An AI Powered Multilingual Guide for Tamil Nadu's Heritage Tourism using Large Language Models

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Abstract: Cultural heritage tourism greatly aids the preservation and promotion of historical sites, but many tourists struggle to obtain up-to-date, multilingual, and contextualized information. The visitor experience is limited by the lack of personalization, interactivity, and language accessibility in traditional heritage guides and static information boards. With the help of Large Language Models (LLMs), natural language processing (NLP), and geospatial technologies, this paper offers a voice-assisted, AI-powered heritage guide that offers dynamic, multilingual insights about Tamil Nadu's historical sites. Through the integration of an LLM-based interactive tour assistant with text-to-speech and speech-to-text capabilities, visitors can ask conversational questions regarding the significance and history of the site. Real-time data APIs also offer information on visitor trends, the best times to visit, and weather conditions. The suggested framework ensures smooth exploration of heritage sites by using the Google Maps API for navigation. Additionally, adaptive learning is used by the solution to tailor suggestions according to user preferences. Benchmarking techniques are employed to compare the performance with conventional tour guide knowledge and information generated by Large Language Models (LLMs). It is designed to be web-based and compatible with mobile devices, making it convenient for both tourists and culture enthusiasts.

Keywords: Cultural Heritage, Google Maps API, Heritage Tourism, Large Language Models (LLM).

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I. INTRODUCTION

One significant industry that greatly contributes to economic growth and cross-cultural exchange is tourism. Every year, millions of tourists visit Tamil Nadu due to its rich history and iconic landmarks. However, tourists often face challenges when trying to gain in-depth historical insights, navigate sites effectively, and overcome language barriers. Traditional methods such as signboards, brochures, and human guides have limitations in terms of accessibility, personalization, and multilingual support. Natural Language Processing (NLP) and Artificial Intelligence (AI) are advancing rapidly, revolutionizing how tourists engage with cultural heritage. By integrating voice-assisted systems, realtime data, and Large Language Models (LLMs), it is possible to create interactive and immersive storytelling experiences. This strategy improves the accessibility and attractiveness of heritage sites, as indicated by studies on AI-based virtual guide systems for cultural tourism [5] and speech technologies to enhance tourist interaction and experience [6].

> Importance of Cultural Heritage Tourism

Cultural heritage tourism is indispensable for preserving, promoting, and celebrating a location's historical, cultural, and architectural wealth. It allows visitors to learn about the customs, monuments, art, language, and lifestyle of ancient civilizations. Cultural tourism has become a method of knowledge transfer between generations and a significant tool for economic development and community involvement. States in South India, such as Tamil Nadu, are especially rich in culture. Annually millions of tourists in the world are attracted from all over the world by Tamil Nadu with its magnificent temples, historical forts, ancient architecture, living traditions, and UNESCO world heritage sites. Heritage tourism is one of the biggest boons to the state's economy as it creates job opportunities and helps local artisans and craftsmen. Nevertheless, tourists today expect more personalized, interactive and multilingual experiences than regular tourism guides, including physical signage or human substantive guides can provide. The fact is that most visitors have difficulty getting more relevant and updated information

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about the historical importance of places due to language barriers, lack of digital resources or simply the absence of ondemand guidance. In the digital age, adopting new technologies such as Artificial Intelligence (AI), Natural Language Processing (NLP), and Geospatial Technologies tourism can transform the visitor experience. AI-powered heritage guides are now offering visitors personalized, voiceenabled, multilingual, and context-aware information. Recent reviews of natural language processing (NLP) applications in multilingual tourist systems highlight these advancements [1]. Furthermore,there is a growing emphasis on utilizing AI for the preservationof cultural heritage and the enhancement of smart tourism experiences [8].

Limitations of Traditional Tour Guides

Static information boards and traditional tour guides have several limitations that affect the tourism experience. especially in cultural and heritage locations. First, human tour guides may not be accessible to all tourists, particularly in remote or less-visited areas. Even when they are available, language barriers can pose significant challenges for foreign visitors who may not be familiar with the local language. Static board displays provide limited information, typically presented in one or two languages, and do not allow for personalization or interaction. Additionally, the information on these boards remains unchanged over time, lacking the latest updates and contextual insights that modern travelers expect. Traditional methods also fail to engage more techsavvy younger generations, who are looking for digital experiences and interactivity. Visitors often have diverse interests and specific questions about history, culture, or architecture that typical tour content does not address. This highlights the need for a new, technology-based solution that can provide dynamic, multilingual, and personalized information to tourists in an interactive and accessible format, as emphasized in recent reviews of technology gaps in tourism service delivery [9] and in studies discussing AI-based personalization in hospitality and tourism [10].

➢ Role of AI & NLP in Solving this Gap

Artificial Intelligence (AI) and Natural Language Processing (NLP) play crucial roles in enhancing traditional tour guides by creating intelligent, personalized, and interactive solutions for visitors. AI-driven systems have the capability to manage extensive historical and cultural content, filter user interests and preferences, and deliver tailored information in real-time. Meanwhile, NLP enables the system to analyze and respond in natural human language, removing language barriers and facilitating multilingual communication. Using speech-to-text and text-to-speech systems, visitors can interact with the AI-driven heritage guide through voice input, which enhances engagement and ease of use. The AI can also monitor visitor behavior and preferences to offer personalized recommendations, such as nearby landmarks, local restaurants, or optimal visiting hours based on crowd trends. Additionally, real-time data integration with APIs provides current information, including weather updates, visitor movements, and event schedules. By combining AI, natural language processing (NLP), and geospatial technologies, this paper bridges the gap between technology and tourism, transforming how cultural sites are visited and experienced by a global audience. The increasing implementation of AI technologies to automate tourism interactions and enhance visitor satisfaction has been well-documented in recent research [11], while bibliometric studies emphasize the rising role of NLP and AI in smart tourism infrastructure [12].

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> Objective of this Project

The primary goal of this paper is to create and develop an AI-driven, voice-enabled heritage tour guide system that enhances the cultural tourism experience in Tamil Nadu. The paper aims to utilize cutting-edge technologies such as Artificial Intelligence (AI), Natural Language Processing (NLP), and geospatial tools to provide customized, interactive, and multilingual information to visitors at historical and cultural sites. This system has been designed to overcome the limitations of traditional tour guides by offering live, interactive content that engages in voice-based conversations, responding to visitor inquiries in real time. The paper aims to provide navigation support using the Google Maps API and to suggest attractions based on user interests. It will also offer upto-date information, such as weather conditions and visitor statistics, through real-time data APIs. Another key objective is to enhance accessibility for both local and foreign visitors by incorporating multiple languages and voice interaction. The paper envisions creating a web-enabled and mobile-friendly portal that will transform the process of discovering heritage sites into a smart, interactive, and enriching experience, showcasing Tamil Nadu's rich cultural heritage on an international platform. Recent advancements in AI-supported tourism applications have shown the potential to improve both user satisfaction and destination management through such intelligent systems [13]. Additionally, studies on forecasting tourism behavior using real-time data reinforce the importance of integrating dynamic information systems into modern tourism infrastructures [14].

II. RELATED WORK

Tourism is undergoing rapid transformation due to the application of new technologies, such as Artificial Intelligence (AI), Natural Language Processing (NLP), and intelligent systems. Numerous studies have examined how AI enhances tourism services, improves visitor experiences, and helps to overcome language barriers. This section reviews literature related to the applications of AI in tourism, the development of intelligent tourism systems, the use of NLP for multilingual support, and the integration of geospatial technologies to assist with navigation. These research studies provide a solid foundation for developing an AI-based heritage tour guide system.

S. Kim [7] proposed that the integration of real-time data APIs, such as weather conditions, visitor trends, and event schedules, is crucial for improving tourist planning and safety. API services allow for dynamic data retrieval, providing tourists with up-to-date information during their trips.

D. Turner [2] proposed that Google Maps API is widely used in tourist applications for route finding, identifying local attractions, and estimating travel time. The API provides accurate geolocation services, interactive maps, and real-time Volume 10, Issue 5, May – 2025

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traffic information, allowing tourists to explore new places effortlessly.

P. Zhang [6] proposed that Voice-guided technologies are becoming increasingly popular in tourism for voice-free interaction and personalized guidance. Speech-to-text and text-to-speech technology enable tourists to ask questions vocally and receive audio feedback, improving accessibility and user convenience during travel.

R. Navigli [1] proposed that Natural Language Processing (NLP) plays a crucial role in the tourism industry by enabling multilingual communication between tourists and various systems. Tools powered by NLP, such as Google Translate, voice assistants, and AI chatbots, help bridge the language gap. Numerous studies highlight the use of NLP in applications such as speech recognition, language translation, and interactive dialogue within the tourism sector.

M. Li [5] proposed that research has explored AI-driven virtual tour guides that interact with travelers in real-time and provide location-specific information. These systems incorporate AI, natural language processing (NLP), and geospatial technology to provide tailored cultural experiences, improve accessibility, and boost visitor interaction.

Ivanov, S., & Webster [4] proposed that Artificial Intelligence (AI) has been extensively utilized in the tourism sector to enhance services for travelers and automate various processes, such as travel suggestions, hotel reservations, and customer support. AI-powered chatbots and virtual assistants can comprehend user requests and provide personalized travel information, thereby improving the overall tourism experience. Additionally, AI algorithms can predict tourist behavior and offer customized travel recommendations based on individual preferences.

III. PROPOSED SYSTEM & METHODLOGY

➢ System Architecture

The proposed system architecture for the AI-based heritage guide in Tamil Nadu is designed to offer an interactive and personalized experience for tourists. This architecture integrates several technologies, including Speechto-Text (STT), Text-to-Speech (TTS), Large Language Models (LLM), and the Google Maps API, to create a smart virtual tour guide.The system records users' voice queries about the nearby tourist attractions, the background of heritage monuments, cultural aspects, or travel routes. Utilizing natural language processing (NLP) and AI models, the system processes these queries and delivers contextualized responses in multiple languages. Additionally, it provides dynamic route planning, real-time visitor information, and personalized suggestions based on the user's preferences and location. The design enables smooth communication between the front-end interface and back-end processing units, providing accurate and relevant information to tourists. The integration of a multilingual voice assistant enhances accessibility for both domestic and international travelers. Similar system designs have been successfully applied in speech-enabled tourism applications [15], and emerging AI frameworks for cultural tourism highlight the importance of context-aware, real-time interfaces [16].

> Methodology

The proposed paper's methodology focuses on designing and developing an AI-based smart heritage tour guide system aimed at enhancing the tourism experience in Tamil Nadu. This system utilizes advanced technologies, including Artificial Intelligence (AI), Natural Language Processing (NLP), geospatial tools, and speech processing techniques. The primary goal is to create an interactive and user-friendly interface that allows visitors to ask questions in either voice or text format and receive accurate, real-time answers about heritage sites. The approach involves implementing Large Language Models (LLMs) for answering questions, the Google Maps API for mapping, and Text-to-Speech (TTS) and Speech-to-Text (STT) technologies to facilitate communication. The system is designed to support multiple languages, provide personalized suggestions, and offer real-time data access. This approach aims to deliver a seamless and error-free tourism experience through smart, intelligent technology. The integration of such technologies into tourism systems is gaining global traction, with research showing how AI pipelines and automation are transforming digital tourism infrastructures [17], and speech-enabled interfaces significantly improving usability and user satisfaction in travel tech [18].

> Tools & Technologies Used

To implement this AI-powered heritage tour guide system, various modern technologies and tools are employed. The system utilizes Large Language Models (LLMs), such as OpenAI's GPT models, to process user queries and generate human-like responses. NLP libraries like spaCy, NLTK, and transformers are used for language processing and to support multiple languages. The integration of the Google Maps API enables real-time location tracking, route planning, and suggestions for nearby tourist attractions. The system utilizes Text-to-Speech (TTS) technology to convert generated text into voice output, while Speech-to-Text (STT) technology converts user voice input into text. For building the user interface, contemporary web app, framework like Django are used to create an interactive and user-friendly experience. Prior research highlights the effectiveness of AI and NLP integration for responsive user systems in tourism [19], while recent studies emphasize the significance of real-time geographic and voice-based interfaces in smart heritage systems [20].



Fig 1 System Architecture

IV. MODULES

The proposed AI-driven heritage tour guide system consists of several functional modules, with each module tasked with delivering a smooth and personalized tourism experience. A detailed explanation of each module follows below:

➢ User Interface (UI)

The User Interface (UI) is the front-end component of the application that tourists will interact with. It is designed to be user-centric, responsive, and accessible for both mobile and web platforms. Users can input queries via voice or text to receive recommendations, navigation paths, and personalized content in multiple languages.

➢ Voice Assistant

This module enables interactive communication between the user and the system. It uses Speech-to-Text (STT) technology to convert the user's voice input into text for processing. When generating a response, the Text-to-Speech (TTS) engine translates the output text back into voice, providing a real-time audio response to the user in their desired language.

➢ Real-Time Data API

This module integrates various external APIs to retrieve live data, such as weather conditions, the number of current visitors at a location, opening hours of attractions, and realtime traffic information. The Real-Time Data API ensures that users receive up-to-date and accurate information during their visit.

> Personalization Engine

The Personalization Engine is responsible for customizing the tour guide experience based on user preferences, language choice, past search history, and geographical location. It stores user profiles and behavior patterns to offer relevant content and suggestions that meet individual needs.

> Navigation Module

The Navigation Module integrates the Google Maps API to offer route guidance, location tracking, and suggestions for nearby places. It helps users find the best routes to their desired heritage sites and displays landmarks and nearby facilities on the map.

Recommendation System

This module analyzes user queries, location, visit time, and the popularity of sites to provide intelligent suggestions. It recommends nearby points of interest, local events, dining options, and cultural activities. The recommendation system enhances the overall tourism experience by directing users to additional sites beyond the main heritage attractions.

V. EVALUATION

The performance evaluation of the planned AI-based heritage tour guide system was conducted to assess its effectiveness, usability, and capability in providing real-time, multilingual, and personalized tourist information. The system was tested across various use-case scenarios using simulated user queries related to Tamil Nadu's most popular historical sites.

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Functional Testing

The system was tested for essential functionalities, including voice interaction, query interpretation, real-time data fetching, map-based guidance, and multilingual support. Inputs were provided in both text and speech formats in English and Tamil. Responses generated by the Large Language Model (LLM) were cross-verified with conventional sources of information, and the system successfully delivered contextually accurate and detailed information in over 90% of the test scenarios.



Fig 2 Functional Testing Accuracy

➤ Usability Testing

User interface and accessibility were assessed by conducting mock testing with a panel of 15 participants from various age groups. These participants performed simple tasks such as locating heritage sites, inquiring about historical significance, navigating to specific points, and listening to verbal responses. Feedback was collected on the system's clarity, user-friendliness, and interactivity. The system was preferred by 87% of users compared to traditional static signboards or printed brochures.

➢ Response Time and Accuracy

The average system response time, from receiving an input query to delivering output, was measured at less than 2.5 seconds. This time includes both voice recognition and text-to-speech output. The accuracy of location recommendations, directions, and heritage information was evaluated against verified tourism databases and official state heritage sources, resulting in an average accuracy rating of 93%.



Fig 3 Response Time and Accuracy

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Comparative Evaluation

To evaluate the system's effectiveness, compared traditional tour guide methods, such as signboards and human guides, with the AI-based assistant in three key areas:

personalization, accessibility, and multilingual support. The AI system significantly outperformed the conventional methods in all these aspects, demonstrating its real-world potential to enhance digital cultural tourism.

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Fig 4 Comparative Evaluation

VI. RESULT & DISCUSSION

The proposed AI-based Smart Heritage Tour Guide System has been successfully developed and tested in various scenarios to assess its performance and user experience. The system provides dynamic, real-time, and multilingual information about heritage sites in Tamil Nadu. It features a voice assistant that effectively manages user queries in both text and voice formats. The integration of Speech-to-Text (STT) and Text-to-Speech (TTS) modules facilitates seamless interactions between users and the system.

Users can access accurate historical information, directions, and location-based recommendations tailored to their preferences. The system helps users find nearby

locations, plan routes, and obtain real-time traffic and weather updates through Google Maps API integration.

Analysis indicates that this system outperforms conventional tour guides by offering an interactive, customized, and language-appropriate solution. It enhances the tourism experience and fosters greater awareness of cultural heritage.

This paper also paves the way for future expansion, allowing the system to be implemented in other geographical areas, support additional languages, and incorporate Augmented Reality (AR) for an even richer experience moving forward.

Signup with Gmail
Email:
Sign Up Already have an account? Login here

Fig 5 Signup Page



Fig 6 Acknowledgement of Signup Page

Login with Gmail Emoil: cpgmailcon Password:
Login



Fig 8 Welcome Page



Fig 9 Map Page



Fig 10 Description Page

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Fig 11 Route to the Selected Place

← Back		Valluvar Kottam - Virtual Tour
	Welcome to your virtual four of Valluvar Kottam! I'm your Al four guide. Feel free to ask me anything about this heritage site, its history, architecture, or any other aspects you're interested in. How can I help you today?	
		history 10:19:11 am
	Valluvar Kottam in Chennal was built in 1976 in honor of the classical Tamil poet and philosopher Thiruvalluvar, author of the Thirukkural. 10:18:11 am	
	English V (Ask about the heritage site	Send

Fig 12 Chabot Page

VII. CONCLUSION AND FUTURE WORK

This paper successfully demonstrates the design of an AI-based Smart Heritage Tour Guide system that bridges the gap between cultural tourism and modern technology. The system enhances the tourist experience by providing real-time, interactive, and personalized updates about historic sites, particularly in Tamil Nadu. By integrating advanced technologies such as Large Language Models (LLM), Natural

Language Processing (NLP), Speech-to-Text (STT), Text-to-Speech (TTS), and the Google Maps API, the system addresses the limitations of traditional tour guides. Tourists are no longer dependent on static display boards or guides constrained by language barriers. Instead, they can interact with the AI assistant in their native language to receive context-specific information about the history, culture, and significance of world heritage sites. Additionally, the recommendation engine, real-time data APIs, and navigation

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module provide an intelligent travel experience, allowing users to discover new places easily and safely. This solution has the potential to transform the tourism industry by preserving cultural heritage while embracing digital advancements. Future improvements could include the introduction of Augmented Reality (AR), user-specific profiles, and AI analytics to enhance the user experience and manage tourism more effectively.

The current AI-based Smart Heritage Tour Guide system serves as a strong foundation for promoting cultural tourism, but there is still significant potential for future enhancements and additions. One key area for development is the convergence of Augmented Reality (AR) and Virtual Reality (VR) technologies. This advancement will enable users to access interactive 3D visualizations of historical sites, ancient architecture, and cultural rituals directly through their smartphones or AR glasses. Another aspect that requires improvement is the creation of a more robust personalization engine, utilizing machine learning algorithms that can adapt based on user behavior, preferences, and feedback over time. This will allow the system to offer highly tailored recommendations for places to visit, local cuisine to try, and cultural events to experience. Additionally, expanding multilingual support to include more regional and international languages will help the system reach a broader audience of international travelers. Future developments could also include creating an offline version of the app, allowing users to access critical information without an internet connection, particularly in remote heritage locations where network connectivity is limited. Finally, there is potential for exploring the integration of artificial intelligence into wearable technology, such as smartwatches or intelligent earphones, to provide tourists with hands-free, real-time navigation.

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