



Optics

Automated Vision Test

System to estimate visual acuity from wavefront aberrations

Visual acuity (clearness of vision), usually measured by an eye doctor using an eyechart, is one of the most commonly applied clinical tests in the world. With the patient's participation, it measures the smallest letters that can be reliably identified at a specified distance, and thereby tests the resolving power of our eyes. The result, often quoted as a pair of numbers like 20:20, lets us know how we perform relative to population norms, and determines if corrective lenses or refractive surgery can help us better perform tasks like reading or driving. The traditional test for acuity requires the patient to look and report which letters they see. This invention provides an automated system to estimate visual acuity based on objective measurements of the eye optics and wavefront aberrations (WA). WA are represented in a particular form known as the Zernike polynomials. A typical measurement on the eye of a patient will consist of a list of approximately 16 numbers that constitute the coefficients of the polynomials. The WFAMetric is an algorithm that converts the list of numbers into an estimate of the visual acuity of the patient. If changes are planned to the WA of the patient the predicted change in acuity can be calculated.

BENEFITS

- Connects wavefront aberrations to visual acuity
- Operates accurately, simply, and fast
- Incorporates optical and neural filtering, neural noise, and an ideal decision rule
- Includes the actual optotypes and simulates the process of optotype recognition and/or text analyses

technology solution



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THE TECHNOLOGY

The Wavefront Aberrations (WA) are a collection of different sorts of optical defects, including the familiar defocus and astigmatism that are corrected by eyeglasses, but also more complex “higher order” aberrations such as coma, spherical aberration, and others. The WA provide a comprehensive description of the optics of the eye, and thus determine the acuity. But until recently, a practical method of computing this relationship did not exist. Our solution to this problem is to simulate the observer performing the acuity task with an eye possessing a particular set of WA. When a letter is presented, we first distort a digital image of the letter by the specified WA, and add noise to mimic the noisiness of the visual system. From previous research, we have determined the appropriate noise level to match human performance. We then attempt to match the blurred noisy image to similarly blurred candidate letter images, and select the closest match. We repeat this for many trials at many letter sizes, and thereby determine the smallest letter than can be reliably identified: the visual acuity. We have streamlined and simplified the key steps for this simulation approach so that the entire process is robust, accurate, simple and fast. Results are typically obtained in a few seconds.



The technology could be used to expedite a patient's vision testing.

APPLICATIONS

The technology has several potential applications:

- Automated vision testing
- Automatic prescriptions for eyeglasses and contact lenses
- Custom optical implants, such as intraocular lenses
- Prediction of acuity following laser surgery
- Refinement of laser eye surgery methods
- Ophthalmic aberrometers

PUBLICATIONS

U.S. Patent 8,408,707

“Predicting visual acuity from wavefront aberrations,” 2008, *Journal of Vision* 8(4):17, 1–19

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