Agile Development of a Virtual Tour for Universidad Autónoma Metropolitana: Unidad Iztapalapa - One of the First Virtual Campus Experiences in Mexico City

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Abstract: This paper presents the development process and outcomes of a virtual tour for Universidad Autónoma Metropolitana - Unidad Iztapalapa, one of the pioneering virtual campus experiences in Mexico City. Utilizing the Scrum framework with one-week sprint cycles, the project was executed over two academic terms, focusing on iterative development and continuous feedback. The virtual tour incorporates advanced 3D modeling, interactive guides, and dynamic student avatars, aiming to provide an immersive and informative experience. Key deployment strategies included hosting on AWS S3 and proprietary SSH servers using Docker containers, ensuring broad accessibility. Despite a small development team of four members, the project successfully reconstructed 16 major campus buildings, representing 44% of the infrastructure, and integrated features such as informational buttons and navigational aids. The results highlight significant advancements in virtual campus environments, with future work directed towards mobile optimization, gamified learning modules, and cooperative virtual interactions.

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1 INTRODUCTION

A virtual tour is a simulation of a virtual location presented through a sequence of images or interactive elements (Cardona, 2023). Today, various institutions employ virtual tours to engage users and provide an immersive experience. Examples include universities, museums, archaeological sites, and public spaces.

While this technology is useful for exploring streets in a neighborhood or another state, it is limited to just street. It does not directly involve the interiors of places such as museums, archaeological sites, or private locations like residential complexes or schools.

Although most of the examples have their own means of offering virtual tours, they share a common limitation: they are 360° photographs. This restricts in-depth exploration within structures or their surroundings.

The Universidad Autónoma Metropolitana also offers virtual tours across its campuses: Unidad Azcapotzalco presents a 360° video of its main buildings without additional information (UAMA, 2021); Unidad Cuajimalpa provides a general video walkthrough of its facilities (UAMA, 2021); Unidad Iztapalapa features a brief video overview lacking detailed content (UAMI, 2022); Unidad Lerma has no current virtual tour, only an early promotional video showing the original construction plan (UAML, 2010); and Unidad Xochimilco stands out with a web-based tour that combines 360° photographs and informational overlays (UAMX, 2022).

As observed, most UAM campuses offer a predefined virtual tour, without the possibility of freely exploring the facilities. Some of the previously listed tours follow a Google Maps-style navigation, while others do not provide an updated view of the campus.

Since this project was developed at Unidad Iztapalapa, we focused on modeling this campus first to establish a methodology that can later be applied to other UAM units. This methodology aims to create a

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fully explorable environment, allowing users to freely navigate the university's facilities.

Currently, a 2017 project titled "Recorrido Virtual De La Unidad Iztapalapa" exists, where students pursued a similar objective to the vision of this new version. The previous project included the construction of 3D models for Building A, AA (General Rectorate), B (Classroom Building), and L (Library). However, only Building A was fully developed with complete interior facilities, while the rest only featured external façades, leaving their interiors empty.

Further details on this first version of the Unidad Iztapalapa virtual tour will be reviewed in Section 2, followed by an analysis of the hypothesis and the objectives outlined proposed in this work. This study, conducted as part of a terminal research project for the Bachelor's in Computer Science program, aims to develop a new virtual tour for Unidad Iztapalapa leveraging these tools and methodologies.

1.1 Hypotheses

- H1: The use of advanced tools such as Blender, Unity, MakeHuman, and Substance Painter significantly improves the efficiency and visual quality of interactive 3D virtual tours (Moskvin et. al. 2022).
- H2: Implementing Scrum (Schwaber & Sutherland, 2020) and Work Breakdown Structure (WBS) (Haugan 2001) frameworks leads to better time management, clearer task delegation, and faster development cycles in educational technology projects with small teams.
- H3: Early identification and mitigation of project risks reduces delays and helps maintain consistent progress during iterative development (Dawley 2014).
- H4: An immersive virtual campus tour enables users to engage in realistic exploration scenarios, which can support educational and research activities (Loureiro et. al. 2020).
- H5: A publicly available and updated virtual tour increases the visibility of the institution and positively influences prospective students' perception of the university.

To guide the scientific reflection of this study, the following research questions are proposed:

- RQ1: How does the use of agile methodologies affect the development speed and consistency of educational 3D environments?
- RQ2: What are the main architectural and technical limitations in building scalable, interactive campus simulations?
  - RQ3: How do users perceive the realism and usefulness of a virtual campus when enhanced with intelligent NPCs?

1.2 Objectives

1.2.1 General Objective

To develop the foundation for a virtual tour of Universidad Autónoma Metropolitana - Unidad Iztapalapa, creating an engaging experience with user-friendly controls.

1.2.2 Specific Objectives

- Evaluate the methodological process involved in the creation of simulated virtual environments, based on the interpretation of structural blueprints and architectural data.
- Apply Scrum and Work Breakdown Structure (WBS) as core project management strategies to structure and monitor the development cycle.
- Assess the suitability and integration of tools such as Unity, Blender, MakeHuman, and Substance Painter in the construction of immersive 3D environments.
- Design and implement an interactive virtual representation of a significant portion of the UAMI campus, emphasizing user-friendly navigation and informative content.
- Deploy the virtual tour on a public cloud-based platform to ensure accessibility and scalability.

The article is organized into several key sections. The introduction provides an overview of the project and its objectives. Section 2 reviews the first virtual tour developed in 2017, which serves as the predecessor of this project, to contextualize its evolution and development process. Section 3 details the methodology, including the Scrum framework, sprint structure, and development tools used. Section 4 presents the results, showcasing the progress made, key features implemented, and visual comparisons of real and virtual environments. Section 5 discusses conclusions and outlines future work, emphasizing the potential for further development and the scalability of the project. Finally, references are provided to acknowledge the sources that informed this study.

2 PREVIOUS WORKS

2.1 Related Work

The development of virtual tours in educational institutions has gained relevance in recent years, especially as universities seek to provide accessible and immersive ways to explore their campuses remotely. The work by (Radianti et al. 2020), analyse the use of virtual reality in higher education and conclude that immersive environments foster better spatial awareness and emotional engagement.

Various projects worldwide have attempted to develop interactive campus tours. For instance, Stanford University and MIT have implemented WebGL-based tours with limited interactivity, relying mainly on panoramic photography. Other efforts focus on gamification and NPC interaction, as seen in projects such as Virtual MIT and Campus Explorer.

Within Mexico, few universities offer fully explorable 3D environments. Most rely on 360° videos or static walkthroughs. As discussed earlier, other UAM units have partial or outdated virtual tours, mostly limited to photographic representations. This highlights the novelty and impact of the present project in offering a dynamic and interactive 3D reconstruction of a significant portion of the Iztapalapa campus.

Recent research on the use of immersive technologies in place-based research, such as the review by (Cinnamon and Jahiu,2023), highlights the potential of 360-degree video and virtual tours as tools for spatial understanding and engagement. While our approach focuses on fully explorable 3D environments rather than video-based experiences, their analysis offers valuable insight into the pedagogical and exploratory value of virtual reconstructions.

2.2 Previously Virtual Tour

As previously mentioned, a project was developed in 2017 in which a group of students recreated part of the campus, specifically the area of the main plaza. Below is an overview of the contents of this virtual tour

The 2017 project offers a limited scope, covering only the main plaza area. The tour is restricted to the plaza itself and the interior of one building. Additionally, it includes some NPCs (non-playable characters) walking around the accessible zone.

The 2017 virtual tour includes only buildings A, AA, B, and L. Among these, Building A is the most interactive, featuring an explorable ground floor, a staircase leading to the second level, and the architectural model displayed beneath the stairs. In contrast, Building AA contains some exterior details but remains inaccessible.

Both Buildings B and L have well-defined exterior structures, yet their interiors are empty, lacking floors or classrooms, and remain inaccessible due to map limitations. Additionally, placeholders (cubes) represent other buildings that were not fully designed.

The explorable area is restricted to the central section of the main plaza, with invisible barriers limiting movement beyond certain points. However, the virtual tour includes interactive features such as sitting at tables, purchasing snacks and water from vending machines, and disposing of items in trash bins. These elements enhance user immersion, making the environment feel more dynamic and engaging.

The virtual tour allows users to choose between a female and a male character, providing a basic level of personalization within the experience. Additionally, a first-person mode is available for a more immersive navigation.

To enhance the environment and make the university feel more dynamic, NPCs (non-playable characters) are included, either standing or walking around the available space. However, players cannot directly interact with them, except by obstructing their path when they are moving or pushing them when they are stationary.

3 PROJECT DEVELOPMENT TIMELINE

This section details the workflow of the project, which was carried out over a six-month period, spanning two academic trimesters at Universidad Autónoma Metropolitana - Unidad Iztapalapa (UAMI), denoted by the acronyms 24P and 24O, concluding on January 27, 2025.
During this timeframe, the development focused on a specific, delimited area of the university, corresponding to the central part of the campus, where most of the teaching buildings, the general rectorate, and the main buildings of the three divisions are located:

- Ciencias Básicas e Ingeniería (CBI)
- Ciencias Biológicas y de la Salud (CBS)
- Ciencias Sociales y Humanidades (CSH)

This central area is highlighted in Figure 1.

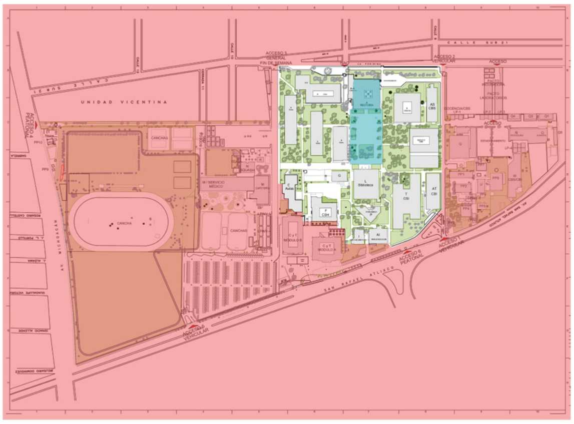

Figure 1: Areas selected for implementation in this version of the UAMI virtual tour.

In Figure 1, different colored areas represent distinct levels of reconstruction: red zones are excluded due to size or limited accessibility; blue marks the currently explorable area from the previous version, including the main plaza and Building A; and areas in the default color indicate the newly added explorable regions, expanding both interior and exterior coverage in this version.

The development of the virtual tour relied on a combination of tools specialized in 3D modeling, animation, and game engine integration. The main platforms used were Blender for geometric modeling, MakeHuman for avatar generation, Substance Painter for texture painting, and Unity for scene integration and interactivity. These tools enabled the team to produce coherent and responsive experience while maintaining asset modularity and visual fidelity.

We decided to use the Scrum agile framework (Schwaber & Sutherland, 2020), which emphasizes iterative development, regular feedback, and continuous improvement.

The development process was structured around weekly Sprints, with a total of 22 iterations, corresponding to the academic calendar of two consecutive trimesters during which the project was executed (Young et al., 1995).

This framework was selected to facilitate team coordination, promote progressive integration of features, and maintain a manageable workload within a university environment. The specific application of Scrum, including team roles, tools, planning sessions, and retrospective practices, will be detailed in the following subsections.

3.1 Implementation of Scrum Methodology

The development of the UAMI Virtual Tour was managed using the Scrum framework, with a small team of four members: Benjamín Moreno-Montiel served as Product Owner, leveraging his position as a full-time professor to obtain architectural plans, access the campus for manual measurements, and guide the team using insights from the 2017 tour; Abel Isaac Samaniego-Álvarez acted as Scrum Master, coordinating tasks and providing technical leadership due to his experience with Blender and Unity; while Luis Quiñones-Hernández and Eva Lorena Pérez-de-la-Luz worked primarily as Developers, contributing to 3D modeling, Unity integration, and feature implementation.

The project spanned two academic trimesters (24P and 24O), with a structure of *22 one-week Sprints*. Sprint Planning sessions were conducted weekly, where user stories were evaluated using *Planning Poker* with the *Fibonacci sequence* to estimate complexity and effort. Tasks were organized and tracked using *Jira* with *Kanban boards*, and the codebase was maintained in a shared *GitHub repository* to enable remote and asynchronous collaboration.

Burndown Charts were used weekly to monitor progress and team velocity. Although daily stand-up meetings were not feasible due to academic commitments, weekly checkpoint meetings were held, and progress updates were regularly exchanged via *Discord*.

Sprint Reviews and Retrospectives were conducted at the end of each Sprint to assess deliverables, identify blockers, and adjust workflows as necessary. This agile structure facilitated transparency, rapid feedback, and continuous improvement throughout the development of the virtual tour.

3.2 Product Backlog Overview

The development of the UAMI Virtual Tour followed the Scrum agile framework, organizing tasks into six main categories and classifying them based on their stage in the planning process. The product backlog was structured into six categories:

1. Initial Setup – Software installation (Unity, Blender, GitHub, etc.), blueprint collection, and review of the 2017 tour.
2. Narrative & UX – Character design, mechanics planning, and environmental storytelling (including night scenarios).

3. 3D Modeling – Buildings B, C, E, F, L, T, AT and areas like plazas and sports zones; future additions include monuments and other facilities.
4. Unity Integration – Object and NPC placement, with initial scenes functional and future expansions planned for interactive storytelling.
5. Visuals & Textures – Application of materials via Substance Painter, with plans for enhanced lighting and special effects.
6. User Interaction – Informational panels, music, and basic NPC behaviors, with future goals including scoring systems and AI-driven interactions.

This well-organized Product Backlog helped maintain a clear development workflow (Young et. al. 2016), making it easier to track progress and laying the groundwork for future improvements to the UAMI Virtual Tour.

While the Product Backlog is traditionally organized and prioritized by business or user value, in this academic context we opted to group the backlog items by type of technical activity (e.g., modeling, interface, mechanics). This structure better reflected the internal workflow of the development team, which was composed of students learning to apply Scrum in a software engineering context. The Product Owner defined and validated the backlog items collaboratively, focusing on pedagogical clarity and incremental progress rather than stakeholder-driven business value. Each group of tasks contributed specific features toward the overall functionality of the virtual tour

3.3 Buildings and Infrastructure of UAM Iztapalapa

The campus of Universidad Autónoma Metropolitana - Unidad Iztapalapa (UAMI) includes a wide range of academic, administrative, and recreational spaces such as division-specific buildings, libraries, cafeterias, sports courts, and plazas. For this version of the virtual tour, a significant subset of these facilities was selected for reconstruction, including core academic buildings, green areas, and common zones. A summary of the progress made on these elements is provided later in the Results section.

3.4 Deliverables of the 22 Proposed Sprints

In this section, we will briefly present each of the deliverables obtained in the 22 proposed Sprints. As previously mentioned, we used the Scrum framework to better organize and carry out the development of this virtual tour. Scrum, as an agile methodology, emphasizes iterative development, collaboration, and flexibility, which are essential when dealing with complex projects like virtual environments. Each Sprint allowed us to incrementally build and refine different components of the project, including 3D modeling, user interaction features, and integration of educational content.

This approach not only facilitated continuous feedback and adaptation but also ensured that the project remained aligned with its objectives throughout the development process. The effectiveness of Scrum in managing similar projects has been highlighted in various studies, such as the work by (Gordillo et al. 2024), who examined and compared the effectiveness of virtual reality serious games and LEGO Serious Play for learning Scrum, demonstrating the benefits of iterative workflows in enhancing productivity and quality in software development.

3.4.1 Summary of Development Activities (Sprints 1–22)

The development of the UAMI Virtual Tour spanned 22 Sprints across two academic trimesters and followed a structured Scrum approach. The first phase (Sprints 1–3) focused on foundational planning, including backlog definition, team role assignments, architectural exploration, and tool validation. During the next phases (Sprints 4–17), the team transitioned into active development, modeling objects, characters, and buildings such as C, T, and B, while introducing features like story mode selection, NPC dialogues, interactive buttons, and user customization. Visual and performance optimization efforts were also carried out, including texture compression and resolution reduction, which cut the overall project size nearly in half without sacrificing fidelity.

During Sprints 15–17, the project's storage size was reduced from 1.32 GB to 803 MB by reorganizing assets and applying optimizations such as lowering texture resolution (e.g., walls, NPCs, trees) and converting 32-bit textures to 8-bit. These changes significantly improved loading times and responsiveness, particularly on lower-end devices, without compromising visual quality.

Figure 2 showcases the virtual assistants designed to support users within the virtual tour, specifically located in Building B. These characters evoke the administrative processes typical of the UAMI campus during the 1990s, enhancing the nostalgic and informative aspects of the tour. Additionally, the bottom section of the figure highlights the comprehensive progress achieved, reflecting the culmination of efforts during the final Sprints dedicated to the project's deployment and optimization, illustrating the fully developed virtual environment.

Figure 2: Virtual Assistants and Final Project Deployment.

To enrich the educational value of the experience, the development team consulted the Servicios Escolares office, located on the ground floor of Building B, to identify the most frequently asked questions by incoming students. Based on this input, the NPCs were programmed with a simplified chatbot-like dialogue system, offering preloaded questions and answers that users can explore by interacting through the mouse. These dialogues address topics such as enrollment requirements, procedures for dropping or modifying courses, duration and structure of degree programs, and general information about campus facilities.

This interaction model transforms NPCs into informative guides, supporting prospective students and visitors as they virtually explore the university. By simulating real-life consultations with staff, the experience not only provides practical value but also enhances immersion and realism.

From Sprints 18–22, deployment and testing were prioritized. Sprint 18 prepared the Unity environment for WebGL builds, configuring resolution, platform settings, and debug options. Sprints 19–20 handled the deployment to AWS S3, adjusting access policies and permissions to serve the project as a static site. The project was also hosted via Amazon Amplify for added reliability. In the final stage (Sprints 21–22), a Docker-based deployment was implemented on a proprietary SSH server, ensuring greater control and scalability.

Finally, Figure 3 showcases the virtual tour running on the website hosted under the domain *mathonline.izt.uam.mx*, provided by Universidad Autónoma Metropolitana - Unidad Iztapalapa.

4 RESULTS

The development of the Virtual Tour of Universidad Autónoma Metropolitana - Unidad Iztapalapa aimed to create an immersive, interactive environment that accurately represents the campus infrastructure. This section presents the outcomes of the project, showcasing the visual and functional fidelity achieved through meticulous 3D modeling, texturing, and deployment strategies outlined in the previous sections.

Figure 3: Virtual tour of the UAM Iztapalapa in a Proprietary SSH Server Using Containers.

Key buildings and areas within the campus have been reconstructed, reflecting architectural details and environmental elements that contribute to the authentic virtual experience. In contrast to the limited and static 2017 version, the current platform allows users to freely explore the campus and interact with elements such as signs, buttons, and NPCs. The improved graphical fidelity and architectural accuracy also offer a more realistic and informative experience. Table 1 summarizes the key differences between both versions.

Table 1: Comparison between the 2017 and 2024 versions of the UAMI Virtual Tour.

Feature	2017 Tour Version	2024 Tour Version
Rendering Technology	Photographic stitching	Free exploration with FPS controls
Navigation	Linear walkthrough	Free exploration with FPS controls
Interactivity	None	Buttons, NPCs, animated elements
Buildings Covered	2 main buildings	14 buildings + common areas
Platform	Local .exe	Web-deployed (Docker + AWS S3)
Multi-user Capability	Not available	Planned with Photon Unity

Compared to the 2017 version, the current virtual tour represents major improvements in rendering (real-time 3D with FPS navigation), interactivity (buttons, NPCs, animated avatars), and scalability (web deployment and multi-user planning). Table 1 summarizes these differences. At present, the virtual environment includes 14 reconstructed buildings and common areas, representing 44% of the campus, with key features such as navigation guides, informative signage, and animated student characters. Table 2 details the progress for each reconstructed element. Although no formal user evaluation has been conducted yet, future work will involve empirical studies to assess the platform’s usability and educational value, particularly for prospective students and faculty.

Table 2. Progress of Reconstructed Elements in the Virtual Tour Project.

Building A - Rectorate	Building L - Library	Building W - Maintenance
Building AA	Building M – Cafeteria, SM	NAO
Building B	Building N	Main Plaza
Building C	Building Ñ - Supply Office	Soccer Field
Building D	Building O - Warehouse	Tennis Court
Building E	Building P - Graduate Studies	Basketball Courts
Building F	Building R	Tree Plaza
Building G - Bookstore	Building S	Fast Soccer Courts
Building H and AH	Building AS	Onca Plaza
Building I - Supercomputer	Building T	Volleyball Courts
Building AI - Imaging	Building AT	Open-Air Theate
Building K - Kiosk	Building U	Tennis Courts

The development of this virtual tour offered several insights into the application of Scrum methodologies in educational software projects. One major challenge was aligning weekly Sprints with the irregular academic schedule, which was addressed through asynchronous updates and a flexible delivery model. Another observation concerns the balance between model fidelity and performance, which required iterative optimization strategies throughout the project. The project also revealed that user immersion benefits significantly from the integration of NPCs, which opens the door for further AI-enhanced features. Overall, the iterative Scrum-based approach proved effective in maintaining progress, encouraging collaboration, and allowing continuous integration of feedback even in an academic setting.

To conclude, Figure 4 presents a visual comparison between real-life and virtual representations of four key areas of the UAM Iztapalapa campus. These include: the NAO (Nuevo Acceso Oriente), which serves as the main student entrance; Building A, home to the general rectorate; Building B, which houses the most frequently used classrooms in the CBI; and Building T, a central academic hub for CBI activities and the origin points of this virtual tour project.

Figure 4: Real and Virtual Representations of NAO, Building A, Building B, and Building T.

5 CONCLUSIONS AND FUTURE WORK

The development of the virtual tour for Universidad Autónoma Metropolitana - Unidad Iztapalapa demonstrated the effectiveness of applying the Scrum framework with weekly sprint cycles (Haavisto, 2021), which enabled consistent progress despite the small development team. Key features—such as interactive information buttons and virtual campus guides—were successfully integrated to enhance user engagement. However, limitations persist due to the project's broad scope and resource constraints.

A significant challenge was the mismatch between architectural blueprints and the actual

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building layouts, which led to manual on-site measurements to accurately recreate interior spaces. Future iterations would benefit from closer coordination with campus facilities to access updated structural data.

Next steps include extending the tour to cover more campus areas and deploying mobile-ready versions via Unity's Android and iOS build targets. Building on the current Docker-based SSH deployment, future releases will incorporate optimizations like texture compression, resolution scaling, and simplified shaders. Multi-user functionality will be explored through Photon Unity Networking (Camarinha-Matos et al., 2001), and learning modules will follow a mission-based structure aligned with academic divisions. Planned user experience assessments include surveys and guided walkthroughs with prospective students.

Additionally, the NPC system will evolve from static administrative support into an intelligent network of academic mentors distributed across the campus. While current NPCs in Building B deliver answers to frequently asked student questions (Dawley et al., 2014), future agents will leverage large language models such as BERT or GPT, fine-tuned on academic content, to offer interactive guidance about programs, courses, and research areas. This opens a new research line in AI-assisted education, where LLMs complement—rather than replace—human instructors by offering scalable, high-quality academic support in immersive virtual environments.

The main scientific contributions of this work are: (1) the structured application of Scrum in an immersive academic development context, (2) a robust, web-deployable architecture for virtual campus tours, and (3) the design of an AI-integrated framework for educational NPCs using large language models.

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