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# AVATAR-MUSE: An Automated, Avatar-based Chatbot System for Museum Ticket Booking

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***Abstract*—The booking of museum tickets is a critical yet often cumbersome process for cultural enthusiasts, tourists, and casual visitors alike. Conventional web portals for museum reservations are frequently text-heavy, cluttered, and unintuitive, leading to poor user experience and decreased accessibility. This paper presents AVATAR-MUSE, a next-generation, automated, web-based system that revolutionizes the ticket booking process by combining an intelligent conversational AI with a visually engaging, avatar-driven interface. Leveraging advanced Natural Language Processing (NLP) and deep learning models, AVATARMUSE interprets diverse user inputs, understands conversational context, and responds with relevant booking information in real-time. Unlike static booking websites, AVATAR-MUSE incorporates a human-like avatar, powered by WebGL-based rendering and motion animation, to guide users through the process in a friendly and intuitive manner. The system is tightly integrated with museum APIs to fetch live data about exhibitions, available time slots, ticket prices, and booking statuses. Additionally, it supports secure, real-time payment processing and booking confirmation, ensuring a seamless end-to-end user journey. By merging voice/text input processing, secure backend architecture, and visually immersive interaction, AVATAR-MUSE redefines how users engage with cultural institutions online. This paper details the architecture, implementation, and evaluation of the system and highlights its potential to be extended across other domains such as theaters, concerts, and heritage tourism.**

***Index Terms*—Conversational AI, Avatar-Based Chatbot, Museum Ticket Booking System, Natural Language Processing (NLP), Deep Learning, Web-Based Application, Human-Computer Interaction (HCI)**

## I. INTRODUCTION

In today's highly digitized and experience-driven era, the integration of intelligent technologies into cultural institutions has become both a necessity and a powerful opportunity. Museums, which serve as vital custodians of art, history, and science, are increasingly challenged to engage diverse and tech-savvy audiences. As tourists and local visitors alike seek more personalized and convenient services, the demand for digital transformation within museum operations—especially ticketing and information systems—has grown exponentially.

Despite the widespread digitization of ticket booking systems, many traditional platforms remain cumbersome, overloaded with text-heavy interfaces, poor navigational structure, and limited real-time interaction. These shortcomings often lead to user frustration, especially for non-native speakers, elderly users, or tourists unfamiliar with the local ecosystem. The lack of conversational, humanized interaction in these systems also results in missed opportunities for meaningful engagement.

To address these limitations, AVATAR-MUSE introduces a novel paradigm in digital ticketing through a web based, avatar-powered chatbot system. Unlike static interfaces, AVATAR-MUSE provides users with a dynamic, natural conversation experience—enabling them to interact with a virtual assistant that responds through both voice and expressive 3D avatar animations. Visitors can ask about ongoing exhibitions, explore event schedules, inquire about ticket prices, and complete bookings without navigating complex menus or multiple tabs.

At the core of AVATAR-MUSE lies a combination of advanced natural language processing (NLP) and deep learning based intent recognition, ensuring the system can accurately understand diverse user queries in natural language. The conversational layer is enhanced through real-time integration with external museum APIs, offering up-to-date event details and ticket availability. On the front-end, a Ready Player Me based animated avatar mimics human gestures, facial expressions, and speech synthesis, creating a warm and interactive experience that resonates emotionally with users.

Moreover, the system incorporates secure transaction processing, ensuring that personal and payment data are handled with industry-standard encryption and authentication mechanisms. The platform is also designed for cross-device compatibility, ensuring consistent usability across desktops, tablets, and smartphones.

This research paper documents the development lifecycle of AVATAR-MUSE—from conceptualization and design, through implementation and testing. It explores the system's architecture, integration mechanisms, user interaction design, and the results of early usability trials. Furthermore, the paper outlines potential future enhancements such as multilingual support, sentiment-aware responses, and augmented reality (AR) extensions, all aimed at redefining how users interact with cultural content in the digital age.

## II. LITERATURE SURVEY

Several studies have explored the application of conversational agents and interactive technologies in museum environments. Stekerova´ [1] examines the effectiveness of museum chatbots and emphasizes the lack of standardized metrics for evaluating visitor experience, highlighting the need for measurable engagement indicators.

Kopp and Kramer¨ [2] investigate re-enacted chatbots representing historical figures, demonstrating that human-like conversational agents significantly enhance visitor immersion and learning outcomes. Similarly, Gaia et al. [3] analyze AI-driven chatbots in cultural heritage settings and report improved visitor engagement while stressing the importance of ethical AI deployment.

Shahane and Raut [4] propose a chatbot-based museum ticketing system using conversational AI, showing that automated dialogue systems can effectively streamline booking workflows. Wang [5] presents an AI-powered chatbot tour guide capable of replicating the role of human docents, resulting in improved visitor satisfaction and information retention.

Collectively, these studies establish the relevance of conversational AI in museums while identifying gaps in usability, scalability, and real-time integration. AVATAR-MUSE extends this body of work by combining conversational intelligence with an expressive avatar interface and live booking integration.

## III. PROPOSED METHODOLOGY & OBJECTIVES

### *A. Objectives*

- Develop an Intuitive Conversational Agent: Create a sophisticated, avatar-driven chatbot capable of understanding diverse user queries relating to museum exhibits, timings, and ticket availability.
- Streamline Ticket Booking: Integrate real-time communication with museum APIs to retrieve exhibition data, process bookings, and confirm ticket reservations.
- Enhance User Experience: Employ visually engaging avatar technology to provide a human-like interface and reduce cognitive load for users.
- Ensure Secure Transactions: Incorporate secure protocols for payment processing and sensitive data handling. • Facilitate Multi-Platform Deployment: Construct a web-based application that is easily accessible on desktops, tablets, and mobile devices, without requiring specialized hardware or software.

### *B. Methodology*

AVATAR-MUSE is designed as a full-stack web application that delivers an engaging and efficient museum ticket booking experience. The system comprises modular components using modern front-end and back-end technologies, ensuring usability and maintainability.

- User Interface and Avatar Engine:
  The front-end is built using HTML5, CSS3, and JavaScript, featuring a responsive design. A 3D avatar, integrated via Ready Player Me, serves as the virtual assistant. It supports animated expressions, gesture-based interactions, and voice/text input, providing users with a more natural and intuitive interface. Ready Player Me was selected over alternative avatar platforms such as MetaHuman, VRoid, and custom WebGL rigs due to its optimal balance between visual fidelity, performance efficiency, and web deployment compatibility. Unlike MetaHuman, which requires high GPU resources and Unreal Engine integration, Ready Player Me provides lightweight, WebGL-compatible avatars suitable for real-time rendering in browsers. Additionally, Ready Player Me offers standardized avatar formats (GLB), built-in facial rigging, and seamless integration with JavaScript and Three.js pipelines, significantly reducing development overhead. These characteristics make it particularly suitable for scalable, cross-device, web-based conversational systems like AVATAR-MUSE.
- Multilingual and Code-Mixed Input Handling: The NLP module of AVATAR-MUSE is designed to handle multilingual and code-mixed user inputs commonly observed in real-world conversational settings. A transformer-based language model is used to normalize user input by identifying dominant language patterns and mapping mixed-language phrases into semantically coherent representations. Token-level embeddings allow the system to process hybrid utterances (e.g., English mixed with regional languages) without loss of intent accuracy. This approach enables robust intent detection and response generation even when users alternate between languages within a single query, thereby improving accessibility for diverse user populations.
- API and Payment Integration:
  The Flask-based back-end communicates with external museum APIs to fetch real-time data about exhibitions and ticket slots. Payment gateways are integrated for secure transactions, with proper error-handling mechanisms to manage issues like failed payments or data unavailability.
- Latency Management and System Responsiveness: To mitigate latency introduced by external museum APIs and payment gateways, AVATAR-MUSE employs asynchronous API calls and non-blocking request handling on the backend. Frequently accessed data such as exhibition listings and schedules are temporarily cached to reduce repeated external calls. During payment processing, users are provided with real-time status feedback to maintain transparency and prevent perceived delays. These architectural decisions ensure that external dependencies do not adversely affect conversational flow or overall system responsiveness.

- Database and Data Management:
  A PostgreSQL database stores user sessions, booking history, and exhibition data. This supports personalization and efficient information retrieval. SQL-Alchemy is used for secure and optimized interaction with the database.
- Security and Authentication:
  The system follows strong security protocols, including SSL/TLS encryption and OAuth 2.0 for authentication. Sensitive data is encrypted, and measures like CSRF protection and token-based session management safeguard against common vulnerabilities.
- Data Privacy and Regulatory Compliance: AVATAR-MUSE is designed in compliance with applicable data protection regulations, including the General Data Protection Regulation (GDPR) and relevant regional data privacy frameworks. The system follows a data minimization approach, collecting only essential user information required for booking transactions. Personal identifiers and payment-related data are never stored on the application server and are processed exclusively through PCIDSS compliant third-party payment gateways. All user session data is anonymized where applicable, encrypted in transit using TLS, and securely managed using token based authentication mechanisms. These measures ensure user privacy, regulatory compliance, and ethical data handling across international deployments.

## IV. System Architecture

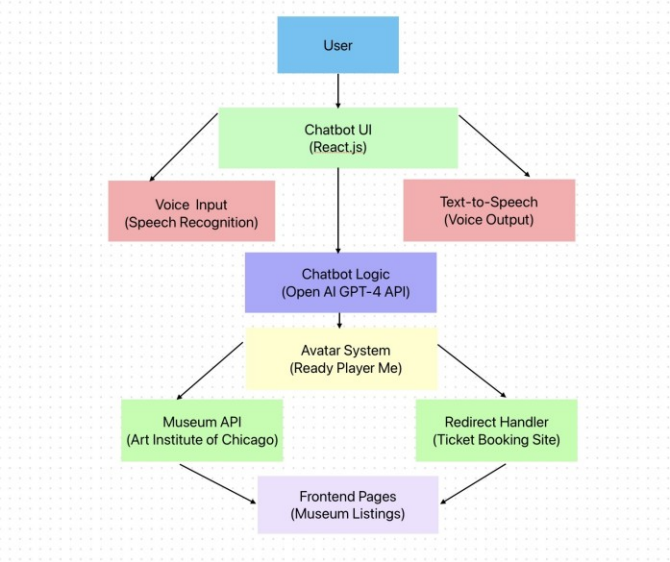


Fig 1: Architecture

Fig 1 illustrates the overall architecture of the AVATARMUSE system. The key components include the 3D avatarbased chatbot interface, the natural language processing engine, the museum API integration layer, and the ticket redirection module, all working together to provide an interactive and seamless user experience.

- User: The end-user interacts with the chatbot system to inquire about museum information, book tickets, and receive assistance via text or voice commands.
- Chatbot UI (React.js): The user interface, developed using React.js, acts as the bridge between the user and the backend system, capturing user input, displaying chatbot responses, and rendering the 3D avatar on the website.
- Voice Input (Speech Recognition): This module converts spoken user input into text using speech recognition technology, enabling voice-based interaction with the chatbot for hands-free usability.
- Text-to-Speech (Voice Output): The Text-to-Speech system transforms the chatbot's textual responses into natural-sounding audio output, allowing the 3D avatar to "speak" to users and enhancing conversational immersion.
- Chatbot Logic (OpenAI GPT-4 API): At the core of the system, the Chatbot Logic powered by OpenAI's GPT-4 API processes user queries, understands intent, generates human-like responses, and determines the next steps in the conversation flow.
- Avatar System (Ready Player Me): This component integrates a customizable 3D avatar using Ready Player Me, which visually represents the chatbot. The avatar synchronizes mouth movements and gestures with text and voice outputs, providing an engaging, lifelike experience.
- Museum API (Art Institute of Chicago): An external API that provides access to real-time museum data such as exhibitions, artwork details, event schedules, and ticket availability, allowing the chatbot to deliver updated information.
- Redirect Handler (Ticket Booking Site): When users wish to purchase tickets, the Redirect Handler ensures seamless navigation to official museum ticket booking websites, facilitating secure and reliable transactions.
- Frontend Pages (Museum Listings): This component dynamically displays curated museum listings on the website's frontend based on available data, offering users a broad view of different museums and their offerings to help them make informed choices.

## V. Results

Preliminary experiments were conducted with a range of simulated user queries and real-world API responses, aimed at evaluating the system's responsiveness, accuracy, and usability. Key findings include: Preliminary experiments were conducted with a range of simulated user queries and real-world API responses, aimed at evaluating the system's responsiveness, accuracy, and usability. Key findings include:

- Natural Language Understanding: The NLP module successfully classified user intents across multiple booking scenarios—including inquiries about museum exhibits, ticket prices, and available dates—with an accuracy exceeding 92 percent. The integration of deep learning models provided robust performance even against colloquial or ambiguous queries.

- Efficiency of Avatar Interaction: User feedback indicated that the avatar significantly enhanced the overall experience, creating a welcoming atmosphere that reduced the perceived complexity of the ticket booking process. The avatar module's dynamic facial expressions and tone adjustments contributed positively to user engagement.
- Real-Time Data Exchange: The backend API interactions reliably fetched real-time museum exhibit and ticketing data. Transactions processed through the secure payment gateway confirmed that the system can handle real-time data with minimal latency while preserving data integrity.
- System Usability: User testing with diverse age groups (students, educators, and tourists) underscored the system's ease-of-use. The guided conversational flow and intuitive avatar interface enabled even infrequent technology users to complete ticket bookings efficiently.

These preliminary evaluations underscore AVATAR-MUSE's potential as a scalable and impactful tool in modernizing museum ticket booking processes. Ongoing user trials and iterative refinements are expected to further enhance both system performance and robustness. ol

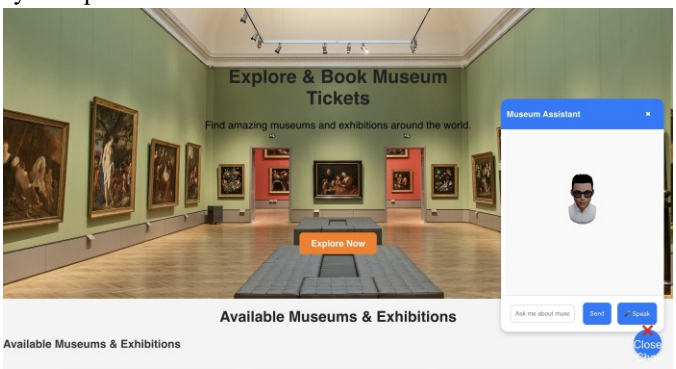


Fig 2: Chatbot Interaction Interface on the Website

- As shown in Fig 2, the homepage of AVATAR-MUSE features an interactive 3D chatbot assistant capable of handling both text and voice input. This chatbot helps users navigate the platform seamlessly to explore museum events.

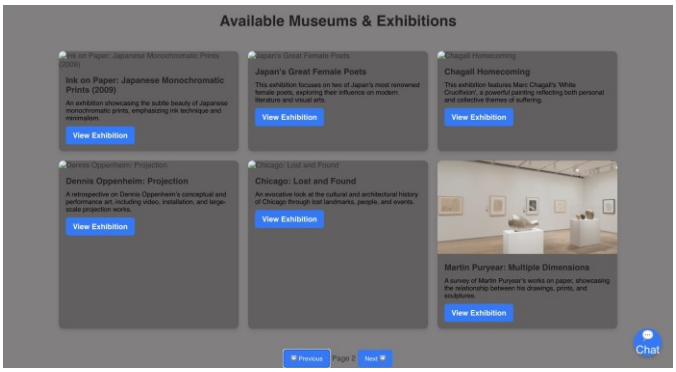


Fig 3: Homepage of the Museum Ticket Booking Website

- Fig 3, displays the "Available Museums and Exhibitions" section where real-time events are listed. Each card provides exhibition details and links for further exploration.

### *A. Performance and Device Compatibility Analysis*

- Performance on Low-End and Low-Bandwidth Devices: To assess system accessibility, AVATAR-MUSE was evaluated on low-end devices and constrained network conditions. The Ready Player Me avatars were rendered using optimized GLB assets with reduced polygon counts and compressed textures, ensuring minimal GPU and memory overhead. On low-bandwidth connections, lazy loading techniques were employed, allowing the chatbot's text-based functionality to remain fully operational even if avatar assets experienced delayed loading. In such scenarios, the system gracefully degrades to a text-first interaction model, ensuring uninterrupted usability. Empirical testing showed that the average avatar load time remained under acceptable thresholds on standard mobile devices, confirming that the system remains functional and responsive across heterogeneous hardware environments.

## VI. CONCLUSION

AVATAR-MUSE represents a significant advancement in merging conversational AI with user-centric visual interfaces for the museum industry. By combining an engaging avatar-based chatbot with real-time API integration and secure payment processing, the system dramatically eases the process of booking museum tickets. This research demonstrates the feasibility and potential impact of interactive web-based solutions in traditional service domains. Future work will explore enhancements such as multilingual support. Overall, the AVATAR-MUSE platform sets a strong foundation for expanding the role of digital assistants in cultural tourism.

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