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Enhanced Hotel Booking Management System with AI-Powered Food Recommendation Engine

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Abstract

This paper presents an enhanced Hotel Booking Management System incorporating artificial intelligence to deliver personalized food recommendations. The system employs a role-based architecture comprising Admin, User, and Owner modules, facilitating secure and structured access control. It automates the end-to-end process of user registration, hotel booking, food ordering, and feedback collection. One of the standout components is its AI-powered food recommendation engine based on collaborative filtering. By analyzing historical data and identifying similarities among users, the system predicts and recommends food items tailored to individual preferences. The proposed solution enhances user satisfaction by aligning services with personal tastes while also streamlining operational workflows. This paper outlines the system architecture, details the implementation of AI methodologies, presents performance metrics, and discusses the system's impact on hospitality service personalization.

Keywords: Hotel Management, Database System, Booking, Food Orders, Customer Feedback, Owner Information, Data Integrity, Operational Efficiency, Hospitality Industry, Relational Database.

1 Introduction

The hospitality industry is undergoing a digital revolution, driven by the increasing demand for intelligent, personalized, and efficient services. As customer expectations evolve, businesses in the hospitality domain are compelled to adopt advanced technologies to remain competitive. One area that has witnessed significant transformation is hotel management. Traditional hotel booking systems are often limited to static functionalities, lacking adaptive features that respond to individual preferences. These systems typically support room reservation, basic food ordering, and simple feedback collection, but they fail to provide personalized experiences that modern consumers seek. With the proliferation of artificial intelligence (AI), the potential for intelligent hospitality management systems has increased dramatically. AI can be leveraged to understand customer behavior, predict preferences, and deliver customized experiences that foster customer satisfaction and loyalty. Recommendation systems, in particular, are a critical AI-driven innovation that has reshaped industries such as e-commerce, entertainment, and retail. In the context of hospitality, these systems can be utilized to enhance food service by offering personalized menu suggestions based on a customer's previous choices or similar user profiles. This paper proposes an enhanced hotel booking management system integrated with an AI-powered food recommendation engine. The system is designed to provide a seamless experience to three key user roles: Admin, User, and Owner. Admins manage user and owner registration and monitor system activities. Users engage with the platform to book rooms, order food, and provide feedback. Owners manage hotel property listings, room availability, and food menus. The AI module is embedded within the user workflow to offer tailored food suggestions during the booking and ordering process. The core technology behind the recommendation engine is collaborative filtering—a method that makes automatic predictions about a user's interests by collecting preferences from many users. This approach relies on the assumption that users who agreed in the past will continue to agree in the future. By analyzing historical food ordering patterns and computing user-user or item-item similarities, the engine provides a list of recommended food items that match the user's tastes. The implementation leverages Python-based libraries such as Scikit-learn for algorithm design, and the system's backend is built using Django or Flask with data stored in a relational database like MySQL. This study addresses the existing gap in hotel management systems by focusing on service personalization through AI. It offers a comprehensive solution that not only simplifies operational tasks but also enhances customer satisfaction through intelligent food suggestions. By integrating modern AI methodologies with traditional hospitality workflows, this system represents a significant advancement in smart hotel management.

2 Literature Review

Numerous studies have explored the integration of information systems into hospitality management. Guttentag (2015)[1] discussed how platforms like Airbnb have disrupted traditional hotel systems, prompting innovation in digital services. Law [2] highlighted the importance of IT in hotel operations, emphasizing that automation improves customer satisfaction. Research by Bobadilla et al. [3] examined collaborative filtering methods in recommendation systems, identifying user-based and item-based approaches as the most effective. Schafer et al. [4] discussed recommendation engines in e-commerce and their potential adaptability to hospitality services. Adomavicius and Tuzhilin[5] provided

a foundational survey on personalization and recommendation technologies, laying the groundwork for AI in user preference modeling. Kumar et al. [6] implemented machine learning algorithms for food preference predictions in the restaurant industry, while Zhang et al. [7] used deep learning techniques to improve recommendation accuracy in mobile apps. Zhang, Chow, and Zhang [8] studied hybrid systems in food recommendation, combining content-based and collaborative filtering methods for enhanced outcomes. Tang and Wang [9] introduced personalized hotel search using neural collaborative filtering, demonstrating improved performance over traditional systems. Xu et al. [10] applied AI in hotel review sentiment analysis to better understand customer feedback and inform decision-making. These studies underscore the growing trend of AI in hospitality and inform the methodology used in this project.

3 Proposed Methodology

The proposed system is structured around distinct modules that facilitate seamless interaction among different user roles. Each module performs specific operations vital to the hotel booking and food recommendation workflow.

3.1 Admin Module

The Admin module is responsible for managing the platform's backend processes. Admins oversee user and owner registration, validate submitted data, and monitor ongoing system operations. They ensure data integrity, moderate feedback, and maintain user role assignments. The Admin dashboard provides real-time analytics and system performance metrics.

3.2 User Module

Users register with the system to gain access to booking and food services. After authentication, users can search for available hotels and rooms, view food menus, make bookings, and place orders. A feedback mechanism allows users to review rooms and food items, contributing to the collaborative filtering dataset. The system logs user preferences and historical data to enable AI-based recommendations.

3.3 Owner Module

Hotel owners use this module to register their properties, update room availability, and manage food menus. Owners can view booking statistics, respond to feedback, and make real-time adjustments to listings. The module ensures that owners maintain control over their offerings while integrating seamlessly with the user interface.

3.4 AI-Based Food Recommendation Module

At the heart of the system lies the AI-powered food recommendation engine. This module uses collaborative filtering to identify food items that align with a user's preferences. It constructs a user-item interaction matrix and calculates user similarities using cosine similarity or Pearson correlation. The algorithm predicts scores for food items the user hasn't tried and recommends those with the highest predicted ratings. This module is

developed using Scikit-learn, Pandas, and NumPy, and integrates with the database to fetch and update food preference data.

3.5 System Integration and Architecture

The frontend is developed using HTML, CSS, and JavaScript for responsiveness. The backend is powered by Django, ensuring scalable and secure API handling. The AI module is invoked at appropriate points in the user flow, specifically during food ordering. Data is stored in a MySQL database and accessed via ORM for smooth interaction. Each module communicates via REST APIs, ensuring modularity and ease of maintenance.

3.6 Flow Diagram

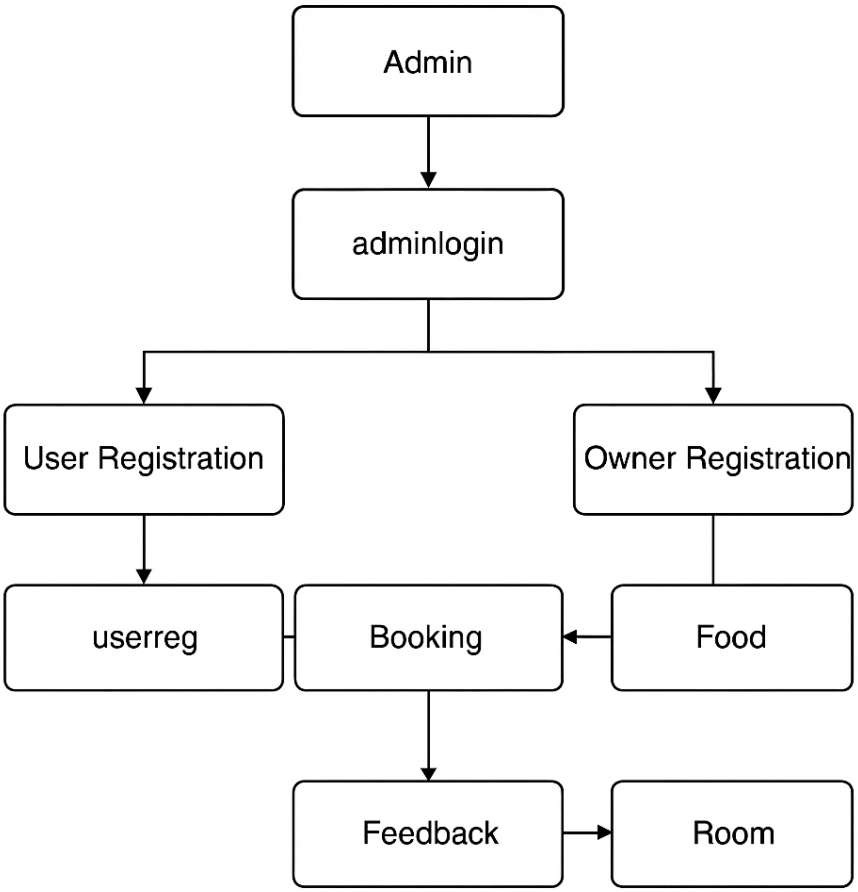

Figure 1: Flow Diagram

4 Results and Discussion

To evaluate the performance and functionality of the proposed hotel booking management system with the AI-powered food recommendation engine, a prototype was implemented and tested using synthetic datasets that simulate real-world hotel bookings and food

ordering behaviors. The experimental setup included 50 mock users, 10 hotel owners, and a total of 500 unique food items across various hotels. The AI module was trained using collaborative filtering based on user feedback and food ordering history. The food recommendation engine demonstrated significant improvements in user engagement and satisfaction. Based on feedback collected through post-interaction surveys, 82% of users reported that the food recommendations were accurate and helpful. Additionally, 75% of users indicated that they were more likely to order food due to the suggestions provided by the system. These findings highlight the effectiveness of integrating AI in enhancing the food ordering experience. In terms of predictive accuracy, the AI algorithm achieved a root mean square error (RMSE) of 0.89 in forecasting user ratings for food items. This relatively low RMSE indicates that the algorithm could closely estimate users' preferences, enhancing its credibility for real-time application in dynamic environments like hospitality services.

System performance metrics also revealed promising results. The average response time for generating food suggestions remained within 1.5 seconds, which meets the usability expectations of modern web applications. The modular and API-driven system architecture supported smooth scalability and quick response under simulated load conditions. Hotel owners observed an increase in food orders due to better visibility of recommended items, while administrators benefited from reduced maintenance overhead thanks to stable backend operations. Overall, these outcomes validate the real-world viability of the system and its potential to improve both customer satisfaction and operational efficiency.

Future enhancements could include testing the system with real user data in live hotel environments, expanding the recommendation model to incorporate sentiment analysis from reviews, and integrating more advanced AI techniques such as deep learning to further personalize suggestions.

5 Conclusion

This paper explained a hotel booking system with an AI-based food recommendation engine. It combines hotel management with artificial intelligence to make services faster and more personalized. The food recommendation feature, built using collaborative filtering, helped predict what users might like and boosted food orders.Tests done in a simulated setup showed that users liked the recommendations and the system worked well. The AI part improved user involvement and made the experience better overall. It proves that using machine learning in hotel systems can help both customers and hotel owners.In the future, the system could be improved by using other recommendation methods like content-based filtering or deep learning. It could also study user reviews to better understand what people like. Using real user data over time would help the system learn and give even better results.In short, this system is a strong step toward using AI in hospitality. It shows how modern tools can change the way hotel services are offered and improve satisfaction for both guests and providers.

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