Visual resolution through Maxwellian view optics

Dennis R. Hopkins
Pacific University

John J. Kruger
Pacific University

Recommended Citation
Visual resolution through Maxwellian view optics

Abstract
Visual resolution through Maxwellian view optics

Degree Type
Thesis

Rights
Terms of use for work posted in CommonKnowledge.

This thesis is available at CommonKnowledge: https://commons.pacificu.edu/opt/411
Copyright and terms of use

If you have downloaded this document directly from the web or from CommonKnowledge, see the “Rights” section on the previous page for the terms of use.

If you have received this document through an interlibrary loan/document delivery service, the following terms of use apply:

Copyright in this work is held by the author(s). You may download or print any portion of this document for personal use only, or for any use that is allowed by fair use (Title 17, §107 U.S.C.). Except for personal or fair use, you or your borrowing library may not reproduce, remix, republish, post, transmit, or distribute this document, or any portion thereof, without the permission of the copyright owner. [Note: If this document is licensed under a Creative Commons license (see “Rights” on the previous page) which allows broader usage rights, your use is governed by the terms of that license.]

Inquiries regarding further use of these materials should be addressed to: CommonKnowledge Rights, Pacific University Library, 2043 College Way, Forest Grove, OR 97116, (503) 352-7209. Email inquiries may be directed to: copyright@pacificu.edu

This thesis is available at CommonKnowledge: https://commons.pacificu.edu/opt/411
Visual Resolution Through Maxwellian View Optics

by

Dennis R. Hopkins

John J. Kruger

Research Presented In Partial Fulfillment for the O.D.
Degree Requirement, Pacific University

May 11, 1975
Introduction

A cataract usually occurs in persons past middle age. It also occurs secondarily in many systemic and ocular diseases. When this occurs the only treatment which will restore vision to the cataractous eye is surgical removal of the lens. But many diseases that affect the lens also affect the patient's fundus, or in the case of senile cataracts, senile macular degeneration may also be present. In these cases visual acuity will not be restored after surgical removal of the lens.

With dense opacities of the lens conventional ophthalmoscopic examination of the fundus can not be performed to determine if any fundus degeneration has developed. Also, with a developing cataract a gradual loss of vision, due to the decreasing transparency of the lens, parallels the development of the cataract. Eventually the patient will be virtually blind. Therefore visual acuity cannot be measured by conventional means to determine if surgery will restore vision. If fundus degeneration is present, the surgery will be useless.

Campbell and Green (2) have tested visual acuity on cataract subjects using Maxwellian view optics and high luminance interference fringes on the retina with a low power gas laser. Using the same principle, Goldman (1) was able to test visual acuity and his results verified those of Campbell and Green. C. R. Carvonius and R. Hilz (4) compared the effectiveness of normal optics, Maxwellian view optics, and interference patterns in measuring visual acuity through opacities. They showed that visual acuity
was greatly increased using Maxwellian view optics and interference patterns than the normal optics of the eye.

Our thesis project was to build a workable Maxwellian view system which would enable clinicians to test visual acuity through cataracts and to determine if macular degeneration has occurred. Due to the inavailability of patients with cataractous lenses, it was necessary to make simulated cataract plates with plexiglass.

**Materials**

1. Cardboard housing.
2. 40 watt, 115-125 volt incandescent appliance light.
3. Two +15.37 diopter achromatic doublet lenses, 30 mm in diameter, and 65 mm focal length.
4. A 1 mm pinhole pupil.
5. A fifty line per inch grating slide.

**Apparatus**

The light source was a 40 watt, 115-125 volt incandescent appliance light manufactured by General Electric. The light was housed in a cardboard box in order to eliminate stray light. Mounted on the housing was a 1 mm pinhole pupil. Directly in front of the pinhole pupil and 65 mm away from it was a 65 mm focal length achromatic doublet lens. This lens collimated the light through a 50 lines per inch grating slide. The collimated light would then pass through another 65 mm focal length achromatic doublet lens, which focused the light on the nodal point of the
subject's eye when the subject is situated 65 mm from this focusing lens. This system presented to the subject a visual acuity demand of approximately 20/100.

Construction of Simulated Cataract Plates

All plates were made of one-eighth inch plexiglass cut into approximately 3x3 inch squares. Although only a small area was needed for the testing the large size was used because of the ease of handling the larger plates.

Plate I

This plate was fogged by scratching it with sandpaper. Through the plate light projection (ability to determine from which direction a source of light is shining) was the best acuity obtained.

Plate II

This plate was smeared with black drawing ink which did not uniformly cover the plate. Using a reduced Snellen card at 16 inches, one was able to get from 20/40 to 20/200 visual acuity depending on which area of the plate was looked through.

Plate III

This plate was covered with thin white tissue paper. Best acuity obtained through this plate was light projection.

Method of Examination

After turning on the light source and positioning the subject directly in front of the Maxwellian view system, the subject was instructed to
locate the light source through the lenses. In most cases the subjects were not immediately able to see the grating. They were then instructed to slowly move their head (eye) until they could see a spot of light through the system. Once the subjects were able to locate the light, they were instructed to slowly position themselves closer and closer to the focusing lens, but at all times to try to keep the light in the center of the lens. The subject was then told to notice that the illuminated area inside the lens would gradually increase in size until the entire area of the lens was illuminated, and then remain as stationary as possible. At this point, for all subjects, the grating was clearly visible.

The subjects were then asked to sit back and try to repeat the procedure once again. Once the subjects were able to successfully maneuver themselves into the correct position, they were handed one of the simulated cataract plates. Upon being in the correct position we insucted them to place the plate before the eye. Upon placing the plate before the eye they would often have to reposition themselves because a small head movement would misalign the eye with the system. The subjects were then asked if they could see the grating. If they could, which all were able to see, we asked in what direction the lines were pointing. This was done in five random positions for all three plates.

Results

The Maxwellian view system was tested on fifteen different subjects, all of whom had normal visual acuity of 20/20 or better. Each subject's acuity was then checked through each of the three simulated cataract
plates and were found to be as reported earlier (Plate I—light projection; Plate II—20/40 to 20/200; Plate III—light projection).

Each subject was then placed in position before the system with one of the simulated cataract plates in front of his eye. The line grating was then placed in its holder at varying orientations and the subject was asked to identify the grating orientation through all of the simulated cataract plates. At times nothing was seen immediately and a small movement was necessary for the subject to become correctly realigned with the system.

In each case Plate III was the most difficult plate to see the grating through. The easiest plate to see the grating through proved to be Plate II in each case. Each subject, however, was able to identify the orientation of the grating in any of the positions through any of the plates.

Summary

The optical system we built is light, mobile, and inexpensive. Although it has not been used on a cataract patient, unless the opacity is completely uniform and opaque throughout the lens, if there is any transparency in the lens this system will indicate if the patient has the visual acuity remaining to see the grating.

Although the system functions as desired, there may be some problems encountered in its use. Due to the necessity of a very exact alignment, an elderly patient who may not be able to sustain an exact posture for the time required to use the system will have difficulty. Also, if an unsteady eye movement is too large, the eye may move out of alignment with the system. Kinesthetic fixation may aid in this problem.
Bibliography

(2) Green, Daniel G.; Science; Vol. 168; p. 1241.
(3) F. W. Campbell and D. G. Green; J Physiol London; Vol. 181; p. 576.
(4) G. R. Cavonius and R. Hilz; Reports; Vol. 12; Number 12; p. 933.