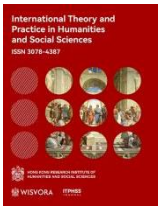
WISVORA

International Theory and Practice in Humanities and Social Sciences

2025 Volume2,Issue8 ISSN 3078-4387



Feasibility Analysis of Combining CityWalk with Augmented Reality

Yusheng Guo[1],Yuan Wang[1],Yalin Li[2*]

[1] *School of Design, Hong Kong Polytechnic University, Hong Kong*

[2]*Lingnan University*

Accepted

2025-08-01

Keywords

CityWalk，Augmented Reality (AR) Technology，User Experience，Technical Feasibility

Corresponding Author

Yalin Li

https://doi.org/10.70693/itphss.v2i8.711

Abstract

In recent years, CityWalk has been a favorite among visitors asanimmersive way of city touring. Traditional CityWalk experiences, however, lacks deep interpretation of the surroundings, andvisitorsare not able to obtain real-time historical, cultural, and architecturalbackground information easily. The rapid development of augmentedreality (AR) technology have provided CityWalk withnewinteractive approaches, enabling users to obtain augmentedinformation in real-time through smart devices. The useof ARtechnology in CityWalk applications, however, still needfurtherstudy, especially in terms of technological maturity, user interactionexperience, data synchronization, and privacy. This paper explores the application prospects of the combinationofAR and CityWalk in three aspects: technical feasibility, interactionoptimization, and content generation. First, fromthe technicalperspective, consider the latest advancements of AR, the popularityof smart devices, and the trend of market growth to describeitsfeasibility in the CityWalk scenario. Second, answeringtheinteractive requirements of CityWalk, the application of GPSandinertial navigation technology and SLAM(SimultaneousLocalization and Mapping) technology was explored to enhancetheprecision and immersion of AR navigation. Meanwhile, throughthecombination of multimodal interaction modes such as voice, vision, and gestures, the user experiences of convenience and operabilitycan be achieved. Finally, the real-time update mechanismof ARcontent based on cloud computing, Internet of Things (IoT) andedgecomputing is discussed to ensure the timeliness of data anduserprivacy security. In addition, user research results showthat over80% of respondents hope to experience localized ARcontent inCityWalk, with 72% willing to pay for high-quality customizedaugmented reality experiences, further validating its commercialpotential. Overall, the combination of CityWalk and AR not onlyenhancestourists' exploration experience, but also provides newpossibilities00 February 00 Keywords CityWalk，Augmented Reality (AR) Technology，User Experience，Technical Feasibility Corresponding Author Yusheng Guo 2 International Theory and Practice in Humanities and Social Sciences | www.wisvora.comfor urban tourism, cultural dissemination, and business modelinnovation. In the future, with the continuous optimizationof ARtechnology, its application in CityWalk is expected to becomeanimportant development direction for smart tourism.

1. Introduction

At present, it is understood that most tourists during the Citywalk process are not aware of the location, architectural background, and cultural information they pass through. In addition, regarding the combination of CityWalk and augmented reality, for example, first tier cities such as Beijing and Changsha have established urban walking routes on public bus routes to help

short-term tourists increase their experience and cultural understanding. In 2023, China Daily reported that AR technology has been applied in the Citywalk route to showcase the stories of the neighborhood and specific cultural customs to tourists. This interactive experience can greatly enrich tourists' knowledge, allowing them to go beyond just a photo based tour. In some previous studies, participants in the experiment experienced the visual enjoyment brought by virtual landscapes when using the Citywalk AR feature. However, on the other hand, they also expressed concerns about the smoothness of gameplay and the frequent acquisition of location information by the device. So, the question is, can the rise of AR technology in Citywalk applications truly enhance users' rich and smooth city experience? Are you unintentionally amplifying the risks of technological dependence and privacy breaches?

My assumption is that with human intervention, if we optimize and upgrade the technology used in the Citywalk process to improve the smoothness, richness of gameplay, and privacy protection of AR during gameplay, it will undoubtedly provide users with a better gaming experience.

Figure 1 provides an overview of my argument and will guide this article. It will serve as the central reference point for me to discuss literature and draw conclusions.

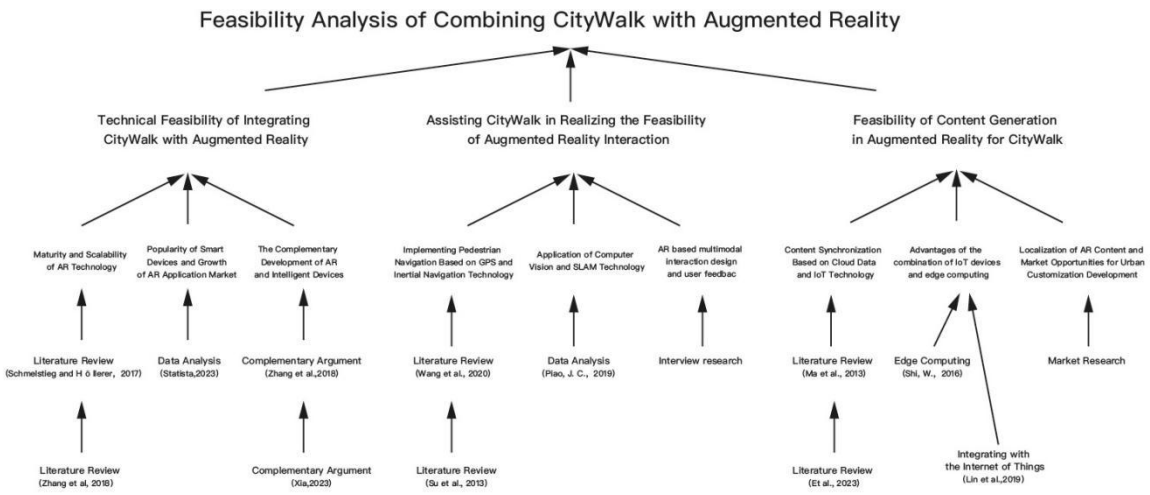


Figure 1. Argument structure of Feasibility Analysis of Combining CityWalk with Augmented Reality

As shown in Figure 1, my argument is to help the combination of CityWalk and augmented reality enhance the maturity and feasibility of AR technology (Section 2), significantly improve interactive technologies such as GPS and inertial navigation technology (Section 3), and utilize cloud data and IoT technologies to achieve the feasibility of combining CityWalk and augmented reality for content generation (Section 4). In the following chapters, I will support my viewpoint by consulting relevant literature.

2. Technical Feasibility of Integrating CityWalk with Augmented Reality

This section provides an overview of the increasing maturity and scalability of augmented reality technology, particularly in enhancing user experience by real-time information, navigation, and interactive content. It emphasizes the complementarity between AR and smart devices such as smartphones and smart glasses. Smartphones provide the processing power required for AR

tasks, while smart glasses deliver immersive, hands-free experiences. They have jointly achieved the widespread application of AR in CityWalk, increasing user interaction and experience through virtual overlay and detailed route information.

2.1 Maturity and Scalability of AR Technology

Scalability and maturity of AR technology is popular subjects of modern technological development. With the integration of virtual information into the real world, AR technology provide rich user experience along with applicability opportunities. As technology continuously develops, AR maturity has been considerably improved in different fields, especially in cultural heritage preservation, education, and business.

Firstly, the basic principle of AR technology is to generate virtual information through computers and overlay it onto the user's real field of view. Schmelstieg and H ö llerer (2017) detailed the basic principles and practices of AR in their work, emphasizing its importance in computer science. AR systems typically comprise sensors, display devices, and computing units that presents corresponding virtual content by processing environmental information and user input in real time. With the development of hardware technology, the types and functions of AR devices continue to change, expanding the application scope of AR technology.

Additionally, the application of AR technology in urban walking have also shown maturity. Research has proved that AR can render urban walking more appealing by providing real-time information, navigation, and interactivity.For example, AR can provide historical information, cultural background, and business recommendations in pedestrian neighborhoods, thereby enhancing the experience of tourists and residents (Jung et al, 2018). In the meantime, the evolution of AR technology has rendered its application on mobile devices more and more ubiquitous, and users are able to view augmented content conveniently through smartphones or AR glasses, which further promote its application in city walking.

2.2 Popularity of Smart Devices and Growth of AR Application Market

According to the latest data from Statista (2023), the number of global smartphone users has exceeded 6 billion in 2023, accounting for 76% of the global population. Compared to approximately 4.8 billion users in 2016, the global number of smartphone users has increased by 25% in just seven years. Not only does this indicate that the popularity of intelligent devices is building up steam globally, but it also presents an enormous potential user base for widespread use of augmented reality technology. Since smartphones have emerged as a indispensible tool in day-to-day life, AR technology is gradually developing from a niche market to a technology application for masses, given the growing need for portable device capabilities from global users.

The size of the AR technology market have also shown a robust growth trend during the same period.According to Statista (2023), the global AR market size was approximately $15 billion in 2020, and in just three years, this number grew to $35 billion in 2023, with an average annual growth rate of over 30%. According to predictions, the global AR market is expected to further soar to $198 billion by 2025, almost six times its current size. Such significant growth reflects the high demand for AR applications in the market, especially driven by industries such as entertainment, education, and retail, where the scope and depth of AR technology applications are rapidly expanding.

The popularity of smart devices and the rapid growth of the AR application market complement each other, which will greatly support the development of Citywalk. The widespread use of smart devices provides reliable hardware support for AR technology, and the continuous innovation and diversified applications of AR technology in turn drive further growth in demand

for smart devices. Market data clearly indicates that AR technology not only has strong market potential, but also will be deeply applied in more industries and fields such as Citywalk in the coming years, bringing users more immersive experiences.

Briefly, the integration of urban walking and augmented reality technology have formed a systematic support at the level of technical feasibility. There is scalability in the current technical framework: by virtue of the coordination of distributed cloud rendering and edge computing nodes, AR applications can ensure support for large-scale users to access urban geographic information data simultaneously (e.g., real-time traffic, complete information reconstruction of historic buildings) without increasing terminal load. The maturity of the technology has been verified in commercial practice, for example, AR games based on LBS (Location Based Services) has been tested by hundreds of millions of users, proving that their positioning stability and data throughput capability can satisfy high-density urban areas' demands. From the core algorithm to the hardware carrier and system architecture, it can be seen that the critical factors of AR technology have been subjected to technical closed-loop verification in the scenario of urban walking.

2.3 The Complementary Development of AR and Intelligent Devices

The combination of augmented reality technology and smart devices has significant complementarity, especially in application scenarios such as CityWalk, where different types of smart devices demonstrate their unique advantages in display, positioning, and data processing. Smartphones, tablets, and wearable devices (such as smart glasses) provide users with different ways of interaction and technical support, and the functions of these devices can complement and promote each other, further promoting the application and optimization of AR technology.

Firstly, smartphones are currently the most widely used devices, with high-resolution screens and powerful processors that enable them to support the display of high-definition images and real-time rendering of complex AR content. For example, the processing power of modern smartphones is sufficient to handle complex AR tasks including 3D object rendering, spatial perception, and SLAM (simultaneous localization and map construction). Zanella et al. (2014) explored the application of IoT technology in smart cities, emphasizing the importance of smart devices such as smartphones in data collection and user interaction. The combination of AR technology and smartphones enables users to obtain real-time information in urban environments, enhancing their walking experience. Therefore, users can experience high-definition virtual object overlay effects in CityWalk through their smartphone devices and obtain detailed information on their walking routes in real-time. The popularity of smartphones has provided a broad hardware foundation for AR technology, which is also an important factor for the large-scale promotion of AR applications.

At the same time, wearable devices such as smart glasses have shown great potential in freeing up users' hands. Compared to smartphones, smart glasses can seamlessly integrate with users' daily activities, especially when walking and exploring cities. Users can wear smart glasses and view augmented reality content through the transparent screen in their field of view, without frequently looking down at their phone screens or operating devices. Regarding the application of wearable devices in autonomous scene exploration, Skarredghost (2025) pointed out that the combination of AR technology and smart glasses can provide a more immersive user experience, especially in scenarios that require hands-free use, enhancing user interaction with the environment. This design not only enhances user convenience, but also reduces the possibility of distraction during walking, allowing users to interact more freely with the surrounding real world and AR content. For example, users can view virtual highlighted route directions, street names, or

cultural attraction introductions on glasses instantly while walking, without even holding any device in their hands, enabling a more immersive experience for applications such as CityWalk.

3. Assisting CityWalk in Realizing the Feasibility of Augmented Reality Interaction

This chapter explains how AR technology is employed to enhance pedestrian navigation by fusing GPS and inertial navigation systems for precise location tracking. It mentions the application of SLAM technology for real-time overlay of virtual objects for delivering immersive experiences. In addition, it explains how multimodal interaction based on user feedback in the form of visual, voice, and gesture control can potentially enable the CityWalk experience to be interactive and personalized.

3.1 Implementing Pedestrian Navigation Based on GPS and Inertial Navigation Technology

AR technology application relies on precise positioning systems, and for CityWalk applications, GPS (Global Positioning System) and inertial navigation technology form the foundation. GPS can provide global positioning data, suitable for outdoor pedestrian navigation.

GPS technology forms the heart of pedestrian navigation in cities. It can provide real-time location information to direct users along the best walking route.

However, skyscrapers and complex street layouts in urban environments has the effect of blocking and reflecting GPS signals, and therefore affect the positioning accuracy. As a solution to this issue, researchers have proposed a technique that combines inertial navigation systems (INS) with GPS. Positioning is estimated by INS using acceleration and angular velocity measurements, and navigation continuity can be ensured in the event of degraded or lost GPS signals. For example, Wang et al.（2022） explored the application of GNSS (Global Navigation Satellite System) technology in autonomous navigation, emphasizing the importance of combining GPS with INS to improve the reliability and accuracy of positioning.

Secondly, the advantage of inertial navigation technology is that it is not dependent on external signals and therefore work well in environments of unstable GPS signals. INS can provide high-frequency position updates in a short time period, which is essential for pedestrian navigation. However, the long-term precision of INS will decline over time, mainly due to sensor drift and accumulation of errors. Therefore, the GPS and INS fusion algorithm have been a research focus area, with the aim of utilizing the long-term stability of GPS and the short-term high precision of INS to achieve more robust pedestrian navigation.Research has shown that using data fusion techniques such as extended Kalman filters can effectively improve positioning accuracy (Zheng et al., 2013).

Briefly, the technological complementarity of inertial navigation system (INS) and GPS global positioning system provide essential support for AR navigation in urban walking. GPS, owing to the extensive coverage of satellite signals, can provide a stable global positioning reference in open outdoor environments, and INS naturally compensates for the positioning interruption caused by signal blockage in complex environments such as urban canyons by high-frequency measurement of acceleration and angular velocity. The combination of the two achieves favorable synergy through algorithms such as extended Kalman filters: GPS long-term stability remove the accumulative error of INS, and the short-term high accuracy of INS fills the navigation gap in the event of GPS signal loss. Studies have shown that such fusion technology significantly improve

positioning reliability and accuracy, enabling AR navigation systems to guarantee accurate alignment between virtual information and physical scenes in dynamic urban environments. Through the integration of the core function of two technologies, users can obtain a continuous and uninterrupted navigation experience in the course of urban walking, with overall optimization from macro path planning to micro point of interest guidance.

3.2 Application of Computer Vision and SLAM Technology

One of the basic challenges of AR technology is how to accurately seamlessly integrate virtual information and real scenes, and SLAM technology is the key to solving this problem. SLAM technology combines computer vision and sensor data to follow the physical world around the user in real time, and it builds a three-dimensional map based on environmental characteristics, thereby enabling virtual objects to be accurately overlaid on the real scene. Piao, J. C.（2019）proposed a real-time visual inertial SLAM based on adaptive keyframe selection for mobile AR applications（Figure 2）. It combines adaptive keyframe selection method and lightweight visual inertial odometry method to help AR achieve improved efficiency and real-time performance.

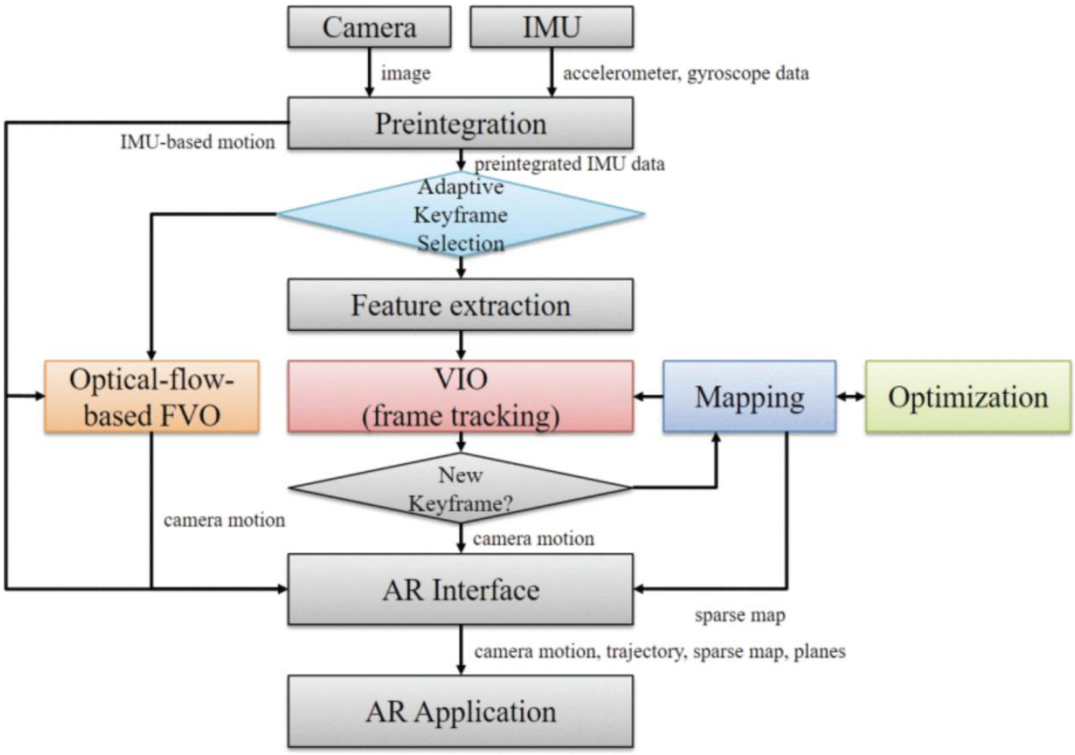


Fig. 2. Structural architecture of adaptive keyframe selection visual–inertial odometry based SLAM.

In application scenarios like CityWalk, SLAM technology can enrich users' walking exploration experience by real-time overlaying virtual signs, navigation hints, and historic building information on the walking path, realizing immersive interactive experience. For example, Apple's ARKit and Google's ARCore AR platforms both widely adopt V-SLAM technology, which combines image information from cameras with sensor data like accelerometers and gyroscopes to help user devices achieve high-precision spatial localization and scene recognition in complex urban environments. The technology enables users to experience more immersive and precise augmented reality in CityWalk, for example, real-time recognition of buildings and landmarks along the walking path and overlaying virtual space with

corresponding information markers.

Based on the 2023 SLAM Technology Market Analysis Report, the growth rate of SLAM technology on AR platforms is over 40% annually. It is projected that the technology will quickly penetrate various industry applications in the future, such as urban navigation, indoor positioning, and cultural tourism. Particularly in cultural and urban exploration applications, the use of SLAM technology significantly improve the interactive experience of the user, allowing them to dynamically recognize the main features in the environment and display detailed historical context or route information using AR technology.This data indicates that SLAM technology has become an indispensable foundational technology in modern AR applications, and its application scope will continue to expand.

Based on these data and research, the combination of SLAM technology and computer vision clearly plays a key role in the application of AR technology, especially in applications such as CityWalk that require real-time scene overlay. SLAM technology can ensure users obtain high-precision navigation and information display in complex urban environments. This technology not only enhances the usability and stability of AR systems, but also makes augmented reality experiences more immersive and interactive, further promoting the application development of urban walking exploration.

3.3 AR based multimodal interaction design and user feedback

To explore the optimization direction of multimodal interaction technology for urban walking experience, the research team conducted in-depth interviews with 10 active users who utilize walking navigation apps for daily use. Respondents have a strong preference for the visual overlay function of AR technology, especially in dynamic route guidance. Users have specific demands such as "real-time projection of semi transparent navigation arrows through smart glasses" (P3 respondents) or "highlighting coffee shop logos within 200 meters ahead on mobile phone screens" (P5 respondents). This visually dominant interaction mode is thought to be able to effectively reduce cognitive load, allowing users to obtain environmental information quickly through a virtual real fusion interface while maintaining a natural walking posture.

The usefulness of voice channels is elicited in response to interactive constraints under complex walking conditions. More than 60% of the subjects emphasized that in navigating congested intersections or carrying things with both hands, voice prompts (e.g., "turn left to enter the sunshade walkway" or "beware of the construction fence on the right") are operationally safer than visual feedback. One subject who commutes daily in the business district (P7 interviewee) especially pointed out that "the directional sound field prompt of the headphones can not only avoid interfering with the ambient environment, but also ensure that critical information is not missed". This suggests the unique advantage of voice interaction in attention resource allocation.

Further, the potential value of gesture interaction lies in its ability to enhance user control. Some users envisioned dynamic control of AR content using specific gestures, i.e., swiping the index finger to call up a menu or hovering above the palm to select an item. A technology enthusiast (P9 respondent) clarified, "If we could use gestures to zoom in and out of building history information layers, it would be like performing touch screen operations in the air, making the process of exploring the city more immersive. This expectation indicates users' expectations of the natural interaction paradigm - the information layer can be called up and dismissed via body movement, thereby maintaining the coherence of walking rhythm.

Based on the above feedback, the CityWalk AR system design needs to establish a multimodal collaborative mechanism: the visual layer is responsible for the visualization of important spatial information, the voice layer provides real-time reminders of important nodes, and the gesture

layer helps users actively trigger in-depth interactions. Taking the museum tour as an example, users can first locate the target exhibit through visual markers, inquire about the opening time through voice, and finally use gestures to swipe and get the 3D restored model. This kind of layered interactive framework can adapt to diverse environmental conditions (light intensity, noise level), and dynamically adjust modal weights based on user task types (navigation priority/exploration priority), ultimately achieving an immersive walking experience of "eye ear hand" collaboration.

4. Feasibility of Content Generation in Augmented Reality for CityWalk

This section focuses on how Internet of Things, edge computing, and cloud data synchronization can achieve real-time AR content update to provide users with accurate and timely information. With the integration of edge computing and intelligent devices, AR provides immersive experience with low latency. In addition, user questionnaires have indicated an overwhelming desire for localized AR content, particularly for cultural exploration. This offers immense commercialization opportunities, which means that AR-based CityWalk applications can play a vital role in urban tourism and city promotion initiatives.

4.1 Content Synchronization Based on Cloud Data and IoT Technology

Within the Citywalk scenario, the synchronization of cloud data and Internet of Things technology have become an important research direction to improve urban management and user experience.

To begin with, cloud computing provides the Internet of Things with powerful data processing and storage abilities, enabling urban pedestrian navigation and management systems to update and fetch information in real time.According to Leite et al.'s (2013) research, the architecture model of the Internet of Things provides the foundation for effective data transmission and processing. For urban walking, sensors can acquire real-time location information and environmental data of pedestrians, and upload the data to the cloud for analysis and processing. A data synchronization mechanism like this not only improve the real-time nature of information, but also provides decision support for urban administrators.

Additionally, with the emergence of new technologies such as federated learning, cloud data and IoT content syncing are evolving constantly. The federated learning algorithm proposed by the public can achieve distributed data training while protecting data privacy, providing new ideas for content synchronization of IoT devices (Zahri et al., 2023). By processing data and training models locally, the need for the cloud is reduced and data processing efficiency and security are improved.

In the scenario of combining CityWalk and AR, real-time synchronization of content along walking routes can be achieved by the synchronization of cloud data and IoT technology. For example, when the user reaches an attraction or a landmark, the AR system can fetch related historical data from the cloud or edge servers nearby and display it in real-time on the user's device.IoT devices (such as smart sensors, monitoring devices, etc.) can also collect real-time traffic, weather, and other data in the city, further enriching users' walking experience. Through such data synchronization and management mechanisms, CityWalk can ensure the timeliness and accuracy of augmented reality content while protecting data privacy, and enhance overall technical feasibility and user experience.

4.2 Advantages of the combination of IoT devices and edge computing

Edge computing is a distributed computing paradigm that pushes computing resources from the centralized data center to the edge of the network. Its purpose is to improve the efficiency and response speed of data processing. The core technologies of edge computing include virtualization, containerization, distributed computing architecture and local data processing, which greatly reduces the amount and delay of data transmission（Shi, W.，2016）.

The combination of Internet of Things (IoT) devices and edge computing technology provides strong support for the application of augmented reality (AR) in urban roaming. Undeniably, the efficient operation of IoT devices relies on powerful data processing capabilities. Edge computing technology provides a necessary supplement here. Compared with traditional cloud computing, edge computing can distribute data processing tasks to devices close to data sources, such as intelligent street lights, Wi Fi access points or small data centers. This technological layout greatly reduces the delay problem of data transmission and improves processing efficiency（Hasan et al.,2024）. For AR applications with high real-time requirements such as CityWalk, edge computing can ensure that the data collected by IoT devices can be processed nearby and quickly transferred to user devices, thus ensuring that users can obtain the required enhanced information in real time during walking. For example, when a user enters a specific historical street, edge computing can instantly process the historical building data collected by IoT devices in the area and present it to the user through the AR system, without relying on remote servers for data transmission and processing. This can greatly reduce data latency and enhance user interaction experience.

4.3 Localization of AR Content and Market Opportunities for Urban Customization Development

In order to gain a deeper understanding of the localization needs of AR content among users in different cities, the author conducted a comprehensive market research and collected feedback from 200 users in different cities through online questionnaires. The purpose of this survey is to evaluate users' needs and expectations for localized AR content, especially the potential application of AR content in urban culture, history, and landscape.

In terms of questionnaire design, the survey questions cover users' level of understanding of AR content, their expectations for localized and city customized content, and their needs for AR technology during daily walking or travel. For example, users are asked "Do you want to see customized AR content related to local culture, history, or landscape in the walking app?" and "What aspects of AR content can best enhance your walking experience?" At the same time, users are also asked about their pain points and improvement suggestions in daily use of the walking app to ensure that the research data fully reflects their real needs for AR localized content.

The survey results show that over 80% of respondents believe that localized and city specific content is one of their key needs when using walking apps. Specific data shows that 82% of users believe that if AR content can be combined with local historical culture or famous attractions, it will significantly enhance their walking or city exploration experience. Among them, 65% of users explicitly stated that they are not only using walking apps for navigation, but also looking forward to learning about the cultural background or neighborhood history of their city through AR technology. For example, a interviewee from Beijing said, "Being able to see historical introductions of buildings and city stories through AR while walking makes my exploration process more interesting and meaningful." Another interviewee from Paris mentioned, "Every city has its unique cultural and artistic atmosphere, and AR technology can allow tourists to feel this atmosphere, especially around famous historical sites.

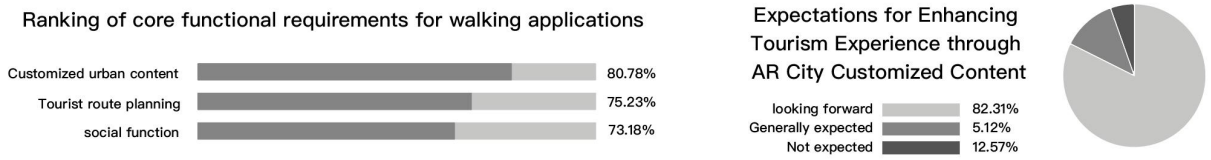


Fig. 3. Detailed data from the questionnaire survey.

According to user research data, 72% of users believe they are willing to pay extra for customized AR content, especially in tourism or cultural exploration. For example, one interviewee mentioned, "If I can experience in-depth local culture and attraction introductions through AR, I am willing to pay to unlock more content." This indicates that the development of AR localization and customized content can not only enhance users' walking experience, but also has obvious commercialization potential, providing new revenue models for urban tourism and cultural promotion.

Based on these survey data, it can be concluded that users have a strong demand for localized and customized AR content, especially in urban exploration and walking applications. This provides a huge market opportunity for CityWalk to develop AR content with local characteristics. By combining local culture, history, and landscape, CityWalk not only provides users with a personalized and immersive walking experience, but also provides strong support for the commercial and cultural development of the city. With the continuous maturity of AR technology, future urban walking applications are expected to become important tools for city promotion and tourism promotion, while also providing broad market space for commercial cooperation and innovation.

5. Conclusions/Discussion

If we want to use augmented reality in CityWalk to enhance the experiential tourism experience and more diverse features, we should improve the feasibility of technology, interaction, and content generation.

Firstly, in terms of basic functions, the effective integration of CityWalk and augmented reality should be ensured. Improving the maturity and scalability of AR technology can provide tourists with real-time information, navigation, and interactive experiences to enhance the attractiveness of urban walking. The popularity of smart devices and the growth of the AR application market have also determined that mobile phones are the most suitable carrier for the practical application of combining CityWalk and augmented reality for the general public. The application of AR in wearable devices such as smart glasses is also expected to help enhance the convenience of tourists and reduce distractions and dangers during walking in CityWalk in the near future.

Secondly, in terms of user experience, efforts should be made to enhance interaction. The development of GPS global positioning system and INS inertial navigation technology can help CityWalk improve the continuity and breadth of navigation, thereby enhancing the user experience. The combination of SLAM technology and computer vision can ensure users obtain high-precision navigation and information display in complex urban environments, and make augmented reality experiences more immersive and interactive. The multimodal interaction design of AR, such as voice and gesture, enables users to easily obtain the required information and interact with it in different scenarios, providing a personalized walking experience.

Again, in terms of experience richness, efforts should be made to enhance the generated content. The application of cloud data and IoT technology can achieve real-time content updates on pedestrian routes while protecting data privacy. For AR applications with high real-time requirements such as CityWalk, edge computing can ensure that the data collected by IoT devices can be processed nearby and quickly transferred to user devices, thus ensuring that users can obtain the required enhanced information in real time during walking. The strong demand for localized and customized AR content from users can not only improve the user experience of Citywalk products, but also provide richer cultural sources and promotional channels for cities and the tourism industry.

References

Schmalstieg, D., & Höllerer, T. (2016). Augmented Reality: : Principles and Practice (1st edition). Addison-Wesley Professional.

Jung, T. H., Lee, H., Chung, N., & tom Dieck, M. C. (2018). Cross-cultural differences in adopting mobile augmented reality at cultural heritage tourism sites. International Journal of Contemporary Hospitality Management, 30(3), 1621–1645. https://doi.org/10.1108/IJCHM-02-2017-0084

Statista. (2024). Smartphones - statistics & facts. Statista. Retrieved January 23, 2025, from https://www.statista.com/topics/840/smartphones/

Zanella, A., Bui, N., Castellani, A., Vangelista, L., & Zorzi, M. (2014). Internet of Things for Smart Cities. IEEE Internet of Things Journal, 1(1), 22–32. https://doi.org/10.1109/JIOT.2014.2306328

Skarredghost. (2025). Smart Glasses and AR Glasses at CES: Latest advancements in immersive technology. *SkarredGhost Tech Reviews*. Retrieved from https://skarredghost.com/2025/03/13/smartglasses-ces-ar-glasses/

Wang, C., Xu, A., Sui, X., Hao, Y., Shi, Z., & Chen, Z. (2022). A seamless navigation system and applications for autonomous vehicles using a tightly coupled GNSS/UWB/INS/Map integration scheme. Remote Sensing, 14(1), 27. https://doi.org/10.3390/rs14010027

Zheng, J., Wang, Y., & Ahmed, K. (2013). Performance comparison for vehicle tracking in urban areas: gps/ins integrated system vs. gps alone. Port-Said Engineering Research Journal, 17(1), 115-121. https://doi.org/10.21608/pserj.2013.42999

Piao, J.-C., & Kim, S.-D. (2019). Real-Time Visual–Inertial SLAM Based on Adaptive Keyframe Selection for Mobile AR Applications. *IEEE Transactions on Multimedia*, 21(11), 2827–2836. https://doi.org/10.1109/TMM.2019.2913324

Yang, J. and Zhou, T. (2023). Application of slam technology combined with ar in minimally invasive surgery. Applied and Computational Engineering, 28(1), 158-163. https://doi.org/10.54254/2755-2721/28/20230298

Zhao, R., Ge, Y., Duan, Y., & Jiang, Q. (2023). Large-field gesture tracking and recognition for augmented reality interaction. Journal of Physics: Conference Series, 2560(1), 012016. https://doi.org/10.1088/1742-6596/2560/1/012016

Leite, J. R. E., Martins, P. S., Ursini, E. L., Arthur, R., Vieira Estrela, V., Loschi, H. J., Saotome, O., & Iano, Y. (2018). Internet of Things: An Overview of Architecture, Models, Technologies, Protocols and Applications. In Proceedings of the 3rd Brazilian Technology Symposium (pp. 75–85). Springer International Publishing AG. https://doi.org/10.1007/978-3-319-93112-8_8

Zahri, S., Bennouri, H., & Abdelmoniem, A. M. (2023). An Empirical Study of Efficiency and Privacy of Federated Learning Algorithms. https://doi.org/10.48550/arxiv.2312.15375

Shi, W., Cao, J., Zhang, Q., Li, Y., & Xu, L. (2016). Edge Computing: Vision and Challenges. *IEEE Internet of Things Journal*, 3(5), 637–646. https://doi.org/10.1109/JIOT.2016.2579198

Hasan, B. T., & Idrees, A. K. (2024). Edge Computing for IoT. In Learning Techniques for the Internet of Things (1st ed., pp. 1 - 20). https://doi.org/10.1007/978-3-031-50514-0_1

Kwon, D. and Park, Y. (2024). Design of secure and efficient authentication protocol for edge computing-based augmented reality environments. Electronics, 13(3), 551. https://doi.org/10.3390/electronics13030551