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Elevating Tanzania's Tourism: Integrating GIS, AR and AI for Immersive Exploration and Promotion

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Abstract: *This study presents a comprehensive examination of the integration of Geographic Information Systems (GIS), Augmented Reality (AR) and Artificial Intelligence (AI) in tourism promotion in Tanzania. The literature review underscores the significance of these technologies in enhancing visitor experiences, destination management, and marketing strategies. The proposed integrated system design combines GIS's spatial mapping capabilities, AI's personalised recommendations, and AR's immersive content delivery to optimise tourist satisfaction and engagement. Key components include the GIS module for spatial data management, the AI recommendation engine for personalised suggestions, and the AR interface for immersive content overlay. Discussions highlight how the proposed system, by addressing critical challenges in the tourism sector, aligns with existing research findings and reassures its effectiveness. Ultimately, the study emphasises the potential of GIS, AR and AI technologies to revolutionise tourism promotion in Tanzania, fostering sustainable growth and cultural appreciation while enhancing visitor experiences.*

Keywords: *Artificial Intelligence (AI), Augmented Reality (AR), Destination Management, Geographic Information Systems (GIS), Tourism Promotion.*

1. INTRODUCTION

With its diverse cultural heritage and breathtaking natural landscapes, Tanzania stands out as a unique destination for tourism development [1]. From the iconic Mount Kilimanjaro to the idyllic beaches of Zanzibar, Tanzania offers many attractions catering to various interests and preferences. For instance, the Serengeti National Park, renowned for its annual wildebeest migration, draws wildlife enthusiasts and photographers worldwide [2]. Moreover, the Ngorongoro Conservation Area, housing the Ngorongoro Crater, presents visitors with a rare opportunity to witness a vast array of wildlife in their natural habitat [3].

Tanzania has employed various initiatives to promote tourism, including high-profile events like film productions, including "The Tanzania Royal Tour by Honourable Samia Suluhu Hassan, the President of the United Republic of Tanzania [4]. Memorable slogans like "Tanzania Unforgettable" resonate with visitors, emphasising the country's unique experiences. Infrastructure upgrades like the Julius Nyerere International Airport expansion improve accessibility. Conservation efforts, highlighted by the Serengeti Wildebeest Migration, showcase Tanzania's commitment to wildlife preservation. Collaborations with travel agencies, exemplified by partnerships with National Geographic Expeditions, enhance marketing reach. These initiatives collectively spotlight Tanzania's diverse offerings, attracting travellers seeking adventure, wildlife, and cultural immersion.

Despite the abundance of attractions, Tanzania's tourism sector needs help effectively promoting its offerings to domestic and international audiences [5]. According to Wamboye et al. [6], inadequate marketing strategies, limited accessibility to information, and suboptimal visitor experiences hinder the sector's growth potential. To address these challenges, this study critically examines the role of Information and Communication Technology (ICT) solutions by specifically combining Geographic Information Systems (GIS), Augmented Reality (AR), and Artificial Intelligence (AI) in enhancing tourism promotion.

Existing research on ICT solutions, particularly GIS, has highlighted their potential to revolutionise tourism promotion by facilitating better spatial mapping, data analysis, and information dissemination [7]. While some studies have explored the application of GIS in tourism contexts globally, more empirical evidence remains specific to Tanzania's tourism industry.

On the other hand, incorporating AR into the GIS-based tourism promotion system can further enrich visitor experiences and address some challenges the tourism sector faces. According to Bozzelli et al. and Castilla et al. [8, 9], AR technology overlays digital content in the real world, offering users interactive and immersive experiences. By integrating AR features into the existing GIS platform, stakeholders can provide prospective tourists with a more engaging and informative way to

explore Tanzania's attractions. Through virtual tours, interactive maps, and immersive visualisations, AR enhances the visualisation of tourist destinations and facilitates better understanding and appreciation among visitors [10].

In addition to GIS and AR technologies, Artificial Intelligence (AI) can significantly enhance tourism recommendations. According to Haleem et al. [11], AI analyses extensive datasets to offer personalised suggestions, aiding targeted advertising. By tailoring recommendations to individual preferences, AI maximises the reach and impact of promotional efforts, contributing to the widespread dissemination of tourism advertisements and information [11]. This research aims to fill this gap by providing empirical insights into the efficacy of GIS, AR, and AI adoption in driving sustainable growth within the Tanzanian tourism sector and suggesting an integrated GIS, AR, and AI-based application design to be implemented to enhance tourism promotion in Tanzania.

This study proposes an integrated tourism management system incorporating GIS, AR, and AI solutions into Tanzania's tourism promotion strategies to enhance tourism attraction. It advances the understanding of how ICT solutions, particularly GIS, AR, and AI, can be leveraged to overcome existing challenges and drive growth within Tanzania's vibrant tourism industry.

2. LITERATURE REVIEW

This section critically examines existing research. It begins by exploring current practices in tourism promotion and the benefits of GIS in spatial mapping, data analysis, and information dissemination. Subsequently, it delves into studies highlighting AR's effectiveness in enhancing visitor experiences and engagement within the tourism industry. Finally, it discusses the challenges and limitations of implementing GIS and AR technologies in tourism, addressing data accuracy, accessibility, and socio-cultural implications.

2.1 Current Practice

This section describes the methods, technologies, or approaches currently used to promote tourism attraction in Tanzania. It provides a baseline understanding of the status quo and discusses potential improvements or advancements.

In Tanzania, current tourism advertising primarily relies on traditional methods such as print media, television commercials, and brochures distributed through travel agencies. These methods have been the cornerstone of tourism promotion for years but often lack personalisation and may not effectively reach target audiences, especially in the digital age where travellers increasingly rely on online platforms for trip planning [12, 13].

According to Soward & Li [7], GIS, AR, and AI are increasingly used in various sectors. GIS is employed in urban planning and development projects to analyse spatial data for infrastructure planning, land use management, and environmental conservation. It helps authorities make informed decisions regarding resource allocation, disaster management, and sustainable development.

On one hand, AR technology is utilised in education to create interactive learning experiences. Students can use AR-enabled applications to visualise complex concepts, conduct virtual experiments, and engage in immersive educational activities [14]. On the other hand, AI finds applications in healthcare for disease diagnosis, patient monitoring, and drug discovery. AI-powered systems analyse medical data to identify patterns, predict health outcomes, and personalise treatment plans, improving healthcare delivery and patient outcomes [15].

GIS, AR and AI can be integrated into tourism to enhance visitor experiences and promote destinations. According to Magige et al. [16], GIS technology enables the mapping of tourist attractions, infrastructure, and natural resources, facilitating destination management and marketing. AR enhances visitor engagement by providing immersive experiences and real-time information about attractions [10]. On the other hand, AI-driven recommendation systems analyse tourist preferences and behaviour to provide personalised travel recommendations, itinerary planning and targeted marketing campaigns [11], enriching the tourism experience and stimulating industry growth in Tanzania.

2.2 Opportunities of GIS, AR and AI in Tourism

The generic system that combines GIS, AR and AI systems for tourism promotion will enhance the tourist experience in Tanzania in the following expects:

i. **Enhanced planning, resource management, and market segmentation:** GIS offers numerous opportunities in tourism by providing spatial analysis tools for destination planning, resource management, and market segmentation. It enables effective mapping of tourist attractions, infrastructure, and transportation networks, facilitating better decision-making for stakeholders. GIS also supports the development of location-based services and personalised travel experiences, enhancing visitor satisfaction. Additionally, it aids in monitoring tourism impacts on the environment, fostering sustainable tourism practices for long-term industry growth [7].

ii. **Enhanced exploration and understanding:** Tourists use the AR-powered tourist guide application while visiting Serengeti Tourists National Park. To explore the park, they can point their smartphone or tablet at various landmarks, such as migration routes or watering holes. Instantly, AR overlays provide real-time information about the wildlife species present, their behaviours, and their ecological significance [17]. Studies have shown that interactive AR experiences significantly enhance tourists' understanding and engagement with their surroundings. By overlaying relevant information onto the physical environment, tourists gain deeper insights into the attractions they visit. This leads to a more fulfilling and educational experience [18].

iii. **Immersive virtual tours:** Tourism destinations worldwide increasingly adopt virtual tours. Research indicates that virtual experiences help tourists preview attractions and increase their likelihood of visiting in person—this immersive preview fosters excitement and anticipation, leading to more memorable visits [17]. A tourist planning a trip to Mount Kilimanjaro can take a virtual tour of the mountain using the AR-powered application. They can explore different trails, campsites, and viewpoints through their device. They can even experience a simulated climb to the summit, complete with panoramic views and educational insights about the mountain's geology and ecology.

iv. **Personalised recommendations and itinerary planning:** Upon entering a new city like Stone Town in Zanzibar, tourists can access customised recommendations tailored to their interests and preferences through the AR-powered application. The app suggests nearby attractions, historical sites, restaurants, and cultural experiences based on their previous interactions and preferences. Personalisation is a critical trend in tourism technology. Studies by [19, 20] have demonstrated that providing personalised recommendations and itineraries significantly enhances tourists' satisfaction and overall travel experience. The system can deliver tailored suggestions that align with tourists' expectations by leveraging GIS data and user preferences.

v. **Interactive cultural experiences:** Interactive cultural experiences have been shown to deepen tourists' appreciation for local cultures and foster cross-cultural understanding. By incorporating AR technology, tourists can engage with cultural heritage innovatively, leading to more meaningful and authentic experiences [17]. While exploring the Ngorongoro Conservation Area, tourists can use the AR-powered application to access immersive cultural experiences. They can virtually interact with Maasai tribespeople, learn about their traditions, and participate in traditional ceremonies, such as the Maasai dance.

vi. **Seamless access to information:** Providing seamless access to information through mobile applications has become increasingly important [9]. Individuals increasingly turn to digital platforms for various trip-planning activities, including researching destinations, booking accommodations and activities, and accessing real-time travel information. Mobile applications provide a convenient and centralised solution for travellers to gather information, make reservations, and navigate unfamiliar destinations, streamlining the travel experience [21]. [22] suggests that tourists value easy access to relevant information during their travels, and mobile applications equipped with AR features can offer a convenient and engaging way to deliver this information. A tourist hiking through the Usambara Mountains can use the AR-powered application to scan QR codes placed at scenic viewpoints. Instantly, they receive detailed information about the region's geological formations, flora and fauna, enhancing their appreciation of the natural beauty surrounding them.

vii. **Data analysis and personalisation:** AI algorithms analyse diverse data sources, including past travel behaviour, demographic information, social media interactions, and user preferences [20]. By processing this data, AI can create detailed profiles of individual tourists and understand their preferences, interests, and travel habits [19]. In Tanzania, where tourism is a significant economic driver, leveraging AI for data analysis and personalisation aligns with the country's goal of promoting sustainable tourism. By tailoring experiences based on tourists' preferences and behaviours, Tanzania can enhance visitor satisfaction, encourage repeat visits, and preserve its cultural and natural heritage.

viii. **Predictive analytics:** AI can use predictive analytics to anticipate tourists' needs and preferences based on historical data and real-time trends [19]. For example, AI algorithms can predict which destinations a tourist is likely to enjoy based on their past travel history, online searches, and social media activity. In Tanzania's tourism industry, predictive analytics powered by AI can revolutionise marketing strategies and enhance visitor experiences. AI algorithms can predict tourists' preferences by analysing historical data and real-time trends, allowing stakeholders to tailor offerings and promotional campaigns accordingly [20]. This proactive approach enables Tanzania to anticipate and meet tourists' needs effectively, fostering satisfaction and loyalty while driving sustainability.

ix. **Contextual recommendations:** AI-powered recommendation systems consider contextual factors such as location, time of day, weather conditions, and local events. This enables AI to provide recommendations relevant to the tourist's current situation and surroundings [23]. For instance, AI might suggest indoor activities during rainy weather or nearby cultural events [24]. In the dynamic tourism landscape of Tanzania, AI-powered contextual recommendations can significantly enhance visitor experiences. By considering location, time, weather, and local events, AI algorithms can offer tailored recommendations that align with tourists' current circumstances and preferences. For example, during rainy weather, the system might suggest indoor activities or cultural events nearby, ensuring tourists make the most of their time and enhancing their overall satisfaction.

x. **Dynamic personalisation:** AI continuously learns from user interactions and feedback, allowing recommendations to adapt and evolve. Tourists engage with recommended attractions and provide feedback [19]. According to Habil et al. [25], AI refines its understanding of their preferences and adjusts future recommendations accordingly. In Tanzania's vibrant tourism sector, dynamic personalisation powered by AI fosters a continuous improvement loop for visitor experiences. By analysing user interactions and feedback, AI algorithms refine recommendations, adapting to tourists' preferences. This iterative process ensures that recommendations remain relevant and engaging, ultimately enhancing visitor satisfaction and loyalty while driving sustainable growth in Tanzania's tourism industry.

xi. **Multi-channel integration:** AI-powered recommendation systems can integrate seamlessly across multiple channels, including websites, mobile apps, social media platforms, and virtual assistants. This enables tourists to receive personalised recommendations through their preferred communication channels, enhancing convenience and accessibility [26]. The multi-channel approach ensures that tourists can access personalised recommendations through their preferred platforms, improving convenience and accessibility. Whether planning a trip, browsing social media, or interacting with virtual assistants, tourists receive tailored suggestions that enrich their travel experiences, fostering satisfaction and engagement in Tanzania's tourism offerings [23].

xii. **Enhanced user experience:** By providing personalised and relevant recommendations, AI improves the overall user experience for tourists. AI-driven recommendations help tourists discover new destinations, activities, and experiences that align with their interests, leading to higher satisfaction and engagement [19]. AI-driven recommendations significantly enhance the user experience by providing personalised and relevant suggestions [25]. By leveraging AI algorithms, tourists can discover new destinations, activities, and experiences that align with their interests and preferences. This tailored approach leads to higher satisfaction and engagement, ultimately enriching the travel experience and fostering lasting memories of Tanzania's diverse attractions and cultural heritage.

xiii. **Promoting sustainable tourism:** AI can promote sustainable tourism by recommending eco-friendly accommodations, responsible tour operators, and off-the-beaten-path destinations. By encouraging tourists to explore lesser-known areas and adopt sustainable travel practices, AI contributes to preserving natural and cultural heritage sites [19]. In Tanzania, AI can be crucial in promoting sustainable tourism by recommending eco-friendly accommodations, responsible tour operators, and off-the-beaten-path destinations. By encouraging tourists to explore lesser-known areas and adopt sustainable travel practices, AI contributes to preserving the country's natural and cultural heritage sites. This promotes responsible tourism development, minimising environmental impact while supporting local communities and biodiversity conservation efforts.

2.3 Challenges for Implementing GIS, AR and AI

Implementing GIS, AR, and AI technologies in the tourism sector faces several challenges that include but are not limited to the following:

i. **Infrastructure limitations:** Infrastructure limitations pose significant challenges to deploying GIS, AR, and AI technologies in Tanzania. Salemink et al. [27] observed that rural areas often need more reliable internet connectivity and basic technology infrastructure, hindering widespread adoption and effectiveness of these applications. This digital divide exacerbates disparities in access to information and services, limiting the potential benefits of these technologies for rural communities and impeding overall tourism development in the country [28].

ii. **Data quality and availability:** Ensuring the accuracy, completeness, and availability of GIS spatial data and relevant AI training data is paramount for effective implementation. It forms the foundation for reliable decision-making, personalised recommendations, and immersive AR experiences. Inaccurate or incomplete data may lead to misleading recommendations and diminish the overall user experience, highlighting the system's critical need for data integrity [29]. However, Tanzania may encounter challenges related to outdated or incomplete datasets, which can compromise the reliability and efficacy of GIS, AR, and AI applications. Addressing these issues requires investment in data collection, maintenance, and quality assurance processes to enhance these technologies' usability and effectiveness in promoting tourism [29].

iii. **Digital literacy:** According to Li et al. [30], digital literacy poses a significant challenge for tourists and local stakeholders who may lack the requisite skills to utilise GIS, AR, and AI applications effectively. Addressing this gap necessitates comprehensive training and educational programs to empower users with digital literacy skills [31]. By enhancing understanding and proficiency, Tanzania can unlock the full potential of these technologies to promote tourism effectively and sustainably.

iv. **Cultural Sensitivity:** Cultural sensitivity is paramount when developing AR experience to prevent cultural misrepresentation or appropriation. Pelzang & Hutchinson [32] observed that Aligning AR content with local norms

and values requires community involvement and careful consideration. Engaging stakeholders can help ensure that AR experiences respect cultural traditions. This collaborative approach fosters mutual understanding, promotes authenticity, and enhances the tourism experience while avoiding potential conflicts or misunderstandings.

v. **Privacy and security concerns:** Privacy and security concerns arise when collecting and managing tourist data for AI-driven recommendations [33, 34]. Robust data protection measures and transparent data handling practices are essential to address these issues and foster user trust. Implementing stringent security protocols, anonymising sensitive data, and obtaining explicit user consent can help mitigate privacy risks. Additionally, providing clear information about data usage and adhering to relevant privacy regulations is crucial for maintaining transparency and accountability.

vi. **Integration and interoperability:** According to Bazargani et al. [35], integration and interoperability between GIS, AR and AI systems pose challenges due to differences in data formats, platforms, and technologies. Developing standardised protocols and APIs for data exchange can facilitate smoother integration processes. Additionally, fostering collaboration among developers and stakeholders to create compatible systems and frameworks is crucial for achieving seamless interoperability and maximising the potential of these technologies in the tourism sector [35].

vii. **Cost and sustainability:** According to Zigahet al. [36], Cost and sustainability are significant considerations in implementing GIS, AR and AI technologies. The initial investment and ongoing maintenance costs can be substantial, posing financial challenges, especially in resource-constrained environments like Tanzania. Finding sustainable funding models, such as public-private partnerships or grants, and prioritising investments in technology infrastructure is crucial for ensuring these initiatives' long-term success and viability [37]. Additionally, exploring cost-effective solutions and innovative financing mechanisms can help overcome financial barriers and promote sustainable technology adoption in the tourism sector.

According to Costa et al. [38], addressing these challenges requires a coordinated effort from government agencies, private sector stakeholders, academic institutions, and local communities to develop tailored solutions that harness the full potential of GIS, AR and AI technologies. This collaborative effort is crucial for ensuring the effective implementation and sustainable utilisation of these advanced technologies to support the growth and development of Tanzania's tourism sector.

3. METHODOLOGY

This study's methodology involves utilising empirical research and critical analysis. It evaluates the feasibility and effectiveness of integrating GIS, AR and AI solutions into the country's tourism promotion strategies. It proposes an integrated system design that combines GIS's spatial mapping capabilities, AI's personalised recommendations, and AR's immersive content delivery to optimise tourist satisfaction and engagement. Through user interaction, data flow, and future enhancements, the system aims to revolutionise tourism promotion in Tanzania, promoting sustainable growth and cultural appreciation.

4. DESIGN OF A PROPOSED SYSTEM

4.0 System Overview

The integrated system combines Geographic Information Systems (GIS), Augmented Reality (AR), and Artificial Intelligence (AI) to enhance tourism attraction experiences. It leverages GIS for spatial data management, AI for personalised recommendations, and AR for immersive content delivery.

The system will be used by prospective tourists who intend to travel to Tanzania and the tourists on-site. Prospective tourists can search and get recommendations from the system. The AI recommendation engine integrated into the system will provide personalised suggestions to tourists based on their preferences, interests, and previous behaviours, making searching for places to visit easier. The system will also utilise GIS's spatial mapping capabilities to provide tourists with detailed information about attractions, directions, and nearby amenities. The AR interface will offer an immersive content overlay, providing tourists with an interactive and informative way to explore Tanzania's attractions by offering a trailer of the prospective destination. This will encourage prospective tourists to visit the places shown by the system.

At the points of interest (natural wonders, historical sites, cultural landmarks, amusement parks, and more), the system will enhance tourist experiences by providing interactive maps, virtual tours, and immersive visualisations that allow visitors to explore and appreciate the natural landscapes and wildlife. The AR feature will enable tourists to view digital content overlaid on real-world objects, providing an engaging and informative way to learn about the park's history, culture, and wildlife. The system will also provide real-time updates on wildlife sightings and park conditions, allowing tourists to plan their visits better. Integrating GIS, AR, and AI technologies into Tanzania's tourism sector will significantly enhance the visitor experience, promoting sustainable growth and cultural appreciation while fostering economic development.

4.1 Key Components

Designing the modules for a tourist attraction management system involves considering each component's functionality and integration. Below is the high-level design for each of the specified modules.

4.1.1 GIS module

i. **Purpose:** The GIS module manages spatial data related to tourist attractions, including maps, points of interest, and route information.

ii. **Components:**

1. *Map Data Management:* Store and manage geographical data such as maps, landmarks, and routes.
2. *Point of Interest (PoI) Management*: Store information about tourist attractions, hotels, restaurants, etc., including their geographical coordinates.
3. *Route Planning:* Provide functionality for generating optimal routes between attractions based on user preferences and constraints.
4. *Geospatial Analysis:* To identify patterns and insights in tourist behaviour and attraction popularity, perform spatial analysis.
5. *Technologies:* GIS software libraries (e.g., GDAL, GeoPandas), spatial databases (e.g., PostGIS), mapping APIs (e.g., Google Maps API).

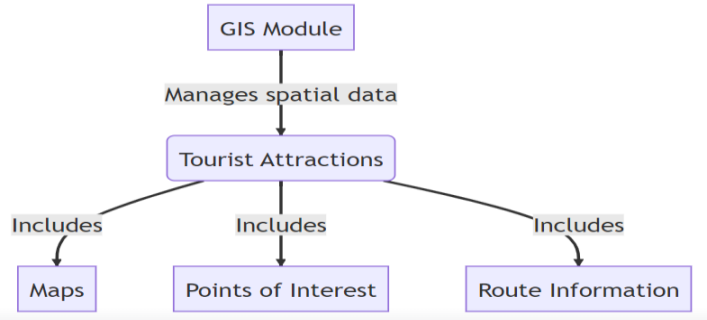

Figure 1: GIS module for managing spatial data related to tourist attractions

4.1.2 AI Recommendation Engine

i. **Purpose:** The AI recommendation engine analyses tourist preferences and behaviour to provide personalised recommendations for attractions, activities, and accommodations.

ii. **Components:**

1. *User Profiling:* Create and update user profiles based on demographic data, past behaviour, and stated preferences.
2. *Recommendation Algorithms:* Develop algorithms (e.g., collaborative filtering, content-based filtering, hybrid methods) to generate personalised recommendations.
3. *Feedback Loop:* Incorporate user feedback to improve recommendation accuracy continuously.
4. *Technologies:* Machine learning frameworks (e.g., TensorFlow, PyTorch), recommendation algorithms, and data analytics tools (e.g., Pandas, Scikit-learn).

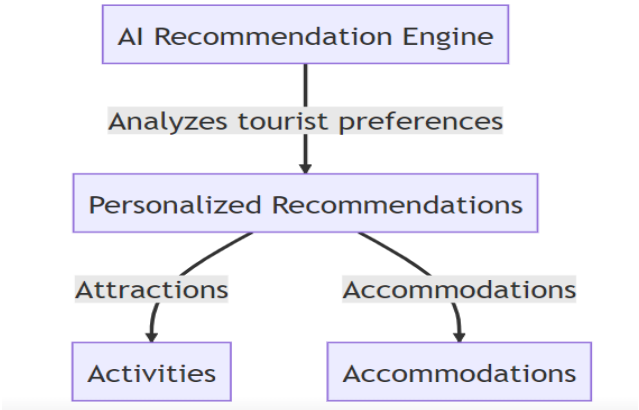

Figure 2: AI recommendation engine for visitor recommendations

4.1.3 AR Interface

i. **Purpose:** The AR interface delivers interactive and immersive content overlaying digital information onto physical locations using mobile devices or AR glasses.

ii. **Components:**

1. *Marker Detection:* Detect physical markers or landmarks in the real world to anchor AR content.
2. *Content Rendering:* This involves overlaying digital information such as 3D models, text, images, and videos onto the real-world environment.
3. *Interaction Handling:* Enable user interaction with AR content through gestures, touch, or voice commands.
4. *Localization and Mapping (SLAM):* Provide accurate positioning and mapping of the user's environment for seamless AR experiences.
5. *Technologies:* AR development frameworks (e.g., ARKit, ARCore), computer vision libraries (e.g., OpenCV), and 3D rendering engines (e.g., Unity, Unreal Engine).

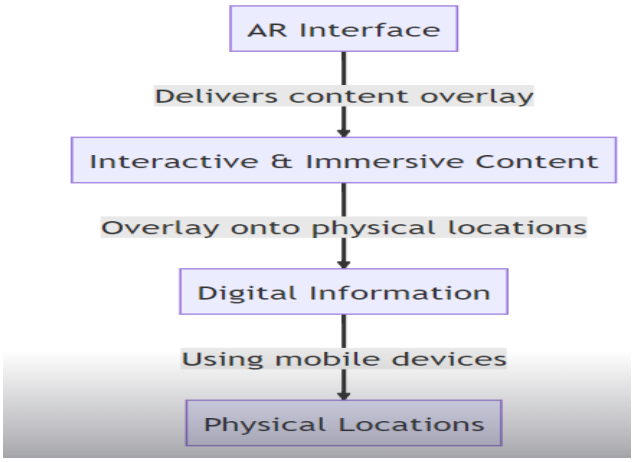

Figure 3: AR module to enhance visitor engagement

4.2 Integration

The GIS module can provide spatial data to the AI recommendation engine and the AR interface. For example, the AI engine utilises PoI data to recommend attractions, while the AR interface can use map data to render AR content. The AI recommendation engine enhances user experiences by providing personalised recommendations for attractions and activities integrated into the AR interface to tailor AR content based on user preferences. User feedback collected by both the AI engine and the AR interface is used to improve the recommendations provided and the AR content displayed, creating a closed loop for continuous improvement.

By integrating these modules, the tourist attraction management system can offer a comprehensive solution that enhances the tourist experience and engagement by leveraging spatial data, artificial intelligence, and augmented reality.

4.3 Functionality

The integrated tourist attraction management system seamlessly combines GIS management, AI recommendation, and AR experience functionalities to offer a comprehensive solution for tourists and administrators alike. Administrators can efficiently update and manage spatial data encompassing tourist attractions, trails, and amenities through the GIS management module, ensuring accurate and up-to-date information. The AI recommendation engine harnesses tourist profiles, historical data, and contextual information to deliver personalised recommendations for attractions and activities, enhancing the overall tourist experience. Meanwhile, tourists are provided with immersive AR overlays in real-time, offering information, multimedia content, and interactive experiences at tourist destinations, enriching their exploration and engagement. The system optimises tourist satisfaction, engagement, and management efficiency through this cohesive integration.

4.4 User Interaction

i. Tourists can access the AR-enabled mobile application to explore attractions, receive personalised recommendations, and engage with AR-enhanced content.

ii. Administrators utilise the GIS administration interface to update spatial data, manage GIS layers, and integrate AR content with GIS locations.

4.5 Data Flow

i. **GIS Data:** Includes spatial information about tourist attractions, trails, amenities, and environmental factors. The GIS data contains information about tourist attractions, such as historical landmarks, natural wonders, and cultural

hotspots. It also includes data about trails and amenities, such as parking lots, restrooms, and picnic areas. Additionally, the GIS data provides insight into various environmental factors that may impact the tourism industry, such as climate, terrain, and wildlife.

ii. **AI Analysis:** The system analyses tourist profiles, preferences, and contextual data to generate personalised recommendations. By analysing tourist profiles, preferences, and contextual information, the system offers constructive suggestions that help tourists get the most out of their travels. This technology considers many factors, such as age, gender, interests, and previous travel history, to provide tourists with significant recommendations.

iii. **AR Content:** Delivers AR overlays containing multimedia content, interactive guides, and contextual information based on tourist preferences and location. This cutting-edge technology leverages augmented reality to enhance the sightseeing experience for tourists. Utilising location-based data and user preferences delivers a variety of multimedia overlays that provide rich and contextual information about the surrounding environment. These overlays can include interactive guides, images, videos, and other relevant content that enhances visitors' understanding of the local culture and history. This technology represents a significant shift in how we approach tourism by providing a personalised and immersive experience that caters to the unique interests of each tourist.

Generally, The GIS data, AI analysis, and AR content significantly enhance the system's capabilities by providing personalised recommendations, enriching the sightseeing experience, and offering insight into various environmental factors that may impact the tourism industry. By leveraging GIS data, the system can provide tourists with accurate information about tourist attractions, trails, amenities, and environmental factors. The AI analysis considers many factors, such as age, gender, interests, and previous travel history, to offer constructive suggestions that help tourists get the most out of their travels. Finally, the AR content enhances the sightseeing experience for tourists by providing multimedia overlays, interactive guides, and other contextual information based on their preferences and location. These features work together to create a seamless and immersive visitor tourism experience.

4.6 Supporting Platforms and Infrastructure for the System.

Integrating AR, AI, and GIS technologies involves coordinating multiple devices and components to provide users with superior immersive experiences and precise data.

i. **Smartphones and tablets:** The System will be deployed on Smartphones and Tablets**.** Smartphones and tablets are widely used for AR experiences due to their portability and accessibility. They come equipped with cameras and screens that enable the capture and display of AR content, offering users visual overlays and interactive experiences. These devices also feature built-in GPS capabilities that allow them to track the user's location, which is essential for integrating GIS data and providing location-based experiences.

ii. **The smart grasses:** The Smart Grasses will be integrated with the system for users who want to use it on-site. Smart glasses offer a hands-free AR experience and can provide users with real-time information and visual overlays without the need to hold a device. These glasses often include built-in cameras and sensors that capture the environment, enabling AR overlays and interactive content to be presented directly in the user’s field of view.

iii. **AI processing** units are crucial for data analysis and machine learning tasks in smartphones and cloud servers. They power AI-driven personalisation, such as real-time recommendations, voice recognition, and translations, thus enhancing the user experience.

iv. **Sensors:** Devices are equipped with various sensors, including accelerometers, gyroscopes, and GPS modules, which accurately track the user’s location and movement. This tracking is crucial for aligning AR overlays with the real-world environment and enabling GIS functionalities.

v. **Cloud computing:** The system will also be deployed into a platform that significantly enhances AR, AI, and GIS use. It offers scalable and efficient data processing to support AI algorithms, AR rendering, and GIS mapping, ensuring high-performance computing capabilities. Real-time data processing and storage allow up-to-date information delivery, facilitating AR overlays, AI recommendations, and GIS navigation. Additionally, cloud platforms offer secure and scalable storage for large volumes of data, such as GIS datasets, AR content, and AI training data.

According to Golightly et al. [39], Cloud computing also improves accessibility and collaboration, enabling seamless access to AR, AI, and GIS tools and data from any location with internet connectivity. This allows for cross-device compatibility and synchronisation, providing consistent experiences for visitors on smartphones, tablets, and other gadgets. Moreover, cloud-based delivery of AR content ensures that tourists receive the latest and most relevant information at various sites. In contrast, cloud-based AI capabilities allow for advanced model training and testing, leading to more accurate recommendations and predictions. The pay-as-you-go cloud computing model makes adopting AR, AI, and GIS

technologies more cost-effective and sustainable. At the same time, energy-efficient data centres reduce the carbon footprint and support environmentally responsible tourism practices.

4.7 Future Enhancements

i. **Integration with IoT:** Incorporate data from IoT sensors for real-time environmental monitoring and crowd management.
ii. **Natural Language Processing (NLP):** Enable voice-activated AI assistants to provide personalised recommendations and assistance to tourists.

5. DISCUSSIONS

The proposed integrated tourism management system, which combines Geographic Information Systems (GIS), Augmented Reality (AR), and Artificial Intelligence (AI), aligns with existing research findings and addresses critical challenges and opportunities identified in the literature. Let us critically discuss how the proposed system relates to the literature presented in the article.

i. **GIS Module Integration:** The literature review emphasises the importance of GIS technology in managing spatial data related to tourist attractions. The proposed GIS module encompasses map data management, point of interest (PoI) management, route planning, and geospatial analysis. This aligns with existing research highlighting GIS's role in destination management and marketing, particularly in mapping tourist attractions and infrastructure [16].

ii. **AI Recommendation Engine:** The proposed system's AI recommendation engine reflects the literature's findings regarding AI's significance in providing personalised recommendations and enhancing visitor experiences. Research suggests that AI-driven recommendation systems can analyse tourist preferences and behaviour to offer tailored suggestions for attractions, accommodations, and activities, thereby maximising visitor satisfaction [19, 20].

iii. **AR Interface Enhancement:** The proposed system's AR interface component corresponds to literature discussing the benefits of AR technology in delivering immersive and interactive experiences to tourists. Studies highlight AR's potential to overlay digital content onto physical environments, providing real-time information about tourist attractions and enhancing visitor engagement [17, 10].

iv. **Data Quality and Availability:** The literature underscores the importance of ensuring data accuracy and availability to implement GIS, AR, and AI technologies effectively. The proposed system acknowledges this challenge by emphasising the need for reliable spatial data management and AI training data to support personalised recommendations and immersive AR experiences [29].

v. **Digital Literacy and Cultural Sensitivity:** The literature discusses the crucial role of addressing digital literacy and cultural sensitivity concerns in successfully adopting ICT solutions in the tourism sector. The proposed system recognises the need for comprehensive training programs and community involvement to promote digital literacy and ensure culturally appropriate AR experiences [32, 30].

vi. **Integration and Interoperability:** The literature highlights challenges related to integrating GIS, AR, and AI systems due to differences in data formats and technologies. The proposed system addresses this challenge by emphasising the seamless integration of modules and the importance of standardised protocols for data exchange to maximise interoperability [35].

vii. **Cost and Sustainability:** The literature discusses cost and sustainability considerations as essential for the long-term viability of ICT initiatives in the tourism sector. The proposed system suggests exploring sustainable funding models and innovative financing mechanisms to overcome financial barriers and promote technology adoption [36].

The proposed integrated tourism management system reflects insights from existing literature on the role of GIS, AR, and AI technologies in enhancing tourism promotion, visitor experiences, and destination management. By addressing challenges and leveraging opportunities identified in the literature, the system aims to revolutionise tourism promotion in Tanzania and foster sustainable growth within the vibrant tourism industry.

6. CONCLUSION

By integrating GIS, AR, and AI technologies, Tanzania's tourism promotion system offers tourists a dynamic and immersive way to explore the country's rich cultural and natural heritage. Through interactive experiences, virtual tours, personalised recommendations, and seamless access to information, tourists can enhance their understanding, engagement, and enjoyment of Tanzania's diverse attractions. This enriches individual travel experiences and contributes to the sustainable growth and promotion of tourism in Tanzania.

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