Bezel-less Visual Elimination Solution for Standalone Display Devices

A Technical Whitepaper on a Hybrid Architecture
based on Optical Refraction and Computational Vision

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This whitepaper and all technical solutions, algorithm logic, and architectural designs contained herein are defensively published as Prior Art by **Shuo Zhang** and **Shanghai Magical Battle Syou Jyo Network Technology Co., Ltd.** This document is licensed under the **CC BY-SA 4.0** (Attribution-ShareAlike 4.0 International) license. Any individual or organization is free to access, use, and explore commercialization under the premise of compliance with this license. The purpose is to break the technical barriers in the display device industry and prevent the aforementioned concepts from being over-monopolized by any third-party patents.

Abstract

This technical solution proposes a low-cost, highly applicable ”zero-bezel” visual elimination system for standalone display devices. Addressing the severe edge distortion defects caused by existing pure optical bezel-less solutions, this system adopts a hybrid hardware-software collaborative architecture. On the physical level, a ring-shaped optical refraction lens is introduced to obscure the physical bezel; on the computational level, multimodal visual algorithms—including inverse distortion mapping, global overscan, and edge pixel extrapolation based on Gaussian blur and motion compensation—are executed in real-time at the GPU or SOC driver layer. This solution not only achieves a 1:1 lossless bezel-less visual experience for standalone displays but also provides a foundational frame generation compensation strategy for seamless multi-screen splicing arrays.

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1 Technical Field

This solution relates to the interdisciplinary field of display technology and computer vision, specifically concerning a method and system architecture that combines optical lenses with low-level computational graphics pipelines to eliminate the physical bezels of display panels and achieve seamless multi-screen splicing.

2 Background Technology

In the current display device industry, restricted by the packaging processes of LCD/OLED panels and the physical limitations of backlight modules, a physical black border (bezel) of a certain width inevitably exists around the screen. Most existing ”bezel-less” concepts merely refer to ultra-narrow bezels. If pure optical solutions (such as utilizing prisms or refractive lenses to cover the bezel) are directly applied to standalone display devices, they introduce a fatal flaw: edge interfaces of operating systems (e.g., taskbars), critical television broadcast subtitles, or HUDs in gaming interfaces will suffer from severe non-linear distortion due to optical stretching, rendering the device fundamentally unusable.

3 Detailed Implementation (Standalone Architecture)

This system consists of a physical ring-shaped optical refraction lens assembly and a computational vision module running at the graphics processing unit (GPU) driver layer or smart TV SOC low-level layer. The core visual compensation algorithm encompasses the following two modules:

3.1 Inverse Distortion Mapping and Global Overscan

Before the image frames are output to the physical display panel, the system performs an inverse geometric transformation on the image within the lens coverage area to counteract the inherent physical ”stretching” and distortion effects of the optical lens. Two adaptive mapping logics are provided:

- **Local High-Density Compression Mapping (Lossless Content Restoration Mode):** Targeting core UIs, gaming HUDs, or critical edge information areas, a software-level ”squeezing” mapping is executed. Its compression ratio is the reciprocal of the physical lens’s magnification ratio, thereby achieving a 1:1 lossless restoration of edge content on the user’s retina.
- **Global Overscan and Anti-Distortion (Immersive Expansion Mode):** The entire screen display content is proportionally enlarged (similar to an Overscan mechanism) so that the edge images naturally spill over into the lens coverage area. For the overflowed pixels, an **Anti-Distortion Matrix** algorithm based on the lens surface curvature is applied. The optical distortion of the lens perfectly ”decodes” the pre-set reverse distortion when light passes through, perfectly resolving the physical correctness of the edge display.

3.2 Edge Gaussian Blur Expansion (Full-Screen Ambient Construction)

When the physical lens refraction range exceeds the actual effective pixel coverage area, an edge sampling rendering mechanism is introduced: the outermost effective pixel features are captured, mirrored, and subjected to a **Gaussian Blur** algorithm to extend soft colors to the extreme edges of the lens. This mechanism can completely conceal the absolute boundary of the physical bezel, generating an immersive effect similar to ambient lighting (Ambilight).

4 Extended Application: Multi-Screen Splicing

In multi-screen configurations (e.g., side-by-side dual screens), it is often only necessary to eliminate the single physical bezel at the adjacent splicing point. Forcing a global proportional enlargement (Overscan) would disrupt the overall aspect ratio, while relying solely on pure physical lenses to forcibly stretch a single edge would cause severe visual tearing at the seam.

Pixel Extrapolation Strategy Based on Motion Compensation and Frame Generation: Addressing the asymmetrical edge requirements of multi-screen splicing, this system draws inspiration from mature Frame Generation and Motion Compensation technologies in modern graphics pipelines. While maintaining the original 1:1 image ratio, the system extracts Motion Vectors and edge pixel features from current and historical frames to deduce and **additionally render** a small portion of logically coherent extended pixels in real-time. The pixels dynamically generated by the algorithm are refracted by the single-edge lens, accurately covering the physical seam. With minimal performance overhead, this strategy achieves a visually near-seamless continuous giant screen array.

5 Figures and Principle Analysis

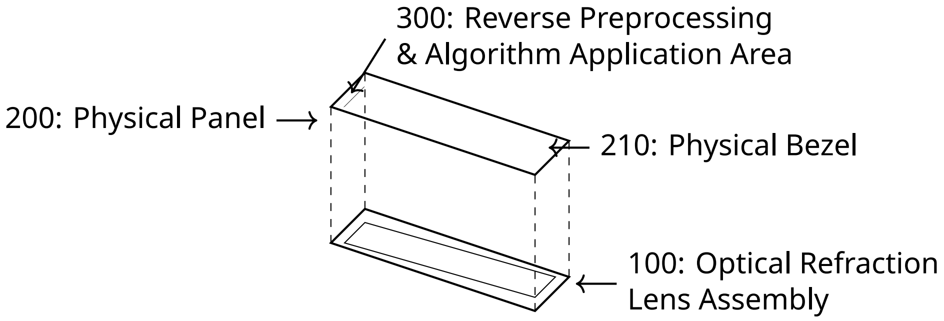

Figure 1: Exploded View of the 3D Structure of the Hybrid Hardware-Software System

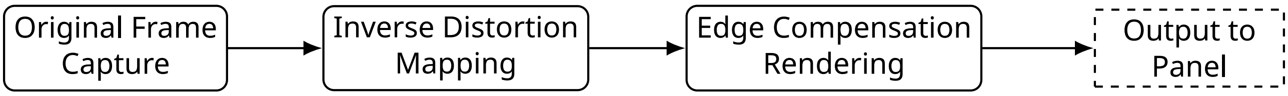

Figure 2: Flowchart of the Multimodal Computational Vision Rendering Pipeline

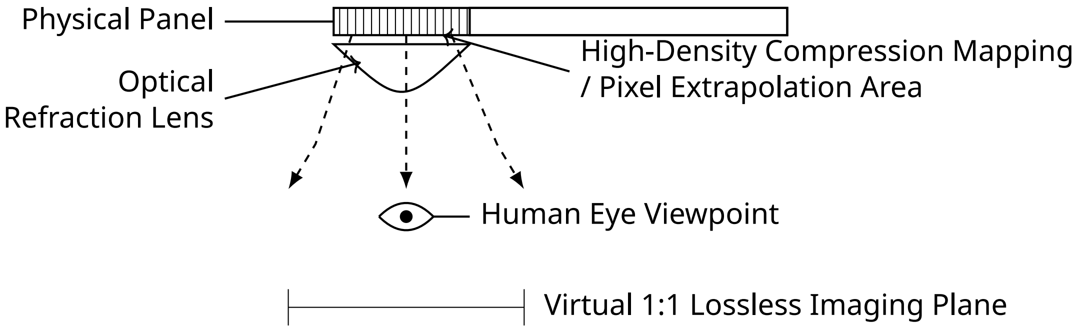

Figure 3: Optical Cross-Section Principle Diagram of Visual Stretching and Algorithmic Cancellation