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AI VIRTUAL CAMPUS TOUR: A WEB PLATFORM FOR EXPLORING COLLEGES REMOTELY

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Abstract

Selecting a college is a major milestone in life. However, it is not feasible for every student to visit every campus they shortlist. Distances, travel costs, and time might make campus visits a challenge; besides, online data about colleges could be distributed across various sites and brochures. This paper will focus on the AI Virtual Campus Tour, which is a web application where students, their parents, and applicants can virtually tour college campuses. In addition, this platform utilizes 360-degree pictures, videos, interactive maps, hotspots, optional 3D, and conversational assistant that leverages natural language processing and RAG to answer any queries with information validated by the universities.

Keywords : Virtual Campus Tour, Virtual Reality, Augmented Reality, Computer Vision, 360-Degree Imaging, Conversational Assistant, College Recommendation, Web Application

I. INTRODUCTION

The choice of a college may affect one's learning process, budget, and even future career prospects. In most cases, the applicants compare colleges which are located in various cities or states, but to see each one of them personally takes much time, effort, and expenses. For students who live far away, international applicants, and those who have some mobility issues, these visits become especially problematic. All colleges provide information about themselves on their websites and in brochures; still, a few photos and descriptions will hardly give an applicant a complete picture of how the classrooms, laboratories, libraries, hostels, and sports infrastructure are laid out and look like. Moreover, all information is provided by the colleges in different ways.

In this paper, there is proposed AI Virtual Campus Tour which will bring together 360-degree images of campuses, interactive maps, an assistant that answers questions, recommendations of colleges, and comparative analysis. The tool is designed for those who want to get acquainted with the campuses and select a few institutions among many other candidates.

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II. LITERATURE SURVEY

This section describes technologies which could potentially be used in the development of the platform under consideration and highlights their strengths and weaknesses when applied in the context of campus exploration.

A. Virtual Reality and Immersive Learning. According to Slater and Wilbur, the defining characteristics of virtual reality were called immersion and presence, and these concepts are still used to evaluate immersive systems . Radianti et al. provided an overview of immersive virtual reality in higher education and pointed out that most applications are designed for particular disciplines and have not undergone thorough evaluation. Makransky et al. found out that while virtual reality improved the experience of being immersed in a science simulation, there was no improvement in learning; on the contrary, the learning process worsened because of excessive immersion [6]. Thus, for campus exploration, easy usability appears to be more important than immersion. Azuma conducted a survey of the augmented reality literature and introduced his definition of AR, which implies that AR should comprise real and virtual objects that are integrated, interactive, and registered with respect to the real world.

B.360-Degree Photography and Virtual Walkthroughs. A panorama consists of overlapping images joined into one image. Brown and Lowe suggest an automated process for image joining using feature matching that does not depend on the order and orientation of the images. Connecting panoramas with hotspots provides a basic walkthrough without 3D modelling. The limitation is the user's ability to see only what was captured in the photograph, which depends on the quality of the photographs.

C. Web-Based Virtual Tours and Interactive Navigation. Tours provided through web pages do not require installations and function on mobile devices. The W3C WebXR Device API defines a standardized interface for rendering virtual reality content in web browsers [9]. Web-based tours have limitations in the form of bandwidth and device/browser compatibility.

D. Chatbots and Question-Answering Systems. Adamopoulou and Moussiades provided a historical perspective on chatbots, the technologies used, and their applications, ranging from rule-based pattern matching to learning-based ones. Okonkwo and Ade-Ibijola reviewed educational chatbots and their advantages and disadvantages. The development of language representations such as BERT was helpful for solving language understanding problems. In terms of retrieval, Karpukhin et al. proved that dense passage retrieval is more efficient than traditional sparse retrieval when dealing with open-domain question answering, and Sentence-BERT allows comparing sentences semantically efficiently . Lewis et al. presented a novel approach called RAG where a retriever works in combination with a generator making sure that answers depend on retrieved facts. However, Ji et al. discussed the issue of hallucinations in text generation and concluded that fluent and ungrounded answers are still a problem. This is why the assistant here should rely on credible sources and acknowledge

E.Recommendation systems. Koren et al. described matrix factorization, a common technique in collaborative filtering applications. The Recommender Systems Handbook discussed content-based, collaborative, knowledge-based, and hybrid approaches to recommendation systems, as well as issues with evaluation like the cold start problem and biases. Given that the new system has no user or college information at first, content-based and knowledge-based approaches can serve as better candidates than collaborative filtering.

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F. Computer vision, 3D reconstruction, and digital twins. Structure-from-motion techniques like COLMAP infer camera poses and 3D geometry from a set of photos . Neural Radiance Fields synthesize novel views from a set of images , and 3D Gaussian Splatting enables real-time rendering of those scenes . Grieves and Vickers introduced the idea of the digital twin, a digital replica of a physical system. These methods would be able to provide a more precise campus map; however, they require significant amounts of data gathering and processing, and thus are considered as a possible extension only.

G. Virtual Experiences in Education, Tourism, and Institutional Engagement. Guttentag explained the use of VR in tourism for planning, marketing, and access. Tussyadiah et al. determined that VR presence influenced attitudes toward destination places. Such research deals with tourism, not admissions, hence the use of it in college admission process would be an assumption, which requires more evidence to prove. I could not confirm any peer-reviewed research regarding the virtual campus tour experience for college admissions process; IEEE Xplore, ACM Digital Library, and Scopus need to be checked prior to submitting the paper.

TABLE I. LITERATURE SURVEY

Ref. No.	Author & Year	Research / Study	Method/ Approach
[1]	S. E. Chen, 1995	QuickTime VR, image-based navigation	Navigable virtual environment by panorama without 3D modeling
[2]	Radianti et al., 2020	Systematic review of immersive VR in higher education	Mapped applications, design features, and knowledge gap
[3]	Lewis et al., 2020	Retrieval-augmented generation	Combination of retrieval and generation for answers based on knowledge
[4]	Guttentag, 2010	Virtual Reality applications in tourism	Explained applications of virtual tours for planning, marketing, and accessibility purposes
[5]	Slater and Wilbur, 1997	Framework for immersive virtual environments	Immersion and presence for evaluation of VR
[6]	Makransky et al., 2019	Experiment on immersive VR in a science laboratory simulation	More presence does not necessarily equate to better learning

III. PROBLEM FORMULATION AND OBJECTIVES

A. Problem Definition. The prospective candidates need concrete, realistic and comparable facts about the campuses. The prospective students will be comparing infrastructure, environment, accessibility and facilities of different colleges, but the information is disparate, textual, inconsistent and outdated. It is not possible to visit all the colleges physically.

B. Conceptual Formulation. The AI Virtual Campus Tour is a system which transforms the input provided above to the output given below.

Input: (1) Preferences and requests from the user; (2) Profile information of the colleges; (3) Images, 360-degree images, videos, and 3-D images of the campus; (4) Location details about the campus and interactive maps; and (5) Interactions and accessibility preferences of the users.

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Output: Interactive campus tour, request results, navigation of the campus, and recommendations.

C.Illustrative Recommendation Model. Relevance function that assigns importance to rank the colleges according to a particular user is as follows:

$$R(c,u) = w_1F(c,u) + w_2I(c,u) + w_3L(c,u) + w_4A(c,u)$$

where c is a college and u is a user. F(c,u) is the suitability measure of the college with respect to preferences of the user which can be courses or priorities; I(c,u) is the suitability measure of the college in terms of infrastructure like lab, library, and hostel facilities; L(c,u) is the suitability measure of the college with respect to location, i.e., distance or city; and A(c,u) is the suitability measure of the college with respect to accessibility or any other user's requirement. All the variables range between 0 and 1 and the weights w_1 to w_4 are non-negative and sum up to1.

D. Research Objectives. The objectives are to:

1. Provide remote access to college campus environments.
2. Allow users to navigate through college campuses interactively.
3. Answer campus-related queries using authenticated information.
4. Suggest colleges or facilities according to user preferences.
5. Allow comparison of multiple colleges or facilities.

IV. MOTIVATION FOR AI-BASED VIRTUAL CAMPUS EXPLORATION

The proposed platform can serve a number of stakeholders well. When applying to colleges away from home, students will incur costs associated with traveling and may not have many chances to assess a potential institution before making a choice. In the process of admissions, side-by-side information will be helpful when comparing universities that present their websites and brochures in different ways. Parents and guardians would like to look at hostels, transport, and safety facilities. Students with physical impairments may use the tour to see the locations of ramps and elevators. College institutions may find virtual previewing useful when repeatedly being asked for a tour of the campus.

By providing easier access to information about campuses, the platform will aid applicants in making informed choices in the process of shortlisting. Such advantages should be viewed as potentials rather than facts. Research conducted in the area of virtual previewing in tourism suggests that such activities can affect the attitude towards destinations, but the influence on the college choice needs evaluation.

V. PROPOSED SYSTEM AND METHODOLOGY

A. Data Collection and Preparation of the Contents. The participating institutions would provide authentic college profiles, course information, description of facilities, images, panoramas, videos, maps, and optional 3D models. All these pieces of information would include meta-information such as the name of the institution, type of facility, date and time of data collection, coordinates or its place on the floor plan, the device that collected the data and information about permissions and consent forms. There would be guidelines specifying minimum resolution, lighting, consistency in exposure, and removing humans and other sensitive information from images. All panoramas would be marked with

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their location on the campus map. Each institution would appoint a designated individual to take care of its data and adhere to an updating policy, such as annually or upon changing of facilities.

B. Data preprocessing and reconstruction of campus. Media files are analyzed in terms of resolution, blurriness, exposure, and integrity. When several photographs were taken to create a panorama, they can be matched and blended [8]. The media files are then compressed in several different resolutions in order to make them load at an appropriate resolution, and their location on the map is marked alongside neighboring locations.

C.AI Assistant and Natural Language Processing. Queries are typed in natural language. Intent detection sorts out the queries into intent types including facility information, courses, hostel, transport, accessibility, navigation, and comparisons, and detects entities including colleges and facility names. Verified documents are segmented and embedded with sentence encoders and indexed. After receiving the query, the retriever finds relevant segments by dense or hybrid retrieval and then the language model produces the answer based on the segments following the RAG approach. The AI assistant will need to (i) provide answers only based on the verified information that has been received, (ii) mention the source of the information and the date of the latest verification, (iii) notify about the absence of the information or its ambiguity, suggesting contacting the institution, and (iv) refrain from making unsubstantiated claims. This set of guidelines will help reduce the issue of hallucinations as described in the literature, but not get rid of them, therefore necessitating measures for assessing their effect.

D. Virtual Tour and Campus Navigational Interface. Interface will be a web/mobile app, which uses 360 degree images with hot spots for moving to another space as well as for seeing more information about facilities. The floor plans and maps indicate the user's location and allow him/her to navigate to any desired destination, having labels attached to all places. Search and filters will allow users to select particular facilities, such as laboratories and sports grounds. WebXR can be used for viewing in proper headsets, however, the default mode does not require any additional device so people without a headset will not be excluded.

E. Recommendations and Comparison of Colleges. Recommendation module considers user's preferences, such as courses, infrastructure, location, hostel conditions, accessibility and transport facilities and applies filters and scoring according to Eq. (1). At the beginning when there is no interaction data, content-based and knowledge-based recommendation approaches can be used with the addition of hybrid approaches afterward.

User Interface, Security and Privacy. The user interface should function on computers, tablets and phones. It should be accessible according to the accessibility guidelines like the WCAG, which include keyboard functionality, text equivalents, sufficient contrast, video captioning and screen reader accessibility. The user interface and the digital assistant must operate in English and the main Indian languages. Web browsing must not be dependent upon registration. In case accounts are created for saving the user's preferences, the minimum amount of personal information should be collected with user permission. Encryption should be done both for transferring and storing data.

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VI. PROPOSED SYSTEM ARCHITECTURE

The proposed architecture has six layers, shown in Fig. 1.

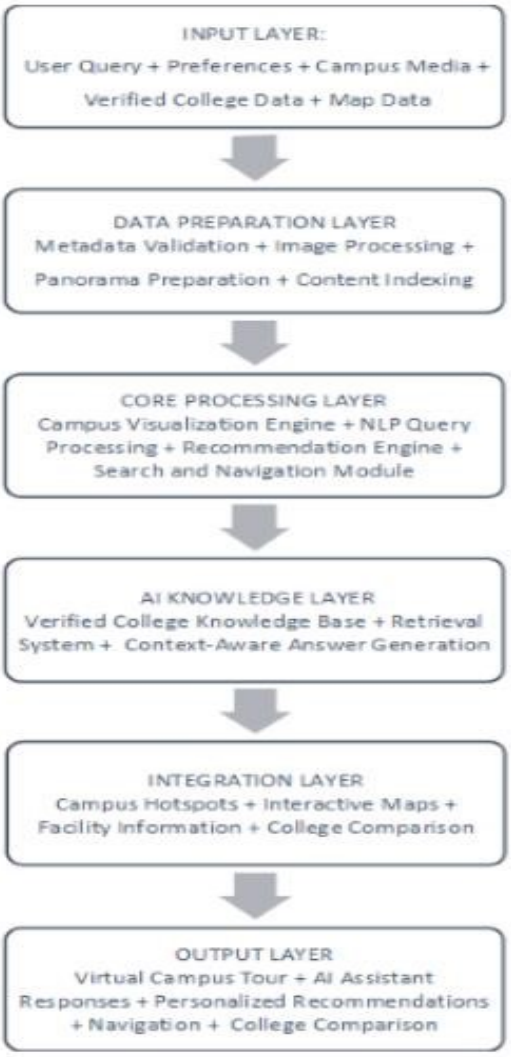


Fig. 1. Conceptual architecture of the proposed AI Virtual Campus Tour. The diagram shows a proposed architecture, not a deployed or verified system.

Input Layer. This layer takes inputs in the form of user queries and preferences, media from institutions, verified information about colleges, and maps.

Data Preparation Layer. The layer ensures that metadata validation is done, which ensures that required metadata fields and permissions are available. Image processing includes quality checks and compression, while panorama preparation includes stitching and formatting. Content indexing prepares indices for text and media metadata for searching and embedding.

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Core Processing Layer. Campus viewer creates panoramas, hotspots, and additional 3D elements. Language component deals with intent recognition and entity extraction. Recommendation engine computes relevance scores while the search and navigation component carries out filtering, location searches, and pathfinding between places on the campus.

AI Knowledge Layer. An institution-verified knowledge base of each college contains both structured and unstructured data. The retrieval engine retrieves passages corresponding to each query, and the answer generation component writes responses restricted to only what was retrieved.

Integration Layer. This layer connects the components such that the response by the assistant can trigger the opening of the appropriate hotspot, selecting the map can trigger the appropriate panorama to be opened, and all information relating to facilities is synchronized with the knowledge base.

Output Layer. Virtual tours, answers, recommendations, navigation, and comparisons will be available to the user. User input, such as rating of answers, may be made available to administrators according to Section V-F.

VII. EVALUATION METRICS

This section describes how the system can be evaluated. No experimental data are presented in this paper as the system has not been developed.

A.Metrics. Usability metrics will be provided by the System Usability Scale (SUS) and their corresponding benchmarks, along with the effectiveness, efficiency, and satisfaction metrics of ISO 9241-11 . Task completion rate is the ratio of completed exploration tasks among all users. Navigation success rate is the rate of successfully completing the navigation process to get to the needed page. Questionnaires will be used to determine users' perceived usefulness and confidence in making their college decision. Technical metrics will be given as the average loading time of pages and media on various types of networks (fast, average mobile, and slow) and various types of devices. For the assistant, human evaluators will judge the relevance and accuracy of the answers in comparison with the ground-truth knowledge base. Retrieval metrics will be provided as retrieval accuracy (whether the right passage has appeared in top-k results) and grounded-answer rate (percentage of answers with evidence).

B.Pilot Study Design. A pilot study with informed participants could involve the comparison between the AI Virtual Campus Tour and regular university websites in terms of accessing campus information. The sample could consist of potential students, their parents, and, if possible, accessibility-oriented students, using different devices and different locations and languages. Ethical clearance and informed consent would be required. The pilot study could employ within-subject or between-subject design, and if subjects complete both conditions, the sequence of task execution would have to be counterbalanced. Tasks could involve searching for the closest hostel, finding the library and its operating hours, checking accessibility, and comparing two universities on some criterion. Measurement could include task completion time and accuracy, SUS scores, satisfaction with task performance, ratings of assistant's responses, and system logs with consent.

C. Weaknesses of the Evaluation Study. The small sample size and its non-random nature are expected in a pilot study. Novelty can affect the study. Rating answers requires subjective judgment, thus, several raters should be involved in that. The actions of the participants might differ from their claims; e.g., they might not apply for college admission in the end.

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VIII. CHALLENGES AND LIMITATIONS

Media costs and effort. Good-quality panoramas take time and money to create and maintain. That may be solved through covering the most important buildings at first, giving instructions on how to shoot them, and using consumer 360-degree cameras together with quality control.

Incomplete and non-uniform data. The data may be outdated or different from the institution to the institution. Thus, the platform should use a uniform data template, ask institutions to validate their data, show the date of the last data update, and say clearly what information is not available.

Problems with bandwidth and device capabilities. Large media files will slow down loading with low-speed Internet or old devices. Possible solutions are adaptive resolution, lazy loading, caching, and low-bandwidth mode which includes only images and text.

Accessibility issues. Some people cannot use panoramas and VR due to visual, motor, and vestibular impairments. That is why the platform should provide keyboard navigation, support for screen readers, text description and captioning for all the scenes, and low-immersion mode.

IX. APPLICATIONS

The possible applications are admission process, recruitment process, and virtual exploration of the college campus. Admission applicants could do a virtual exploration while looking for suitable colleges; the parents or legal guardians could get a preview of hostels, modes of transportation, and other facilities offered by the college. The students from other cities or even countries could shortlist their preferred college without having to spend any money on traveling. Users could get information on ramps, elevators, and available pathways which would help them to make arrangements for their visit. The colleges could also include the virtual tour in their website and admissions pages or can use them in educational fairs and expos. New students admitted to that particular college could use it to get acquainted with the college campus.

X. FUTURE DIRECTIONS

Short-term improvements include multilingual interaction, verified data on academics and placements, and dynamic recommendations depending on the user's feedback. Additional accessibility statistics and privacy-aware analytics using aggregated anonymous statistics may also be added. Adopting a standardized format for campus information would allow the inclusion of additional colleges as well as comparison.

Medium-term extensions.Some of the possible improvements include conversation scripts that describe the journey according to the interests of the user, live guided tours conducted by the institution staff, viewing using a VR headset via WebXR [9] , and AR-enabled navigation assistance for the physical visitor .

Possible advanced research topics.Campus digital twins, highly detailed 3D worlds created using photogrammetry and neural rendering, and accessibility route planning are some of the research topics that would require data, computation, and privacy considerations. Each of these requires validation before they can be offered as an extension.

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XI. CONCLUSION

The idea for the AI Virtual Campus Tour suggested in this paper is that of a remote tour of college campuses to allow the students and their families to explore and compare them. The six-layer structure of the application encompasses panoramic pictures, 3D materials, maps, navigation features, the retrieval-based conversational assistant and preferences-based recommendations and comparisons. The benefits associated with this idea would include improved availability of information about campuses and a more efficient short-listing process. All these benefits are yet to be confirmed by the results of a pilot study that will focus on usability, task completion rate, effectiveness and quality of retrieval and answers, relevance of recommendations, system performance and accessibility. The challenges to be addressed would include cost and time required to generate campus media, accuracy of institutional information, unsupported AI responses, privacy concerns, biased recommendations and limits of virtual visit.

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