



# Autonomous Visual Field Test & Diagnosis System in Space and on Earth

Wolfgang Fink<sup>1,2,3</sup> (PI)  
Alfredo Sadun<sup>3</sup> & Jonathan Clark<sup>4</sup>

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<sup>4</sup>NASA Johnson Space Center, Houston, TX 77058

Drs. Wolfgang Fink (PI), Alfredo Sadun, and Jonathan Clark

Caltech patents pending!

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### In General:

Technologies supporting seamless interface between detection, diagnosis and intervention  
Support of NASA's Human Exploration and Development of Space (HEDS) program  
Enabling future long-term NASA space missions (e. g.: ISS, trip to Mars)

### In Particular:

Fully autonomous diagnosis expert system for visual field classification  
Using non-invasive optical technology  
Advanced monitoring and early detection  
Comprehensive diagnosis of eye and brain diseases affecting the visual field

### Vision:

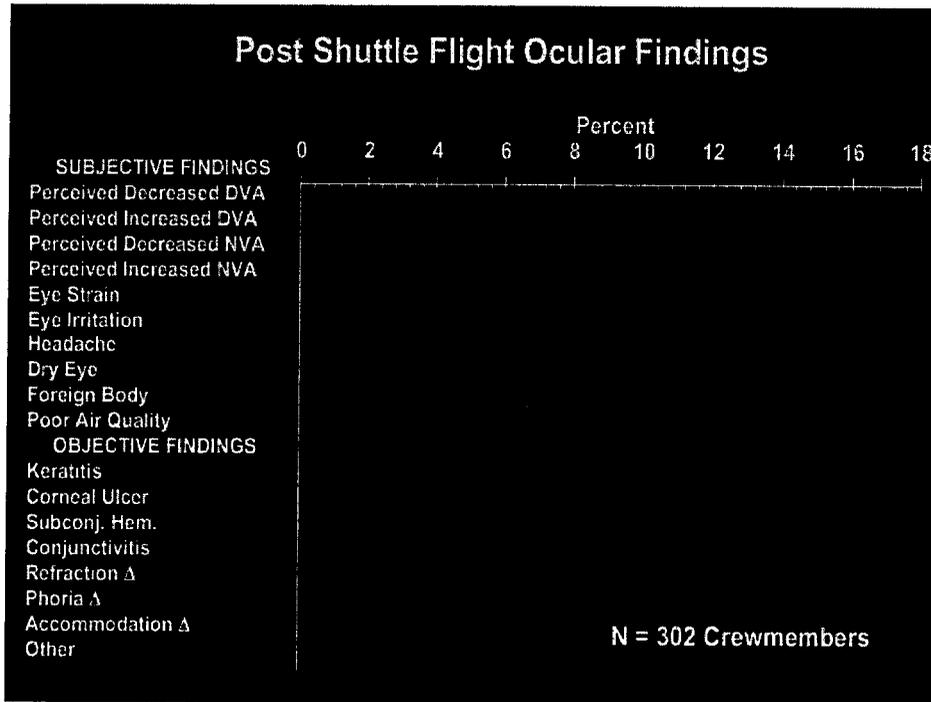
3D Computer-Automated Threshold Amsler Grid Test → Creation of Database and Development of Autodiagnosis System



Drs. Wolfgang Fink (PI), Alfredo Sadun, and Jonathan Clark

Caltech patents pending!

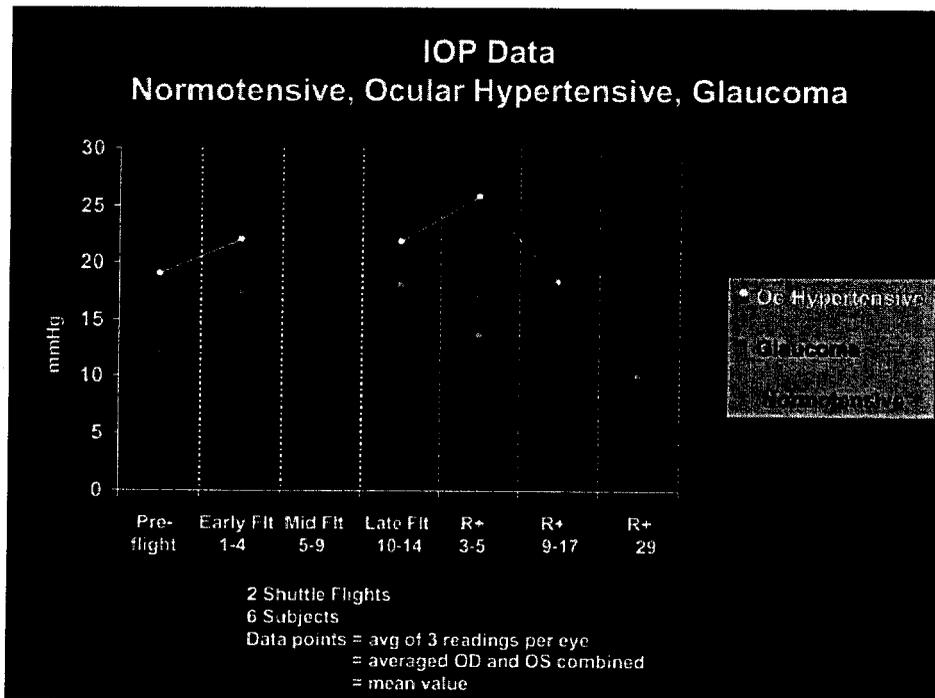
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Autonomous Visual Field Test & Diagnosis System in Space and on Earth  
 Ocular Conditions in the Operative Environment of Space Flight



Condition	ICDA Code	Response
Cataract	366.9	23
Diabetes, Background Ret.	362.01	0
Drusen, Retina	362.57	5
Glaucoma	365.9	2
Hypertension, Ocular <i>GLAUCOMA SUSPECT</i>	365.04	16 8
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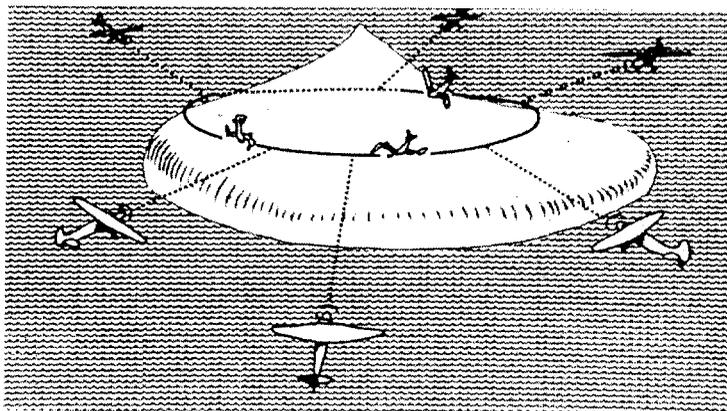
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Autonomous Visual Field Test & Diagnosis System in Space and on Earth  
 Background: Perimetry



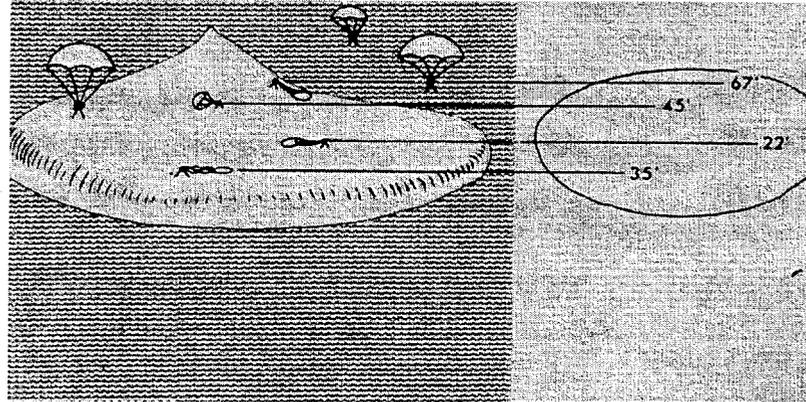
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Autonomous Visual Field Test & Diagnosis System in Space and on Earth  
Background: Campimetry



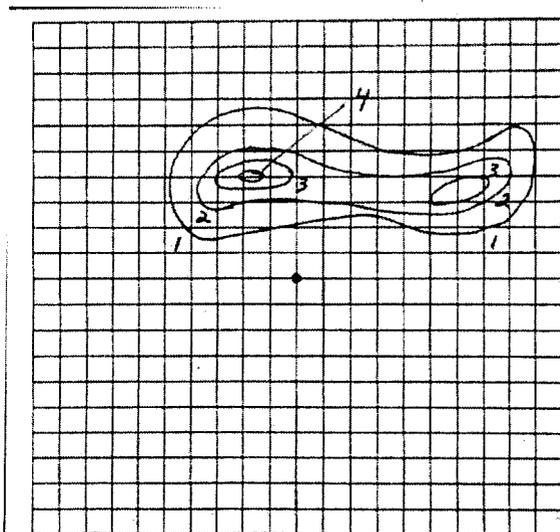
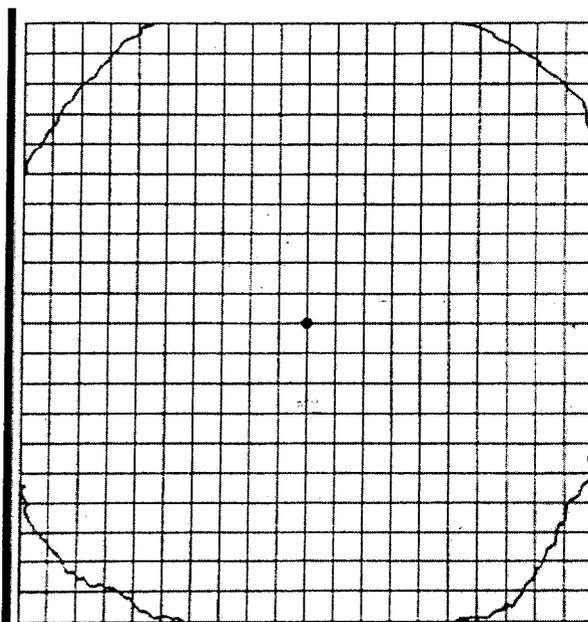
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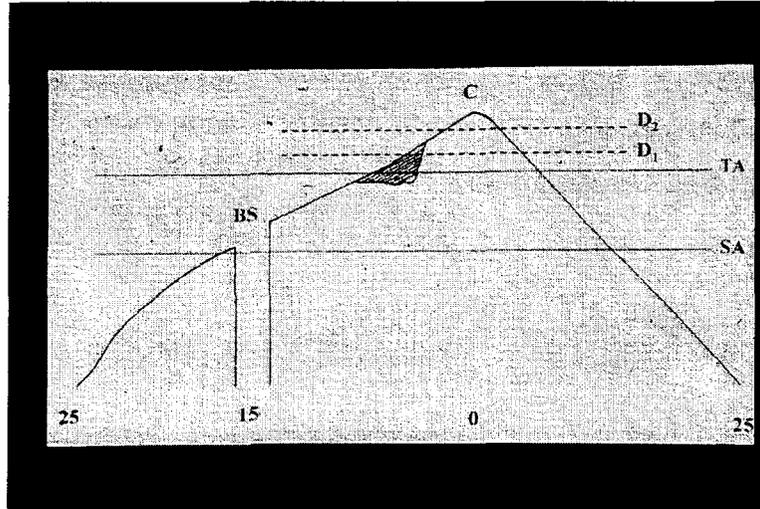
Autonomous Visual Field Test & Diagnosis System in Space and on Earth  
Background: Amsler Grid Testing



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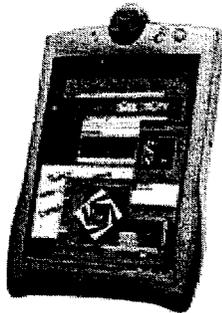
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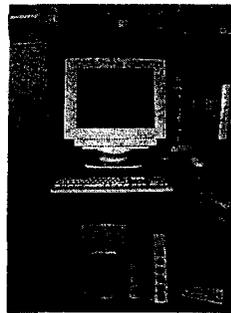


Touchsensitive  
TFT-panels

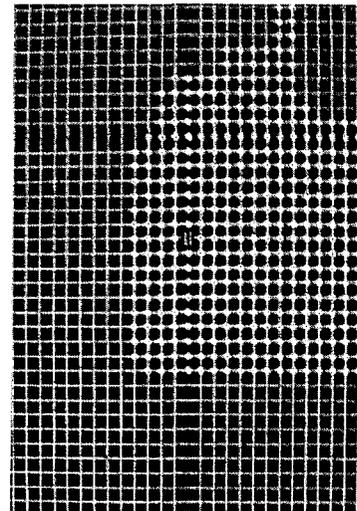


OR

Touchsensitive  
Monitors



3D Computer-Automated  
Threshold Amsler Grid Test



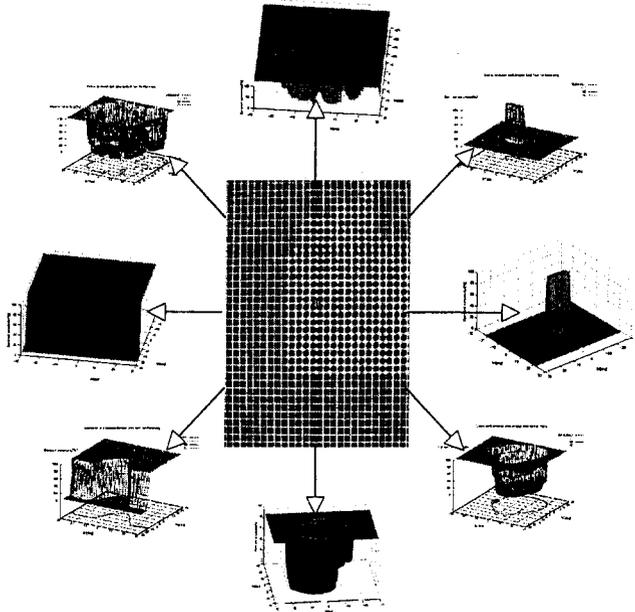
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Autonomous Visual Field Test & Diagnosis System in Space and on Earth  
3D Computer-Automated Threshold Amsler Grid Test



Devised by *Fink & Sadun* in 2000  
Recent Publicity in Press & Audio-Visual Media:

- CNN Headline News
- NASA TV
- KCAL
- KCET "Life & Times Tonight"
- TechTV
- National Geographic
- Reuters
- NSF Press Release
- NSF News Highlights
- Caltech Press Release
- JPL Media Release
- JPL website
- USC News "USC Today"
- USC "HSC Weekly"
- USC "Trojan Family Magazine"
- USC "USC Health Magazine"
- Spiegel Online
- Informationweek
- SpaceDaily
- SPACE.com
- Spinoff Technologies
- Acrotech News and Review
- Federal Telemedicine News
- GeoCities
- MacNow Magazine
- Science News Network
- PITSCO The Cause

Caltech patents pending!

Further Information on the 3D Visual Field Test:

<http://www.wfbabcom5.com/wf335.htm>

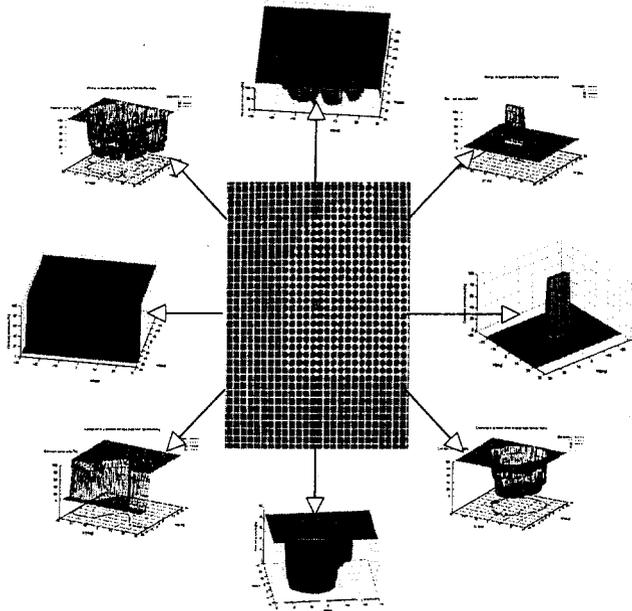
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Autonomous Visual Field Test & Diagnosis System in Space and on Earth  
Advantages of 3D Computer-Based Threshold Amsler Grid Test



Major Advantages:

Non-invasive

Easy & Quick (4-5 min per eye)

High Spatial Resolution & Accuracy  
(typically 1 °, down to 15 ')

3D Structure of Visual Field Defects  
e.g.: location, depth, shape, extent,  
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No additional Payload (NASA)

Accessible through the Internet

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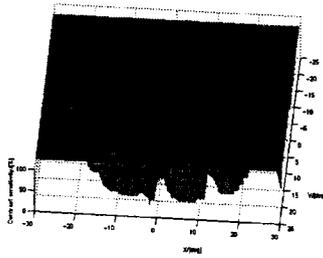
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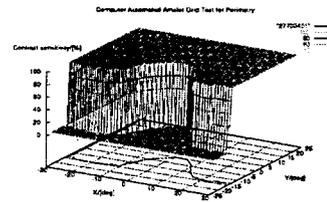
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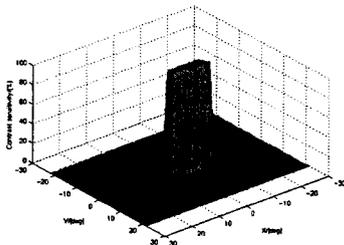
Optic Neuritis



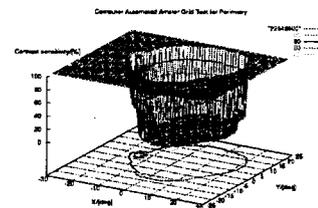
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Glaucoma



ARMD: "dry" vs. "wet"



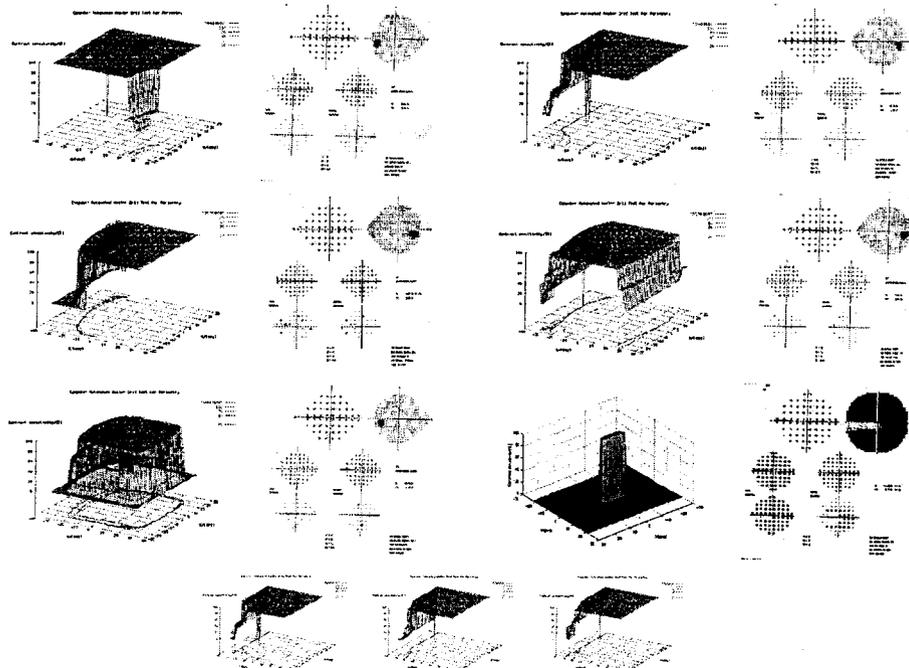
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Caltech patents pending!

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Glaucoma Suspects



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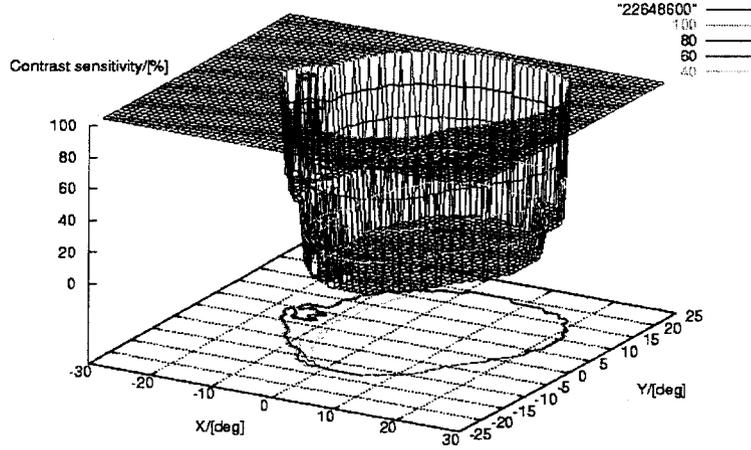


# Autonomous Visual Field Test & Diagnosis System in Space and on Earth

## Example Examination Result



Computer Automated Amsler Grid Test for Perimetry



### ARMD

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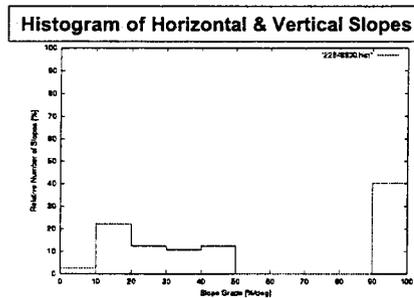
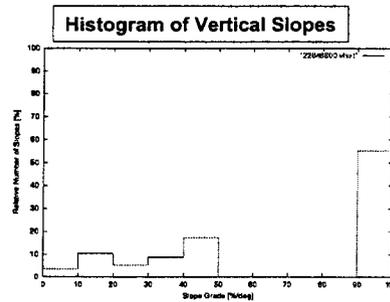
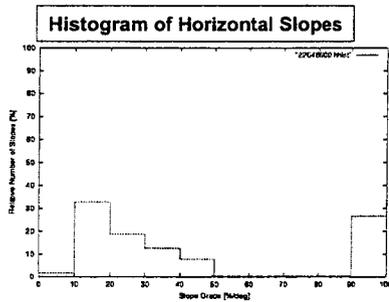
Caltech patents pending!

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# Autonomous Visual Field Test & Diagnosis System in Space and on Earth

## Example Analytical Analyses



VF Area at Contrast Sensitivity 0%	685 deg <sup>2</sup>
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Average Value of <i>all</i> Slopes	57±37%/deg

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Caltech patents pending!

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Patient examination  
data retrieval



Database of *shapes* and  
*slopes* of 3D structure of  
visual field defects

Identification of *signature*  
*patterns* for various  
ophthalmological and  
neurological conditions

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Knowledge extraction from large database of *3D shapes* and *slopes* that are likely  
to be *signature patterns* for various ophthalmological and neurological conditions



**Sophisticated Pattern Recognition  
Classification Algorithms**  
*using*  
**Analytical Analyses  
Neural Networks  
Classifier Systems**

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**Autonomous (Onboard) Physician**

Screening & Monitoring on a frequent and regular basis

Early Detection of various Eye/Brain Diseases

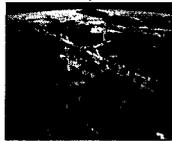
Reduced Astronaut Medical Data Transmission



Centralized  
Worldwide  
Remote Diagnosis  
(Telemedicine)



Autonomous  
Onboard Physician  
on Shuttle Missions



Autonomous  
Onboard Physician  
on ISS



Autonomous  
Onboard Physician  
on Trip to Mars



Autonomous  
Onboard Physician  
on Trip to Jovian  
Moons

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Caltech patents pending!

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NSF

R&TD

**Acknowledgements:**

**Dr. Steven Koonin, Provost of Caltech**

**Dr. Tom Prince, Chief Scientist of JPL**

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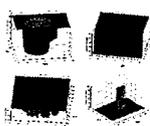
Advanced monitoring and early detection

Comprehensive diagnosis of eye and brain diseases affecting the visual field

### Vision:

3D Computer-Automated Threshold Amsler Grid Test

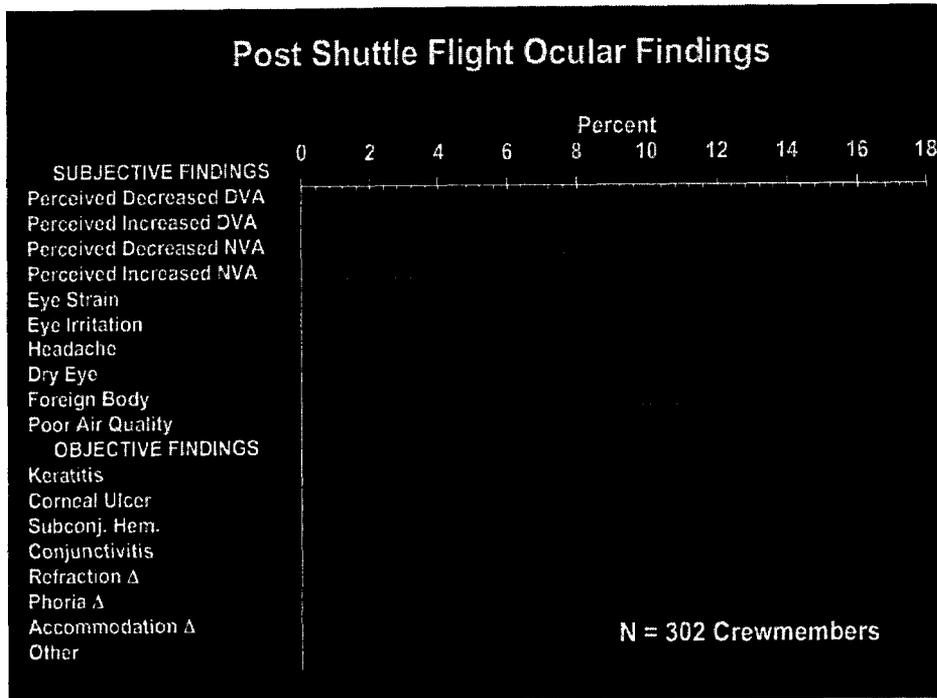
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Caltech patents pending!

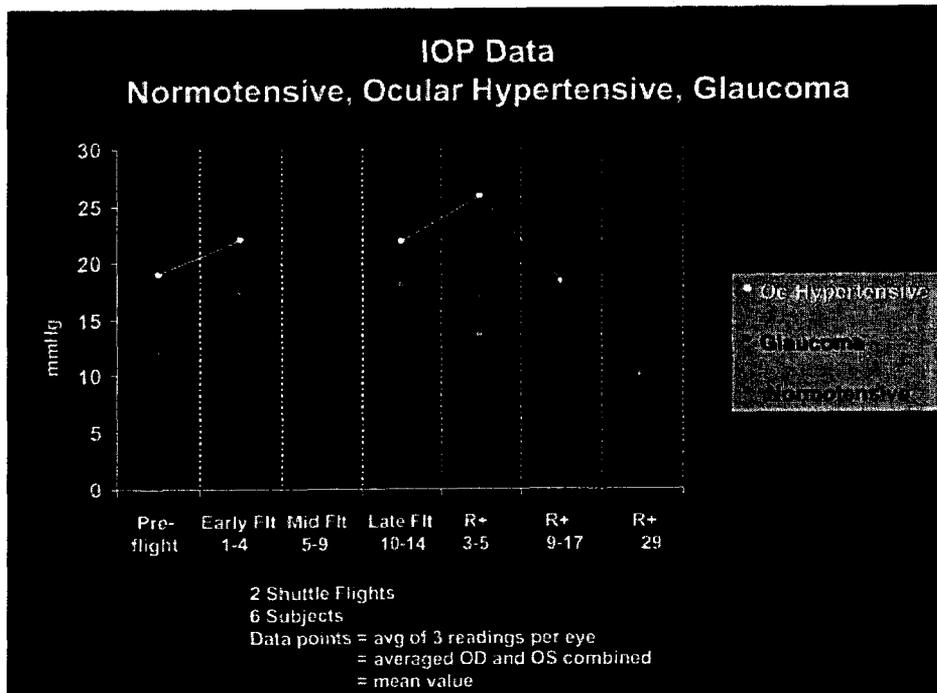
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Caltech patents pending!

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Autonomous Visual Field Test & Diagnosis System in Space and on Earth  
 Ocular Conditions in the Operative Environment of Space Flight



Description	ICD-9-CM	ICD-10
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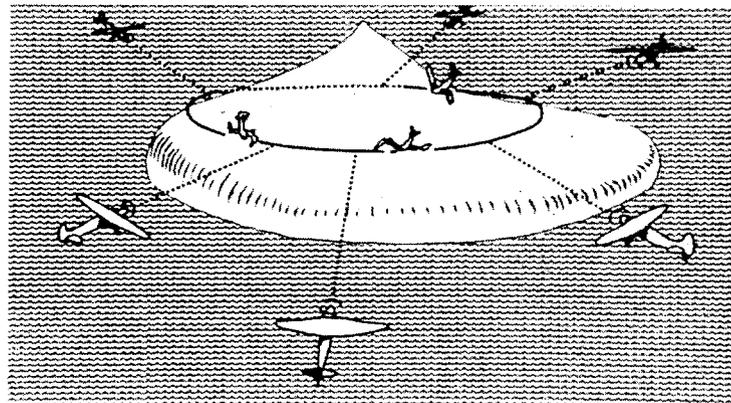
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Caltech patents pending!

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Autonomous Visual Field Test & Diagnosis System in Space and on Earth  
 Background: Perimetry



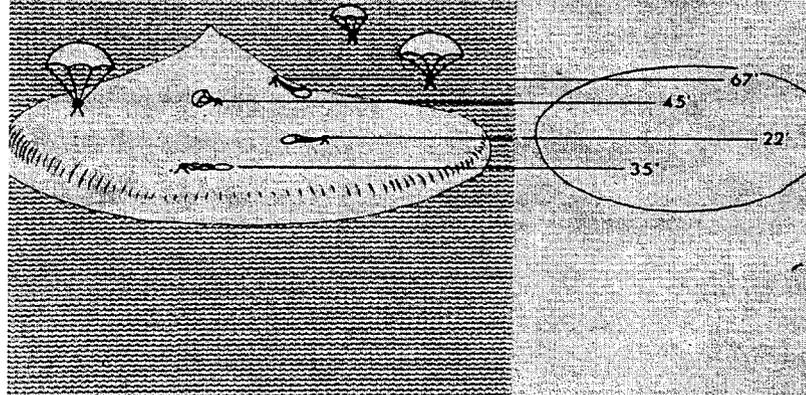
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Autonomous Visual Field Test & Diagnosis System in Space and on Earth  
Background: Campimetry



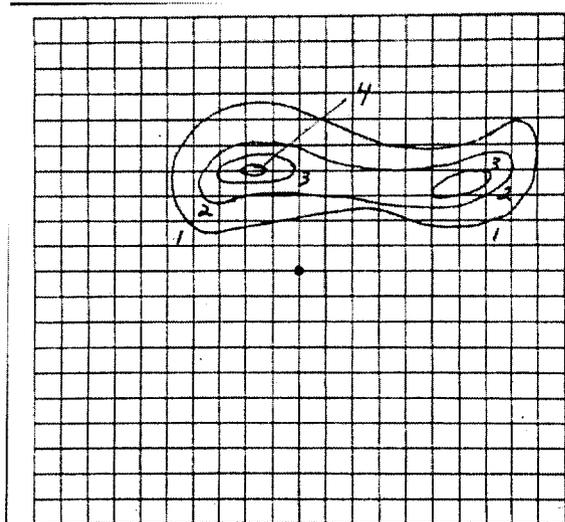
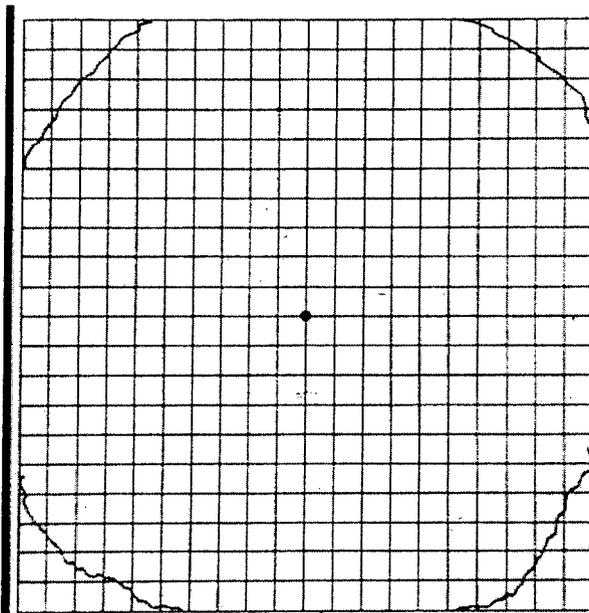
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Autonomous Visual Field Test & Diagnosis System in Space and on Earth  
Background: Amsler Grid Testing



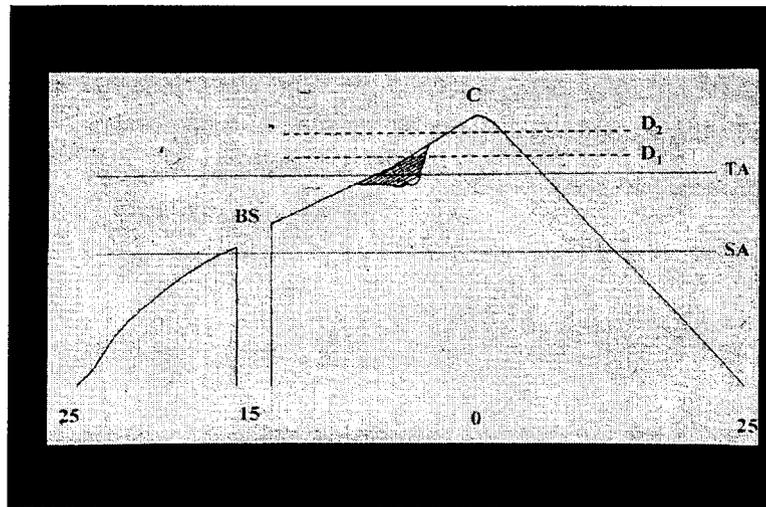
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Autonomous Visual Field Test & Diagnosis System in Space and on Earth  
Background: Island-of-Vision/ Hill-of-Vision



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Autonomous Visual Field Test & Diagnosis System in Space and on Earth  
Examination via Touchscreen Technology

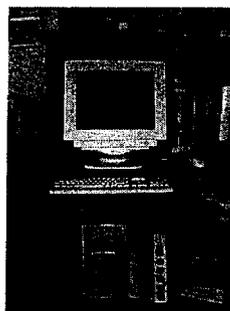


Touchsensitive  
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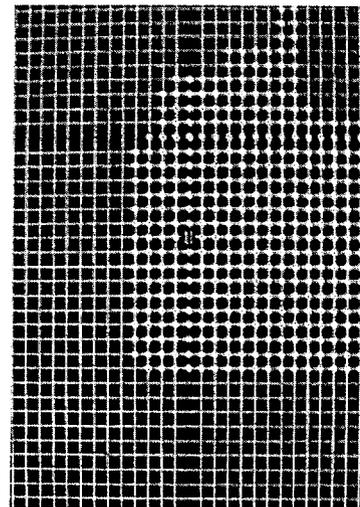


or

Touchsensitive  
Monitors



3D Computer-Automated  
Threshold Amsler Grid Test



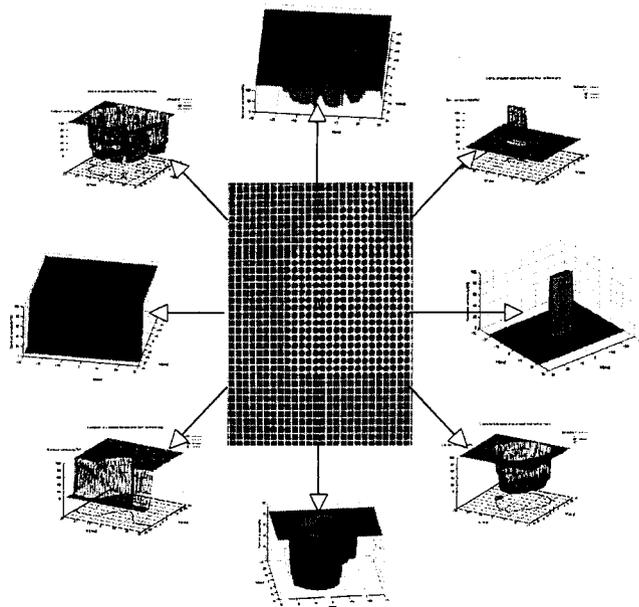
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Autonomous Visual Field Test & Diagnosis System in Space and on Earth  
3D Computer-Automated Threshold Amsler Grid Test



Devised by *Fink & Sadun* in 2000  
Recent Publicity in Press & Audio-Visual Media:

- CNN Headline News
- NASA TV
- KCAL
- KCET "Life & Times Tonight"
- TechTV
- National Geographic
- Reuters
- NSF Press Release
- NSF News Highlights
- Caltech Press Release
- JPL Media Release
- JPL website
- USC News "USC Today"
- USC "HSC Weekly"
- USC "Trojan Family Magazine"
- USC "USC Health Magazine"
- Spiegel Online
- Informationweek
- SpaceDaily
- SPACE.com
- Spinoff Technologies
- Acrotech News and Review
- Federal Telemedicine News
- GeoCities
- MacNow Magazine
- Science News Network
- PITSCO The Cause

Caltech patents pending!

Further Information on the 3D Visual Field Test:

<http://www.wfbabcom5.com/wf335.htm>

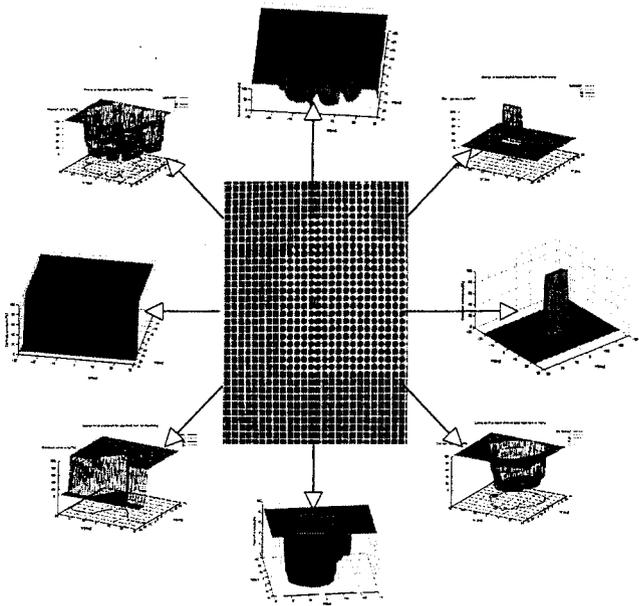
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Advantages of 3D Computer-Based Threshold Amsler Grid Test



Major Advantages:

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e.g.: location, depth, shape, extent,  
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Accessible through the Internet

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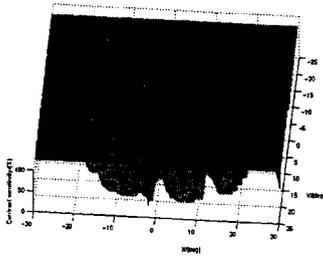
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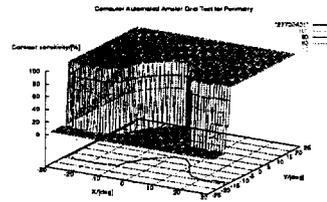
Autonomous Visual Field Test & Diagnosis System in Space and on Earth  
Clinical Pilot Studies Conducted



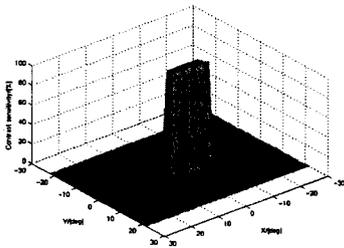
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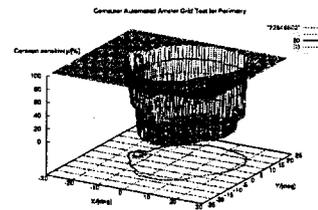
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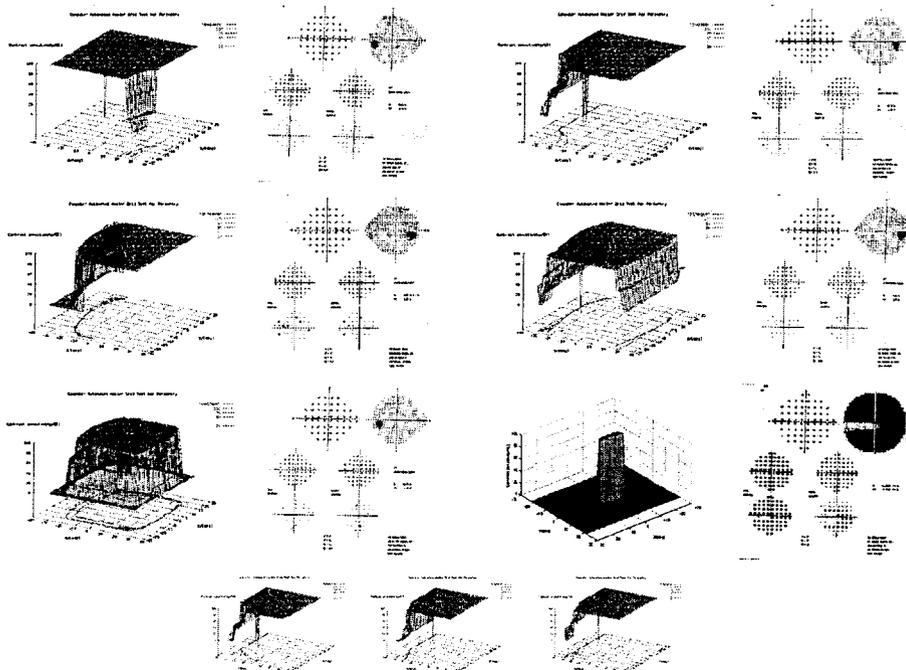
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Autonomous Visual Field Test & Diagnosis System in Space and on Earth  
Clinical Pilot Studies Conducted



Glaucoma Suspects



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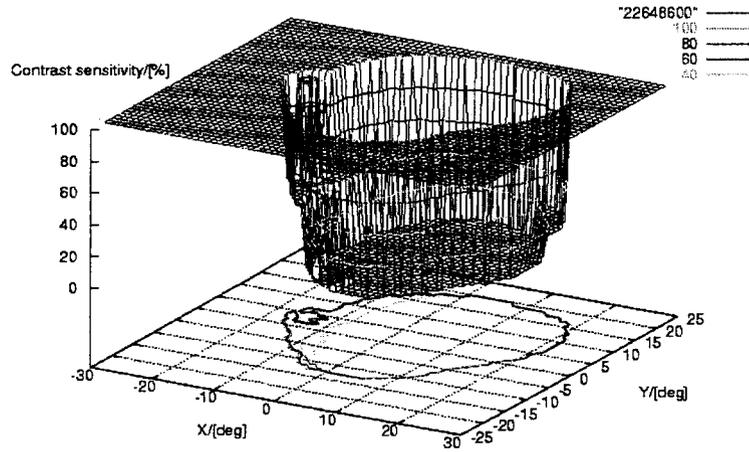


# Autonomous Visual Field Test & Diagnosis System in Space and on Earth

## Example Examination Result



Computer Automated Amsler Grid Test for Perimetry



**ARMD**

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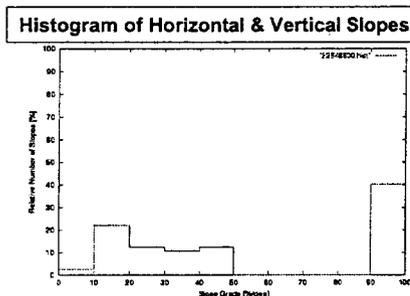
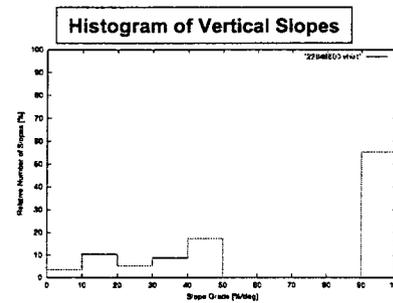
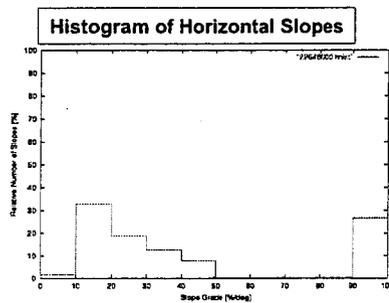
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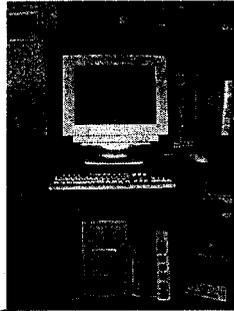
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Patient examination  
data retrieval



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Identification of *signature  
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JPL



Knowledge extraction from large database of *3D shapes* and *slopes* that are likely  
to be *signature patterns* for various ophthalmological and neurological conditions



Sophisticated Pattern Recognition  
Classification Algorithms  
*using*  
Analytical Analyses  
Neural Networks  
Classifier Systems

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**Autonomous (Onboard) Physician**

Screening & Monitoring on a frequent and regular basis

Early Detection of various Eye/Brain Diseases

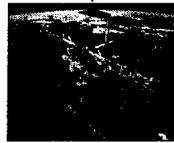
Reduced Astronaut Medical Data Transmission



Centralized  
Worldwide  
Remote Diagnosis  
(Telemedicine)



Autonomous  
Onboard Physician  
on Shuttle Missions



Autonomous  
Onboard Physician  
on ISS



Autonomous  
Onboard Physician  
on Trip to Mars



Autonomous  
Onboard Physician  
on Trip to Jovian  
Moons

Drs. Wolfgang Fink (PI), Alfredo Sadun, and Jonathan Clark

Caltech patents pending!

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Caltech patents pending!

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