How to evaluate the optical performance of spectacle lens with micro lens array

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Abstract

Background: A novel spectacle lenses with micro lens array on its front surface have been reported to have comparable efficacy to other pharmacological treatments for myopia control in children. Beside the myopia control efficacy and safety, optical performance is another important property because the micro lens array on the lens may effect the vision. Single value of standard optical indices, such as point spread function (PSF) and modulation transfer function (MTF), are not sufficient to assess this type of spectacle lens because they may vary drastically from one position to another on the lens. This results in decreased and uneven visual quality. When turning the head or rotating the eyes, the wearer may feel unexpected flicker and target shifting that do not happen wearing standard spectacle lenses.

Objective: The aim of this study is to find a way to quantitatively evaluate the optical performance due to the existence of micro lens array on spectacle lens.

Method: Two new indices are defined and calculated from PSFs to assess the unexpected flicker and target shifting, local light intensity (LLI) and local target shift (LTS). Furthermore, as microlenses are discretely distributed within the pupil area, there is no symmetry about any point of axis and then the MTF value of any spatial frequency changes with the azimuth direction. This MTF dependance on azimuth is also unique that worth to be evaluated. Another two indices, mean MTF (MMTF) and maximum difference of MTF (DMTF) are defined, each represents the average MTF and MTF variations range within all azimuth directions, are also defined and examined in this study.

Results: Two designs, honeycomb and multiple rings distribution, of this spectacle lens are examined. Both LLI and LTS values, and their variations on the lens explained the flicker and target shifting pattern while wearing each lens and turning head. Theoretically, the value of MMTF relates to the percentage of micro lens area, while the value of DMTF relates to the uniformity of micro lens distribution within the pupil area on the lens. The difference of visual experience between the two designs corresponds with the difference of MMTF and DMTF between the two designs.

Conclusion: The new defined optical performance indices, LLI, LTS, MMTF and DMTF, and their variations across the lens are effective to evaluate the optical performance of a spectacle lens with micro lens array. Optical performance due to the micro lens array depends on the distribution of micro lenses, power and size of each micro lens, i.e. the design of the lens. If the myopia control efficacy is determined by the defocus power of each micro lens and the density of micro lenses on spectacle lens, there should be a distribution pattern that gives the best optical performance under a specified condition.