https://doi.org/10.22398/2525-2828.926145-161

Communal Houses of the Javari Valley: an AI Contribution through Stable Diffusion for the Preservation of Brazilian Cultural Heritage

Casas Comunais do Vale do Javari: uma contribuição de inteligência artificial por meio de Stable Diffusion para a preservação do patrimônio cultural brasileiro

Silvio Lasmar dos Santos[I], Marcos Paulo Cereto[I], Lúcio Tiago Maurilo Torres[I]

ABSTRACT

This study explored the application of Generative Artificial Intelligence (AI) in the reimagining and digital preservation of indigenous communal houses in the Northwestern Amazon. By discussing the transformative potential of AI technologies in interpreting and safeguarding this irreplaceable cultural heritage, the research highlights the intrinsic role of these structures as hubs of community, social, and spiritual life among indigenous peoples. Through the analysis of a photographic collection, the research aimed at digital conservation and the investigation of new architectural forms in the pursuit of bridging tradition and innovation. This study, by employing Generative AI, opens new horizons for the understanding and reinterpretation of indigenous architecture and culture, demonstrating the potential of this technology as a possible tool for the preservation and celebration of global architectural heritage. The results underscore the AI's ability to generate visual representations that capture the formal essence of the communal houses, providing insights for future research and practical applications in material cultural heritage.

Keywords: Indigenous architecture. Material cultural heritage. Artificial intelligence.

RESUMO

Este estudo explora a aplicação de inteligência artificial (IA) generativa na reimaginação e preservação digital de casas comunais indígenas do Noroeste Amazônico. Ao discutir o potencial transformador das tecnologias de IA para interpretar e salvaguardar esse patrimônio cultural material insubstituível, a pesquisa destaca o papel intrínseco dessas construções como núcleos de vida comunitária, social e espiritual nos povos indígenas. Por meio da análise de um acervo fotográfico, a pesquisa visa à conservação digital e à investigação de novas formas arquitetônicas, com a busca de uma ponte entre tradição e inovação. Este estudo, ao empregar a IA generativa, abre novos horizontes para a compreensão e reinterpretação da arquitetura e cultura indígenas, demonstrando o potencial dessa tecnologia como possível ferramenta para a preservação e celebração do patrimônio arquitetônico mundial. As imagens resultantes evidenciam a capacidade da IA de gerar representações visuais que capturam a essência formal das malocas, com percepções para futuras pesquisas e aplicações práticas em patrimônio cultural material.

Palavras-chave: *Arquitetura indígena. Patrimônio cultural material. Inteligência artificial.*

[I]Universidade Federal do Amazonas – Manaus (AM), Brazil. E-mails: silviolasmar96@gmail.com; mcereto@ufam.edu.br; lucio.torres@ufam.edu.br
Received on: 02/19/2024. **Accepted on:** 06/06/2024.

INTRODUCTION

According to Hazucha (2022), the intersection of generative artificial intelligence (AI) and architectural heritage is an emerging field of research, brimming with innovations and opportunities. This article focuses on the use of generative AI to visually recreate *malocas*, which are emblematic and historically rich structures of the people of the Northwest Amazon. These constructions are more than mere buildings; they serve as symbolic sites for community activities, ceremonies, and ritualistic practices, reflecting the richness and traditions of the societies that build them.

Generative AI is a technology that uses machine learning algorithms to create new and original content based on large datasets. This type of AI can generate works of art, texts, music, and other types of digital content that extend beyond what has been explicitly programmed (Delsignore, 2022).

Generative AI operates based on models that learn patterns and characteristics from the data they are trained on. For example, in the context of visual arts, tools like ChatGPT and Stable Diffusion can analyze thousands of artworks and learn the aesthetics, styles, and techniques present in those works. Once trained, these models can generate new images that reflect the learned patterns but in new and unique ways (Hutson; Harper-Nichols, 2023).

In this context, generative AI emerges as a tool to capture and reinterpret the essence of these structures. This research aimed not only to preserve the image of these buildings but also to explore new forms of architectural and cultural expression.

The methodology adopted in this study involved preparing an image bank with 73 records of longhouses, using photos from *Instituto Socioambiental* to capture the architectural and cultural essence of these structures. Evaluation criteria for selecting images to train the generative AI model focused on ensuring high visual quality and cultural significance. Firstly, the images needed to have sufficient resolution for clear detail, be free of visual obstructions, and be well-lit to facilitate effective training. This included capturing different perspectives, angles, and lighting conditions. Furthermore, it was essential that the images authentically represent the architecture and cultural elements of *malocas*, such as the iconography on their walls and the textures of the materials used in their construction. Images were resized to a 1:1 aspect ratio and 512 px for training the AI models, which were then trained to learn and assimilate the style and characteristics of *malocas*.

The aim of this study was to explore the use of generative AI for the digital preservation of indigenous *malocas*, evaluating its effectiveness in digitally reproducing a crucial aspect of indigenous heritage. Additionally, the study aimed to investigate how this technology can facilitate the emergence of new perspectives and representations and examine how these representations can contribute to enriching global understanding of indigenous communities and their traditions. This study also sought to demonstrate the importance of implementing sensitive and respectful technological approaches in cultural heritage contexts.

MALOCAS AND COMMUNAL HOUSES

An epicenter of indigenous culture and architecture

Hans Staden, a German adventurer and mercenary born around 1525 in Homberg, Hesse, Germany, traveled to Brazil on two occasions, first as a soldier and later as an artilleryman in a Portuguese fortress. During his second trip, he was captured by a *Tupinambá* tribe on the coast of what is now the state of São Paulo, remaining in captivity for approximately nine months.

His work is one of the oldest descriptions of Brazil's indigenous people, their cultural practices, rituals, and everyday life. It also provides valuable information about the region's flora and fauna. Staden's (2014) report is considered an important document for studying the first contacts between Europeans and Brazilian indigenous peoples, even though his descriptions are filtered through the perceptions and prejudices of a 16th-century European.

In his book *Viagem ao Brasil*, Staden (2014) describes in detail the homes of the *Tupinambás*, showing appreciation for their functionality and adaptation to the environment. He notes that the huts are built collectively, highlighting the communal aspect of indigenous society. *Malocas*, large and domed in shape, are covered with palm leaves to prevent rain from entering, and there are no internal divisions, providing a shared space for families. The doors are low, requiring one to bend over to enter or exit, and each couple has their own designated space inside the cabin. Staden (2014) also mentions the importance of proximity to resources such as water, firewood, game, and fish when choosing the location of the huts, reflecting the deep connection with the natural environment. His description suggests a recognition of social organization and efficiency in housing construction, despite the context of captivity and cultural differences.

Cristina Sá and Corrêa (1979), in their study on indigenous housing in Alto Xingu (Mato Grosso – MT), detail the cultural importance and functionality of this traditional house. The authors highlight its collective construction and intrinsic symbolism. The house, besides serving as a shelter, reflects social organization and the community's relationship with the environment, incorporating natural elements into its structure and layout. Its construction is a communal process that emphasizes social cohesion, involving meticulous steps from selecting materials to dividing space for various social and family functions. This underscores the profound link between housing, culture, and environmental sustainability.

Today, *malocas*, although rarely used as residential spaces, continue to serve as centers for meetings and festivities, playing a vital role in the social life of communities. For instance, the headquarters of the Federation of Indigenous Organizations of Rio Negro (*Federação das Organizações indígenas do Rio Negro* – FOIRN) in São Gabriel da Cachoeira (Amazonas – AM) includes a *maloca* where assemblies and celebrations are held. In his book *Viagens pelo Amazonas e Rio Negro*, Alfred Russel Wallace (1979) described a *maloca* he visited in 1851 on the Uaupés River (in Açaí-Paraná) as a large house, highlighting the historical significance of these structures.

In the past, these lodges were the epicenter of important ceremonies and daily life. Hugh-Jones (1979), in his study of the Tukano people, emphasizes the role of malocas in Jurupari rituals, which delineated distinctions and connections within anthropological models of descent and consanguinity.

> Jurupari had said "'You will do all this in my memory." In memory of the one who had ascended, they made masks and dances. He is the chief of the dancers and leads the dance. Those who don't want to dance are whipped. He is also the chief of the instruments. Women must not see the instruments. Since Jurupari had to keep the secret of that music, women have never seen the instruments. Men will kill them if they do. They did not want to live where Jurupari had died; they dispersed and built their houses on the riverbanks (Hugh-Jones, 1979, p. 307).

In addition to serving as venues for religious ceremonies and rituals, *malocas* functioned as spaces for daily activities, work, food storage, and social gatherings. The internal organization of malocas reflected a hierarchy and spatial distribution that valued both practical use and traditional cultural norms. Objects found within these structures, such as hammocks, benches, and cooking utensils, attest to the rich daily life that unfolded inside them. The deepest part of *malocas* typically housed the chief, while preceding areas were reserved for visitors, illustrating a clear spatial division and respect for hierarchy (Figure 1).

Source: Instituto Socioambiental Collection(2019).
Figure 1. *Tukano maloca*, Caruru community, Tiquié River, Alto Rio Negro Indigenous Territory, Amazonas.

> The dancers who used to dance the *oko wewo* dance now go out to dance *hia basa*, which starts and ends outside the house in the square. The dance continues throughout the night and into the next day. At noon, a singing session is held to pour out the beer. Hosts and senior guests walk to the

> female end of the house. The singer carries a long spear rattle (*murucu besuu*). This spear is decorated at one end with engraved designs, white tufts, and feather plumes. At the other end, there is a swelling filled with small quartz stones. Standing between the two shamans, the singer holds the spear in one hand and strikes it with the other, causing it to rattle with a rapidly increasing rhythm (Hugh-Jones, 1979, p. 98).

With the population growth of the *Tukano* people and the proliferation of *malocas*, there was an evolution in materials and the crafting of ceremonial instruments. Historically, items like benches were adorned with small stones (quartz), similar to other ceremonial instruments. However, over time, they transitioned to being primarily made of wood, with sizes varying according to the user's status within the community. For example, benches measured four palms in size for a *baya* (dance master) and three ones for their companions. These benches served both ceremonial purposes and were utilized in everyday household activities.

> There may be more than thirty subdivisions among the *Tukano*, each with its own name and ideally forming a hierarchical set. Currently, with all the dispersions that have occurred over the past centuries, hierarchical positions are a source of controversy and varying interpretations. The *Tukano* are traditional makers of the ritual bench made of wood (*sorva*) and painted on the seat with geometric motifs similar to those of woven patterns. It is a highly valued object, mandatory at ceremonies and rituals where they sit (Cabalzar; Ricardo, 2006, p. 42) (Figure 2).

Contact with colonizers and missionaries led to the destruction of malocas, which were replaced by villages and communities along the rivers. This process increased population density and altered territorial organization. Despite these

Source: Instituto Socioambiental Collection (2019).
Figure 2. Itacoatiara Mirim *Maloca*, peri-urban region of São Gabriel da Cachoeira.

changes, there was resistance, and the *maloca* tradition was maintained and adapted to new social contexts, becoming a symbol of cultural preservation over the centuries.

"There was a large *maloca* and several small houses. The Indians of this village, who have already traveled with traders from the Rio Negro, try to imitate their customs and thus are getting used to living in separate houses" (Wallace, 1979).

Aloisio Cabalzar (2006), along with Carlos Alberto Ricardo, in their work Indigenous Peoples of the Rio Negro: An Introduction to the Socio-Environmental Context of the Northwest of the Brazilian Amazon (*Povos indígenas do Rio Negro: uma introdução à socioambiental do noroeste da Amazônia Brasileira*), emphasizes the diversity and complexity of indigenous cultures in the Rio Negro (AM) region, underscoring the importance of *malocas* as central elements of these civilizations. In another work, "The Profane Temple: Salesian Missionaries and the Transformation of *Maloca Tuyuka*" (*O Templo Profano: missionários salesianos e a transformação da maloca tuyuka*), Cabalzar (1999) analyzes how the arrival of Salesian missionaries and the resulting religious conversion impacted the structure and significance of *malocas* for indigenous peoples, highlighting the tension between internal customs and external influences.

These works highlight how *malocas* have been impacted by external factors, such as colonization and religious conversion, over time. They also demonstrate how indigenous peoples have resisted and adapted traditions to preserve their identities. Thus, *malocas* go beyond being a mere physical structure; they are a symbol of the cultural resilience of indigenous peoples in the face of historical and social transformations.

"The Salesians also insisted a lot and eventually succeeded in convincing the Indians to abandon their *malocas* and settle in villages composed of separate houses for each family under the false pretexts of sexual promiscuity" (Cabalzar; Ricardo, 2006).

For Almir de Oliveira (2014), indigenous houses represent complexity and diversity, challenging the common perception that they are all the same. Oliveira (2014) emphasizes the connection between the architecture of these houses and the worldview of different cultures, where construction reflects both material and spiritual properties, social organization, and kinship relationships. The author also discusses the negative impact of colonization, which aimed to destroy longhouses and alter habits, breaking traditions and separating families. However, there is a movement to revive and reclaim these customs by reconstructing *malocas* as spaces of memory, ritual, and education, highlighting the ongoing effort to preserve indigenous culture amidst contemporary challenges.

The social, cultural, and political organization of *malocas*, with their new spatial configuration, continues to strengthen the identity of the indigenous people, their knowledge, and their epistemologies, which have often been devalued by the West. The upper Rio Negro microregion, rich in civilizational and immemorial heritage, exemplifies this significance.

It is important to highlight the contemporary nature of indigenous constructions in the Amazon. The deconstruction of the colonialist idea of primitivism, tied to a pre-Columbian past, is materialized through the modernity of biodegradable and sustainable solutions adapted to new times, using the means and materials available over the centuries. The formal resumption by AI of these communal houses provides a new perspective for students from native peoples, who have been present in public universities since 2012 with the implementation of quotas (Law 12.711 of 2012), and opens a positive scenario of cultural visibility.

Malocas and communal houses as buildings

The architecture of *malocas* is both functional and symbolic. Each family group, as described by Rezende (2006), organizes its own housing, which serves as the center for socializing and learning cultural values. These structures are fundamental to the organization of the indigenous way of life, and their disruption has had a profound impact on these customs.

Wallace (1979), during his visit to Jauarité in the region of the Uaupés River (AM), described a *maloca* as a large house measuring about 150 feet (approx. 46 m) in length, 75 feet (22.86 m) in width, and 30 feet (9.1 m) in height, capable of housing approximately a dozen families or about a hundred people. These structures follow a distinctive architectural plan, generally in the shape of a parallelogram with semicircular ends, indicating a design that is both functional and aesthetically significant.

> Their houses are the common domicile of numerous families, sometimes of an entire tribe. In plan, the house is a parallelogram with a semicircle at one end. The dimensions of one I saw in Jauarité were 150 feet in length, 75 feet in width, and about 3 feet in height. This house accommodated about twelve families, approximately one hundred individuals. During times of festivals and dances, it can shelter between 300 and 400 people (Wallace, 1979, p. 589).

Construction follows a hierarchy of shamans and chiefs, with each community building their *maloca* according to their origin and level of hierarchy. For instance, the *Tukano* people construct structures symbolizing the body of the creator father, the Moon God *Yepá Õakhë*, and adorn them with animal symbols and other significant elements.

The roofs of *malocas* typically featured steeply sloped gables. *Caraná* straw was predominantly used for roofing due to its effectiveness in providing protection against rain and its durability. Additionally, other materials like braided or sewn *buçu* were commonly employed. The walls were often constructed from woven palm, with lengths varying from 2 to 3 m (Figure 3).

The main walls of *malocas* are typically constructed using tree bark up to a certain height, with the upper portions complemented by *açaí* palm. In some regions, *paxiúba* trunks are also used. These structures served not only as residences but also as places where knowledge, rituals, and traditions were passed on and reinforced.

Source: Instituto Socioambiental Collection (2019).
Figure 3. São Pedro Community *Maloca*, Alto Rio Negro Indigenous Territory (AM).

Furthermore, the paintings on these walls, often simple charcoal traces, and the supporting pillars had special significance. Beksta (1988) highlights that the pillars were named after Desana ancestors, with each side of the *maloca* representing different hierarchies within the community.

Sá and Corrêa (1979) state that the construction and use of a traditional house in Alto Xingu (MT) is presented as a process that incorporates specific technical knowledge and deep integration with the environment. This process begins with the careful selection of materials, which must be gathered sustainably, respecting seasonality and natural resource regeneration. The organization of the house's internal space follows patterns that reflect the social structure and ritual functions of the community, illustrating how indigenous architecture is inherently linked to the cultural and spiritual aspects of the Upper Xingu people. The construction process itself is collective, involving labor and the transmission of knowledge across generations, thereby strengthening community bonds and cultural identity.

These architectural details of *malocas* illustrate the complexity and richness of indigenous traditions and practices, showcasing a deep connection between physical, spiritual, social, and individual spaces.

GENERATIVE ARTIFICIAL INTELLIGENCE AND CREATIVE ECONOMY

The emergence of the generative AI tool Stable Diffusion, an image-generating artificial intelligence used in various applications such as MidJourney and DALL-E, in 2022, disrupted established practices in the art world. This led to debates about the validity of "AI Art" and sparked the emergence of a new market for non-fungible tokens (NFTs) (Hutson; Harper-Nichols, 2023).

Such generative tools utilize machine learning algorithms and neural networks to create complex and intricate works. These AIs undergo training sessions where they are exposed to images paired with textual descriptions to learn contextual understanding, textures, shapes, and colors (Hutson; Harper-Nichols, 2023).

A distinctive feature of AI-generated art is its capability to work with large datasets, enabling artists to create highly diverse and expressive works that incorporate a wide range of visual elements.

The ability to generate images via text prompts democratizes access to artistic creation, as it does not necessarily require creators to possess traditional artistic skills. However, it also sparks debates about the distinction between genuine art and mere pixel reproductions produced by a machine.

Open-source[1] options like Stable Diffusion highlight the increasing integration of AI in contemporary art, despite initial resistance from traditionally trained artists, primarily over copyright concerns (Delsignore, 2022; Hazucha, 2022).

Generative AI has revolutionized creative economy by introducing new methods for producing and distributing cultural content. As emphasized by Davenport and Bean (2023), the entertainment industry, particularly in Hollywood, has undergone substantial transformations owing to these systems' capability to automate the creation of scripts, storyboards, and images. This has enhanced efficiency and reduced costs. Moreover, this technology's ability to adapt existing content to new contexts further underscores its value in fields requiring ongoing innovation in creative materials (Davenport; Bean, 2023).

The discourse surrounding AI in the creative sector extends beyond operational enhancements to encompass ethical and cultural implications. The deployment of intelligent algorithms challenges conventional norms of authorship and originality, prompting debates about the authenticity of AI-generated content. Content production heavily reliant on historical and pre-existing data can result in works that lack innovation, potentially perpetuating stereotypes and established forms rather than fostering creativity (Davenport; Bean, 2023).

Furthermore, the integration of this tool into creative and productive practices reflects shifts in working relationships within cultural and creative industries. The automation of tasks traditionally performed by humans has necessitated a reevaluation of professional roles. For instance, the Writers Guild of America strike underscored concerns about job security and working conditions amid technological innovations (Davenport; Bean, 2023).

Despite the challenges, there are promising prospects for AI in creative economy. According to Trevisan and Braga (2022), these technologies offer unprecedented opportunities for experimentation and the development of new forms of artistic expression. Scholars argue that AI can serve as a tool for exploring uncharted artistic

1 It refers to software whose source code is publicly available for use, modification, and sharing by anyone. This code is developed collaboratively and distributed under licenses that allow its use, modification, and redistribution, typically at no cost to users.

territories and expanding the frontiers of human creativity through innovative collaborations between humans and machines.

The evolution of these algorithms in the creative market indicates that future generations of creators will need to adjust to an environment where technology plays a central role. Effectively integrating AI into creative practices will be crucial for defining success in the upcoming era of cultural and artistic production. The adaptation to these tools will showcase the technical skills of those involved and their capacity to shape and influence the cultural trajectory of their works (Heaven, 2023).

METHODOLOGY: GENERATIVE ARTIFICIAL INTELLIGENCE IN THE RECONSTRUCTION OF *MALOCAS*

Adopting the methodology outlined by Hutson and Harper-Nichols (2023) in their study *Generative AI and Algorithmic Art: Disrupting the Framing of Meaning and Rethinking the Subject-Object Dilemma*, this study initiates with the creation of an image repository of *malocas*, utilizing a photo collection sourced from *Instituto Socioambiental* as primary dataset.

Initially, 73 records of *malocas* were selected and subjected to analysis with stringent image quality criteria, mandating a minimum resolution of 300 dpi to ensure clear capture of fine details.

The images must include frontal, side, and aerial angles to provide a comprehensive, three-dimensional view of the structures. The scenes should be unobstructed, without visual obstacles in front of or near the structures, to avoid distortion in the generated images. Various focal lengths are explored, including detailed close-ups of decorative and textural elements, as well as general views that illustrate how *malocas* are integrated into their surroundings.

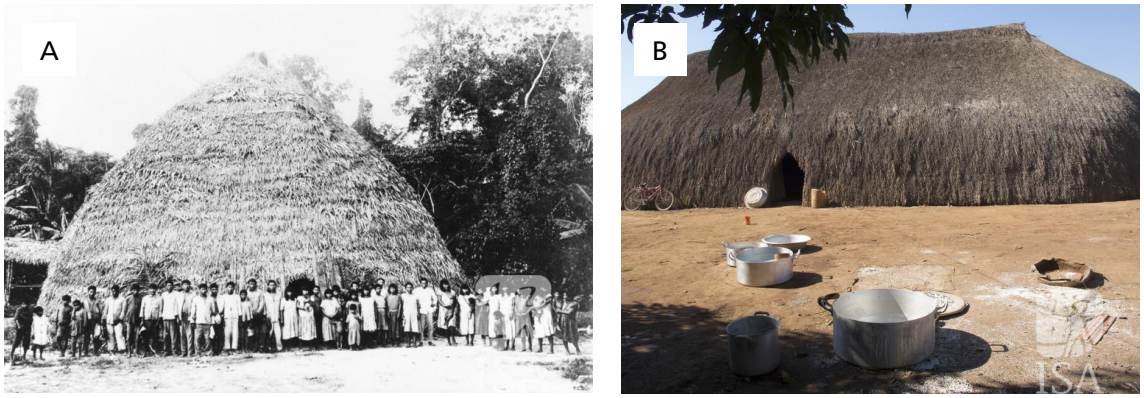
In addition to technical aspects, it is crucial that the images authentically portray the architecture and cultural elements of *malocas*. Special attention is given to distinct characteristics such as the shape, construction materials used, paint, straw, and wood.

After the selection process, 33 photographs were discarded, resulting in 40 images that met the necessary requirements for AI training (Figures 4 and 5).

Subsequently, the "Automatic1111 / Stable Diffusion web UI" [2] interface was installed on a Ryzen 7 5700x computer with 32 gigabytes of RAM and a dedicated RTX 3070 graphics processor, using GitHub to run it locally via Python. This setup enables the training of generative models offline, disconnected from the internet. The next step involved uploading the images to the Astria.ai platform, where they were resized to a 1:1 ratio at 512 px for standardization.

Astria.ai is a tool within the field of generative art where users can upload images to train AI models. These models learn and incorporate the style and characteristics of the uploaded artworks through a training process. Once trained, these

2 User interface for generative AI tools like Stable Diffusion.



Source: Instituto Socioambiental Collection (2019).
Figure 4. Samples of images discarded in the selection.

Source: Instituto Socioambiental Collection (2019).
Figure 5. Samples of images qualified for training.

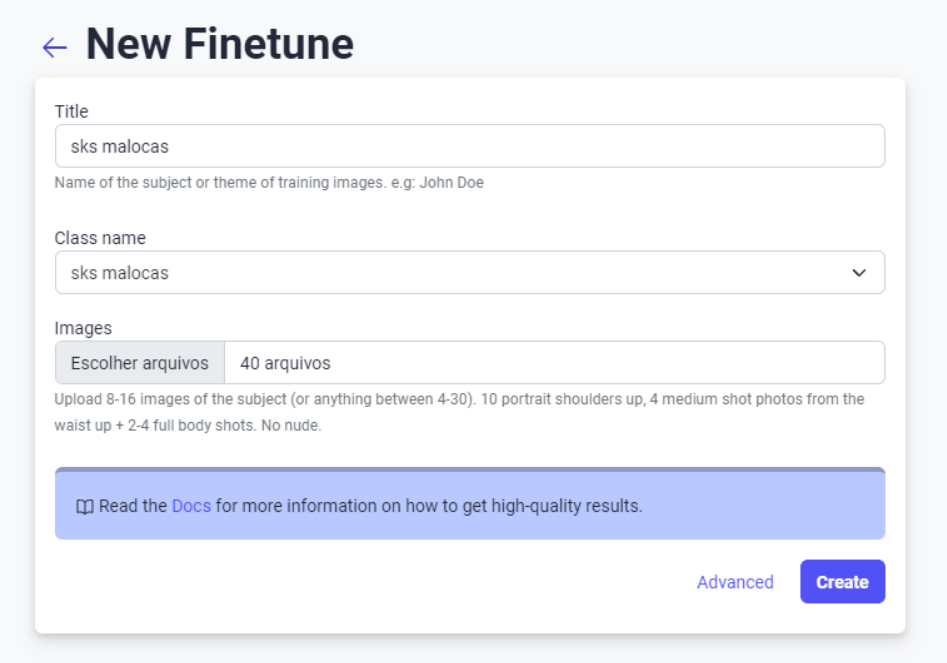
models can generate new pieces of art that reflect the original style while incorporating unique elements generated by AI. Additionally, the tool allows users to export these trained models as checkpoint files, which are compatible with other platforms such as Automatic 1111.

Checkpoint files, often denoted as .CKPT, serve as save points for AI models, preserving the model's state at specific intervals during training. These files store crucial information such as the model's weights, parameters, configurations, and architecture. They are particularly valuable in scenarios where training may be interrupted, enabling users to resume from the last saved point without losing progress.

After uploading the images to Astria.ai, a wait of 32 minutes was required for the generation of a model. This model was subsequently converted into a checkpoint (.CKPT) file for use in Stable Diffusion. These models are referred to as fine-tunes, and users have the option to assign each model a unique name. An example of such a token would be "sks malocas." (Figure 6)

A token functions as an identifier representing a particular model or a set of parameters used in generating new images. For instance, when training a model to create specific images, a token is assigned to denote that trained model. This token can subsequently be used to generate new artworks based on the trained model, ensuring consistency with the predefined style or criteria established during training.

Each token, as an AI-generated reference image, serves as a specific checkpoint in the training process, marking progress and serving as a reference for image

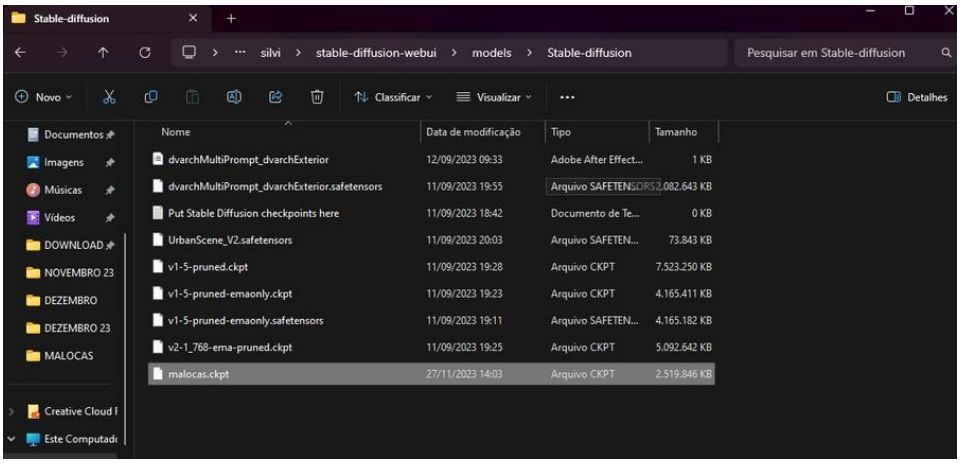


Source: Own authorship (2023).
Figure 6. Using Astria.ai to create the model.

generation. These tokens are crucial for fine-tuning the accuracy and quality of generated images, enabling users to explore various states of the model to achieve optimal results. Through these files, Automatic1111 successfully generated images based on the original photos provided, transforming them into new visual interpretations that preserve the essence and cultural richness of indigenous *malocas*.

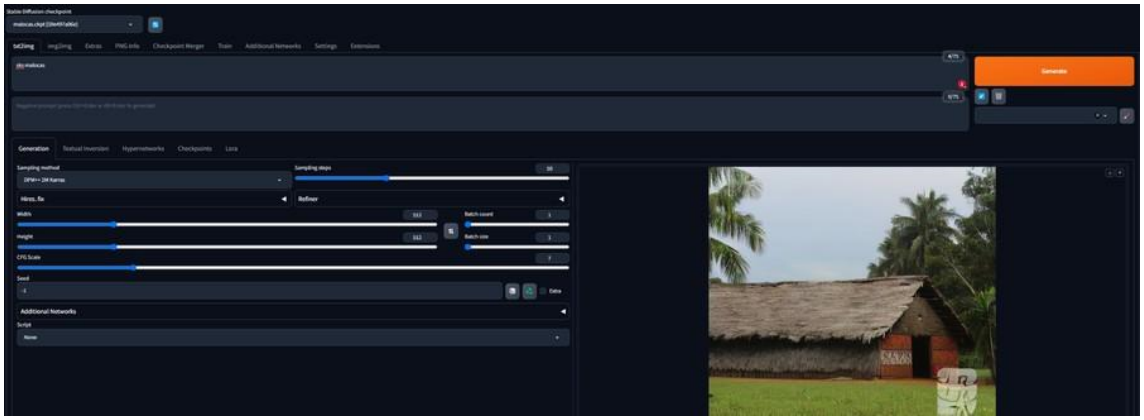
After completing the training of the generative AI model, the next step was to export and integrate the checkpoint file (CKPT) into the production environment for image generation.

Integrating the model into Automatic1111 first required placing the file in the model folder within the corresponding directory in the interface. This integration process is essential to enable the software to recognize and utilize the custom model for imaging (Figure 7).



Source: Own authorship (2023).
Figure 7. Integration of the model into the Automatic1111 interface.

With the infrastructure properly configured and the model integrated into the Automatic1111 "Models" folder, the image generation phase commenced. This process starts by executing lines of text corresponding to the selected token. Each generated image serves as a test, an experiment that allows observation and analysis of the model's capability to interpret and visualize the concepts and architectural characteristics of indigenous malocas with fidelity and creativity (Figure 8).



Source: Own authorship (2023).
Figure 8. Generation of images through the custom model.

The AI-generated representation of *malocas* demonstrates fidelity in architectural and aesthetic aspects, particularly notable in the accurate reproduction of straw roof textures and precise rendering of geometric patterns on the walls, crucial for maintaining cultural authenticity. The application of colors features strong contrasts that effectively accentuate decorative elements, thereby respecting cultural practices associated with these structures.

Adjustments in lighting to better capture the interplay of light and shadow could greatly enhance the three-dimensional perception of *malocas*. These refinements are crucial for advancing the application of AI technologies in digital reconstructions of cultural heritage. They ensure not only technical precision but also deepen the contextual and cultural authenticity required for scientific and educational purposes (Figure 9).

However, it is noted that while the texture of the walls is well represented, greater variation could enhance fidelity to the use of natural materials and manual construction techniques. Additionally, adjusting the color palette to more accurately reflect the natural lighting conditions typical of these buildings' environments could further accentuate the *malocas*' integration into cultural and geographic contexts, both functionally and aesthetically.

At the conclusion of the project, 30 digital representations of *malocas* were generated. Each image reflects a fusion of AI technology with a deep appreciation for the cultural significance of these iconic structures, following a methodical approach that guided the process from data selection to the final stages of image generation.

Source: Own authorship (2023).
Figure 9. Sample of images generated by artificial intelligence.

The digital reconstructions faithfully reflect the original collection, showcasing the technical prowess of the AI model in capturing and conveying the cultural richness and architectural diversity of *malocas*. This outcome is pivotal as it validates the adopted methodological approach, affirming that using original images as a training database is effective for achieving precise and culturally respectful visual representations.

Additionally, the process outlined in the preceding steps provides a practical and comprehensive guide for researchers and creatives interested in exploring the potential of generative AI in digital preservation and interpretation of cultural heritage. The detailed steps, from preparing the image bank to integrating and utilizing models in AI tools, and finally to generating and evaluating images, form a replicable methodology adaptable to diverse contexts.

This project not only achieved its goal of creating visual representations of *malocas* but also paved the way for future investigations and applications of generative AI in the field of cultural heritage. The faithfully generated images provide a new perspective on indigenous architecture, fostering a deeper appreciation of its complexity and beauty, and underscore the role of technology in preserving and celebrating cultural richness (Figure 10).

Architects and designers can leverage tools like Astria.ai and Stable Diffusion to methodically generate representations that honor the historical legacy of *malocas*. While these generative AI tools can extract data from social media platforms like Instagram, their true potential lies in transcending current social media frameworks

Source: Own authorship (2023).
Figure 10. Samples of images generated by artificial intelligence.

and drawing inspiration directly from historical collections. This process can be likened to an artist's "signature brushstroke," enabling architects to continually refine their techniques and workflows for creating increasingly sophisticated and personalized generative content. As the field of generative imaging evolves, this guide aims to empower professionals with the knowledge and skills to push boundaries, unlocking the full potential of this innovative approach.

When assessing the generated images, the meticulous attention to detail in representing the materials used in these constructions stands out, particularly in the texture and arrangement of straw, a crucial element in indigenous architecture. The careful treatment of straw details — including its natural color and weaving pattern — demonstrates a profound understanding of traditional construction techniques.

Moreover, the endeavor to include iconographic representations and illustrations on the walls of longhouses demonstrates a deliberate effort to capture the intrinsic art of these spaces. While the images may not replicate every detail of traditional paintings and adornments with absolute precision, they provide a visual interpretation that aligns with the symbology and themes frequently found in these structures. The variations in patterns and colors seen in the illustrations, for instance, underscore an appreciation for the essential narratives and symbolism within the culture that constructs and inhabits *malocas*.

On the other hand, the challenge of completely and accurately reproducing these intricate illustrations highlights the current constraints of AI tools in capturing the subtleties and depth inherent in manual art. This underscores an area for future advancement in imaging technology, where increased emphasis on the precision of artistic and cultural details could potentially be achieved.

In summary, while the generated images effectively depict the physical structures of *malocas*, there remains an opportunity for enhancement in capturing and reproducing the nuanced and symbolic aspects of the art and decorations that adorn these spaces. Striking a balance between technical precision and cultural expression is crucial for an authentic and respectful representation of *malocas* in their entirety.

This experiment showcased the potential of AI in art creation, highlighting its capacity for innovation and customization in digital imaging. Continued exploration of these techniques promises to further expand the horizons of digital art and design.

CONCLUSIONS

The advent of generative AI tools has revolutionized the realms of art and design, providing professionals with innovative avenues to express creativity. These tools' capability to generate intricate representations of *malocas*, bolstered by extensive image databases, has fostered a new era of exploration and experimentation. The process outlined in this article, focusing on generating AI images of indigenous communal houses using an original art database, offers a comprehensive guide for those aiming to delve deeply into the potential of these cutting-edge tools.

However, as these technologies advance, further research and development to establish standardized processes for creating generative images of *malocas* becomes essential. This evolution may necessitate a shift in art and design curricula, moving beyond conventional technical construction to place greater emphasis on the conceptual framework of creativity.

Additionally, properly exploring and teaching the use of text prompts for AI-generated art is crucial to understanding and anticipating the outcomes of different creative processes. As the boundaries between art and science become increasingly blurred, artists must take a leadership role in developing the algorithms and technologies that support these generative AI tools to fully achieve their creative potential.

These representations offer a new window into understanding these architectural structures, emphasizing their significance as cultural heritage. This work proves the effectiveness of the approach adopted, ensuring that the content generated is original and aligned with the creators' artistic vision, rather than merely replicating content already published on social media.

In summary, the research highlights the transformative potential of generative AI as a tool for the preservation and interpretation of the architectural heritage of indigenous peoples. It expands knowledge about the cultural role of *malocas* in the indigenous context and paves the way for future research on the application of this technology in other forms of digital preservation. These results represent a milestone at the intersection of technology, art, and preservation, opening up exciting possibilities for creative exploration and safeguarding indigenous identity.

REFERENCES

ACERVO INSTITUTO SOCIOAMBIENTAL. **Portal**. Acervo Instituto Socioambiental, 2019. Available at: https://acervo.socioambiental.org. Access on: Nov. 11, 2023.

BEKSTA, Casimiro. **A maloca TuKano:** Dessana e seu simbolismo. Seduc, 1988.

CABALZAR, Aloisio. O Templo Profano: missionários salesianos e a transformação da maloca tuyuka. *In*: WRIGHT, Robin M. (org.). **Transformando os Deuses:** os múltiplos sentidos da conversão entre os povos indígenas no Brasil. Campinas: Editora da Unicamp, 1999. p. 363-398.

CABALZAR, Aloisio; RICARDO, Carlos Alberto. **Povos indígenas do Rio Negro:** uma introdução à socioambiental do noroeste da Amazônia Brasileira. 3. ed. São Paulo: Instituto Socioambiental; São Gabriel da Cachoeira: Federação das Organizações indígenas do Rio Negro, 2006.

DAVENPORT, Thomas; BEAN, Randy. The impact of Generative AI on Hollywood and entertainment. **MIT Sloan Management Review,** 2023.

DELSIGNORE, P. **The new age of creative AI began in 2022.** 2022. Available at: https://medium.com/predict/the-new-age-of-creative-ai-began-in-2022-ece07bb93350. Access on: Nov. 12, 2023.

HAZUCHA, Branislav. **Artificial Intelligence and Cultural Production:** Possible Impacts on Creativity and Copyright Law. 2022. Available at: https://papers.ssrn.com/sol3/papers.cfmHUGH-JONES, Stephen. **The palm and the plêiades:** initiation and cosmology in Northwest Amazônia. Cambridge: Cambridge University Press, 1979.

HEAVEN, Will. Welcome to the new surreal. How AI-generated video is changing film. **MIT Technology Review,** 2023. Available at: https://www.technologyreview.com/2023/06/01/1073858/surreal-ai-generative-video-changing-film/. Access on: Apr. 30, 2024.

HUTSON, James; HARPER-NICHOLS, Morgan. Generative AI and Algorithmic Art: Disrupting the Framing of Meaning and Rethinking the Subject-Object Dilemma. **Faculty Scholarship**, v. 23, n. 1, p. 55-61, 2023.

OLIVEIRA, Almir. Maloca. **YouTube**, 2014. Available at: https://www.youtube.com/watch?v=HrPT4t7Kjag&t=3s. Access on: Nov. 30, 2023.

REZENDE, Justino Sarmento. **Identidade Cultural.** 2006. Available at: http://www.neai.ufam.edu.br/index.php/secoes/espaco-amerindio-neai/109-identidade-cultural. Access on: Nov. 2023.

SÁ, Cristina; CORRÊA, Eduardo. Habitação indígena no Alto Xingu. **Encontros como a Civilização Brasileira**, n. 12, p. 129-142, 1979.

STADEN, Hans. **Viagem ao Brasil**. Rio de Janeiro: Fundação Darcy Ribeiro, 2014.

TREVISAN, Daniel; BRAGA, Alexandre. Inteligência artificial nos *games*. **TECCOGS-Revista Digital de Tecnologias Cognitivas,** n. 26, p. 89-101, jul./dez. 2022. https://doi.org/10.23925/1984-3585.2022i26p90-104

WALLACE, Alfred R. **Viagens pelos rios amazonas e Negro.** São Paulo: Senado Federal, 1979. v. 17.

About the authors

Silvio Lasmar dos Santos: Master's student in Design at Universidade Federal do Amazonas.
Marcos Paulo Cereto: PhD in Theory, History, and Criticism of Architecture by Universidade Federal do Rio Grande do Sul.
Lúcio Tiago Maurilo Torres: Master's student in Design at Universidade Federal do Amazonas.

Conflict of interests: nothing to declare – **Financial support:** *Fundação de Amparo à Pesquisa do Estado do Amazonas*, POSGRAD project of PPGD-UFAM 2022-2023, FAPEAM Process No. 01.02.016301.03143/2022-20, Notice: Resolution No. 005/2022 – POSGRAD 2022/2023, PPGD/UFAM.
Authors' contributions: Santos, S.L.: Data Curation, Methodology, Resources, Software, Visualization, Writing — Original Draft. Cereto, M.P.: Conceptualization, Project Administration, Supervision, Validation. Torres, L.T.M.: Formal Analysis, Writing — Review & Editing.