

Next-Generation Glasses-Free 3D Spatial Display Apparatus

Powered by Real-Time AI Depth Mapping & Dynamic LC Lens Tilting

Strategic Patent Acquisition, Exclusive Licensing & Joint Venture (JV) Partnership Opportunity

This comprehensive proposal is presented by **Tink Innovation** to offer global display manufacturers, fabless semiconductor enterprises, automotive Tier-1 suppliers, and spatial computing investors a foundational intellectual property (IP) asset. The patent covers an integrated architecture for real-time 90fps+ 2D-to-3D conversion, sub-pixel eye tracking, and dynamic electric-field LC lens optical axis tilting.

Patent Title	3D Display Apparatus for Real-Time 2D-to-3D Conversion Using Deep Learning-Based Depth Mapping and Eye Tracking, and Control Method Thereof
IP Status	Domestic Patent Application Completed (Republic of Korea) / PCT International Application in Preparation
Cooperation Models	1) Full Patent Assignment / Exclusive Licensing 2) Joint Venture (JV) Co-Development & Global Commercialization
Proposer / CEO	Tink Innovation / Sungchu Kang (CEO)
Location / Contact	Seoul, Republic of Korea / E-mail: staping@naver.com
Date of Proposal	August 2026

1. Executive Summary & Market Imperative

1.1 The Market Bottleneck in Autostereoscopic 3D Displays

As spatial computing, immersive gaming, and automotive cockpit visualizations accelerate, the demand for glasses-free (autostereoscopic) 3D displays has surged exponentially. However, conventional autostereoscopic displays have historically failed to achieve mainstream commercialization due to **three critical structural bottlenecks**:

- **Absence of Dedicated 3D Content:** High production costs and scarcity of native multi-view content render 3D hardware useless for standard media consumption.
- **Crosstalk & Rigid Sweet-Spots:** Fixed parallax barriers or lenticular lenses cause extreme image ghosting (crosstalk) and visual degradation whenever the user departs from a precise, narrow viewing angle.
- **Latency, Flickering & Visual Fatigue:** Slow depth extraction pipelines and Vergence-Accommodation Conflict (VAC) induce severe dizziness and optical strain during extended viewing.

1.2 Tink Innovation's Foundational Breakthrough

Tink Innovation has formulated a breakthrough system-level architecture that resolves these bottlenecks simultaneously. The proprietary patent establishes an end-to-end, sub-millisecond synchronized pipeline bridging high-throughput neural depth inference, active infrared (IR) pupil-corneal reflection tracking, and dynamic electric-field modulation of a liquid crystal (LC) lens layer.

 **Key Architectural Pillars:**

1. **Real-Time 90fps+ 2D-to-3D Synthesis:** Hardware-decoded 2D video is converted into pixel-level high-resolution depth maps via CNN/ViT architectures with guided upsampling and temporal bounding-box consistency filtering.

2. **Sub-Pixel Active Eye-Tracking (PCCR + Kalman):** Active IR LED illumination and 90Hz+ sensor arrays track pupil centers and corneal glints (PCCR), filtered by Kalman smoothing to eliminate micro-saccade jitter.

3. **Dynamic LC Lens Optical Axis Tilting:** Independent voltage modulation across segmented ITO electrodes dynamically shifts the physical refractive index profile, physically steering light rays toward moving eyes.

4. **Active VAC Fatigue Mitigation:** Built-in duration timers progressively compress the depth range over prolonged sessions to eradicate ocular fatigue.

1.3 Nature of This Proposal

The patent application has been **successfully filed in the Republic of Korea**, and the **PCT international filing phase is currently under active preparation**. The IP is currently positioned at the **conceptual/foundational design stage (TRL 2~3)**—meaning full architectural schematics, mathematical logic, timing synchronization, and control workflows are fully codified in the patent claims, while silicon/panel prototype fabrication and empirical test data remain to be developed in partnership.

Dimension	Conventional Glasses-Free 3D	Tink Innovation Proprietary IP
Content Versatility	Requires expensive native multi-camera 3D content	Real-time 90fps+ 3D conversion of legacy 2D video
Viewing Freedom	Fixed sweet spot; severe crosstalk outside center	Dynamic LC lens optical axis steering (Zero Crosstalk)

Dimension	Conventional Glasses-Free 3D	Tink Innovation Proprietary IP
Multi-User Capability	Single-viewer limited; multi-user visual collapse	Multi-user discrete ID allocation & zoned rendering
2D/3D Mode Switching	Permanent 2D resolution loss due to fixed optical sheets	Lossless 2D flat pass-through (Power Off) / 3D (Power On)

2. Patent Profile & Legal Claims Structure

2.1 Intellectual Property Bibliographic Details

Patent Title (English)	3D Display Apparatus for Real-Time 2D-to-3D Conversion Using Deep Learning-Based Depth Mapping and Eye Tracking, and Control Method Thereof		
Patent Title (Korean)	딥러닝 기반 실시간 뎀스 매핑 및 시선 추적을 이용한 무안경 3D 영상 변환 디스플레이 장치 및 그 제어 방법		
Applicant / Assignee	Tink Innovation	Inventor / CEO	Sungchu Kang
Current Legal Status	Filed in South Korea	International Filing	PCT Application in Preparation (Priority Claim Available)
Primary IPC Classes	H04N 13/00 (Stereoscopic Video), G06T 7/00 (Image Analysis)	Technology Readiness	TRL 2~3 (Foundational Concept & System Architecture IP)

2.2 Robust Multi-Layer Claim Architecture

The patent encompasses an interdependent suite of apparatus, submodule, and methodological claims designed to preemptively block competitor workarounds and establish dominant patent fencing across hardware and software domains.

Claim Number	Claim Type	Codified Scope & Defensive Moat
Claim 1 (Independent)	Apparatus System	Integrated architecture: Synchronized Video Receiver + AI Depth Engine + Timestamp-aligned DIBR Viewport Synthesizer + Dynamic LC Lens Tilting Display Panel .
Claim 1-1	Subsystem	Hardware decoder, image pre-processor, and high-speed DDR FIFO buffer module synchronized with the AI depth engine computation clock.
Claim 2	Subsystem	IR illumination + PCCR vector extraction + Kalman/moving-average jitter filter + discrete multi-user ID tracking.
Claim 3	Subsystem	90fps+ deep inference with inter-frame bounding-box tracking and spatio-temporal consistency correction to suppress depth noise and flickering.
Claim 4	Subsystem	Timer-driven active depth range compression to mitigate Vergence-Accommodation Conflict (VAC) + multi-user viewing zone partitioning.
Claim 5	Subsystem	2D mode (voltage off) / 3D mode (voltage on) switching + segmented ITO local voltage tuning for dynamic optical center-axis tilting .
Claim 6 (Independent)	Method Independent	Complete 5-stage real-time execution method: Signal Ingestion → PCCR Eye Tracking → Deep Depth Inference → DIBR Multi-View → Dynamic LC Beam Steering.

Claim Number	Claim Type	Codified Scope & Defensive Moat
Claims 7 ~ 9	Subsystem / Method	3-axis spatial actuator control mechanism modulating horizontal, vertical, and roll rotation angles for electro-mechanical lenticular arrays.

 Strategic PCT Global Filing Opportunity:

Because the initial application is currently in its statutory domestic filing stage, the acquiring or joint-venture partner can participate in shaping the global filing strategy—designating key target jurisdictions (US, EU, China, Japan, Korea) under joint or transferred title prior to regional phase entries.

3. Deep Technical System Architecture

3.1 Five-Stage Real-Time Pipeline (Patent Figures 1 & 6)

The system synchronizes video decoding, neural depth estimation, binocular optical tracking, and sub-pixel optical modulation under a master timestamp clock.

① Video Ingestion & Pre-processing (100)

- **Interfaces:** Real-time streaming via HDMI, DP, Wi-Fi, BT
- **Hardware Decoding:** Native H.264, H.265, AV1 decompression
- **Pre-conditioning:** Scaling, de-noising, chroma correction tailored for neural tensor input formatting
- **FIFO Buffer Queue:** High-speed DDR buffering matching AI engine 90fps+ throughput and V-Sync

② Active IR PCCR Eye-Tracking (200)

- **IR Optical Array:** 90Hz+ IR-pass sensor + bright/dark pupil illumination
- **Facial ROI Extraction:** Restricts compute overhead to ocular regions
- **PCCR Calculation:** Differential vectors between pupil center and corneal reflection glint
- **Kalman Filter Smoothing:** Eliminates micro-tremor and blink dropouts while tagging multi-user IDs

③ Deep Learning Depth Engine (300)

- **Neural Acceleration:** Tensor conversion on embedded NPU/GPU
- **Multi-Scale Feature Extraction:** Deep CNN or Vision Transformer (ViT) encoder-decoder pipelines
- **Spatio-Temporal Consistency:** Inter-frame bounding-box motion vectors to eliminate depth flickering
- **Guided Upsampling:** Full-resolution depth map restoration

④ Multi-View DIBR & Fatigue Control (400)

- **Timestamp Synchronization:** Merges depth maps and 3D eye coordinates
- **DIBR Rendering:** Generates dynamic left/right eye virtual views
- **Active VAC Suppression:** Progressive depth-range compression triggered by continuous watch-time timers
- **Sub-pixel Interleaving:** High-speed spatial interleaving aligned with LC lens pitch

3.2 Dynamic LC Lens Optical Axis Tilting (Patent Figures 5 & 11)

⑤ Dynamic Beam-Steering Display Panel (500) Mechanism

Fixed lenticular arrays suffer from angular optical mismatch whenever the viewer shifts position. Tink Innovation's patented panel architecture integrates a liquid crystal lens layer governed by **segmented multi-electrode ITO arrays**:

- **2D Display Mode (Power Off):** Zero electric field allows LC molecules to remain in uniform planar alignment, delivering 100% native panel resolution without optical diffraction.
- **3D Display Mode (Power On):** Precise electric field gradients induce a parabolic refractive index distribution, creating an array of cylindrical lenticular lenses.

- **Real-Time Dynamic Tilting:** Synchronized with eye-tracking telemetry, the driving circuit applies differential local voltages across segmented electrodes, physically steering the optical center axis (Center Axis) directly toward the viewer's pupils—guaranteeing continuous crosstalk elimination during rapid head movements.

4. Competitive Differentiation & IP Defensibility

4.1 In-Depth Benchmark Against Existing Technologies

Core Dimension	Legacy Industry Approaches	Tink Innovation Patented Architecture
2D-to-3D Synthesis	• Heuristic color/edge disparity estimation • High latency, prone to edge artifacts • Cannot support real-time broadcast streams	• Deep CNN / ViT Multi-Scale Inference • Sub-frame latency (90fps+ guaranteed) • Guided upsampling matching native display resolution
Viewer Tracking & Optical Steering	• Standard RGB webcam face detection • Static lens: head movement causes blur • Severe angular distortion and ghosting	• Active IR PCCR + Kalman Filter Smoothing • Dynamic LC Lens Optical Axis Tilting • Continuous physical beam redirection to pupils
Visual Ergonomics & VAC Relief	• Static disparity induces severe eye strain • Frame-to-frame depth jitter (flickering) • Usage restricted to under 15 minutes	• Spatio-Temporal Consistency Filtering • Timer-driven Progressive Depth Compression • Extended, fatigue-free commercial viewing
Multi-User Scalability	• Strictly single-user sweet spots • Multi-viewer cross-interference	• Discrete Multi-User ID Management • Spatial Zone Partitioning & Crosstalk Cancellation

4.2 Strategic IP Defensibility: The "Pivotal Standard" Value

High-Barrier Patent Moat Across Hardware & Software:

Autostereoscopic displays require an inextricable link between neural inference algorithms and optoelectronic hardware timing. By comprehensively claiming the synchronization queue between hardware decoders, neural depth estimators, eye telemetry, and segmented LC electrode drivers, this patent creates a **standard-essential IP roadblock** that competitors cannot easily bypass through superficial design modifications.

4.3 Clarification of Development Stage (TRL Status)

The technology currently resides at **TRL 2~3 (Concept Formulation & Validated Architecture)**. The absence of proprietary hardware tooling or locked-in silicon configurations represents a significant strategic advantage for the acquiring partner: it enables seamless integration into the partner's existing display fabrication lines (OLED, Micro-LED, LCD) and custom NPU silicon without legacy technical debt.

5. Target Applications & Global Market Opportunity

5.1 Four High-Growth Commercial Verticals

① Premium Gaming Monitors & Laptops

Target Hardware: 27"~34" 4K/8K Gaming Displays, 3D Creator Laptops

- Instant 90fps+ 3D conversion of standard DirectX/Vulkan 2D games
- Lossless 2D mode for office productivity; instant 3D for immersion
- Single-user ultra-fast IR tracking with sub-millimeter precision

② Flagship Living Room Smart TVs

Target Hardware: 65"~85" Premium OLED/Mini-LED 3D Smart TVs

- Multi-user simultaneous tracking for family viewing experiences
- Real-time 2D-to-3D upscaling for sports, movies, and streaming apps
- Active VAC control enabling full-length feature film viewing

③ Automotive Digital Cockpits & HUDs

Target Hardware: 3D Instrument Clusters, Passenger Entertainment Screens

- Driver eye-tracking for layered ADAS safety warnings and 3D navigation
- Dual-view isolation: driver views cluster data, passenger watches 3D movies
- Zero-latency optical steering conforming to automotive safety standards

④ Medical Surgical Monitors & DOOH Signage

Target Hardware: Endoscopic/Laparoscopic Monitors, Luxury 3D Signage

- Glasses-free spatial depth for microsurgical precision and minimal fatigue
- High-impact 3D commercial displays capturing public gaze in airports/malls
- Direct broadcast of standard 2D advertising content in vibrant 3D

5.2 Market Growth Projections (2024 - 2032)

Market Sector	2024 Base	2028 Forecast	2032 Forecast	Projected CAGR
Glasses-Free 3D Displays	\$1.20 Billion	\$4.80 Billion	\$15.60 Billion	28.4%
Spatial Computing & 3D Vision AI	\$3.50 Billion	\$12.10 Billion	\$38.50 Billion	31.2%
Automotive 3D Displays & HUDs	\$0.80 Billion	\$2.90 Billion	\$8.70 Billion	30.5%

6. Commercialization Roadmap & Risk Mitigation

6.1 Structured 4-Phase R&D Execution Plan (TRL 2 → TRL 8)

Upon finalizing the patent acquisition or joint venture structure, the development timeline transitions through four methodical milestones toward high-volume mass production.

Phase	Core Objectives	Technical Deliverables	Timeline
Phase 1 (TRL 3~4)	Algorithm Optimization & SW Emulation	• Lightweight deep depth inference quantization (INT8/FP16) • PCCR + Kalman filter eye-tracking SDK compilation • 90fps+ inference benchmarks on target NPU hardware	3 ~ 6 Months
Phase 2 (TRL 5~6)	LC Lens Fabrication & PoC Benchtop Prototype	• Segmented ITO electrode patterning and liquid crystal cell assembly • Dynamic voltage driving circuit for center-axis optical tilting • Functional display prototype integration and crosstalk benchmarking	6 ~ 9 Months
Phase 3 (TRL 7)	ASIC Driver IC & Ergonomic Clinical Testing	• Integration of display driver IC (D-IC) with active VAC timer logic • Comprehensive clinical validation of visual fatigue and dizziness relief • Multi-user spatial zoning and crosstalk suppression validation	4 ~ 6 Months
Phase 4 (TRL 8)	Yield Optimization & Global Commercial Launch	• Fab-line process yield tuning for high-volume LC lens lamination • Global safety/EMC certifications and PCT national phase entries • Commercial product release across monitors, TVs, and cockpits	6 Months

6.2 Risk Analysis & Preemptive Mitigation Strategy

⚠️ 1. Neural Compute Latency Frame drops during 4K/8K real-time depth mapping 👉 Solution: TensorRT model pruning, INT8 quantization, and sparse feature upsampling.	⚠️ 2. LC Switching Response Time Lag during rapid head saccades 👉 Solution: Fast-response ferroelectric/blue-phase liquid crystals with overdrive voltage pulses.	⚠️ 3. Manufacturing Yield Electrode alignment errors on large panels 👉 Solution: Compatibility with standard TFT-LCD photolithography and roll-to-roll processes.
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7. Business Partnership Models: Dual-Track Offering

Tink Innovation provides two flexible, value-maximizing collaboration structures tailored to the partner's strategic priorities, balance sheet structure, and R&D appetite.

Option 1: Complete Patent Acquisition / Exclusive Licensing

Model A: Full IP Title Transfer or Worldwide Exclusive License

Scope of Agreement	Total assignment of all patent rights (domestic & international PCT priority rights) or exclusive field-of-use licensing.
Strategic Merits	- Absolute 100% IP ownership with complete freedom to operate and patent fencing. - Unrestricted freedom to develop derivative secondary patents and captive OEM integration.
Transaction Options	- Upfront Lump-Sum Acquisition Fee - Milestone-Based Upfront Fee + Running Commercial Royalties (% of Net Sales).

Option 2: Joint Venture (JV) Co-Development & Commercialization

Model B: Dedicated Joint Venture Incorporation & Risk-Sharing Alliance

JV Core Purpose	Establishing a new corporate entity dedicated to commercializing next-generation glasses-free 3D spatial displays.
Contribution Structure	Tink Innovation: Exclusive IP contribution, core algorithm architecture, PCT expansion leadership. Strategic Partner: R&D financing, hardware pilot fabrication, supply chain, and global B2B distribution.
Equity & Dividends	Negotiated equity split based on independent IP valuation and capital commitment; pro-rata dividend & IP monetization sharing.

Comparison Criteria	Option 1: Patent Acquisition / License	Option 2: Joint Venture (JV) Formation
Governance & Autonomy	100% unilateral control by acquiring partner	Shared board representation and joint strategic governance
Financial Exposure	Direct capital expenditure for asset purchase	Shared development costs; reduced upfront cash requirement
Technical Continuity	Partner executes R&D internally	Continuous technical support and co-innovation with Tink Innovation
Ideal Partner Profile	Global Tier-1 display manufacturers and fabless titans	Strategic corporate investors expanding into spatial computing

8. Financial Projections & Strategic ROI

8.1 Illustrative 5-Year Commercial Revenue & Added Value Model

By integrating this proprietary autostereoscopic technology, the commercial partner can command premium Average Selling Prices (ASP) and superior gross margins across premium monitor and television product categories.

Commercial Year	Year 1 (PoC/ Sampling)	Year 2 (Launch)	Year 3 (Ramp-Up)	Year 4 (Expansion)	Year 5 (Maturity)
Target Shipment Volume	1,000 Units	50,000 Units	250,000 Units	700,000 Units	1,500,000 Units
Gross Revenue Projection	\$1.0 Million	\$40.0 Million	\$180.0 Million	\$480.0 Million	\$950.0 Million
Estimated IP Premium Value	-	\$5.5 Million	\$28.0 Million	\$76.0 Million	\$160.0 Million

8.2 Multi-Faceted Strategic Returns

① First-Mover Dominance in Spatial Hardware

Provides an intuitive, fatigue-free alternative to bulky XR headsets (Apple Vision Pro, Meta Quest), capturing consumers who desire natural spatial immersion without head-mounted gear.

② Substantial Cross-Licensing Revenue

PCT national phase entries across the US, EU, China, and Japan allow the partner to establish a global licensing tollbooth, generating recurring royalty streams from third-party manufacturers.

③ Complete Leverage of Existing 2D Media

Bypasses the catastrophic chicken-and-egg content barrier of past 3D TVs by allowing billions of existing YouTube, Netflix, and AAA gaming frames to be consumed instantly in real-time 3D.

④ Corporate Deep-Tech Valuation Multiple

Elevates enterprise valuation from a traditional display hardware assembler to a high-margin pioneer in On-Device AI Vision and dynamic electro-optical spatial computing.

9. Company Profile & Next Steps

9.1 About the Patent Assignee (Tink Innovation)

Company Name	Tink Innovation
Representative / CEO	Sungchu Kang
Headquarters Location	Seoul, Republic of Korea
Official Business E-mail	staping@naver.com
Core Competency	Next-generation AI computer vision architectures, spatial user interfaces, and advanced electro-optical display intellectual property R&D.

9.2 Step-by-Step Engagement Protocol

Stage	Milestone	Key Action Items
Stage 1	Proposal Review & Initial Technical Discussion	Executive review of this proposal followed by a bilateral technical Q&A via video conference or in-person meeting.
Stage 2	Mutual Non-Disclosure Agreement (NDA)	Execution of a bilateral NDA to facilitate detailed examination of algorithm specifications, mathematical models, and claim files.
Stage 3	Commercial Term Sheet & LOI / MOU	Negotiation of term sheet for Patent Transfer (Option 1) or Joint Venture Incorporation (Option 2) and execution of an MOU.
Stage 4	Definitive Agreement & Global PCT Execution	Closing of definitive contracts, formal title transfer / JV equity allocation, and collaborative PCT national phase filings.

Lead the Future of Glasses-Free Spatial Computing with Tink Innovation.

For detailed inquiries, term sheet requests, or to schedule an executive technical briefing, please contact us directly:

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