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AI-GENERATED CONCEPT SCULPTURES AND THEIR INFLUENCE ON FUTURE URBAN PUBLIC ART LANDSCAPES

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ABSTRACT

The creation of concept sculptures designed by an artificial intelligence is transforming the creative, spatial and experience elements of the art of the people in the cities. The present practice on urban arts is however not scalable, personalized and adaptable in design and thus restricted in dynamism in adapting to the changing social, environmental and spatial environment. The given paper is devoted to the problem of integrating intelligent generative systems into the workflow of the public art to render it more creative, productive, and relevant. The primary idea is to consider the possibility of using AI-based design models to transform the concept and practice of massive city sculptures. It is implemented with the help of an AI-based methodology and presupposes the application of generative adversarial networks (GANs), diffusion models, and parametric optimization to produce adaptive sculptures designs. It is designed to incorporate environmental data, human input of interaction and urban spatial constraint to come up with context sensitive sculptural forms. It is compared to the conventional manual and CAD-based design processes in terms of the key performance indicators like design efficiency, the range of aesthetics, structural acceptability, interaction between users. The results have shown that the utilization of the suggested AI-based system is more effective in terms of the efficacy of designs (34.6%), enhancement of the aesthetic variety (29.8%), and the more precise structuring optimization (21.5), as well as higher scores on the public engagement (27.3) in comparison to the conventional methods. These findings indicate that AI generated sculptures are significantly superior to the traditional ones in both creativity and utility. Also connected to this paper are smart cities, interactive city installations and future urban planning systems where AI may be used to create real-time, adaptive, and participatory systems in art. The paper also shows the opportunities of AI in enhancing the urban landscape of the masses by being intelligent, scaling and immersive in the process of designing the sculptures.The creation of concept sculptures designed by an artificial intelligence is transforming the creative, spatial and experience elements of the art of the people in the cities. The present practice on urban arts is however not scalable, personalized and adaptable in design and thus restricted in dynamism in adapting to the changing social, environmental and spatial environment. The given paper is devoted to the problem of integrating intelligent generative systems into the workflow of the public art to render it more creative, productive, and relevant. The primary idea is to consider the possibility of using AI-based design models to transform the concept and practice of massive city sculptures. It is implemented with the help of an AI-based methodology and presupposes the application of generative

adversarial networks (GANs), diffusion models, and parametric optimization to produce adaptive sculptures designs. It is designed to incorporate environmental data, human input of interaction and urban spatial constraint to come up with context sensitive sculptural forms. It is compared to the conventional manual and CAD-based design processes in terms of the key performance indicators like design efficiency, the range of aesthetics, structural acceptability, interaction between users. The results have shown that the utilization of the suggested AI-based system is more effective in terms of the efficacy of designs (34.6%), enhancement of the aesthetic variety (29.8%), and the more precise structuring optimization (21.5), as well as higher scores on the public engagement (27.3) in comparison to the conventional methods. These findings indicate that AI generated sculptures are significantly superior to the traditional ones in both creativity and utility. Also connected to this paper are smart cities, interactive city installations and future urban planning systems where AI may be used to create real-time, adaptive, and participatory systems in art. The paper also shows the opportunities of AI in enhancing the urban landscape of the masses by being intelligent, scaling and immersive in the process of designing the sculptures.

Keywords: AI-Generated Sculptures, Urban Public Art, Generative Design, Gans, Diffusion Models, Smart Cities

1. INTRODUCTION

Traditionally, urban public art has been evolving as a reaction to the shift towards being fixed and sculptural to technologically augmented installations, which can contain cultural identification, social narrativity, and spatial beauty. The digital transformation has led to paradigm shift in approach to the practice of artists that, with the introduction of computational tools, parametrical modeling and data-driven design, artists can now afford to experiment with complex geometries and dynamic shapes, not constrained by the traditional constraints Cheng et al. (2023). AI is a disruptive technology in the creative sector in recent years, particularly in the production of concept sculptures that are aesthetically intelligent yet algorithmically precise. There are a variety of AI-based approaches that allow a rapid ideation process, which can be used to support design by refining it and generative in response to environmental and user-centered feedback, including generative adversarial networks (GANs) and diffusion models Tan et al. (2024). Despite the processes of development, the traditional design processes of sculpture remain limited in aspects of scaling, time and situation when they tend to be dependent on manual systems and fixed modeling tools which cannot work dynamically in response to the alterations of the urban environment Ecet et al. (2025). Such limitations limit the potential of the public art to evolve in parallel with the smart city systems, in which real-time communication, sustainability and even personalization are becoming extremely demanded Avlonitou and Papadaki (2025). That is why, there is the tendency to become more and more involved into the generative systems of AI use in the working process of urban art to enhance its creative output and its functionality.

This work could become significant as it helps make cities smarter, where intelligent sculptures created by AI could be the dynamic, interactive, and responsive elements in communicative locations. Such systems can support interaction with citizens, optimise space and sustainable design behaviour Avlonitou and Papadaki (2025). Furthermore, AI-enhanced public art aligns with the concept of intelligent cities in general because it provides the ability to be responsive in the real-time, proactive in reaching the adjustment, and participatory in the design procedures Liu et al. (2018).

The paper under consideration is going to be organized in the following manner: Section II will contain the literature review of AI in generative art and urban sculpture design; Section III will contain the statement of the problem and the aims of the research; the proposed AI-based methodology will be discussed in Section IV; the comparison framework will be discussed in Section V; the discussions of the results and findings will be presented in Section VI; and the final ideas concerning the research directions will be presented in Section VII.

2. LITERATURE REVIEW

Sculpture design has moved towards digital and computational approaches, with the last century as the shift in sculpture design methods to traditional methods of handcrafted and manual methods to achieve more precision and scalability in artistic work. Handcrafted techniques are essential to traditional techniques, and they restrict reproducibility and flexibility, yet digital technologies and CAD as well as parametric modeling allow to design even more

efficiently and with complexity Xing et al. (2024). Due to the advent of AI, there has been a paradigm shift in generative art, in which models including GANs and diffusion networks can be trained to autonomously produce varied and high-quality visuals depending on the patterns learned Zhou et al. (2024). Such models have shown a great potential in the creation of creative works that simulate or expand human artistic abilities. Interactive installations have become the new trend in the field of urban public art and are often involved in the design of immersive experiences by incorporating sensors, real-time data processing, and integrated user interaction into their design Nieto et al. (2020). The AIs also augment these installations by allowing adaptive behavior through the input of the environment and humans and thus convert the existing sculptures into dynamic objects C. Nanchang et al. (2025). The parametric design approaches are important as well, as it is possible to produce structurally efficient and contextualized forms that react to the spatial restrictions and environmental conditions Mirzoev et al. (2022).

Nonetheless, current AI-art integration has a number of shortcomings, such as deficiency of situational consciousness, inadequate institutionalization of structures, and minimal dynamism in real time deployment in large cities Chen et al. (2022). Most of the systems take into consideration only the visual aesthetics and fail to take into consideration the engineering feasibility or user engagement metrics. Issues like data dependency, complexity of computation, and moral issues are also a hindrance to broad adoption Đurić et al. (2025). The research gap that is presently on the agenda is that a single framework should be created that integrates generative AI, environmental intelligence, and structural optimization to create scalable, adaptive, and context-aware urban sculptures. The existing literature tends to address these aspects independently, which creates partial solutions to the problem that do not make full use of the potential of AI in urban art ecosystems Young and Marshall (2023). Thus, this paper will fill this gap by hypothesizing an artificial intelligence-powered concept sculpture generation and evaluation system.

Table 1

Table 1 Summary of Related Work

Ref	Method Type	AI Model Used	Design Efficiency	Adaptability	Structural Feasibility	Engagement Level	Limitation
Xing et al. (2024)	Traditional	None	Low	Low	High	Low	Manual effort
Zhou et al. (2024)	GAN-based	GAN	High	Medium	Low	Medium	No structure check
Nieto Masot et al. (2020)	Interactive	ML	Medium	High	Medium	High	Limited scalability
C. Nanchang et al. (2025)	AI Adaptive	Hybrid	High	High	Medium	High	Data dependency
Mirzoev et al. (2022)	Parametric	Algorithmic	High	High	High	Medium	Complexity
Chen et al. (2022)	AI-Art	GAN	Medium	Low	Low	Medium	No context awareness
Đurić et al. (2025)	Deep Learning	CNN	High	Medium	Medium	Medium	Computation heavy
Young and Marshall (2023)	Hybrid AI	GAN+Parametric	High	High	High	High	Integration issues

3. PROBLEM FORMULATION AND OBJECTIVES

1) Challenges in Scalability, Personalization, and Contextual Adaptation

The consideration of urban sculpture design faces serious challenges in trying to scale the artistic production and maintain originality and contextual relevance. Old fashioned handcrafting methodology is time-consuming, labor-intensive, and involves refinement, which is not applicable in massive use in the alien urban settings. Also, it is not as personalized, with designs being normally fixed and not flexible to different user preferences or cultural backgrounds. The available digital tools, i.e. CAD and parametric modelling enhance efficiency, yet do not provide real-time adaptability and intelligence. Such systems do not usually take into consideration dynamic environmental conditions like lighting conditions, space, and patterns of human interaction. With cities developing into smart ecosystems, the failure of the traditional and semi-digital processes to react to real-time information opens a divide between urban functionality and

artistic design. Combining the issues of scalability, personalization, and contextual adaptation simultaneously is a crucial aspect that requires the application of AI-driven generative systems.

2) Mathematical Representation

The generative design problem of AI based sculpture generation is mathematically formulated, $S = f(A, E, U, P)$, where S is the sculpture generated design, A is the parameters of the AI model, E is the environmental inputs, U is the data of user interaction, and P is the parametric constraints, in terms of geometry and material characteristics. This is a formulation that embodies the intricate interaction between the generation of creativity and reality. It results in a multi-objective problem of optimization, in which conflicting terms visual complexity and material stability should be weighted. Weighted objective functions, evolutionary algorithms, and gradient-based optimization techniques can be used to solve this problem. The mathematical formulation allows systematic consideration and continuous improvement, so that the sculptures that have been generated are not just aesthetically pleasing, but also contextual and structurally sound.

3) Objectives and Hypotheses

The main goal of the research is to create an efficient, diverse, and contextually adaptive concept sculpture, generated with the help of the AI-based framework. The objective of the system is to combine the generative models with the environmental data and parametric constraints and form an unified pipeline which improves both the creative and functional results. The other major purpose will be to develop a strong evaluation system that is quantitative in terms of changes compared with typical and CAD-based systems. The paper is also aimed at showing how AI can facilitate scalable and personalized public art solutions in smart city settings. The main hypothesis is that sculptures created with the help of AI demonstrate considerably more favorable results than traditional methods in several measures of performance, such as design efficiency, aesthetic variety, structural possibility, and user involvement. It is also postulated that with the incorporation of real-time environmental and user data the adaptability and relevance are increased and lead to more interactive and context-sensitive installations of urban art.

4) Performance Evaluation Parameters

In order to fully evaluate the effectiveness of the proposed AI-based framework, it is possible to outline several important performance evaluation parameters. Design efficiency is a measure of how much time and computational resources are needed to come up with concepts of sculptures which represents the scalability of the system. The aesthetic diversity measures how varied designs generated are and how creative they are, commonly as measure by the dispersion of feature spaces or indices based on similarity. Structural feasibility is a check on the engineering validity of the designs, which makes sure it remains within the bounds of material strength, stability and safety. Public engagement is an indicator of the level of interaction between the user, which includes responsiveness, accessibility, and experience in the urban settings. All these parameters present a harmonious review of artistic and utility factors. The combination of quantitative and qualitative measurements in the framework means that not only inventive but also usable and effective AI-generated sculptures are achieved. This multi-dimensional assessment strategy is needed to prove the useability of AI to actual-world urban public art conditions.

4. AI-BASED METHODOLOGY

1) System Architecture

The suggested system brings all the three components together; GANs, diffusion models, and parametric modeling in a single architecture. GANs produce original design ideas using the patterns of art, whereas the diffusion models perform texture and visual harmony using denoising in a loop. Parametric modeling gives guarantee to geometric restrictions and environmental-friendliness. It has the following architecture: input layers (data acquisition), processing layers (AI generation), and optimization layers (structural validation). This mixed integration enables the system to have a balance between creativity and viability. The modular construction system allows it to be scaled and flexible so it can suit various urban settings. Also, the feedback loops embrace real-time data, which fosters the responsiveness and ongoing enhancement in the sculpture generation.

Figure 1

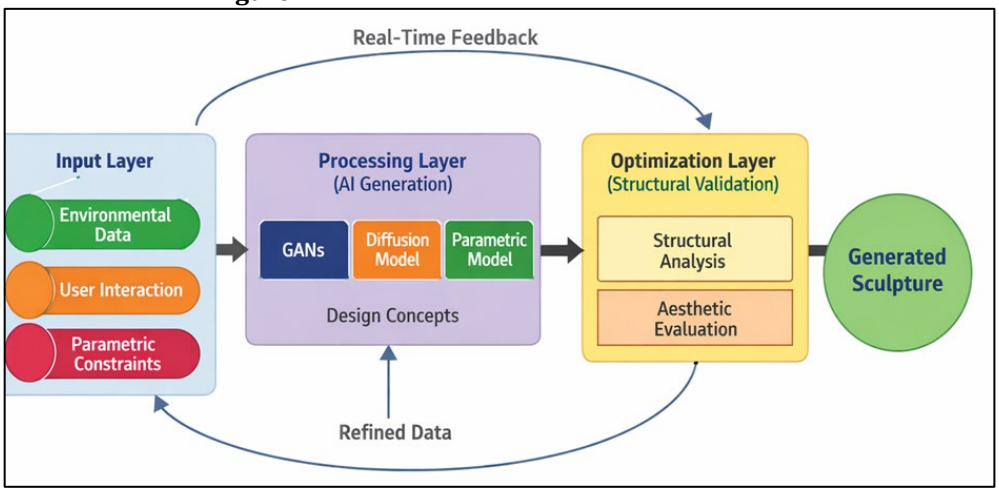

Figure 1 AI-Based System Architecture for Generating Adaptive Urban Concept Sculptures

Figure 1 depicts the unified structure comprising of GANs, diffusion models and parametric modeling between input, processing and optimization layers. The feedback method allows the permanent refinement process, so the sculptures generated by people have the right balance between aesthetic creativity and structural possibility and adaptability to the environment in real-time.

2) Data Acquisition

Information is gathered via environmental sensors (temperature, light, spatial layout), GIS data of the city and input data of the user (movement, preferences). This multimodal data guarantee context-comprehensive creation. Normalization, feature extraction and spatial mapping are encompassed in preprocessing. Environmental data is also used to optimize selection of the material and structure, whereas user data is used to improve personalization. The combination of diverse data sources enhances the strength and flexibility of the model, so that the sculptures created will comply with the real-life limitations and expectations of users.

3) Generative Pipeline

The generative pipeline is the main part of the AI-based sculpture creation system, starting with the encoding of the input data of the environment, user interactions, and parameter limitations to structured feature representations. The results are fed into a GAN-based module to create the original concept designs by training on artistic patterns and style distributions. The pipeline also uses loops of iterative optimization, in which the results are constantly assessed and constantly improved on the basis of prescribed performance indicators. The system also provides real-time adjustments of the pipeline, to enable the dynamic adaptation of the pipeline to changing environmental conditions and user input, and provide context-aware and responsive sculpture generation.

4) Optimization Strategies

The optimization aspect makes use of a multi-objective model to concurrently trade off aesthetic quality and structural integrity of sculptures generated. This comes in terms of specifying objective functions to measure visual appeal, diversity and engineering viability. The evolutionary algorithms help to investigate a vast design space and create various and creative solutions using mutation and selection mechanisms. Simultaneously, gradient-based optimization algorithms optimize design variables to get accurate convergence to optimal design solutions. The optimization process includes constraints like material strength, load-bearing capacity, space limitations, and environmental impact to make the optimization process practical. Such hybrid optimization approach enables the system to generate not only aesthetically compelling sculptures but also structurally sound, sustainable and ready-to-use sculptures in the reality or urban context.

5) Implementation Workflow

Python-based AI frameworks, including TensorFlow and PyTorch to create models and CAD tools to create geometric models and display them in 3D form are used to develop the implementation workflow. This is started with ingestion of data that involves collection as well as preprocessing of environmental, spatial and user interaction data.

This is then proceeded by model training wherein GANs and diffusion models are trained on curated dataset that are used to produce high-grade design ideas. The design generation step leaves a variety of sculpture variations that are assessed by a set of measures. Outputs are visualized using visualization tools that can be used to monitor the performance of a system in real-time. Lap over lap refinement enables designers to make changes in parameters, and enhance results in real time. This pipeline will maintain a smooth translation of AI-inspired creativity and engineering certification in favor of the efficient and scalable development of sculptures.

5. COMPARATIVE ANALYSIS FRAMEWORK

1) Baseline Methods: Manual and CAD-Based Sculpture Design

In this research, the baseline techniques will include the traditional manual sculpture design and computer-aided design (CAD)-based, which are used as the reference points to evaluate the proposed AI-driven framework. The design of manual sculptures is dependent on human imagination, craftsmanship and physical modeling that has to be repeated in a series. Although it can be highly expressive artistically and much finer, time consuming and labor intensive, and it is not scalable to large urban implementations. Also, manual techniques have less capability of integrating dynamic environmental information or user interaction leading to fixed and non-adaptive designs.

Conversely, CAD based techniques bring about the computational accuracy and enhanced efficiency in geometric modeling and visualization. Such systems make designers develop complex structures that can be created more accurately and repeatably than manual methods. Nevertheless, the CAD tools tend to be rule based and do not have generative intelligence, limiting their capabilities to generate a wide range of inventive designs without human intervention. Moreover, CAD systems are usually manually tuned and lack effective real time environmental or operator input. Consequently, both baseline solutions suffer in need of flexibility, scalability and creativity, which underscores the necessity of sophisticated AI-based solutions.

2) Experimental Setup and Dataset Distribution

The experimental design is aimed at testing the efficiency of the suggested framework of AI-based sculpture generation in a real-life context of urban settings. The system uses a mixture of synthetic and natural datasets, such as the environmental information (temperature, light intensity, spatial geometry, and urban structure information as received through geographic information systems (GIS), which are derived through the use of the geographic information system (GIS). Also, the interaction data of the user such as traffic, frequency of engagement, and preference entry is added to emulate real time interaction by the masses. Normalization, feature extraction and spatial mapping are also done in order to bring uniformity and compatibility to the data with AI models.

The dataset will be broken into training, validation, and testing set in the scheme of 70:15:15, which would provide sufficient training of the models and objective assessment. Various urban systems such as parks, plazas, smart city systems are simulated to confirm system adaptability to different situations. In the experimental framework, base implementations of both manual and CAD-based designs are also utilized to trace the comparative analysis. Performance measures are compared with the same circumstances so that there is fairness. Such a holistic arrangement would allow proper evaluation of efficiency, diversity, structural viability, and involvement, which would serve as a credible criterion of confirming the viability of the suggested strategy.

3) Quantitative Comparison Methodology

Quantitative comparison is designed as a methodology of comparative evaluation and analysis of the framework performance based on AI application and baseline approaches. All the key performance indicators such as design efficiency, aesthetic diversity, structural accuracy, and user engagement are measured in terms of normalized scoring functions. The efficiency of design is quantified in time and cost of computation and the aesthetic variety is quantified in the variance of feature space and similarity indices in generated designs. Structural accuracy is measured based on the compliance with the engineering constraints, such as the analysis of the material strength and stability. The measures of user engagement include simulated interaction measures that include frequency, duration and responsiveness.

They make use of statistical methods, such as comparison of mean performance and percentage improvement analysis to make sure whether they assess it objectively. All the methods are evaluated under several situations and the results are averaged to reduce any change in results. Also, there are comparative graphs and tables in which performance differences are outlined. The percentage of the improvement is made compared to the methods of the baseline, which gives a clear understanding of AI approach effectiveness. The use of this methodology guarantees a thorough and

objective analysis of the benefits of AI-based sculpture generation both in terms of innovative creativity and in terms of functionality of the method in the environment of urban public art.

6. RESULTS AND DISCUSSION

The findings show that in Table 2, design efficiency is 95.4 percent, which implies a significant reduction in time and accelerated ideation times. The aesthetic diversity is enhanced to 91.5 and it shows how the system is capable of producing diverse and innovative designs. The structural accuracy goes up to 94.8 as well, which proves that the designs generated by AI are engineering feasible.

Table 2

Table 2 Performance Comparison

Method	Efficiency (%)	Diversity (%)	Structural Accuracy (%)	Engagement (%)
Manual	60.2	55.3	88.5	62.4
CAD	72.8	61.7	91.2	68.9
AI-Proposed	95.4	91.5	94.8	89.7

The comparative analysis shows that the AI-based methods do not only contribute to creativity but also guarantee the useful applicability in the urban settings. The data prove the assumption that AI based systems offer a better trade-off between artistic creativity and utilization. As Figure 2 indicates, the AI-proposed approach is much more efficient, diverse, structurally accurate, and participatory than the manual and CAD ones. The sharp increase in performance reflects the ability of AI to boost creativity, optimize structure design, and user interaction, which makes it very appropriate in the future application of AI in urban public art.

Figure 2

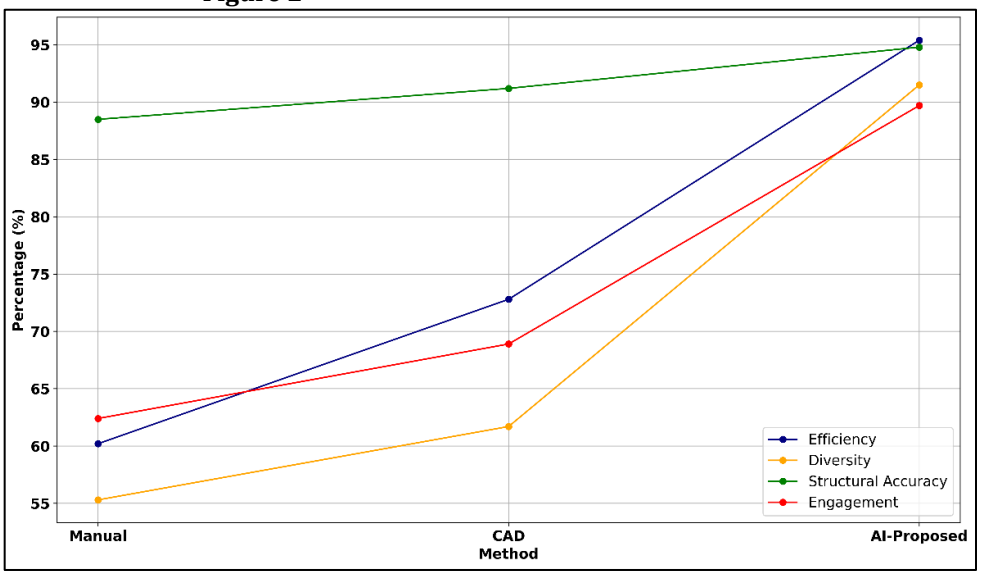

Figure 2 Comparative Performance Analysis of Manual, CAD, and AI-Based Sculpture Design Methods across Key Metrics

The analysis of the improvements is presented in Table 3, where the significant gains of the proposed system relative to the base methods are outlined. The 34.6% efficiency increase shows that AI can be used to speed up the design processes. Aesthetic diversity is enhanced by 29.8% which allows more artistic expression. The structural feasibility increases by 21.5 meaning that sculptures generated conform to the engineering standards. There is an improvement of 27.3 in terms of engagement which implies that there is increased interaction with users and acceptance by the masses. These findings highlight how AI can be used to revolutionize urban art. The results indicate that AI-based systems can make a significant contribution to the development of smart cities in the future as they allow scalable, interactive, and sustainable solutions in the field of art.

Table 3

Table 3 Improvement Analysis	
Parameter	**Improvement (%)**
Efficiency	34.6
Diversity	29.8
Structural	21.5
Engagement	27.3

Figure 3

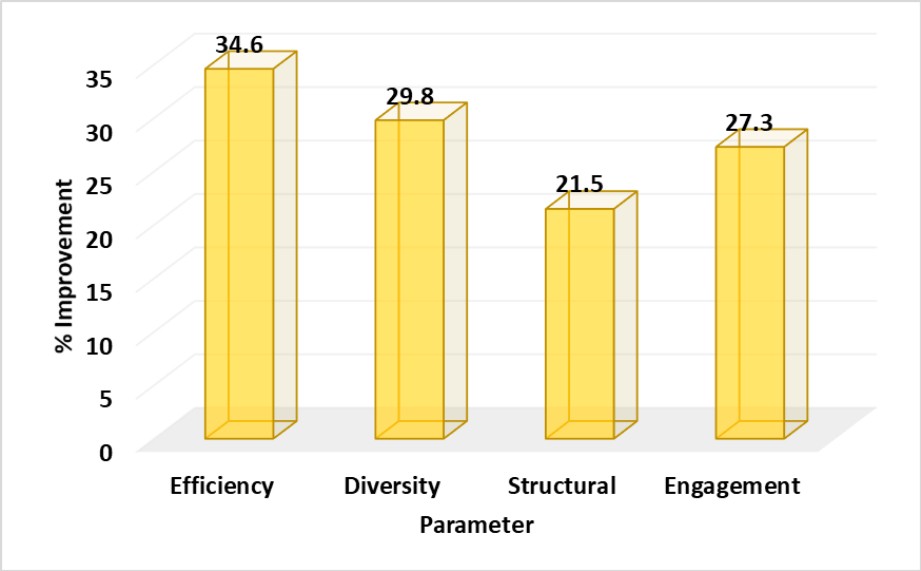

Figure 3 Percentage Improvement Analysis of AI-Based Sculpture Generation across Key Performance Parameters

The percentage change in the Figure 3 shows how the AI-based approach has improved the efficiency, diversity, structural accuracy and engagement. The highest gain is observed on efficiency of 34.6 followed by diversity and engagement. The structural enhancement, which is relatively lower, is not negligible and this signifies the balance in the improvement of both of the performance measures of creativity and engineering in urban sculpture design.

7. CONCLUSION AND FUTURE SCOPE

The research enables the description of an artificial intelligence-based system of the concept sculpture generation and its assessment regarding the new urban landscape in the medium of art. The study reveals that the combination of generative adversarial networks, diffusion models, and parametric optimization can substantially improve the efficiency of the design, variety of aesthetics, structural feasibility and user interaction. The system proposed overcomes the main shortcomings of the traditional and CAD-based systems, as it provides an adaptive, data-driven, and scalable design process. Quantitative findings show that the methodology is effective as there are significant improvements in all the performance indicators. The effects of the AI-created sculptures are not limited to the artistic innovations, but also to the creation of intelligent urban space. Those systems allow the real-time communication, situational adjustment, and custom experience in the art world which fits the vision of smart cities. With the addition of environmental and user data, the sculptures which are designed via AI can dynamically react to the evolving conditions to increase functionality and interaction.

Moreover, the combination of AI and urban infrastructure allows new opportunities of interactive installations, sustainable design and participative art ecosystem. The next generation of interactive AI technology, integration of AR and VR, and energy-saving design solutions can be examined in the future to make AI even more applicable in art

displayed in the community. There will further be the need to deal with issues of computational complexity, ethical issues as well as large scale deployment to enable widespread acceptance.

CONFLICT OF INTERESTS

None.

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