

Significance of Museum Visitor Behavior Analysis¹

Tomáš Dyk, Matěj Viskupič, Martin Dražanský, Ivo Macek

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2 DRAŽANSKÝ, Martin, MACEK, Ivo, GOLDMANN, Tomáš. Monitoring of visitors in museum exhibitions. In: *Journal of the National Museum, Prague, Natural History Series, Vol. 189, No. 1 (2020)*, pp. 155.

Ing. Tomáš Dyk

Faculty of Information Technology
 Brno University of Technology
 idyk@fit.vut.cz

Bc. Matěj Viskupič

Faculty of Information Technology
 Brno University of Technology
 xvisku01@stud.fit.vutbr.cz

prof. Ing. Martin Dražanský Ph.D.

Faculty of Electrical Engineering and Computer Science
 VŠB-Technical University of Ostrava, Ostrava
 TrendBit s.r.o., Brno, Czech Republic
 martin.drazansky@vsb.cz

RNDr. Ing. Ivo Macek

National Museum Prague
 macek@muzeumprahy.cz

Abstract: *The aim of the presented study is to discuss the possibilities of the use of artificial intelligence in the camera system in museums. The article discusses how visitor behavior analysis performed by artificial intelligence could gather invaluable data about visitor. The data could be used by the management of museum to help them optimize layout of the exhibitions and to check detailed statistics about attendance and time spent for each exhibit in the museum.*

Keywords: *artificial intelligence, museum, visitor behavior analysis, visitor tracking system*

Introduction

The traditional methods of studying visitor behavior, which often relies on manual observations and periodic surveys, have provided valuable but limited insight into the dynamics of museum engagement. The advance of artificial intelligence (AI) signals a paradigm shift, which offers museums the tools to gather detailed information of visitor interactions. This article discusses the future of museum, explores what possibilities AI analysis brings particularly in the field of understanding visitor behavior and how they navigate through exhibitions. It is crucial to recognize that the integration of AI in visitor behavior analysis is not a technological upgrade but a transformative force. It has the potential to revolutionize exhibit design, personalize museum experiences, and even further promote interest of the wider public. Moreover, the implementation of AI-driven visitor tracking systems opens up new area in data-driven decision-making, providing museums with the information to optimize spaces, curate tailored experiences and measure how the changes have affected visitor experience.

The Need for AI in Museums

The need for technological integration is becoming more and more crucial in the cultural institutions, and museums are no

exception. This section addresses the need to integrate new technologies into the museum environment, particularly in the context of visitor behaviour analysis facilitated by AI camera systems. This section explores the compelling reasons why artificial intelligence is not just innovation in museums, but a necessity that is moving these institutions into a new era of data-driven decision-making and enhancing cultural engagement.

Limitations of Traditional Approaches

As mentioned in the article², traditional methodologies for analyzing visitor behavior are labor-intensive and susceptible to observational biases. Manual observations, while offering qualitative insights, struggle to capture complex pattern of visitor behavior especially in real-time and across diverse contexts within a museum setting. Surveys, on the other hand, often suffer from response bias based on the last few exhibit and a limited ability to capture the subtle nuances of spontaneous, unscripted behaviors. The limitations of these conventional approaches become particularly evident in modern exhibitions. As museums evolve from static showcases to more interactive with integration of TV screens and projections, the need for a more dynamic and responsive analytical tool becomes more apparent.

Another method for analyzing visitors is a tracking system based on RFID. The system is fast and accurate in analyzing the visitor's path through the museum exhibition. The disadvantage of this solution is that visitors are required to wear special equipment and additional hardware has to be installed in the exhibition so visitors could be detected via RFID. The solution has already been discussed and tested in the articles³ and⁴. While the solution demonstrated great results in tracking visitors, its limitations became apparent in the absence of additional information like demographics and sentiment analysis. In contrast, other methods, such as AI camera systems, could analyze these additional aspects easily in addition to tracking the visitor.

Toward Data-Driven Decision Making

Camera system with AI not only augments the observational capacities of museums but also empowers data-driven decision-making processes. The ability of AI to recognize patterns, predict preferences and analyse individual visitor interactions can provide museum with data to take into account when arranging exhibit layout. This transition from intuition-driven to data-driven decision making represents a fundamental shift, ensuring that museums remain adaptive for their diverse audiences.

Museums could rapidly assess and interpret change in visitor behavior when they change museum layout or rearrange exhibits. This not only accelerates the pace of decision-making for exhibition optimization but also enables museums to adapt promptly to changing visitor preferences. The efficiency and agility afforded by AI-driven behavior analysis empower museums to stay attuned to the evolving needs of their audience. The speed at which AI processes and interprets visitor data contributes significantly to the overall adaptability and effectiveness of modern museum operations.

Possibilities of AI analysis in camera system

This section describes examples of possibilities emerging from the integration of AI within museum camera systems. It explores how AI could open new dimensions in understanding visitor behavior.

Exhibit Engagement Analysis and Demographic Insights

The incorporation of AI camera systems within museum exhibits not only revolutionizes the acquisition of statistics but also affords museums a range of demographic insights. The system can provide detailed statistics concerning visitor demographics, including age, gender, and precise time spent at each exhibit. Understanding how different age groups and genders interact with specific exhibits becomes invaluable for tailoring the museum experience to diverse audience groups.

Detailed statistics on time spent at each exhibit offer nuanced insights into visitor interests, enabling precise adjustments in exhibit design and curators to align with the varied preferences of distinct demographic groups. The integration of AI camera systems not only enhances statistical precision but also empowers museums to deliver exhibits that resonate more effectively with diverse audience.

Visitor Journey Mapping

AI camera systems can also analyze the entire visitor journey within the museum, from entrance to exit. Museums would gain insights into the flow of foot traffic, popular points of interest, and potential bottlenecks. This comprehensive understanding allows curators to strategically design exhibit layouts, optimize interactive elements, and tailor educational content to align with the natural trajectory of visitor exploration. Mapping visitor journey not only enhances the efficiency of museum spaces but also enables a more engaging experience, as museum can adapt and refine exhibits based on the data of each visitor's unique journey.

3 ZANCANARO, Massimo, et al. *Analyzing museum visitors' behavior patterns*. In: *User Modeling, 11th International Conference, 2007, Corfu, Greece, July 25-29, 2007*. Proceedings 11. Berlin, Heidelberg: Springer, 2007, pp. 238-246.

4 LANIR, Joel, et al. *Visualizing museum visitors' behavior: Where do they go and what do they do there?*. In: *Personal and Ubiquitous Computing, Vol. 21, No. 2 (2017)*, pp. 313-326.

Security

The integration of AI camera systems in museum exhibits can also introduce a revolutionary approach to ensuring visitor compliance with security guidelines. Cameras can enhance security by monitoring exhibits and detecting suspicious behavior, helping prevent theft or damage to valuable artifacts. For instance, AI cameras can detect instances where visitors use flash photography, ensuring the preservation of delicate artifacts by preventing potentially harmful flashes. Additionally, these systems can identify instances of physical contact with exhibits, thereby mitigating the risk of unintentional damage caused by touch. AI algorithms can also monitor for unauthorized actions, such as eating or drinking close to exhibits, enhancing both the preservation of artifacts and ensuring a clean and safe environment within the museum.

Furthermore, the possibilities extend to real-time alerts and notifications, allowing security personnel to respond promptly to any observed offences. For instance, if a visitor is detected taking photographs with flash or touching exhibits, the AI system can generate an immediate alert, enabling security personnel to intervene and provide gentle reminders of museum guidelines. This proactive approach not only enhances the security and preservation of exhibits but also contributes to a positive and respectful visitor experience. The AI camera system could serve as a powerful tool for museums to uphold security protocols, safeguard their collections, and create an environment that fosters both education and respect for cultural heritage.

Visitor Feedback and Sentiment Analysis

Cameras can also capture facial expressions and body language, providing insights into visitor sentiment and feedback. By employing sentiment analysis algorithms, museums can categorize and interpret these non-verbal cues, offering

a sophisticated understanding of visitor sentiment. This invaluable data allows museum to measure the success of exhibits and events in real-time.

The granular nature of sentiment analysis enables museums to not only identify general positive or negative sentiments but also to discern subtle variations in emotional responses for each exhibit. Whether it's expressions of delight, curiosity, or contemplation, the AI camera system becomes a perceptive observer, decoding the visitor face expression and body language. Such insights are instrumental in evaluating the effectiveness of exhibits, measuring the impact of interactive elements, and refining content to correspond to the emotional response the museum seeks.

In essence, the utilization of AI camera systems for sentiment analysis in museum exhibits transcends traditional feedback mechanisms by providing a real-time, data-driven understanding of visitor sentiment. This transformative capability empowers museums to continually assess and adapt exhibits, ensuring a dynamic and emotionally resonant museum experience that aligns seamlessly with the diverse and evolving preferences of their audience.

Existing solutions

There are already a couple of existing solutions in the field of AI camera systems, but only few of them focuses on the specific environment of the museum.

Pygmalios⁵ has introduced a sophisticated AI camera system designed primarily for retail environments. Pygmalios leverages advanced computer vision and machine learning technologies to track customer movements, analyze behavior, and optimize retail operations. However, the efficiency of this existing solution in the unique context of museum exhibits, particularly because of less optimal lighting conditions, has encountered challenges. Museums often feature dimly lit environments to preserve artifacts, which may affect the performance of AI camera

⁵ <https://www.pygmalios.com/>

systems initially designed for well-lit retail spaces. This divergence in lighting conditions underscores the need for tailored solutions that can handle challenges posed by museum exhibits environment. There is already existing research focusing on this topic. The article⁶ introduced an algorithm for the analysis of visitor sentiment. The method was already tested in Palazzo Braschi Museum with low light condition, which are typical for museums. The results were promising. Additional research has to be conducted in other areas as described in this article such as demography statistics, security, visitor tracking, etc.

Conclusion

The article described advantages of AI camera systems integration in museum exhibitions, clarifying the profound implications for visitor behavior analysis. The benefits described in the article, spanning exhibit engagement analysis and demographic insights, visitor journey mapping, security reinforcement, and visitor feedback with sentiment analysis, collectively underscore the transformative potential of these advanced technologies. The depth of insights gathered from exhibit engagement analysis and demographic insights enables a refined curation process, fostering resonance with diverse visitor cohorts.

Concurrently, the ability to map visitor journeys facilitates operational efficiencies and affords curators an invaluable lens into the nuanced dynamics of visitor exploration. The augmentation of security protocols through AI camera systems ensures the safeguarding of cultural assets,

while real-time visitor feedback and sentiment analysis offer a continual feedback loop for dynamic exhibit refinement. As museums embrace the intersection of artificial intelligence and cultural preservation, the presented research illuminates a trajectory wherein technology becomes a catalyst for a more profound understanding of visitor interactions. This exploration not only heralds a new era in museum science but also reinforces the imperative for continuous innovation in enhancing the visitor experience within cultural institutions.

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