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COMPUTER VISION IN IMPROVING THE EFFECTIVENESS OF DIGITAL ADVERTISING IN RETAIL

Modern retail is in a state of permanent digital transformation. A key driver of these changes is the implementation of artificial intelligence technologies, and specifically computer vision (CV), which allows machine algorithms to interpret and understand the visual world significantly faster and more accurately than human vision. For marketing management, this signifies a transition from the intuitive management of digital advertising impacts to strategies based on objective visual data in real time. This necessitated a multidisciplinary study aimed at substantiating the role and determining the directions of using computer vision technologies to improve the effectiveness of digital advertising in the offline and online environments of retail enterprises. The study is based on the hypothesis that the integration of computer vision systems to influence the target audience in real time and correspondingly adapt advertising content will significantly increase key engagement metrics and, consequently, conversion from digital advertising compared to traditional non-targeted approaches. The hypothesis is substantiated using the methods of theoretical and conceptual research: systemic-structural analysis, multidisciplinary synthesis, and logical generalization to formulate the study's conclusions. The article considers the stages of implementation and the possibilities of using computer vision technologies in retail. It is noted that in addition to technological advantages, the

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КОМП'ЮТЕРНИЙ ЗІР У ПІДВИЩЕННІ ЕФЕКТИВНОСТІ ЦИФРОВОЇ РЕКЛАМИ В РИТЕЙЛІ

Сучасний ритейл перебуває у стані перманентної цифрової трансформації. Ключовим драйвером цих змін є впровадження технологій штучного інтелекту (ШІ) і, зокрема, комп'ютерного зору (CV), що дозволяє машинним алгоритмам інтерпретувати та розуміти візуальний світ значно швидше та точніше за людського зору. Для маркетинг-менеджменту це означає перехід від інтуїтивного управління цифровими рекламними впливами до стратегій, що базуються на об'єктивних візуальних даних у реальному часі. Це обумовило необхідність проведення міждисциплінарного дослідження, метою якого є обґрунтування ролі та визначення напрямів використання технологій комп'ютерного зору для підвищення ефективності цифрової реклами в офлайн- та онлайн-середовищах підприємств роздрібної торгівлі. В основу дослідження покладено гіпотезу, що інтеграція систем комп'ютерного зору для впливу на цільову аудиторію в режимі реального часу та відповідної адаптації рекламного контенту дозволить значно підвищити ключові показники залученості та, як наслідок, конверсію від цифрової реклами порівняно з традиційними нетаргетованими підходами. У ході дослідження використано методи теоретико-концептуального дослідження: системно-структурного аналізу, міждисциплінарного синтезу та логічного узагальнення для формулювання висновків. Розглянуто етапи впровадження й можливості використання технологій комп'ютерного зору в ритейлі. Зазначено, що крім

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implementation of CV technologies in Ukrainian retail involves two other important factors driven by the war: physical security with remote management, and the compensation of labor resources. The omnichannel dimension of computer vision integration into digital retail advertising is investigated. A comparative characteristic of using CV technologies in offline and online retail environments is provided. The impact of computer vision on the real-time optimization of digital advertising is determined. The specifics of offline and online optimization of advertising impact using CV technologies are described. It is emphasized that a synergistic result in improving the effectiveness of digital advertising is achieved subject to the seamless integration of online and offline computer vision tools into a single omnichannel ecosystem. The conclusions state that the increased efficiency of digital advertising is achieved through the Phygital integration of CV technologies. The combination of a consumer's online preferences with their objective reactions on the sales floor forms an end-to-end behavioral profile, transforming disparate advertising broadcasts into continuous, hyper-personalized interaction.

Keywords: digital advertising, marketing-management, computer vision, Phygital integration, digital behavior, digital trust, advertising strategies, behavioral economics, retail.

технологічних переваг, впровадження CV-технологій в українському ритейлі має ще два важливих фактори, зумовлені війною: зокрема, фізична безпека, віддалене управління та компенсація трудових ресурсів. Досліджено омніканальний вимір інтеграції комп'ютерного зору в цифрову рекламу ритейлу. Надано порівняльну характеристику використання CV-технологій в офлайн- та онлайн-середовищах роздрібної торгівлі. Визначено вплив комп'ютерного зору на оптимізацію цифрової реклами в реальному часі. Описано специфіку офлайн- та онлайн-оптимізації рекламного впливу за допомогою CV-технологій. Наголошено, що синергетичний результат у підвищенні ефективності цифрової реклами досягається за умови безшовної інтеграції онлайн- та офлайн-інструментів CV в єдину омніканальну екосистему. У висновках зазначено, що підвищення ефективності цифрової реклами досягається завдяки Phygital-інтеграції CV-технологій. Об'єднання онлайн-преференцій споживача з його об'єктивними реакціями в торговельному залі формує наскрізний поведінковий профіль, перетворюючи розрізнені рекламні трансляції на безперервну гіперперсоналізовану взаємодію.

Ключові слова: цифрова реклама, маркетинг-менеджмент, комп'ютерний зір, *Phygital*-інтеграція, цифрова поведінка, цифрова довіра, рекламні стратегії, поведінкова економіка, ритейл.

JEL Classification: M31, M37, L81.

Introduction

Modern retail businesses spend substantial budgets on digital advertising but lack objective metrics to measure its effectiveness. Traditional methods, such as surveys, reviews, and complaints, are subjective, delayed, and not always relevant. One of the key communication channels directly at points of sale is digital advertising displayed on Digital Signage screens. However, such content is static and broadcast according to the same scenario for the entire audience. This results in low consumer engagement and makes it impossible to objectively assess the return on investment in these advertising tools. This creates a "blind spot" in customer experience assessment, as shoppers ignore advertising messages for various reasons. A study by Bain & Company (2024) confirmed that 40% of consumers consider the advertisements they see irrelevant, highlighting the need to use computer vision and AI-driven personalization to improve the effectiveness of advertising messages.

The application of computer vision (CV) in retail has attracted the attention of numerous researchers. The significance of this technology was substantiated by Gopinath (2024) in the context of CV's impact on operational efficiency, customer experience, and marketing performance. The researcher emphasized that computer vision enables more accurate advertising targeting and enhances consumer engagement, thereby stimulating conversions and

brand loyalty. Chen and Thompson (2024) argue that CV and artificial intelligence will shape the future of customer interfaces by transforming physical retail spaces into interactive environments.

The global CV technology market is experiencing rapid growth. According to Fortune Business Insights (2026, September 14), its value was estimated at USD 17.84 billion in 2024 and USD 20.75 billion in 2025. The market is projected to grow from USD 24.14 billion in 2026 to USD 72.8 billion by 2034, demonstrating a compound annual growth rate (CAGR) of 14.80%. In the retail sector, the growth in revenue generated by the CV industry has been driven by the increasingly fundamental role of CV in retail automation and the integration of generative artificial intelligence capabilities to expand product portfolios and improve customer experience.

Thus, scientific publications and statistical analyses focus on examining the transformative role of CV in improving retail analytics and consumer experience. Researchers note that computer vision enables real-time analysis of customer behaviour, providing retailers with information on foot traffic, product interactions, movement patterns, dwell times in different areas, and the emotional atmosphere of the retail space. By using surveillance camera data and advanced tracking algorithms, retailers can optimize store layouts, strategically position popular products and advertising displays, and make effective use of high-traffic areas. This will not only enhance customer satisfaction but also increase sales and improve operational efficiency (Nandhini et al., 2024).

Ukrainian researchers are actively investigating related issues concerning the implementation of innovative algorithms in advertising. In particular, the use of Machine Learning algorithms to improve brand management in the online environment is comprehensively examined in the works of Iankovets et al. (2025). The application of ML technologies for dynamic pricing and digital marketing optimization is explored by Ponomarenko et al. (2025). In addition to the technological dimension of communications, domestic scholars pay considerable attention to the ethical aspects of advertising and brand management. For example, in their study of eco-branding among companies in the FMCG sector, Bondarenko and Siazin (2024) emphasize the importance of transparency and warn of the reputational risks associated with unethical manipulation (greenwashing).

At the same time, the application of computer vision in the context of digital advertising in retail remains insufficiently addressed in the scientific literature. Despite the existence of comprehensive studies on the implementation of AI technologies and ethical communications, the application of computer vision (CV) as a tool for optimizing digital advertising requires further investigation. This highlights a research and practical gap in the study of CV tools, the application of which could transform digital advertising into a measurable and adaptive communication channel.

The purpose of this article is to substantiate the role of computer vision technologies and identify areas for their application to improve the effectiveness of digital advertising by retail businesses in both offline and online environments.

The study is based on the hypothesis that integrating computer vision systems to engage target audiences in real time and adapt advertising content accordingly will significantly improve key engagement metrics (Attention Rate and Engagement Rate) and, consequently, increase conversions from digital advertising compared with traditional non-targeted approaches. Theoretical and conceptual research methods were employed, including systems and structural analysis, interdisciplinary synthesis, and logical generalization, to formulate the conclusions.

The main body of the article is structurally divided into three sections. The first examines the stages of implementation and the potential applications of computer vision technologies in retail. It is noted that, in addition to technological advantages, the implementation of CV technologies in Ukrainian retail is influenced by two other important factors arising from the war: physical security, remote management, and the compensation for workforce shortages. The second section focuses on the omnichannel dimension of integrating computer vision into digital retail advertising. It provides a comparative overview of the use of CV technologies across different retail environments. The third section characterizes the impact of computer vision on real-time digital advertising optimization. It describes the specific features of optimizing advertising impact in offline and online environments using CV technologies. It is emphasized that a synergistic improvement in digital advertising effectiveness can be achieved through the seamless integration of online and offline computer vision tools into a unified omnichannel ecosystem.

The informational, theoretical, and methodological basis of the study comprised analytical reports by international and national organizations, marketing research, monographs, and scientific publications by Ukrainian and international authors examining the application of computer vision in digital advertising by retail businesses.

1. Evolution of computer vision applications in retail

The modern retail industry is undergoing continuous digital transformation. One of the key drivers of these changes is computer vision, a field of artificial intelligence that enables machine algorithms to interpret and understand the visual world at a level comparable to human vision, and often much faster and more accurately. For marketing management, this means a shift from intuitive consumer behaviour management to strategies based on objective visual data collected in real time.

The use of machine vision in retail is not an entirely new phenomenon; however, its intended purpose has undergone continuous changes (Grewal, Noble et al., 2020). At the first stage (beginning in the early 2010s), the primary purpose of computer vision was operational security, with CV systems viewed exclusively as tools for loss prevention (Loss Prevention). Algorithms were used to detect suspicious behaviour near checkout counters and monitor shoplifting. This technology was static and did not involve interaction with consumers.

At the second stage (from the mid-2010s), computer vision was also used for inventory management and merchandising. As computing power increased, cameras began scanning shelves to detect out-of-stock items and place orders automatically. During the same period, the first CV tools for generating "heat maps" (visual representations of consumer activity) were developed. These enabled store managers and marketers to analyse shoppers' movement patterns throughout the store and, accordingly, organize store zones, arrange product displays, design window displays, and position advertising materials (Grewal, Noble et al., 2020).

At the current stage, computer vision technologies are shifting towards customer experience (CX) management. The integration of advertising panels with cameras has become possible, transforming them into smart displays capable of recognizing the audience in front of the screen and instantly assessing its reaction to the creative content. The potential applications of CV technologies and the transition of retail from basic operational automation to cognitive marketing management are presented in *Table 1*.

Table 1

Applications of computer vision technologies in retail

Application area	Description of the technological solution	Business impact / KPI
Inventory Management Optimization (NVIDIA, 2022)	Automated shelf scanning and product identification to detect out-of-stock situations	Preventing lost revenue due to empty shelves, timely staff alerts, and maintaining customer loyalty
Consumer Behaviour Analysis and Merchandising (Gartner, 2023)	Generating heat maps, analysing hotspots, identifying demographic characteristics, and tracking dwell time in the store and at specific locations	Optimizing product placement and improving the effectiveness of "golden shelves" based on actual data rather than assumptions
Autonomous Checkouts (Wankhede et al., 2018)	Tracking items picked up by shoppers using a combination of sensors and CV algorithms (the Amazon Go model)	Eliminating queues, improving Customer Experience (CX), reducing operational costs, and minimizing delays during checkout
Loss Prevention (Intel, 2024)	Real-time detection of suspicious behaviour and monitoring of missed scans at self-checkout counters	Minimizing theft (shrinkage) without the need to deploy excessive numbers of security personnel
Digital Advertising: Emotion Counting and Analysis (Affective Computing) (Picard, 2003)	Recognizing and recording visitors' emotions (emotion counters) near digital displays to assess micro-expressions (joy, confusion) at the moment of contact with an advertisement	Assessing emotional responses to creative content in real time and dynamically adapting content to overcome "banner blindness"
Digital Advertising: Pose Estimation and Eye Tracking (Redmon et al., 2016; Grewal et al., 2020)	Tracking gaze direction and body movements (leaning towards the screen, stopping) using high-performance architectures for rapid processing and inference	Generating visual heat maps of screens and accurately measuring shoppers' physical engagement with interactive advertising displays

Source: compiled based on (NVIDIA, 2022; Gartner, 2023; Wankhede et al., 2018; Intel, 2024; Picard, 2003; Redmon et al., 2016; Grewal, Noble et al., 2020).

In addition to technological advantages, the implementation of CV technologies in Ukrainian retail is influenced by two other important factors arising from the war. First, physical security and remote management. Due to persistent threats, air raid alerts, and restrictions on movement, retail chain managers need tools that allow them to monitor store conditions and service quality in real time without being physically present. CV systems can automatically detect smoke, unattended objects, or unauthorized access during curfew hours. Second, workforce compensation. When the number of employees in a store is reduced for objective reasons, some routine operational tasks can be delegated to computer vision (CV) technologies, including queue monitoring, shelf stock control, and verification of price tag accuracy. This allows existing employees to focus on customer service rather than repetitive manual tasks (RAU, 2023).

2. The omnichannel dimension of integrating computer vision into digital retail advertising

The transition of retail to omnichannel and hybrid business models has changed the architecture of advertising communications and, consequently, consumer responses to them (Gopinath, 2025). Digital advertising in retail is no longer limited to users' personal device screens; it extends CV technologies into the physical space of retail premises through interactive Digital Signage panels, smart mirrors and shop windows, and digital advertising displays (Chen & Thompson, 2024). Within this new paradigm, computer vision helps transform advertising delivery from a static process into a dynamically managed channel of interaction.

At the same time, the mechanisms for integrating CV technologies vary considerably depending on the environment in which digital advertising is delivered. In the online environment (e-commerce and mobile retail), computer vision optimizes advertising by analysing users' visual preferences. Algorithms recognize images with which customers have interacted, analyse user-generated content (UGC), and automatically select personalized advertising banners or videos based on visual search (Chen & Thompson, 2024). Engagement metrics are recorded through the interface, including video completion rates, repeat views, pauses, swipe speed, clicks, click-throughs, and saves. The CV system also continuously tests users by presenting videos from other subject areas (for example, 80% familiar content and 20% new content) to expand their "digital profile" and retain their attention, creating what is known as a dopamine loop.

In the offline environment of a retail store, computer vision is integrated directly into digital advertising structures, which use electronic screens, televisions, video walls, or media façades to display advertisements (Digital

Signage). Instead of displaying videos in a traditional repetitive cycle, a camera embedded in an advertising panel analyses the flow of shoppers in front of the screen and instantly adapts the advertising message to the actual audience (Gopinath, 2025). The system captures genuine emotions that cannot be faked, providing businesses with the most honest feedback possible, as it occurs before customers have had time to rationalize their reactions. In addition, cameras can record the influence of sales consultants on shoppers' moods, their reactions to shop windows and product displays, and the impact of promotional campaigns on the emotional atmosphere in the store. They can also track how customers' moods change along their shopping journey and identify the stages at which interest increases or declines. The CV system does not identify individuals or store facial images; it only analyses emotions in real time and converts them into statistical indicators. This is consistent with the requirements of the GDPR and Ukrainian legislation, as personal customer data are not collected.

A comparative analysis of the use of CV to improve digital advertising effectiveness across different retail environments is presented in *Table 2*.

Table 2

Comparative analysis of computer vision applications in online and offline digital advertising

Comparison criterion	Online digital advertising	Offline digital advertising
Method of CV Integration	Integration into recommendation algorithms used by websites and applications	Embedding CV sensors in advertising displays and shelves
Advertising Content Management	Automatic selection of visual banners based on search history	Real-time generation or switching of video advertisements depending on audience reactions
Advertising Effectiveness Metrics	CTR (Click-Through Rate) measures the percentage of users who click on an advertisement or link after seeing it. Page depth indicates the number of website pages viewed by a visitor during a session	Attention Rate measures the degree to which consumers focus on specific content or an advertisement. Dwell time measures how long a viewer's gaze remains fixed on an advertisement
Effectiveness	Optimizing customer acquisition costs (CPC) and website conversion rates	Overcoming "banner blindness" at the point of sale

Source: (Gopinath, 2025; Chen & Thompson, 2024).

Thus, while CV technologies in the online environment focus on improving the accuracy of visual recommendations, in the offline environment, computer vision addresses the "blind spot" of in-store advertising (Chen & Thompson, 2024). It transforms an ordinary advertising screen into an interactive analytical station capable of measuring shoppers' physiological responses and translating them into tangible outcomes: emotional connections, purchases, loyalty, and recommendations. This makes it possible to proceed to a detailed analysis of specific technological methods that enable such optimization during

advertising display and help offline stores compete with online platforms (Grewal, Hulland et al., 2020).

3. Computer vision in real-time advertising optimization

For digital advertising in retail to become an effective, measurable, and manageable communication channel, CV technologies must be deployed in a way that integrates them with the concepts of behavioural economics and enables their adaptive implementation in both e-commerce and the physical space of retail stores (Chen & Thompson, 2024; Gopinath, 2025).

In internet marketing and mobile applications, computer vision serves as a tool for intelligent hyper-personalization that anticipates users' needs (Bain & Company, 2024). The synergy between CV technologies and other machine learning algorithms significantly expands retailers' capabilities. It enables not only the adaptation of visual advertising content for brand management (Iankovets et al., 2025), but also the simultaneous adjustment of prices dynamically in real time according to demand and customer profiles (Ponomarenko et al., 2025). Thus, the real-time optimization of online advertising relies on several key algorithms: semantic analysis of visual content and identification of audience visual preferences, recognition of user-generated content (UGC) for native targeting, visual search technologies, and AR triggers (*Table 3*).

Table 3

Specifics of online advertising impact optimization using CV technologies

Optimization area	CV technologies	Real-time mechanism	Marketing outcome / KPI
Semantic Analysis of Visual Preferences	Neural network analysis of images and videos (Image Recognition)	Scanning and tagging the characteristics of content viewed by the user during a session. Adapting dynamic banners to these characteristics	Hyper-personalization of content delivery, increased advertising relevance, and a higher click-through rate (CTR)
Native Targeting of User Content	Object recognition in User-Generated Content (UGC)	Identifying brand elements or related products in customer-uploaded photographs. Generating seamless advertising offers	Native integration of offers into the platform's visual context and reduced advertising irritation
Shortening the Path to Purchase	Visual Search and AR triggers	Launching an advertising offer for a specific, related, or complementary product when the user activates the camera to search for an item or try it on using AR	Minimizing barriers between desire and purchase, faster conversion, and an increase in impulse purchases

Source: (Bain & Company, 2024; Chen & Thompson, 2024).

In the physical store environment, the assessment and adjustment of advertising impact directly during content playback is based on the

analysis of the following components: gaze direction, emotional response, consumers' physical engagement, safety, and privacy (*Table 4*).

Table 4

CV technologies for offline advertising content optimization

Optimization Area	CV Technologies / Algorithm	Real-Time Mechanism	Marketing Outcome / KPI
Gaze Direction Analysis	Offline eye tracking (Gaze Tracking)	Tracking visitors' pupil movements in front of Digital Signage panels. Generating dynamic heat maps of advertising frames	Accurate measurement of the Attention Rate. Adjusting video duration and layout composition (logo visibility, CTA – call-to-action text or button)
Assessment of Psychological Impact	Emotional Response Recognition (Affective Computing)	Analysing facial micro-expressions (joy, indifference, confusion). Instantly switching ineffective creative content to an alternative through algorithmic processing	Overcoming "banner blindness" and maximizing the level of emotional engagement (Engagement Rate)
Measurement of Physical Engagement	Pose and Motion Detection (Pose Estimation / YOLO)	High-speed detection of movement patterns: leaning forward, slowing down, and reaching towards an advertised product in front of a screen	Objective measurement of Dwell time. Establishing a direct correlation between advertising exposure and conversion
Safety and Privacy	Edge Computing	Local processing of the video stream by the screen's processor without storing facial images; instant conversion of video into anonymous metadata	Compliance with GDPR requirements, removal of ethical barriers, and development of consumer trust in digital technologies

Source: (Chen & Thompson, 2024; Grewal, Noble et al., 2020; Picard, 2003; Redmon et al., 2016).

An important prerequisite for effective offline advertising is the use of an Edge Computing architecture. The video stream is processed locally by the advertising display's processor, instantly transforming the visual feed into anonymized digital metrics without storing facial images. This eliminates ethical barriers, enables advertising targeting without violating consumer privacy, and increases their level of digital trust, which is a pressing issue today. As researchers in ethical marketing (Bondarenko & Siazin, 2024) rightly point out, companies' use of manipulative and unethical practices in eco-advertising leads to a loss of loyalty among target audiences. Therefore, the use of Edge Computing technologies that guarantee anonymization and personal data protection is a prerequisite for ethical and socially responsible marketing management.

Thus, the integration of computer vision technologies creates a continuous cycle of digital advertising optimization in both the virtual and

physical retail environments. Instead of relying on delayed analysis based on inaccurate assumptions, marketing management gains a tool for adapting content in real time, maximizing engagement metrics and encouraging consumers to take conversion-oriented actions. Genuine synergistic improvements in digital advertising effectiveness are achieved through the seamless integration of online and offline computer vision tools into a unified omnichannel ecosystem. When consumers' visual footprints and preferences from e-commerce platforms are algorithmically combined with data on their actual responses to Digital Signage screens in physical stores, retailers obtain a comprehensive behavioural profile. This Phygital integration of CV technologies ultimately transforms digital advertising from a set of disconnected marketing broadcasts into a continuous, hyper-personalized, and measurable dialogue with consumers at every touchpoint.

Conclusions

The study substantiates the role of computer vision (CV) technologies in digital advertising for retail businesses and identifies the main areas of their application in online and offline environments.

It is noted that in the online environment (e-commerce and mobile applications), CV technologies serve as a tool for intelligent hyper-personalization. Semantic analysis of visual preferences, native targeting based on user-generated content (UGC), and visual search make it possible to increase advertising relevance, improve the click-through rate (CTR), and minimize barriers between desire and purchase.

It is established that, in the offline environment, integrating CV sensors into Digital Signage panels overcomes the effect of "banner blindness" by instantly adapting video advertisements to audience reactions.

It is substantiated that the use of eye-tracking technologies (Gaze Tracking), emotional response recognition (Affective Computing), and pose detection (Pose Estimation) converts consumers' physiological responses into precise Attention Rate and dwell time metrics, establishing a direct correlation between advertising exposure and conversion actions. It is determined that processing video streams using an Edge Computing architecture makes it possible to transform visual data into anonymized metadata without storing facial images, thereby ensuring compliance with GDPR requirements, eliminating ethical barriers, and building consumer trust in digital technologies. It is emphasized that synergistic improvements in digital advertising effectiveness are achieved through the phygital integration of CV technologies. The seamless combination of consumers' online preferences with their actual responses in the store creates a comprehensive behavioural profile, transforming disconnected advertising broadcasts into continuous, hyper-personalized interactions.

The results obtained confirm the proposed hypothesis that integrating computer vision systems to influence target audiences in real time and adapt advertising content accordingly will significantly improve

key engagement metrics and, consequently, increase conversions from digital advertising compared with traditional approaches.

Given the dynamic development of artificial intelligence algorithms and the ongoing transformation of the retail environment, promising areas for further research include an in-depth study of algorithms for constructing an omnichannel consumer "digital profile" and the development of a methodology for assessing the economic effectiveness of implementing end-to-end phygital advertising strategies in the domestic retail sector. In the context of current security and energy challenges, research into the technical and economic feasibility of deploying Edge Computing infrastructure for advertising displays across retail chains will also be important.

REFERENCES / СПИСОК ВИКОРИСТАНИХ ДЖЕРЕЛ

Bain & Company. (2024, December 9). 40% of consumers find the ads they see irrelevant; AI-powered personalization can help brands stand out and boost engagement. https://www.bain.com/about/media-center/press-releases/2024/40-of-consumers-find-the-ads-they-see-irrelevant-ai-powered-personalization-can-help-brands-stand-out-and-boost-engagement/

Bondarenko, O., & Siazin, S. (2024). Greenwashing in eco-branding of FMCG enterprises. *Scientia Fructuosa*, *6*(158), 31–50. https://doi.org/10.31617/1.2024(158)03

Chen, L., & Thompson, S. (2024). AI-Powered Retail: Computer Vision and the Future of the Customer Interface. *Journal of Retailing and Consumer Services*, (78), Article 103451. https://doi.org/10.1016/j.jretconser.2023.103451

Fortune Business Insights. (2026, September 14). Computer Vision Market Size, Share & Industry Analysis By Component (Hardware and Software & Services), By Application (Facial Recognition, Image Classification, Object Detection, Object Tracking, and Others), By Industry (Automotive, Manufacturing, Healthcare, Retail, Agriculture, Logistics, and Others), and Regional Forecast, 2026-2034. https://www.fortunebusinessinsights.com/computer-vision-market-108827

Gartner. (2023). Top strategic technology trends in retail for 2024 [Report]. https://www.gartner.com/en/information-technology

Gopinath, R. (2025, April 20). The Role of Computer Vision in Retail and Digital Advertising. *Rajiv Gopinath Analytics.* https://www.rajivgopinath.com/real-time/next-gen-media-and-marketing/the-evolution-of-retail-omnichannel-and-hybrid-models/the-role-of-computer-vision-in-retail-and-digital-advertising

Grewal, D., Hulland, J., Kopalle, P. K., & Karahanna, E. (2020). The future of technology and marketing: A multidisciplinary perspective. *Journal of the Academy of Marketing Science*, *48*(1), 1–8. https://doi.org/10.1007/s11747-019-00711-4

Grewal, D., Noble, S. M., Roggeveen, A. L., & Nordfalt, J. (2020). The future of in-store technology. *Journal of the Academy of Marketing Science, 48*(1), 96–113. https://doi.org/10.1007/s11747-019-00697-z

Iankovets, T., Järvis, M., Fomin, O., Chernobrovkina, S., & Shvets, S. (2025). Using Machine Learning to Improve Brand Management in an Online Environment. *International Review of Management and Marketing*, *15*(6), 118–125. https://doi.org/10.32479/irmm.20649

Intel. (2024). AI and computer vision in retail: Transforming the customer journey [White paper]. https://www.intel.com/content/www/us/en/retail/overview.html

Nandhini, C., John Samuel, J. G., & Sridhar, M. (2024). Seeing is Profiting - Computer Vision as the Game Changer in Retail Customer Experience. *Proceedings of International Conference on Advanced Computing – ICAC – 2024*, 64–67.

NVIDIA. (2022). Smart retail: Using AI to optimize operations and enhance customer experience [White paper]. https://www.nvidia.com/en-us/industries/retail/

Picard, R. W. (2003). Affective computing: Challenges. *International Journal of Human-Computer Studies*, 59(1–2), 55–64. https://doi.org/10.1016/S1071-5819(03)00052-7

Ponomarenko, I., Pavlenko, V., Bondarenko, O., Morhulets, O., Ponomarenko, D., & Melnyk, M. (2025). Machine learning for dynamic price adjustments in digital marketing. *In 2025 IEEE 6th KhPI Week on Advanced Technology (KhPIWeek),* 1–4. Kharkiv, Ukraine. https://doi.org/10.1109/KhPIWeek 61436.2025.11288656

RAU. (2023). RAU and robota.ua Special Project: How the Retail Labour Market Has Changed. RAU Analytics. Association of Retailers of Ukraine. https://rau.ua/news/rau-i-robota-ua-rinok-praci-2023/

Redmon, J., Divvala, S., Girshick, R., & Farhadi, A. (2016). You only look once: Unified, real-time object detection. *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition,* 779–788. https://doi.org/10.1109/CVPR.2016.91

Wankhede, K., Wukkadada, B., & Nadar, V. (2018). Just Walk-Out Technology and its challenges: A case of Amazon Go. *2018 International Conference on Inventive Research in Computing Applications (ICIRCA)*, 254–257. https://doi.org/10.1109/ICIRCA.2018.8597403

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