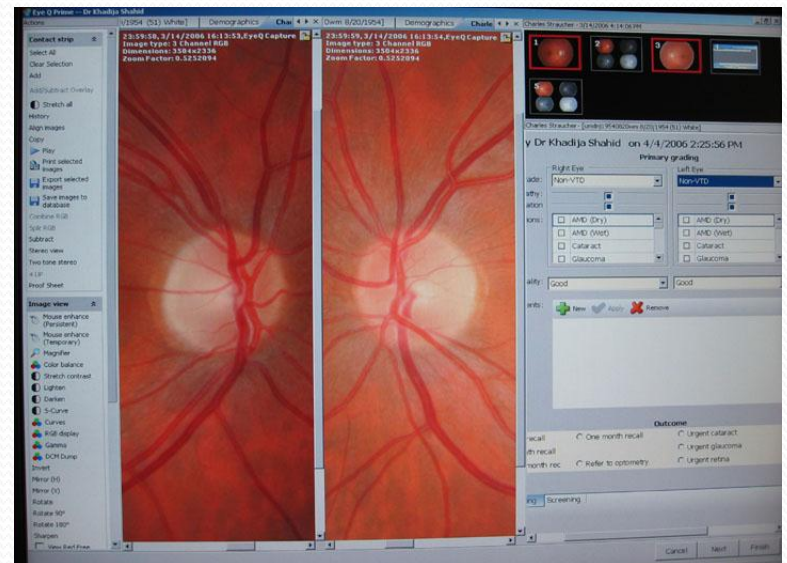


Courtesy Dr B Szirth



NJ Glaucoma

Grading images

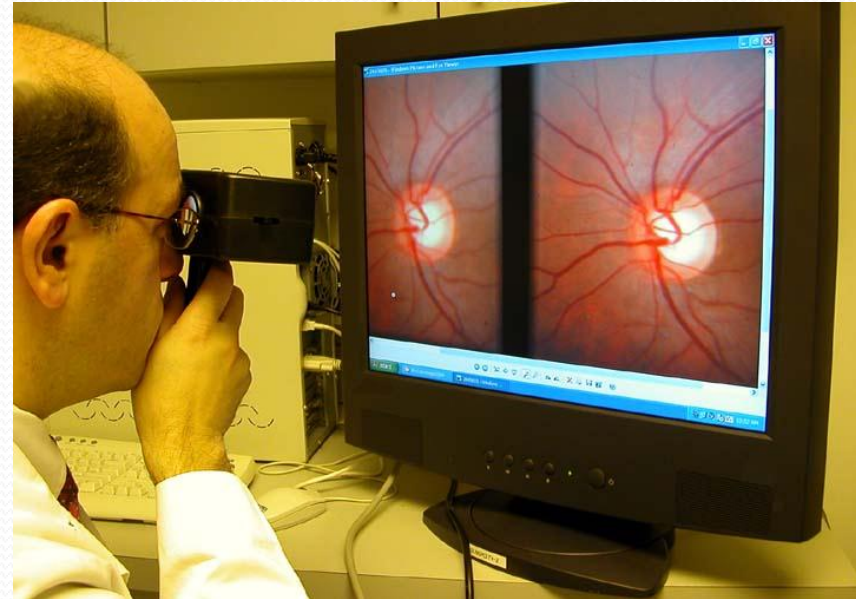
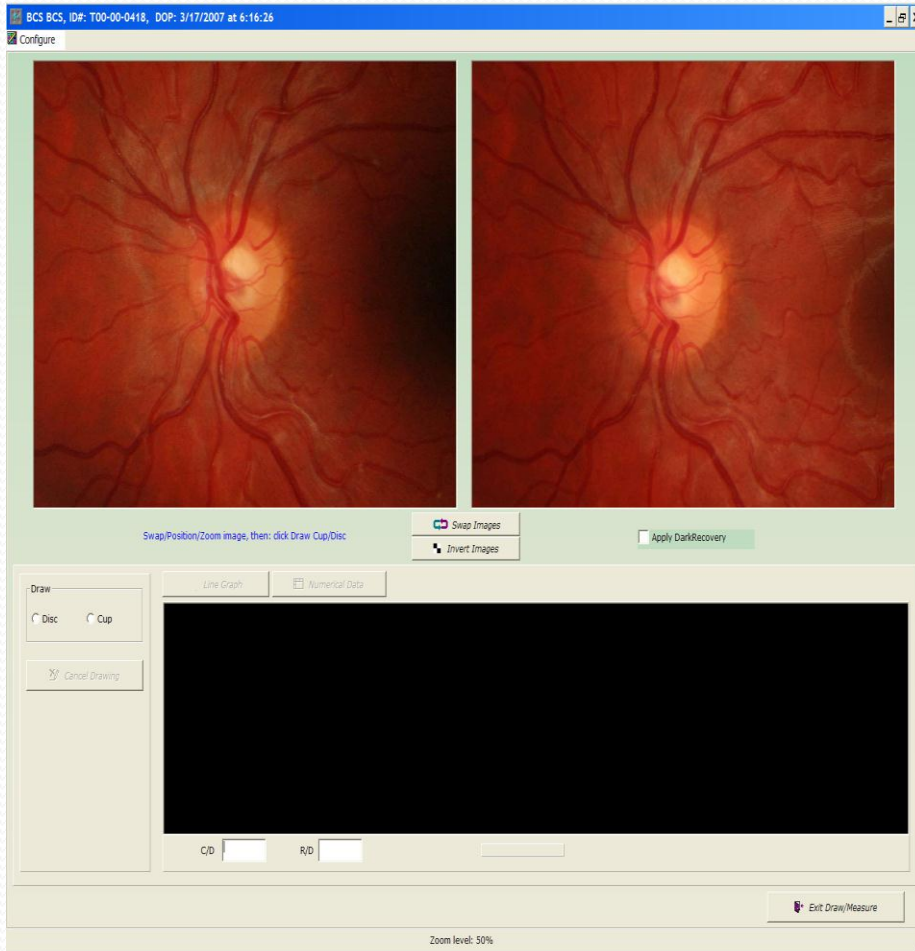


Courtesy Dr B Szirth



NJ Glaucoma

Stereo Imaging – Gold Standard in Glaucoma

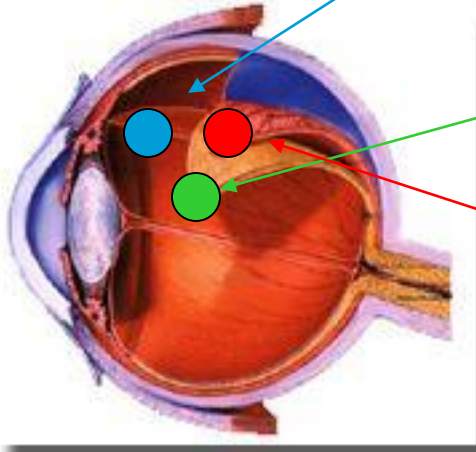


Khouri A, Szirth B. J Telemed & E-Health 2010

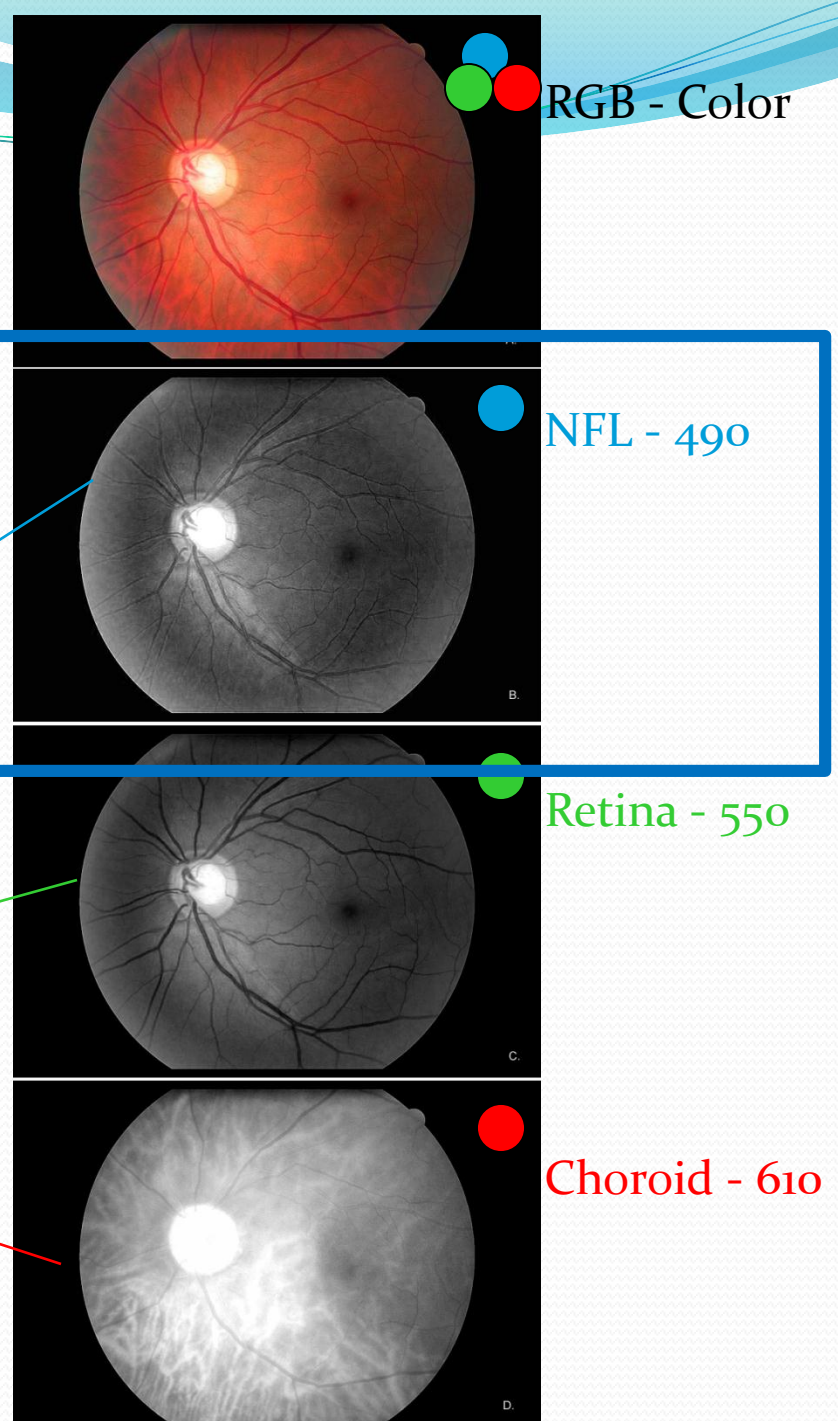
Advances in Digital Imaging

- Software Filters

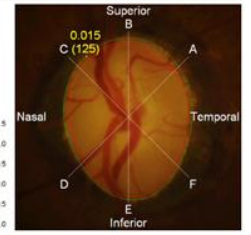
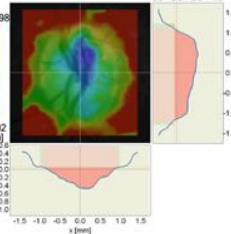
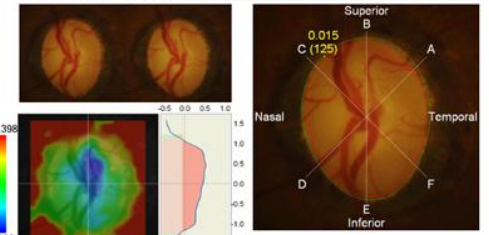
Glaucoma – NFL
Diabetic Retinopathy
Age Related Macular Degeneration



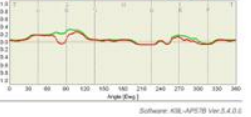
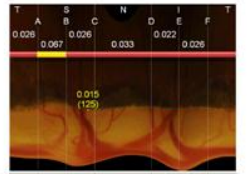
Courtesy Dr B Szirth



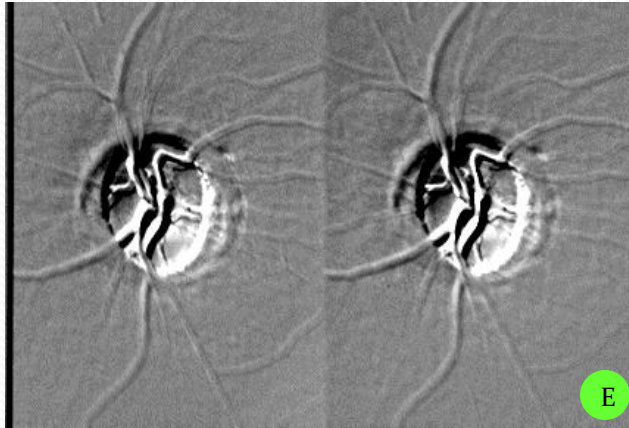
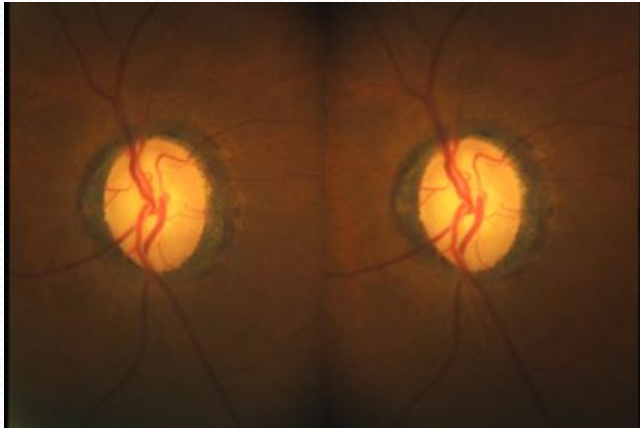
45 - Stereo - Emboss



Vertical Cup Disc Ratio	= 0.938
Superior Rim Width	= 0.109 [mm]
Inferior Rim Width	= 0.046 [mm]
Cup Area	= 3.394 [mm ²]
Disc Area	= 3.881 [mm ²]
Rim Area	= 0.487 [mm ²]
Cup Disc Area Ratio	= 0.875
Rim Disc Area Ratio	= 0.125
Cup Volume	= 0.820 [mm ³]
Disc Volume	= 0.656 [mm ³]
Rim Volume	= 0.031 [mm ³]
Mean Cup Depth	= 0.290 [mm]
Maximum Cup Depth	= 0.659 [mm]
Height Variation Contour	= 0.407 [mm]
DDLS Stage	= 3



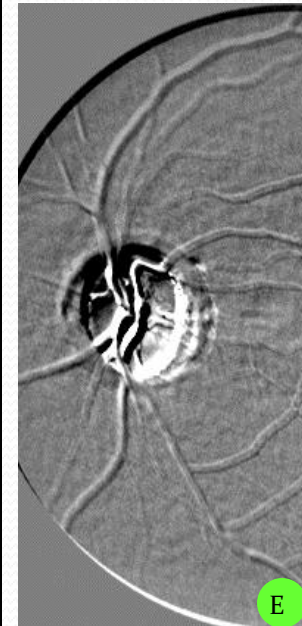
Stereo Retinal Camera - Optic Disc Analysis - (Kowa Company, LTD) Software: KSB-AP/3D Ver. 3.4.0.1



E



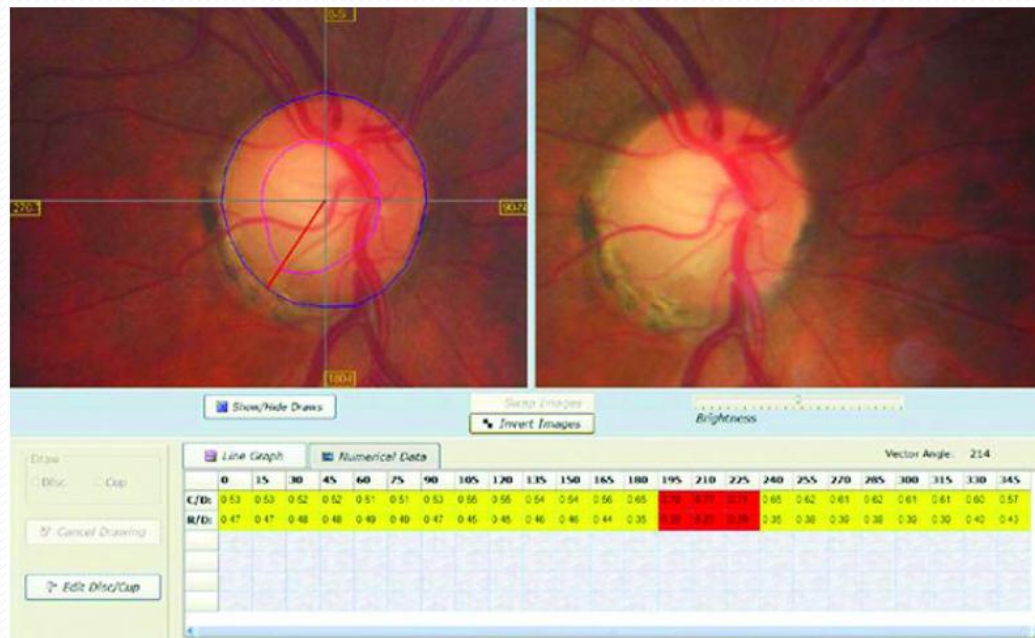
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E

Software Assisted Image Analysis

Software Assisted Optic Nerve Assessment for Glaucoma Tele-Screening





Show/Hide Draws

 Apply DarkRecovery
 Invert Images

Draw

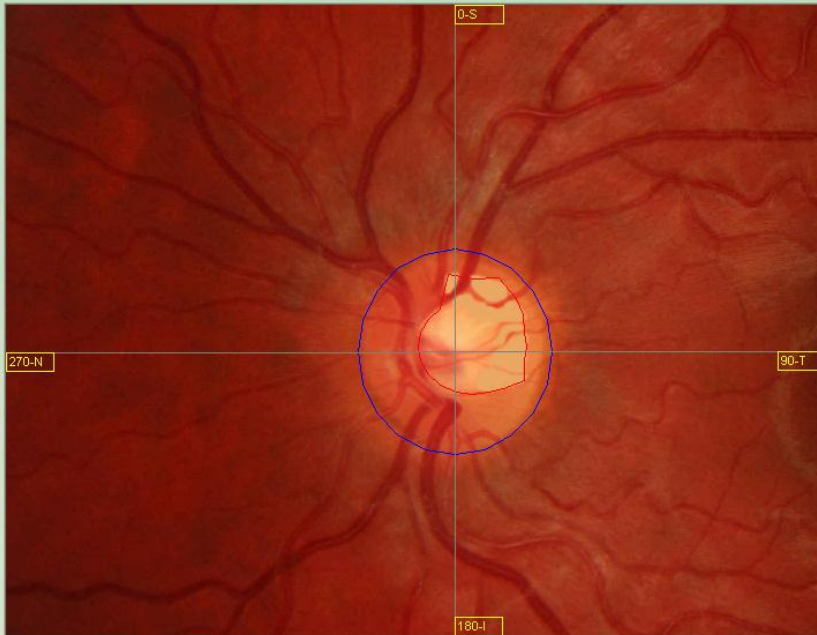
Disc
 Cup

Line Graph
 Numerical Data
 Vector Angle: ---

	0	15	30	45	60	75	90	105	120	135	150	165	180	195	210	225	240	255	270	285	300	315	330	345	
C/D:	0.46	0.47	0.48	0.49	0.50	0.50	0.49	0.48	0.47	0.46	0.44	0.42	0.41	0.39	0.38	0.38	0.38	0.38	0.38	0.39	0.40	0.41	0.42	0.42	0.43
R/D:	0.54	0.53	0.52	0.51	0.50	0.50	0.51	0.52	0.53	0.54	0.56	0.58	0.59	0.61	0.62	0.62	0.62	0.62	0.62	0.61	0.60	0.59	0.58	0.57	0.56

Click on a value to position the Disc vector

Configure



Show/Hide Draws

Swap Images

Invert Images

Apply DarkRecovery

Draw
 Disc Cup

Cancel Drawing

Edit Disc/Cup

Line Graph

Numerical Data

Vector Angle: ---

	0	15	30	45	60	75	90	105	120	135	150	165	180	195	210	225	240	255	270	285	300	315	330	345
C/D:	0.76	0.74	0.65	0.82	0.80	0.74	0.73	0.75	0.69	0.56	0.48	0.43	0.39	0.36	0.35	0.35	0.36	0.37	0.38	0.39	0.40	0.42	0.43	0.53
R/D:	0.24	0.26	0.15	0.18	0.20	0.26	0.27	0.25	0.31	0.44	0.52	0.57	0.61	0.64	0.65	0.65	0.64	0.63	0.62	0.61	0.60	0.58	0.57	0.47

Click on a value to position the Disc vector

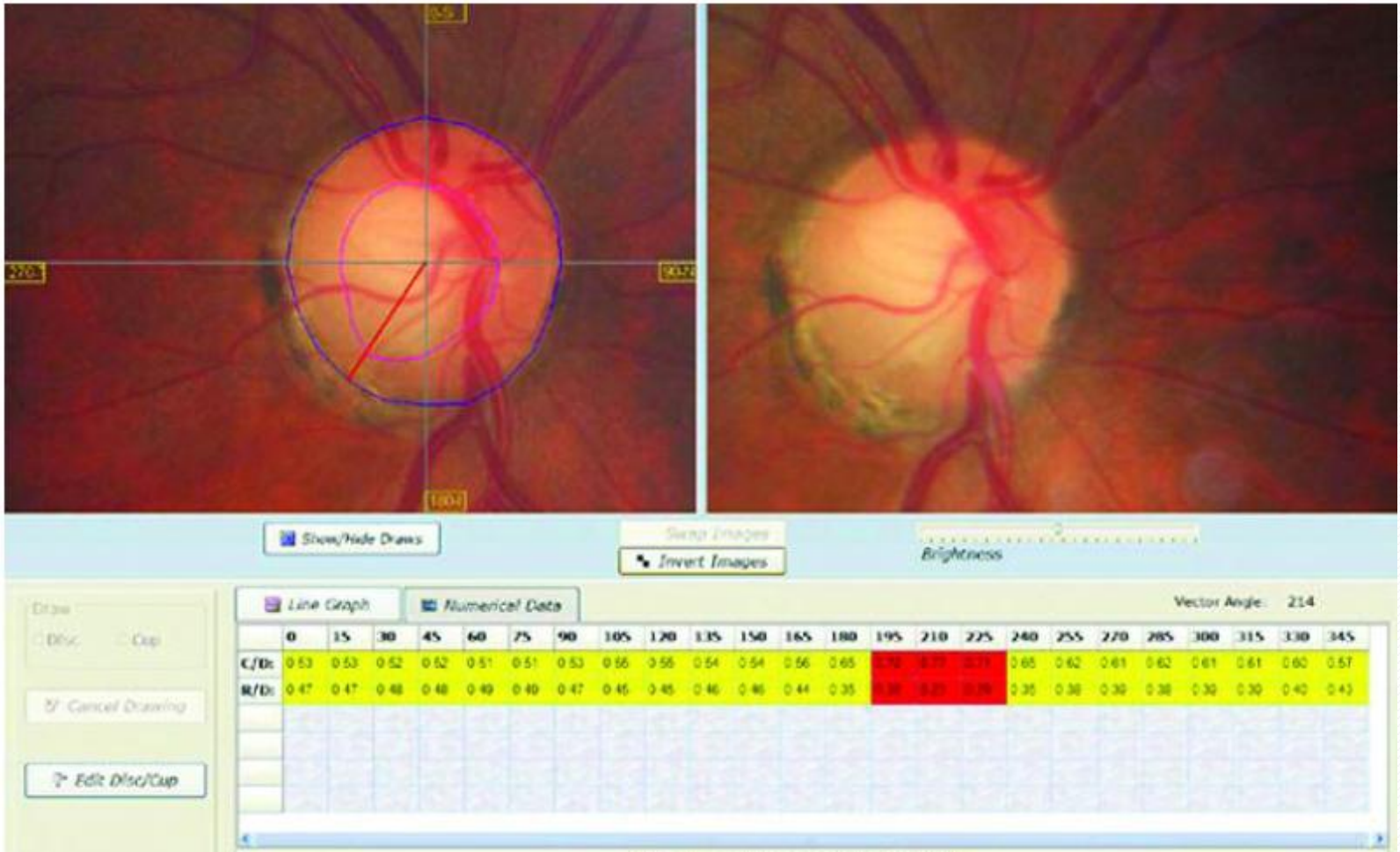
Print Screen

Exit Draw/Measure



NJ Glaucoma

Zoom level: 50%



Quantitative depth analysis of optic nerve head using stereo retinal fundus image pair

Abstract. Depth analysis of the optic nerve head (ONH) in the retinal fundus is important for the early detection of glaucoma. In this study, we investigate an automatic reconstruction method for the quantitative depth measurement of the ONH from a stereo retinal fundus image pair. We propose a technique to obtain the depth value from the stereo retinal fundus image pair, which mainly consists of five steps: 1. cutout of the ONH region from the stereo retinal fundus image pair, 2. registration of the stereo image pair, 3. disparity measurement, 4. noise reduction, and 5. quantitative depth calculation. Depth measurements of 12 normal eyes are performed using the stereo fundus camera and the Heidelberg Retina Tomograph (HRT), which is a confocal laser-scanning microscope. The depth values of the ONH obtained from the stereo retinal fundus image pair were in good accordance with the value obtained using HRT ($r=0.80\pm0.15$). These results indicate that our proposed method could be a useful and easy-to-handle tool for assessing the cup depth of the ONH in routine diagnosis as well as in glaucoma screening. © 2008 Society of Photo-Optical Instrumentation Engineers. [DOI: 10.1117/1.3041711]

Nakagawa T, Suzuki T, Hayashi Y, et al. J Biomed Opt. 2008 Nov-Dec;13(6):064026

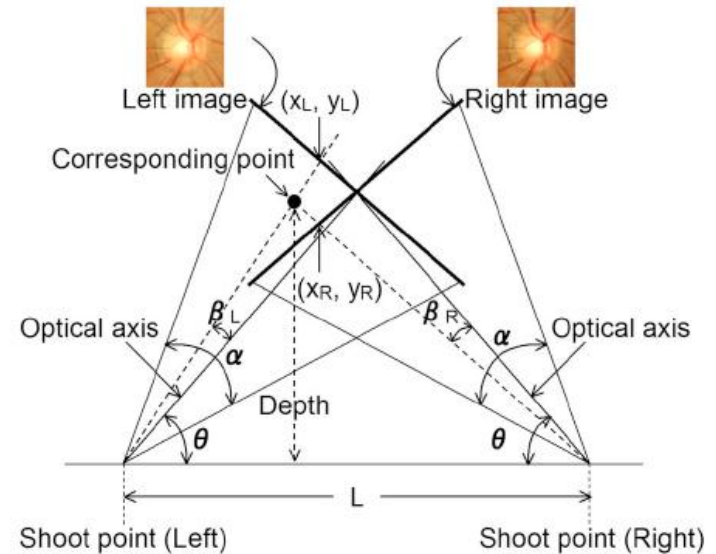
Depth Calculation

- A coordinate system arranged on the optical axis of left and right view points.
- Depth value of each 3D position determined according to disparity in both channels

$$\text{Depth} = \frac{L \times \tan(\theta - \beta_L) \times \tan(\theta + \beta_R)}{\tan(\theta - \beta_L) + \tan(\theta + \beta_R)},$$

$$\beta_L = \tan^{-1} \left\{ x_L \times \tan \left(\frac{\alpha}{2} \times \frac{\pi}{180} \right) \times \frac{2}{W} \right\},$$

$$\beta_R = \tan^{-1} \left\{ x_R \times \tan \left(\frac{\alpha}{2} \times \frac{\pi}{180} \right) \times \frac{2}{W} \right\},$$



Depth Map

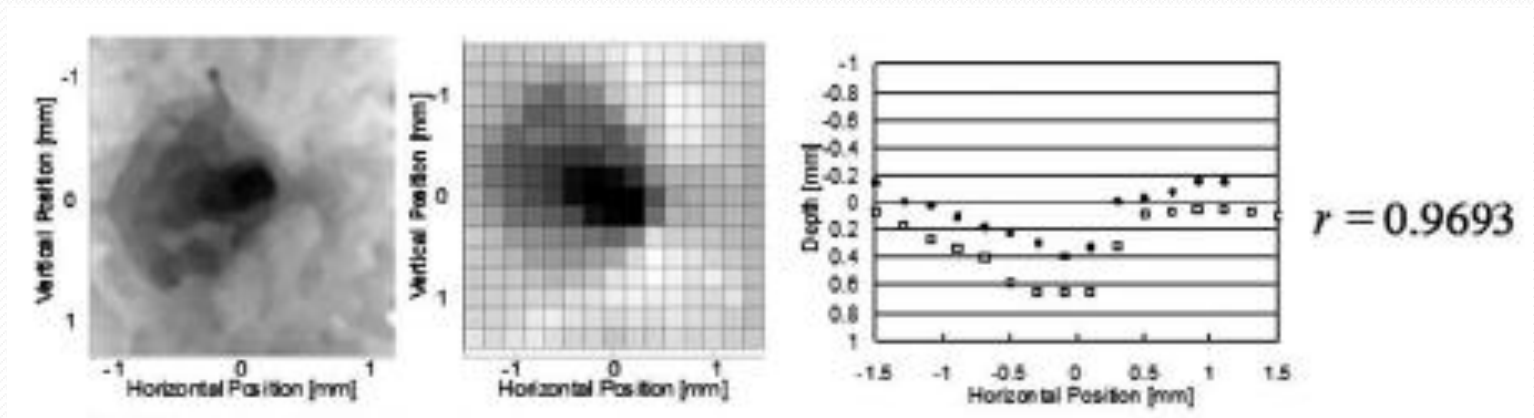
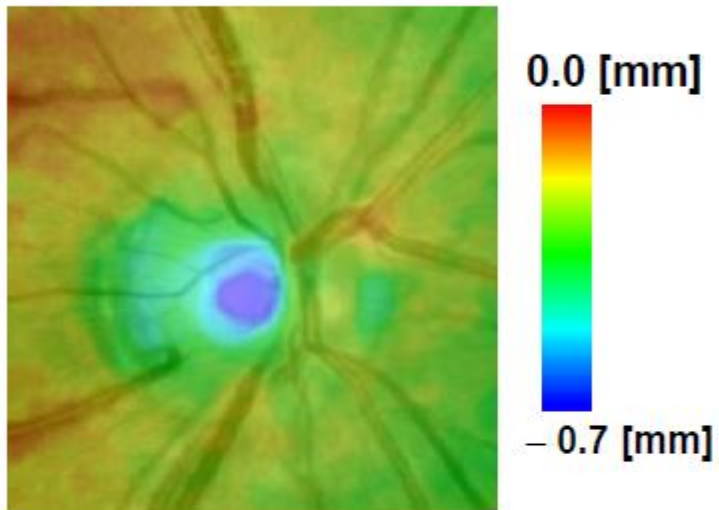


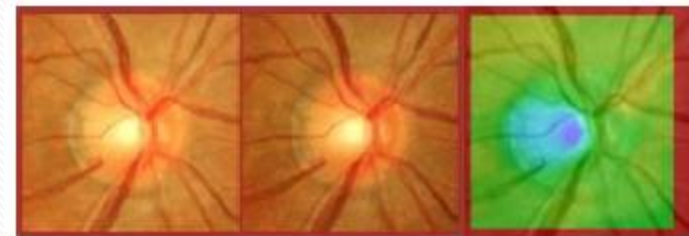
Fig. 8 The first column shows the depth maps generated from stereo fundus image pairs. The second column shows the topographic images obtained using the HRT. The third column shows the plots of the depth values in the depth maps and the topographic images along the midline across the ONH region. The results of the stereo fundus image pairs and the HRT are indicated by white circles and black squares, respectively.

Nakagawa T, Suzuki T, Hayashi Y, et al. J Biomed Opt. 2008 Nov-Dec;13(6):064026

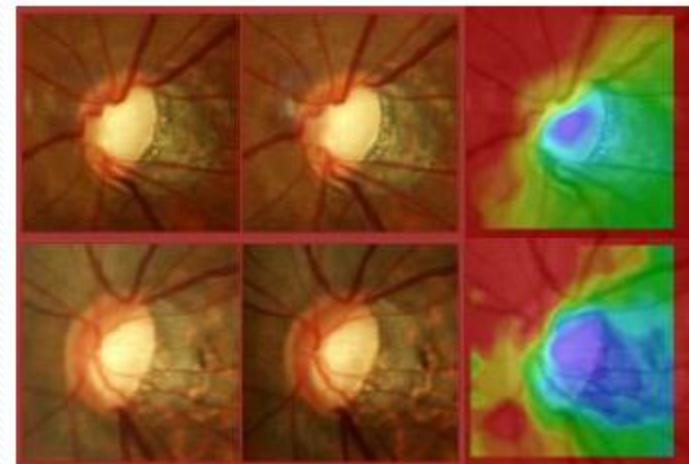
Depth Distribution



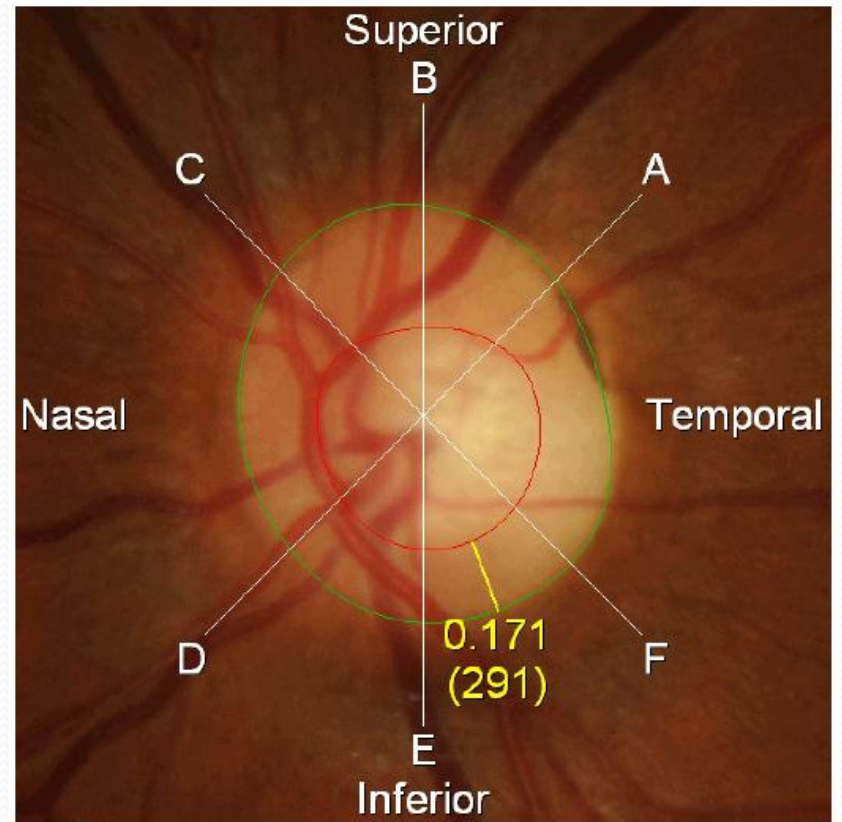
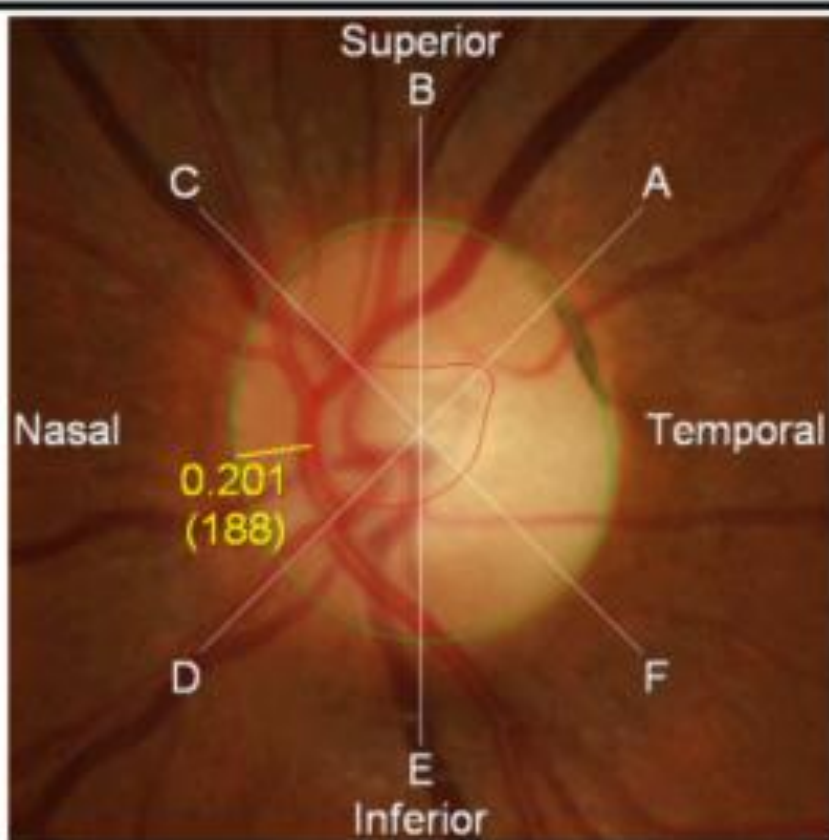
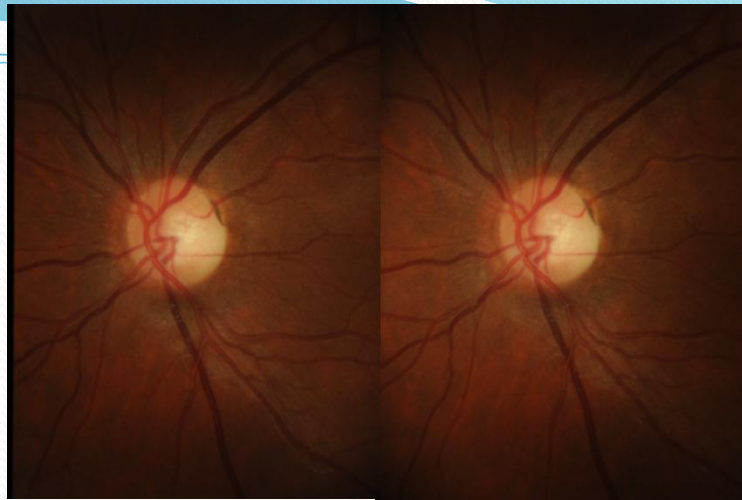
Depth distribution



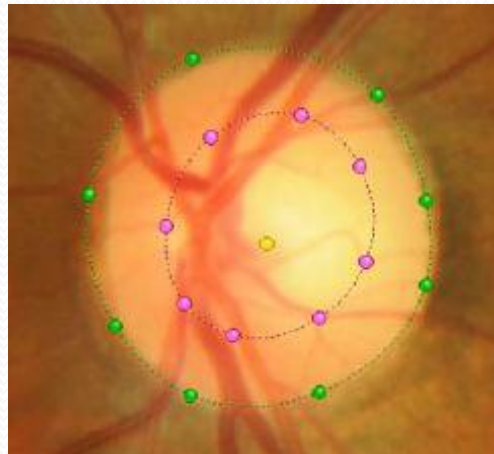
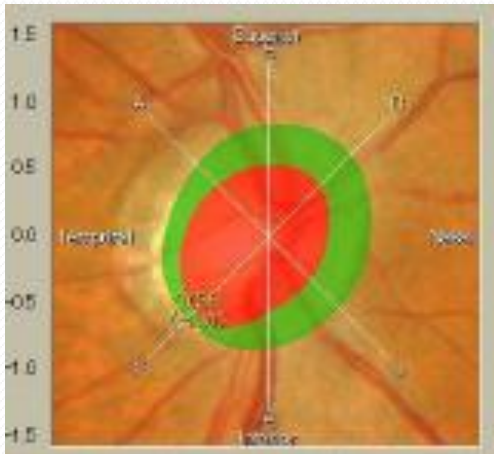
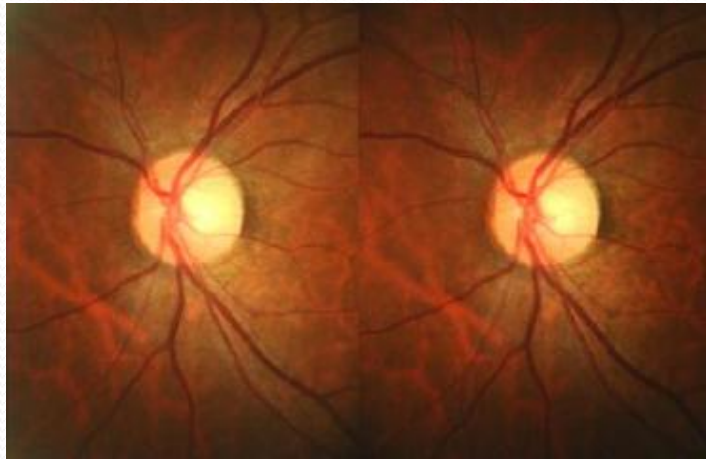
Normal



Glaucoma

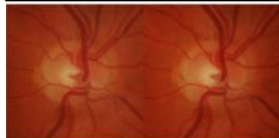
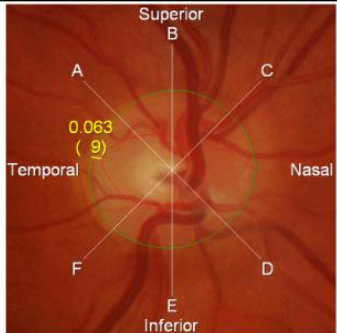


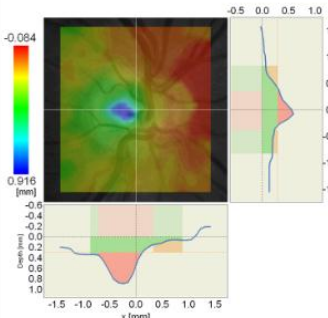
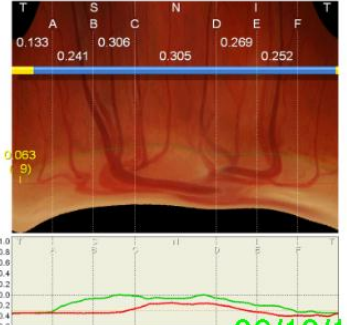
Analysis Software (VK-2 WX)



5/5 **Kowa nonmyd WX^{3D}** RETINAL CAMERA RPT

ID: 0025689 Report: 08/10/2011 12:03:50
 Name: BB Diagnosis: OD
 Photo: 08/03/2011 09:01:50

Vertical Cup Disc Ratio	= 0.452
Superior Rim Width	= 0.460 [mm]
Inferior Rim Width	= 0.454 [mm]
Cup Area	= 0.640 [mm ²]
Disc Area	= 2.260 [mm ²]
Rim Area	= 1.620 [mm ²]
Cup Disc Area Ratio	= 0.283
Rim Disc Area Ratio	= 0.717
Cup Volume	= 0.117 [mm ³]
Disc Volume	= 0.567 [mm ³]
Rim Volume	= 0.219 [mm ³]
Mean Cup Depth	= 0.183 [mm]
Maximum Cup Depth	= 0.679 [mm]
Height Variation Coe	
DDI Stage	

ODRI
BB
0025689

08/10/11
12:03:52

Stereo Retinal Camera - Optic Disc Analysis - (Kowa Company, Ltd.) Software : K9L-APS7B 5.4.0.0

Name BB

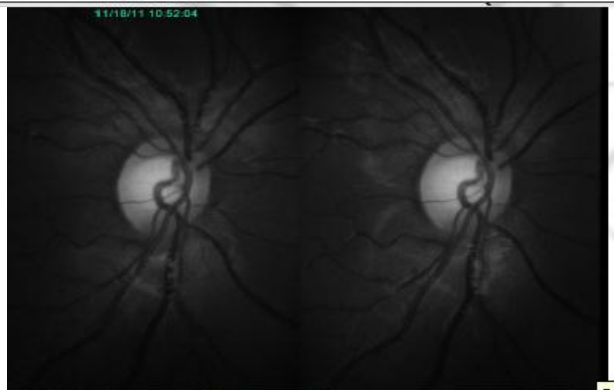
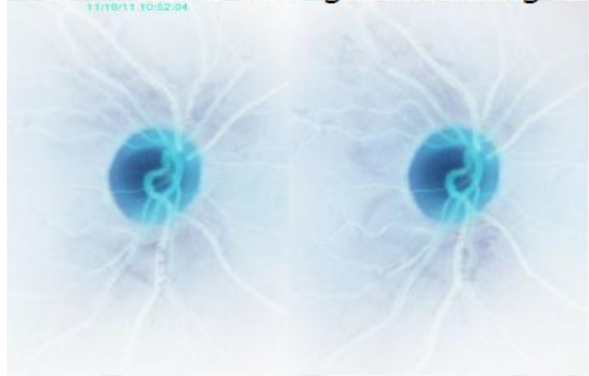


FIGURE 5 Negative Image

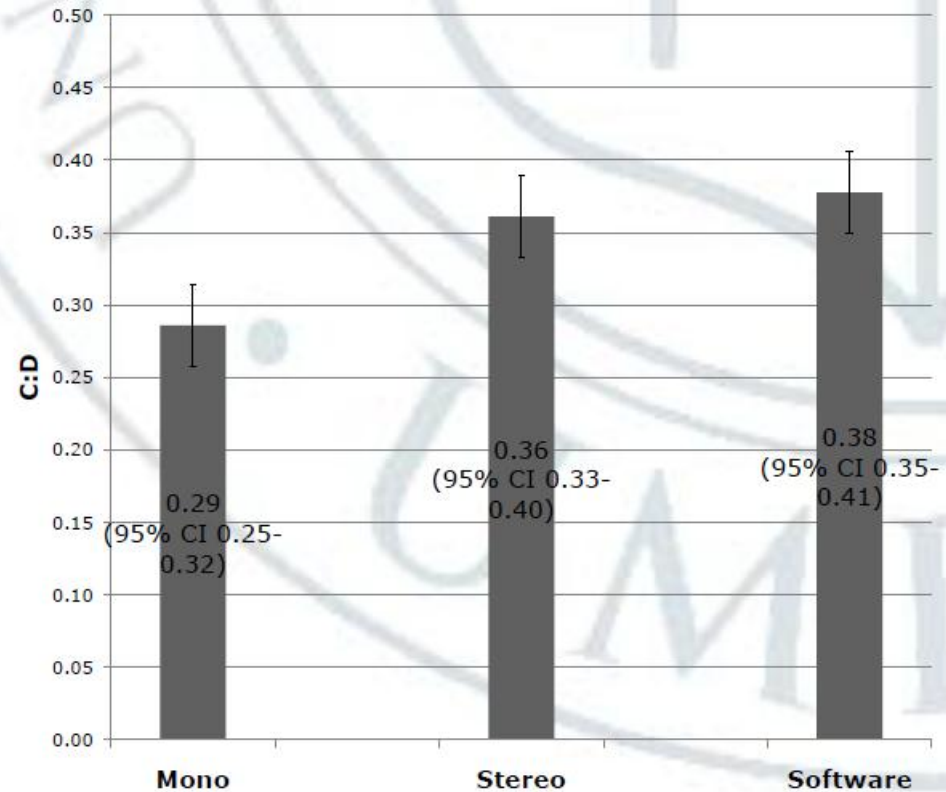


C:\Di
Setti

Stereo vs depth analysis software was not significant ($p=0.45$).

The intra-class correlation coefficient (r) between stereo and software assisted recordings = 0.88.

FIGURE 6 Mean C:D Ratio with 95% CI



Other structural testing

- Optical Coherence Tomography in Tele-Glaucoma

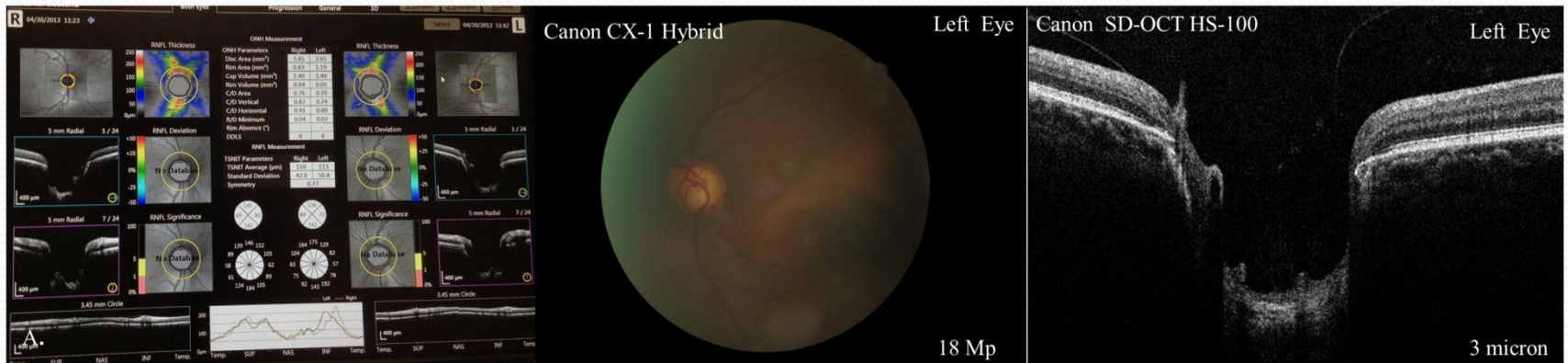


Figure 3: A. Screen-shot of SD-OCT HR

B. Example of presumed RNFL drop off/glaucomatous ONH.

C. View of the Optic Nerve with SD-OCT



NJ Glaucoma

Courtesy Dr B Szirth

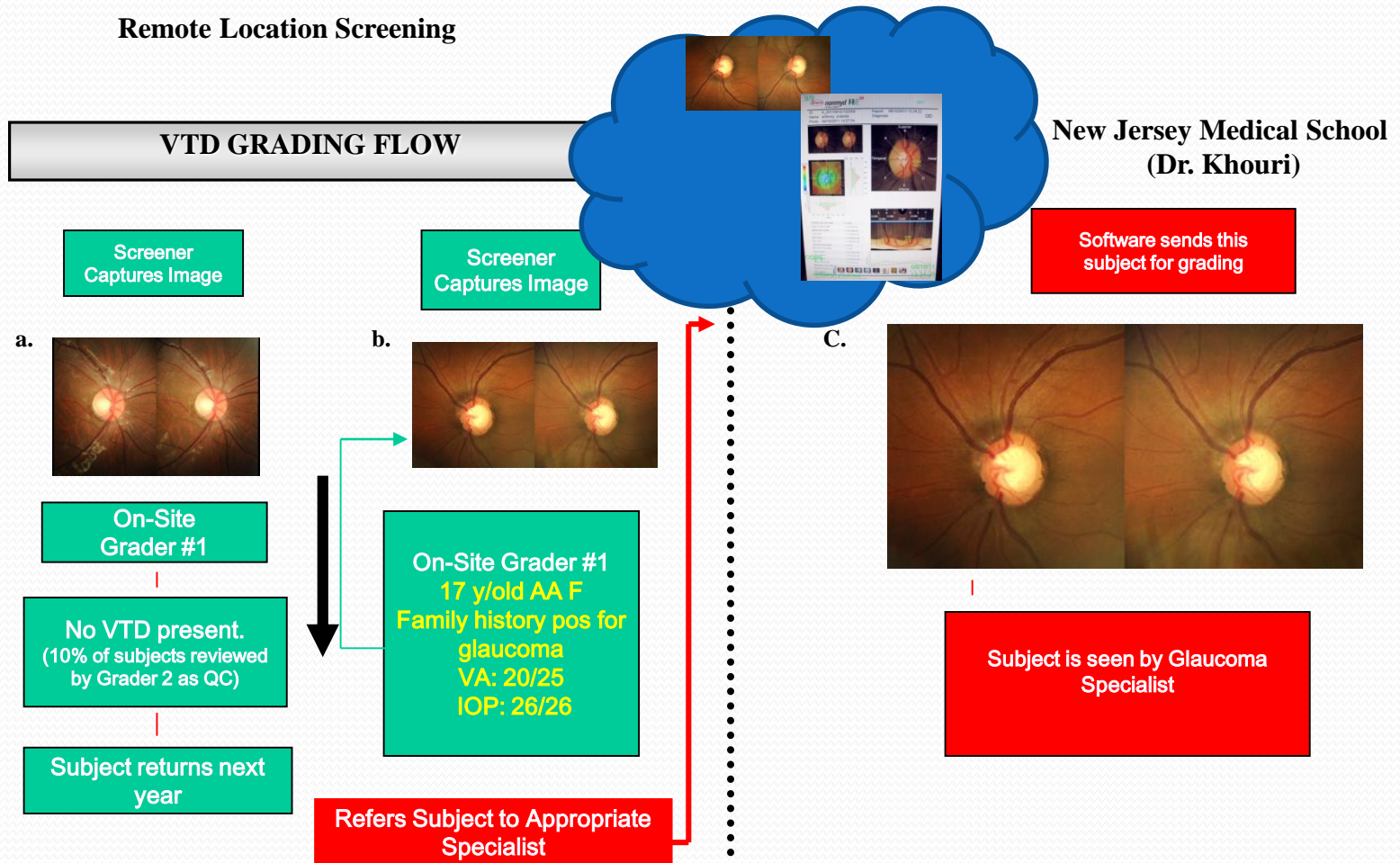
Challenges facing Tele-Glaucoma

- Currently assessment and recommendations are made on-site by the medical director of the screening team.
- Cloud based solutions

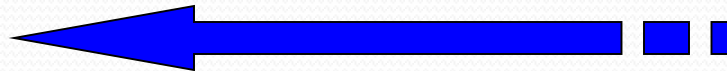
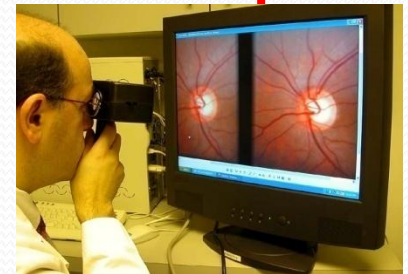
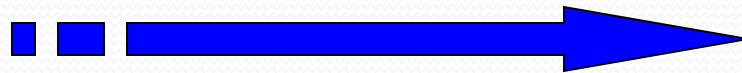
Screening (triage) Flow

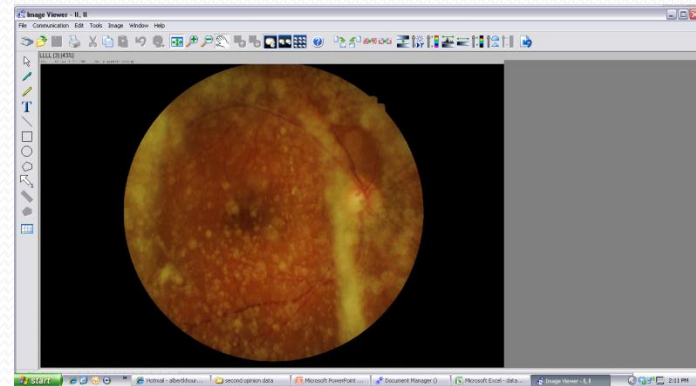
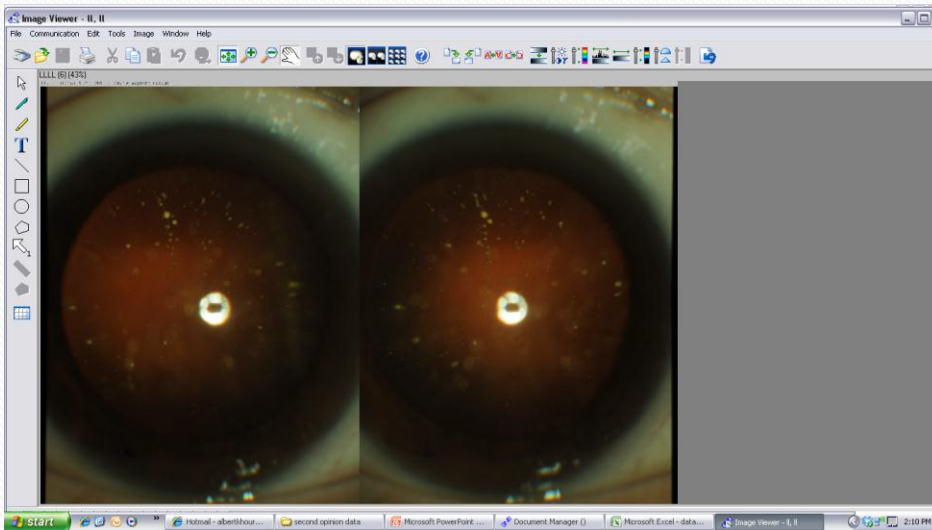
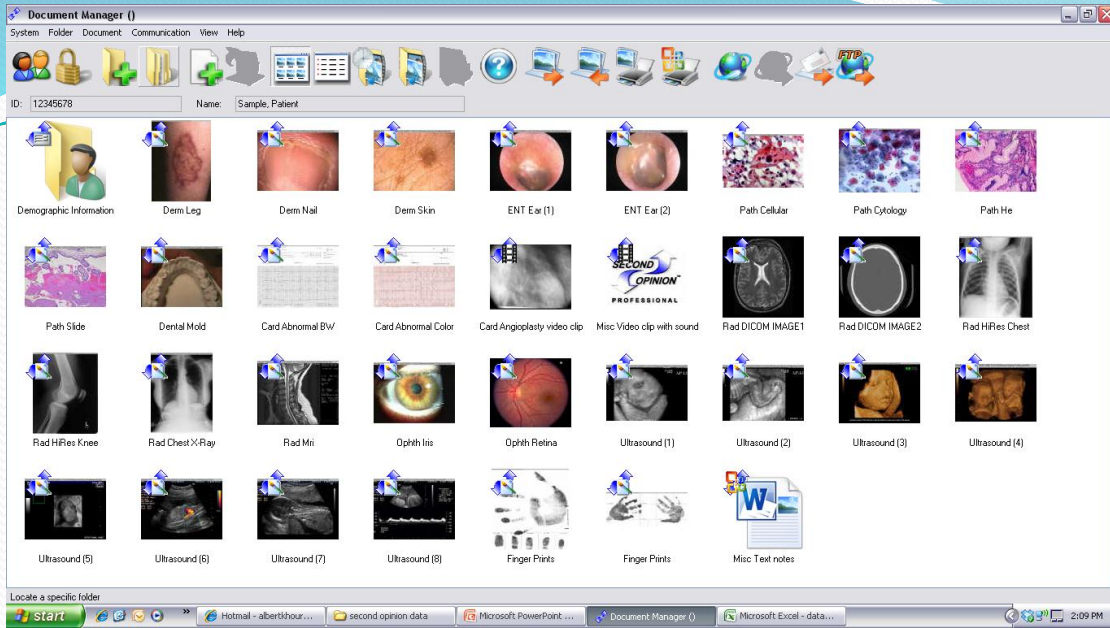


Remote Location Screening



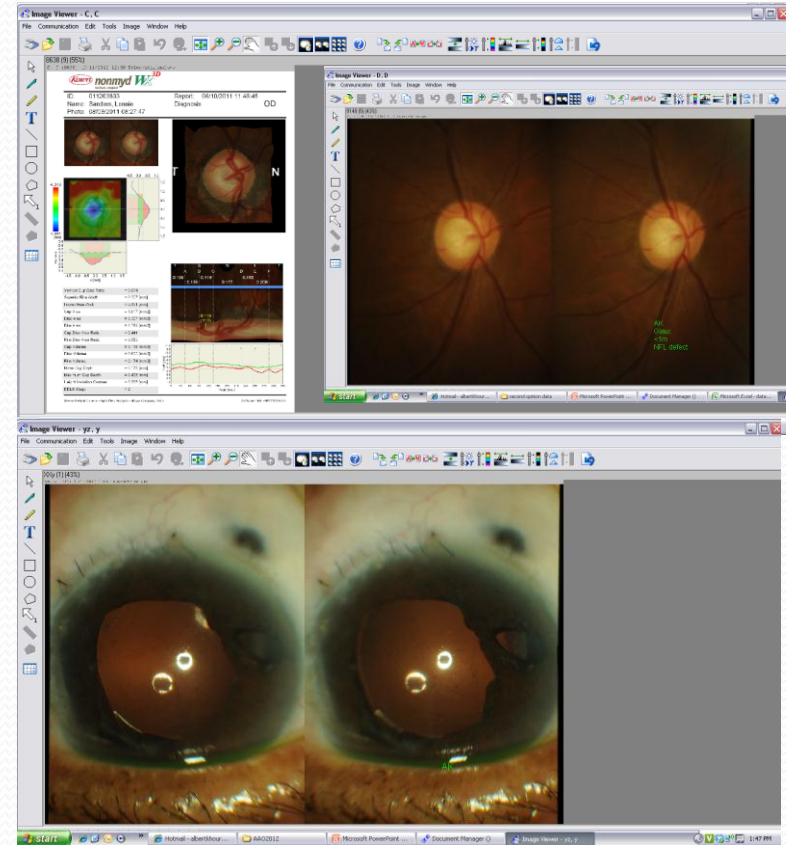
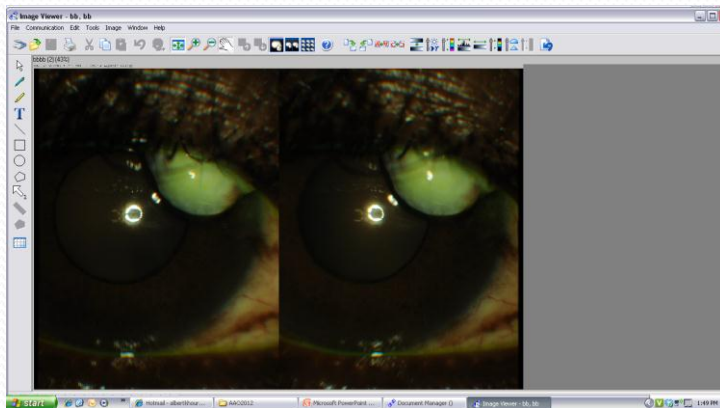
Future Work Tele-Presence





New Jersey Medical School Tele-Glaucoma

- Pilot Experience
 - 58 stereoscopic ONH images
 - Near real time evaluation
 - Wireless 4G Network:
Transmission speed 5-30 sec
per subject
 - No image quality degradation



Conclusions

- Tele-Glaucoma is an evolving field that can offer solutions
 - Specialized care remotely
 - Applications in clinical medicine
 - And...

Glaucoma Awareness

World Glaucoma Week

March 6–12, 2016

WGWeek

What is Glaucoma?

Activities ▾

About WGWeek ▾

Contact



What is Glaucoma?

Glaucoma is a group of eye diseases that cause progressive damage of the optic nerve at the point where it leaves the eye to carry visual information to the brain.

If left untreated, most types of glaucoma progress (without warning nor obvious symptoms to the patient) towards gradually worsening visual damage and may lead to blindness. Once incurred, visual damage is mostly irreversible, and this has led to glaucoma being described as the “silent blinding disease” or the “sneak thief of sight”.

Glaucoma is the second most common cause of blindness worldwide. It is estimated that 4.5 million persons globally are blind due to glaucoma¹ and that this number will rise to 11.2 million by 2020². It is noteworthy that due to the silent progression of the disease – at least in its early stages – up to 50% of affected persons in the developed countries are not even aware of having glaucoma³. This number may rise to 90% in underdeveloped parts of the world.



There are several types of glaucoma. Some may occur as a complication of other visual disorders (the so-called “secondary” glaucomas) but the vast majority is “primary”, i.e. they occur without a known cause. It was once believed that the cause

WGWeek2016

237
Days

14
Hours

50
Minutes

28
Seconds

until World Glaucoma Week 2016
march 6–12, 2016



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Food for Thought!



NJ Glaucoma

IDEAS MARKET

SENTIMENT TRACKER: A COMPUTATIONAL ANALYSIS OF THE CONVERSATION ON SOCIAL NETWORKS

Out of 51,000 posts

FACEBOOK HITS ONE BILLION

The online buzz about Facebook hitting one billion active users—double the 500 million the company hit in July of 2010.

16%
CELEBRATION

'It took the world hundreds of thousands of years to reach a billion users. Facebook did it in under 9.'

'Only 6 billion to go. On this planet.'

'One million users is not cool. You know what's cool? A BILLION USERS.'

'Come on, YouTube, we can top that!'

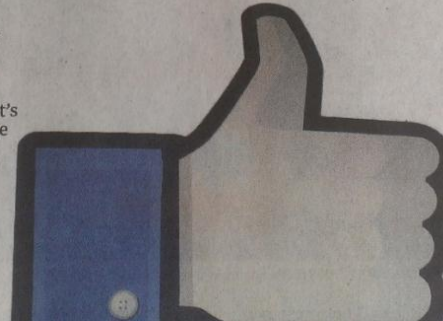
66%
PRIVACY IS DEAD

'Facebook has finally added the option to grant the security and privacy people have hoped for. It's called "Deactivate your account."'

'Just looking at Facebook, it's clear people don't care about their privacy.'

'Well, I guess

1,000,000,000



16%
UNFRIEND

'Actually, this is pretty creepy. The Internet is taking over the world.'

'Recap: Facebook hits 1 BILLION users, share price still in the tank.'

'More users are not the solution to what's wrong with Facebook.'

'A billion people shouldn't be allowed to use

2%
JOKES

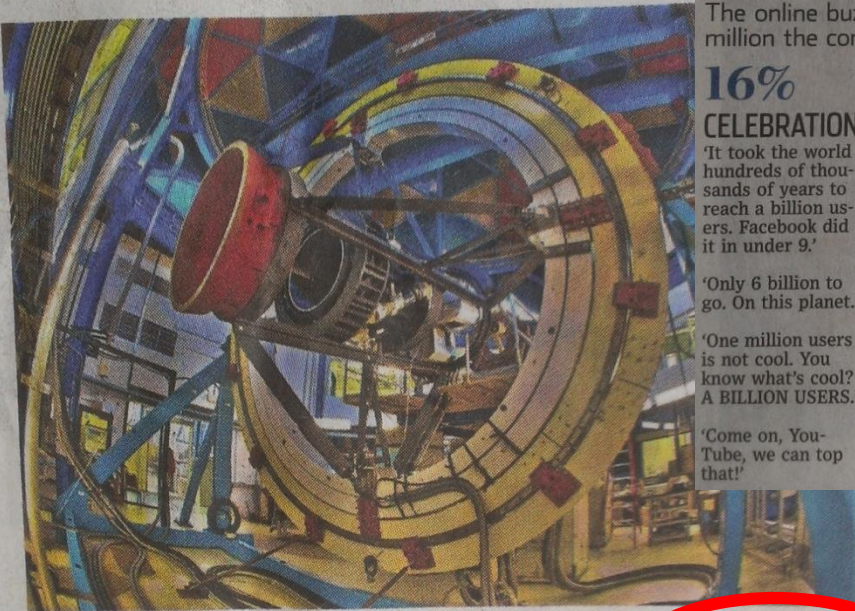
'That's 1 out of every 7 humans. The other 6 are productive people that have meaningful friendships. For now.'

'In other news, 1 billion people are my aunt.'

'So, that's a billion cats dressed as pirates.'

'And all of them are people you didn't like in high

A MEGA-MEGAPIXEL CAMERA



Digital cameras are getting better all the time. But how about 570 megapixels?

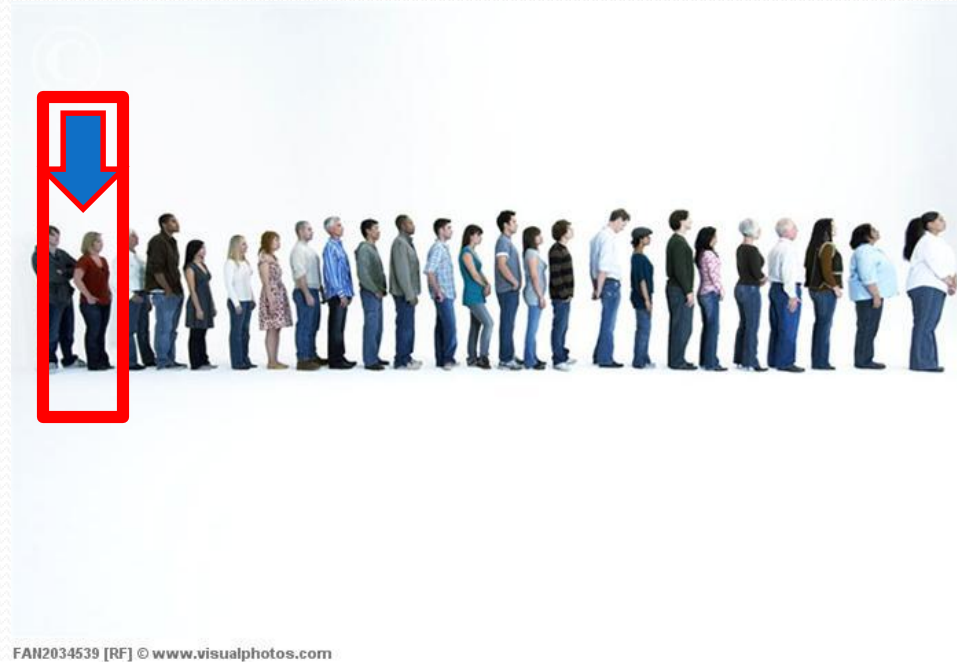
That's the resolution of the phone-booth-size Dark Energy Camera, which took its first pictures of the southern sky last month. In December, scientists will start using the camera to plumb, among other things, the nature of dark energy—considered the key to explaining the universe's accelerating expansion. The camera, created by the Fermi National Accelerator Laboratory in Batavia, Ill., is based at the National Science Foundation's Cerro Tololo Inter-American Observatory in Chile.



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Future Tele-Glaucoma

- Tele-Glaucoma applied at the “gates” of our healthcare system.



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