# Developing and Optimizing Soft-edge Occlusion System for Light Dimming Using Transmissive Liquid Crystal Displays

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Abstract (should be within 1st page)

Systems with occlusion capabilities, such as those used in vision augmentation, image processing, and optical see-through head-mounted displays (OST-HMDs), have gained popularity. Achieving precise occlusion (hard-edge) in these systems is challenging, often requiring complex optical designs and bulky volumes. Conversely, utilizing transmissive liquid crystal displays (LCDs) offers a simpler approach to create an occlusion mask. However, the generated mask often appears defocused (soft-edge), resulting in insufficient blocking or over blocking (occlusion leakage). In this dissertation, I first developed a smart sunglasses system using a single-layered LCD panel. Designed for individuals with light sensitivity, this system adaptively regulates light based on a specific modulation method and employs an optimization algorithm for precise light attenuation, enhancing visual comfort without over-blocking. Using the same prototype, I then delve into the perception of soft-edge occlusion by the human visual system. A user-preference-based evaluation method was applied to minimize perceived occlusion leakage. The study highlighted significant individual differences in the perception of soft-edge masks, leading to varied demands for mask size. This research underscores the importance of personalization in smart eyewear design. Finally, I introduce an innovative approach using a dynamic pinhole array on a transmissive LCD. Positioned between the eye and the occlusion displayed on another transmissive LCD, it offers adaptive pinhole patterns and gaze-contingent functionality. The result demonstrates that this approach enhances soft-edge occlusion, as evidenced by an occlusion mask placed at 4 cm being observed sharply through a 4.3 mm aperture, with the focal plane at 1.8 m.