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Tunable focus ophthalmic lens for refractive error diagnosis and correction

Abstract:

Presbyopia affects over two billion people worldwide, yet current optical solutions–such as multifocal and progressive lenses–often compromise peripheral clarity, introduce distortion, and limit dynamic focus. We present a tunable focus ophthalmic lens designed to overcome these limitations by providing continuous, distortion–free vision correction across near, intermediate, and far distances. The lens features a soft, deformable membrane and fluid–filled chamber that adjust focal power in response to low–voltage actuation. A customizable resting power allows alignment with the user's baseline prescription, and a variable actuation speed mimics natural accommodation transitions. Bench testing confirmed a reproducible relationship between applied voltage and dioptric shift ($\Delta D/\Delta V$), with effective correction demonstrated from +6D to −6D. High–resolution target tests showed sharp visual performance across focal states, without the field–of–view artifacts typical of static or segmented lenses. To enable automatic focusing, a low- power, camera–free vergence tracking system was developed using infrared–based pupil localization to triangulate viewing distance and apply corresponding focal adjustments in real time. By combining correction and diagnostic capabilities in a single wearable system, this technology introduces a scalable, personalized solution for presbyopia and astigmatism. It holds particular promise for both modern clinical practice and low–resource settings, supporting broader efforts to advance accessible, adaptive eye care worldwide.

Biography

Peter Podar is affiliated with the Department of Biomedical Engineering at Vanderbilt University, Tennessee, USA. His work focuses on advancing biomedical technologies through interdisciplinary research, contributing to innovations in medical diagnostics, therapeutics, and healthcare engineering.