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Network Analysis of Smart Glasses and the Gaming Industry Based on CONCOR Clustering and Centrality Measures

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Abstract

Smart glasses are emerging as a next-generation interface that integrates AR, VR, and XR to enable real-time, vision-centered interaction. This study quantitatively investigates the associative structure between smart glasses and the gaming industry through network analysis of approximately 3,000 Naver news articles published between January 2022 and December 2024. Using CONCOR clustering and multiple centrality measures, four core clusters including Technology Convergence, User Experience, Industrial Ecosystem, and Products and Services were identified. Notably, the User Experience cluster highlights physical and perceptual factors such as wearability, visual acuity, and lenses as an independent semantic domain. Centrality analysis further reveals hub, mediating, and influential keywords spanning technological, market, and content-related dimensions. The results demonstrate that the relationship between smart glasses and the gaming industry constitutes a multilayered structure shaped by the interplay of technology, corporate strategy, user experience, and service provision, suggesting the necessity of an integrated perspective for future industry strategy and UX-oriented design.

Keyword : Smart Glasses, Game Industry, Network Analysis, Centrality Analysis, User Experience

1. Introduction

Smart glasses function as wearable devices that superimpose digital information onto the user's field of view through various optical systems such as Optical Head-Mounted Displays (OHMD), transparent Head-Up Displays (HUD), and Augmented Reality (AR) overlays [1][2]. These technologies have expanded into areas that encompass smartwatches, smart glasses, smart fashion, and smart gaming devices, and they are applied across industrial, game-related, and medical domains [3]. As major global

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companies prepare to introduce smart glasses and Head-Mounted Displays (HMD), smart glasses have emerged as a central component of market competition and platform strategy [4]. Despite the rapid expansion of related services and industrial applications, prior research has primarily focused on technological attributes of smart glasses, with limited attention to broader structural dynamics.

This research addresses this gap by analyzing the relational network that connects smart glasses and the gaming industry. The goal is to identify the keywords that serve as hubs, intermediaries, or high-influence elements within the network and to explain how these components relate to industrial strategy and user experience. To guide this analysis, the study examines three questions: (1) What cluster structures characterize the relationship between smart glasses and the gaming industry? (2) Which keywords occupy structurally central positions in the network? (3) What implications do these results hold for game UX design and industrial strategy? To address these questions, the analysis draws on approximately 3,000 Korean news articles published from January 2022 to December 2024.

2. Theoretical Background

2.1 Limitations of HMD-Based Interfaces

Conventional head-mounted displays generate a dynamic visual response to the user's head movements and provide strong presence and immersion in virtual environments [5]. However, visual characteristics such as field of view, frame rate, and latency, as well as visual-vestibular conflict, are frequently associated with virtual reality sickness. Reported symptoms include nausea, dizziness, and visual blur [6][7]. The vergence-accommodation conflict that occurs in stereoscopic displays has been identified as a major cause of ocular fatigue and visual instability because it places excessive demand on the accommodation-convergence system [8]. Experimental research conducted across various display environments has shown that even brief exposure can increase symptoms such as nausea, oculomotor strain, and perceptual confusion. Studies using HMDs report similar patterns, and after-effects that persist for a certain period after device removal have also been observed [9]. These physiological burdens tend to accumulate as wearing time increases and are regarded as a critical constraint on long-duration use. Such physiological and physical limitations have strengthened the demand for next-generation interfaces designed for mobility and extended wear. Smart-glasses-based optical HMDs, characterized by lightweight form factors and an open field of view, are therefore regarded as a promising alternative [10].

2.2 Next-Generation Immersive Interfaces Based on Smart Glasses

Smart glasses function as next-generation interfaces that deliver information overlays within the user's field of view through Optical Head-Mounted Displays. By integrating AR and MR capabilities, they enable interaction centered on the physical environment [10]. Compared with traditional closed HMDs, smart glasses offer an open field of view and lightweight form factor, and they have been adopted as tools for real-time visualization and remote collaboration in medical, industrial, and educational settings [10-12]. These characteristics align with the requirements of next-generation immersive interfaces that demand extended wearability, mobility, and situational awareness. They also address limitations of HMD-based interfaces related to enclosure, weight, and cumulative fatigue. Through real-time information delivery grounded in visual input and environmental context, smart glasses expand the continuity between physical space and digital content. This capability indicates their potential to establish immersive interaction within a new device form factor.

3. Research Method

3.1 Research Design

This research employed network analysis to examine technological trends and industrial relationships between smart glasses and the gaming industry. Textom (textom.co.kr) served as the primary tool for data collection and analysis, and it enabled the systematic extraction of keywords related to smart glasses and the gaming sector from news articles. News articles were selected as the primary data source because media discourse reflects industry-level perceptions, strategic signaling by corporations, and socially salient issues surrounding emerging technologies. Unlike patents or academic publications, which primarily capture technological innovation or scholarly perspectives, news media provide an integrative and timely view of how technologies, markets, user experience, and corporate strategies are interconnected in public and industrial discourse.

The research procedure consisted of three stages: data collection, data preprocessing, and network analysis.

In the first stage, Textom was used to gather text data closely related to the research topic from news articles published over the past three years. In the second stage, unnecessary expressions and duplicated entries were removed to refine the dataset and restructure it into a format appropriate for analysis. In the third stage, convergence of iterated correlations (CONCOR) analysis was applied to identify latent semantic structures within discussions of smart glasses and the gaming industry. CONCOR groups keywords that exhibit similar relational patterns into clusters based on structural equivalence [13],

and the resulting clusters were further examined with reference to high-frequency keywords. Centrality analysis complemented this procedure by quantifying the relative positions and influence of nodes within the network. Through this process, the analysis identified hub, mediating, and influential keywords across clusters. The results offer insights that are relevant to industrial strategy and user-experience development.

3.2 Data Collection and Preprocessing

This research collected approximately 3,000 news articles (350 KB) published between January 2022 and December 2024 by using the keywords ‘smart’, ‘glasses’, and ‘game’. The data were gathered from Naver News, a major Korean platform with high user activity, and included both article titles and full text. To ensure the reliability of the dataset, the preprocessing stage removed advertisement phrases and unnecessary symbols, and duplicated entries were eliminated by verifying consistency between titles and body text. Mecab served as the morphological analysis tool, and the extracted linguistic units included nouns, verbs, adjectives, foreign words, and numbers.

3.3 Analysis Method

This research constructed a keyword co-occurrence network based on the preprocessed text data and used it as the foundation for analysis. The CONCOR technique was applied to identify the structural patterns of discussions related to smart glasses and the gaming industry. Multiple centrality metrics were computed: degree, closeness, betweenness, eigenvector centrality, and PageRank. Degree centrality served to identify hub keywords that maintain direct connections with numerous neighboring nodes. Closeness centrality assessed the speed of information diffusion by measuring average shortest-path distances to other nodes. Betweenness centrality was used to detect mediating keywords that link separate clusters. Eigenvector centrality and PageRank reflected the extent of association with influential nodes and enabled an evaluation of the network impact of global corporations and core technological terms. Through this procedure, the research integrated cluster analysis and centrality analysis to determine the structural characteristics and key elements that define the relational network between smart glasses and the gaming industry.

4. Analysis Results

4.1 CONCOR Cluster Analysis

The relational network between smart glasses and the gaming industry was examined through the CONCOR technique, and the major frequency-based clusters and their representative keywords are presented in [Table 1].

[Table 1] Frequency-Based CONCOR Clusters and Representative Keywords

Cluster	Cluster Name	Representative Keywords
1	Technology Convergence	glasses (1025), games (915), smart (620), smartphone (544), AR (424), VR (303), XR (264)
2	Industrial Ecosystem and Corporations	Meta (524), Samsung (104), Apple (205), market (186), launch (165), global (61), corporation (119)
3	User Experience	wearability (176), visual acuity (76), lenses (107), experience (54), use (201), eye (125), user experience (51)
4	Products and Services	app (72), content (136), function (130), service (69), provision (94), platform (63), product (165)

First, the Technology Convergence cluster reflects the integrative nature of smart-glasses-based gaming, as indicated by keywords such as glasses, games, smartphones, AR, and VR. Second, the Industrial Ecosystem and Corporations cluster centers on terms such as Meta, Samsung, Apple, market, and launch. These keywords indicate the strategic movement of global firms and the competitive structure of the broader industrial landscape. Third, the User Experience cluster consists of keywords closely related to physical and sensory conditions-such as wearability, visual acuity, lenses, and experience-demonstrating that UX forms an independent semantic domain in smart-glasses-based gaming rather than serving as a secondary technical component. Fourth, the Products and Services cluster includes app, content, function, and service. These keywords highlight the service-oriented aspects through which smart-glasses-based gaming is concretely implemented. High-frequency keywords such as glasses (1025) and games (915) served as the central axis of the Technology Convergence cluster, whereas global corporation keywords such as Meta (524), Samsung (104), and Apple (205) occupied core positions within the Industrial Ecosystem cluster. These findings indicate that the relational network between smart glasses and the gaming industry extends beyond a technological perspective and reflects the simultaneous interaction of corporate-driven industrial structures and user-experience factors.

4.2 Centrality Analysis Results

Centrality analysis identified key keywords that hold diverse positional characteristics within the relational network between smart glasses and the gaming industry. These positions represent three

functional roles: hub keywords, mediating keywords, and influential keywords. The main results are presented in [Table 2].

[Table 2] Representative Keywords by Centrality Measures

Measure	Representative Keywords	Centrality Range	Interpretation
Degree Centrality	glasses (1.000), games (1.000), AR (1.000), smartphone (1.000), AI (1.000)	1.000	keywords most directly connected across the network
Closeness Centrality	glasses (1.000), games (1.000), AR (1.000), smartphone (1.000), AI (1.000)	1.000	Keywords with short average path lengths demonstrate a capacity for rapid information diffusion
Betweenness Centrality	glasses · games · smartphone · AR (0.00072), Meta · Apple · market · launch (0.00049)	0.00049~0.00072	Keywords that function as mediators along inter-cluster pathways
Eigenvector Centrality	glasses · games · smartphone (0.1044), Meta (0.1039), VR (0.1039), content (0.1036)	0.1039~0.1044	Highly influential keywords closely connected to other influential nodes
PageRank	glasses (0.0615), games (0.0535), Meta (0.0365), VR (0.0223), content (0.0102)	0.0102~0.0615	Keywords with strong diffusion potential within the network

Degree and closeness centrality indicated the same set of keywords-glasses, games, AR, smartphone, and AI-and each recorded the maximum value of 1.000. These keywords were confirmed as the primary hubs that shape the fundamental structure of the network. In betweenness centrality, Samsung, Apple, market, and launch recorded comparatively higher values. Although the absolute values were low (0.00049-0.00072), these corporate and market-related terms occupied important mediating positions along inter-cluster pathways. Eigenvector centrality and PageRank identified Meta, VR, and content as the highest-ranking keywords. Their strong connections with influential nodes demonstrate their substantial impact within the network diffusion process. These results indicate that each centrality measure reveals the network structure from a distinct analytical perspective. Degree and closeness centrality identify core hub keywords; betweenness centrality highlights bridging keywords that connect clusters; and eigenvector centrality together with PageRank identifies keywords with high diffusion potential due to their association with influential nodes. Consequently, the centrality analysis suggests that technology, corporations, and content hold structural significance in different dimensions of the relational network between smart glasses and the gaming industry.

5. Discussion

The analysis indicates that the relational network between smart glasses and the gaming industry is structured around four major dimensions: technology, corporations, user experience, and services. This structural perspective provides value beyond fragmentary discussions at the individual keyword level, as it offers a framework for understanding the broader patterns of interaction across the industry.

First, the emergence of the User Experience cluster as an independent group is noteworthy. Unlike traditional VR and AR research that has primarily focused on device performance or graphical processing, smart-glasses-based gaming reveals semantic patterns shaped by physical factors such as wearability, visual acuity, and fatigue. This outcome suggests that UX functions as a central determinant of user acceptance and service sustainability rather than as a secondary technical attribute. Even with sufficient technological advancement, the absence of adequate user-experience support may restrict market expansion. Second, the prominence of corporate and market keywords in betweenness centrality highlights the role of global firms as structural coordinators in the convergence of smart glasses and gaming. The presence of terms such as Samsung, Apple, and Meta as inter-cluster connectors indicates that technology, UX, and service development do not evolve in isolation but instead converge through firm-driven strategic decision-making. This pattern implies that platform competition is not merely a contest of technological superiority but has expanded into a broader power structure that shapes the entire ecosystem. Third, the high ranking of content and platform-related keywords in influence measures suggests that smart-glasses-based gaming has begun to establish a market paradigm centered on content consumption and service provision rather than hardware alone. The recurring importance of ‘content’ and ‘service’ indicates that software and content strategy will serve as core competitive factors as the gaming industry incorporates smart glasses as a new platform.

6. Conclusion

This research conducted a quantitative examination of the relational structure between smart glasses and the gaming industry by applying network analysis to approximately 3,000 news articles published between January 2022 and December 2024. Through CONCOR clustering and multiple centrality measures-degree, betweenness, eigenvector centrality, and PageRank-the analysis identified four clusters: Technology Convergence, User Experience, Industrial Ecosystem, and Products and Services. The findings indicate that the smart-glasses-based gaming industry has evolved into a multi-layered structure in which

user experience, global corporate strategies, and content and service competition interact beyond the hardware dimension. The User Experience cluster emerged as an independent group but maintained relatively weak connections to other clusters, a pattern that indicates its potential function as a limiting factor in future industry expansion. In addition, global firms acted as mediators across clusters and occupied central positions that integrate technological, market, and UX-related elements.

Importantly, the prominence of the User Experience cluster-centered on keywords such as wearability, visual acuity, lenses, and perceptual comfort-suggests concrete implications for smart-glasses-based game design. For example, interface layouts should minimize visual clutter to reduce eye strain, play-session duration should be optimized for extended wear without inducing fatigue, and interaction designs should account for the limited field of view inherent to smart glasses. These considerations illustrate how network-level discourse patterns can be translated into practical UX design priorities rather than remaining at an abstract analytical level.

This research has limitations due to its reliance on news-article data. The analysis did not incorporate diverse sources such as patents, academic literature, or corporate reports, and therefore could not fully capture the practical context of user experience. Future studies may benefit from integrating topic modeling, time-series analysis, and qualitative user data to investigate the evolving convergence between smart glasses and the gaming industry in greater depth. By structurally identifying the relational network between these domains, this research provides a foundational basis for subsequent studies on smart-wearable-based gaming ecosystems and offers implications for strategic development in the industry.

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