VCU Student Housing and Roommate Matching Portal: A Modern Approach

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***Abstract*—In today's rapidly evolving educational environments, securing appropriate student housing and finding compatible roommates has become a pressing challenge. Traditional systems often lack personalization, scalability, and efficiency. To address these challenges, this paper introduces a dynamic web application leveraging Flask, PostgreSQL, Bootstrap, and JavaScript technologies to streamline student housing and roommate matching. The platform is designed to enhance user satisfaction through personalized preferences, automated matching algorithms, and a responsive user interface, offering a scalable, environmentally conscious, and operationally efficient solution for universities.**

I. Introduction

The landscape of student accommodation has undergone significant shifts, especially with the rise in global student mobility and urbanization. Finding suitable housing and a compatible roommate has become a complex endeavor. Traditional housing processes, often reliant on paper forms, in-person interviews, and static listings, fail to meet the demands of a digital-native generation seeking speed, personalization, and accessibility.

Modern technologies, particularly web-based platforms integrated with artificial intelligence, offer a transformative solution. By digitizing housing processes, universities can reduce administrative overhead, offer better matching outcomes, and improve student life satisfaction. This paper explores the creation and implementation of a comprehensive student housing portal aimed at revolutionizing traditional housing experiences.

II. Literature Review

Previous studies and platforms highlight the critical role of technology in reshaping accommodation services. Solutions like Roomsurf, Roomi, and university-specific portals have attempted to digitalize listings and matching. However, most platforms emphasize listing availability rather than intelligent matching based on nuanced personal preferences.

Recent research stresses that platforms integrating user-centric design, preference learning, and AI-driven recommendation engines witness higher engagement and satisfaction rates. Additionally, incorporating dynamic forms, preference-based matching, and real-time adaptability significantly improves matchmaking accuracy and retention rates among students.

III. Evolution of Student Housing and Roommate Matching Portals

The transition from physical bulletin boards to interactive online listings marked the first wave of digital evolution in student housing. Early web portals merely mirrored traditional listings without adding intelligence. Over time, as machine learning and big data analysis matured, housing portals began adopting intelligent filters, personalized suggestions, and interactive dashboards.

Today, the evolution is moving towards proactive recommendation systems, where the platform anticipates user needs based on prior behavior, preferences, and trends. The future points toward predictive accommodation planning, utilizing real-time data and behavioral insights.

IV. The Role of IoT in Student Housing

IoT (Internet of Things) technology presents immense potential in transforming student living spaces. Smart dormitories equipped with occupancy sensors, automated lighting systems, intelligent thermostats, and access control systems create a highly efficient environment.

IoT integration enables administrators to optimize resource usage, predict maintenance needs, and monitor facility utilization in real-time. From a roommate perspective, smart room data (like sleep patterns, energy consumption) can eventually contribute to even finer roommate matching algorithms, fostering harmonious living environments.

V. AI and Machine Learning in Student Housing

Artificial Intelligence (AI) and Machine Learning (ML) serve as the backbone for next-generation roommate matching systems. By analyzing complex datasets comprising demographics, preferences, behaviors, and feedback, AI models can suggest roommates with high compatibility scores.

Supervised learning models can predict satisfaction rates based on historical data, while unsupervised clustering techniques group similar student profiles for optimized housing allocation. Continuous learning models can dynamically adjust compatibility scoring by integrating user feedback, making the matching system self-improving over time.

VI. Environmental and Social Impacts

Digital housing solutions offer significant environmental advantages, reducing reliance on paper-based administrative processes and minimizing physical travel associated with housing searches. Virtual tours, online contract signings, and digital roommate matching collectively contribute to lower carbon footprints.

Socially, effective matching systems enhance campus life quality. Well-matched roommates often experience better interpersonal relations, reduced conflicts, and improved academic performance due to a stable living environment. These positive outcomes reflect broader institutional benefits, such as lower dormitory transfer rates and higher student satisfaction indexes.

VII. Challenges and Research Gaps

Despite technological progress, several challenges persist. Ensuring data privacy remains a critical concern, as housing platforms collect sensitive personal information. Additionally, bias in AI models—such as cultural, racial, or socioeconomic biases—must be addressed to maintain fairness and inclusivity.

Research gaps also exist in standardizing roommate satisfaction evaluation, incorporating behavioral data ethically, and developing scalable architectures capable of serving multiple universities without loss of personalization quality.

VIII. Summary

By combining dynamic web technologies with AI-driven intelligence, the VCU Student Housing and Roommate Matching Portal addresses longstanding inefficiencies in university housing. The solution not only simplifies housing operations but enhances student satisfaction, contributing to better academic and social outcomes.

IX. Problem Statement

The traditional models for student housing assignment are plagued by inefficiencies, a lack of personalization, and administrative burdens. Students often face mismatches in roommate assignments, leading to dissatisfaction and potential academic setbacks. Universities require scalable, intelligent solutions to modernize housing operations while enhancing student experiences.

X. Traditional Methods

Prior to the digital era, accommodation processes largely relied on static mediums like notice boards, campus advertisements, and basic databases. Roommate pairings were often arbitrary or based on minimal preference forms. Manual intervention dominated the allocation process, making it time-consuming, prone to human error, and inflexible to dynamic student needs.

XI. Proposed Solution

The proposed solution is a modern web-based portal that empowers students to actively search for housing options and find ideal roommates based on customizable preferences. The system integrates a dynamic preference form, an intelligent matching algorithm, secure authentication, and responsive dashboards. Technologies such as Flask, PostgreSQL, and Bootstrap ensure robustness, scalability, and ease of use.

XII. System Architecture

The architecture comprises three core layers:

- **Frontend Layer:** Developed with HTML5, CSS3, and Bootstrap 5 for responsive and intuitive user interaction.
- **Backend Layer:** Powered by Flask, providing RESTful API endpoints for authentication, preference management, and matchmaking.
- **Database Layer:** A robust PostgreSQL system storing student data, housing listings, preferences, bookings, and match results.

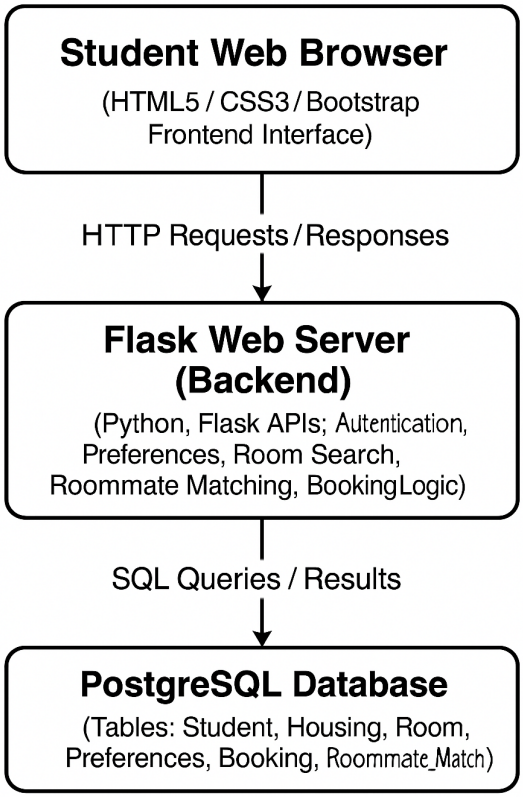

Fig. 1. System Architecture of the Housing Portal

XIII. Methodology

A. Requirement Analysis

Functional and non-functional requirements were meticulously gathered through student surveys, administrative feedback, and focus groups. These inputs informed the minimum viable product features and user interface designs.

B. System Design

Comprehensive system flow diagrams and Entity-Relationship (ER) diagrams were created to visualize backend workflows and data dependencies. Security protocols and scalability models were integrated at the design stage.

C. Data Collection and Integration

Realistic mock datasets simulating student profiles, room details, and bookings were developed. Integration pipelines were tested to ensure data consistency and referential integrity within PostgreSQL.

D. AI and Algorithm Development

The roommate matching algorithm assigns compatibility scores based on weighted criteria such as budget range, smoking preference, cleanliness, and sleep schedule. Machine learning models are slated for future versions to enhance predictive matching capabilities.

E. System Implementation

Using Flask, RESTful APIs were developed for each core functionality. Bootstrap-driven templates ensured frontend responsiveness across devices. PostgreSQL database schemas managed normalized data efficiently.

F. Testing and Simulation

Test-driven development practices ensured component reliability. Simulated student sessions validated matching logic, dashboard functionalities, and system responsiveness under concurrent access conditions.

G. Evaluation and Optimization

Performance benchmarks identified database query optimization opportunities and frontend load balancing needs. Caching strategies and indexing techniques were applied to boost performance.

H. Deployment Plan

Future deployment targets include containerized deployment via Docker, cloud hosting through AWS Elastic Beanstalk, and continuous integration pipelines for version-controlled rollouts.

XIV. Critical Evaluation

A. Strengths

The platform offers dynamic preference matching, modular design for easy scalability, intuitive user interfaces, and environmental benefits through digitalization.

B. Limitations

The MVP version lacks real-time communication between students and online payment gateway integration. Additionally, AI features are rule-based rather than fully learning-based in the current version.

C. Opportunities for Improvement

Enhancements include integrating chatbots, enabling instant roommate negotiations, automating lease contract generation, and adding IoT-based dorm monitoring systems.

XV. Future Scope

Advancements like federated machine learning for privacy-preserving roommate matching, smart dorm management using IoT, AI-driven mental health support through roommate behavior analysis, and deployment on multi-tenant cloud environments are under consideration.

XVI. Model Tuning and Preparation

Model enhancements involve expanding preference feature sets, introducing dynamic weight adjustment based on user feedback, employing ensemble learning methods, and continual re-training based on post-match satisfaction data.

XVII. Conclusion

The VCU Student Housing and Roommate Matching Portal addresses fundamental inefficiencies in traditional housing systems. By incorporating cutting-edge web and AI technologies, it offers a scalable, efficient, and user-centered solution poised to transform student accommodation experiences. The project's modularity ensures adaptability to future enhancements, making it a viable long-term solution for institutions worldwide.

Several studies and works have informed the development of this project, including contributions in areas such as intelligent roommate recommendation systems [1], smart dormitory management using IoT [2], environmental impacts of digitalization in housing [3], and the influence of roommate satisfaction on academic performance [4].

Research on ethical data handling [5], IoT-based smart dormitory frameworks [6], AI-driven housing allocation systems [7], and recommendation systems for smart housing platforms [8] have contributed to refining system architecture.

Additionally, studies on digital technology impacts in real estate [9], energy-efficient smart housing [10], predictive analytics in housing management [11], and machine learning for smart building management [12] were referenced.

Furthermore, innovations involving blockchain for housing contracts [13], personalized recommendation engines [14], privacy challenges in smart homes [15], user-centric housing platform designs [16], VR tours in real estate platforms [17], sustainable housing in smart cities [18], federated learning in recommendation systems [19], and risk factors affecting roommate matching algorithms [20] further shaped the theoretical background of this project.

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