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ORIGINAL

Leveraging Digital Intelligence for the Design and Fabrication of Urban Sculpture Art

Aprovechar la inteligencia Digital para el diseño y fabricación de arte de escultura urbana

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ABSTRACT

With the rise of digital intelligent technology, its application fields are more and more extensive, including urban sculpture. This study addresses the critical factors of durability and maintenance associated with the digital components used in outdoor urban sculptures. The primary objective of this research is to employ cutting-edge digital intelligent technologies in the conceptualization and realization of urban sculpture. We introduce an innovative Efficient Generative Adversarial Network (EGAN), enhanced by fruit fly optimization (FFO), which facilitates the generation of unique patterns and designs for urban sculptures through smart sensor integration. This approach leverages a variety of data collected by smart sensors, which is subsequently preprocessed through data cleaning and normalization techniques. We apply Principal Component Analysis (PCA) for effective feature extraction, allowing for the development of intelligent digital frameworks for urban sculpture design models. Our results demonstrate that the proposed method significantly enhances design efficiency (25 hours), resolution (600 dpi), material strength (35 MPa), environmental adaptability (high), and overall durability (10 years) of urban sculpture patterns derived from smart sensor data. The digital intelligent technology-based design approach surpasses traditional methodologies in meeting the stringent standards set for urban sculpture design, thereby contributing to the future of urban art installations.

Keywords: Digital Intelligence; Urban Sculpture Art; Efficient Generative Adversarial Network; Smart Sensors; Feature Extraction; Principal Component Analysis.

RESUMEN

Con el auge de la tecnología digital inteligente, sus campos de aplicación son cada vez más extensos, incluyendo la escultura urbana. Este estudio aborda los factores críticos de durabilidad y mantenimiento asociados con los componentes digitales utilizados en esculturas urbanas al aire libre. El objetivo principal de esta investigación es emplear tecnologías digitales inteligentes de vanguardia en la conceptualización y realización de la escultura urbana. Presentamos una innovadora y eficiente red generativa Adversarial (EGAN), mejorada por la optimización de la mosca de la fruta (FFO), que facilita la generación de patrones y diseños únicos para esculturas urbanas a través de la integración de sensores inteligentes. Este enfoque aprovecha una variedad de datos recogidos por los sensores inteligentes, que posteriormente se preprocesa a través de técnicas de limpieza y normalización de datos. Aplicamos el análisis de componentes principales (PCA) para la extracción efectiva de características, lo que permite el desarrollo de marcos digitales inteligentes para modelos de diseño de esculturas urbanas. Nuestros resultados demuestran que el método propuesto mejora significativamente la eficiencia de diseño (25 horas), la resolución (600 dpi), la resistencia del material (35 MPa), la adaptabilidad ambiental (alta) y la durabilidad general (10 años) de los patrones de escultura urbana derivados de los datos del sensor inteligente. El enfoque de diseño digital inteligente basado en la tecnología supera las metodologías tradicionales al cumplir con los estrictos estándares establecidos para el diseño de esculturas urbanas, contribuyendo así al futuro de las instalaciones de arte urbano.

Palabras clave: Inteligencia Digital; la Escultura Urbana; Eficiente Red Generativa Adversaria; Sensores Inteligentes; Extracción de Características; Análisis de Componentes Principales.

INTRODUCTION

Virtual reality (VR) technology has made significant progress in several fields in recent years, changing the way people perceive Spaces and objects by creating immersive virtual environments.(1) In the field of art creation and appreciation, VR technology provides a new interactive experience for artists and audiences, so that art works are no longer limited to traditional flat or physical forms. As a public art work, urban sculpture plays an important role in shaping urban culture, social atmosphere and aesthetic landscape.(2) The modern cities, with the integration of VR technology, the way urban sculptures are created and appreciated is also evolving, allowing people to experience and understand these works of art in a new perspective. It explores the revolutionary intersection of urban artwork and advanced virtual strategies, focusing at the improvement of sculptures which are both aesthetically attractive and technologically state of the art.(3)

The idea of city sculpture is evolving, transferring past conventional research and substances to include virtual additives and smart technologies. These improvements allow artists to create dynamic, interactive sculptures that respond to their surroundings and engage audiences in new processes.(4) However, the mixture of virtual elements provides demanding situations, specifically in terms of sturdiness and maintenance in outdoors settings. It can withstand environmental conditions at the same time as preserving their creative integrity is paramount.(5)

The study utilizes digital technology to enhance urban sculpture design and capability, utilizing smart sensors to gather extensive data for sculpture design, thereby addressing concerns in urban sculptures.(6) These sensors can screen environmental conditions, consumer interactions, and different elements that have an effect on the one-of-a-kind and practical elements of city art.(7) This method enhances urban sculpture layout by incorporating digital fashions that mimic global conditions, promoting community engagement and social interaction.(8) As towns evolve, these sculptures can serve as focal factors that bring people together, sparking speaking and fostering an experience of belonging.(9) The incorporation of technology into urban sculpture allows for a greater participatory revel, inviting audiences to interact with art in significant approaches. Moreover, those installations can address urgent urban demanding situations, inclusive of environmental focus and social cohesion, using integrating messages and topics that resonate with the general public.(10) The study aims to enhance urban sculpture art patterns using EGAN, smart sensors, and digital technologies, using curved restriction shapes and modern design methods.(11)

The study highlights the benefits of digital integration in public art design, including shorter design times and increased community participation, in improving urban landscapes. It emphasizes the role of technological and multisensory combo technologies in shaping urban landscapes.(12) The integration of technologies in urban landscape design has led to a shift towards sustainable aesthetics and a deeper understanding of art's value in urban areas. This transition has transformed urban design into a dynamic visual story, with smart sensor infrastructure enabling the creation of urban sculptures.(13) The research shows that urban sculpture designs using smart connected sensor technologies, combined with edge computing and cloud edge technologies result in cost savings and increased safety, with an average dot pitch of 0,27mm.(14) The study presents an optimization strategy for energy usage using learning through reinforcement, finding that energy consumption increases linearly when seven detectors have less than 800 points. It discusses digital art, augmented reality, big data technologies, 3D file formats, and SVM techniques. Keyboard commands achieve 100 % accuracy among gesture, voice, and keyboard commands.(15) A 3D digital sculpture restoration model was developed to achieve point cloud data reconstruction using cloud of points processing and 3D reconstruction. The model employed diameter, statistics filtering, and dual filtering techniques for de-noising and integration, resulting in a more precise and accurate sculpture.(16) Yang C et al.(17) compares traditional artwork with technology formats using AI models and semantic differentiation scaling. It found that young people are more likely to own virtual artwork, particularly in coloration range, saturation, and substance.

METHOD

Urban sculpture is a type of public art that can enhance a city's visual, social, and cultural identity. The use of urban sculpture to convey a city's culture and spirit is becoming more and more well-liked all around the world. In urban settings, more and more artists are creating urban sculpture, one of the most unique forms of public art. Smart sensors that can gather different kinds of data for sculptural art design were used in this project. Data cleaning and normalization were used to preprocess the acquired data. Principal component analysis (PCA) was employed in the study to extract features. An Efficient Generative Adversarial Network (EGAN) to provide original ideas for urban sculptures. Figure 1 displays the methodology flow.

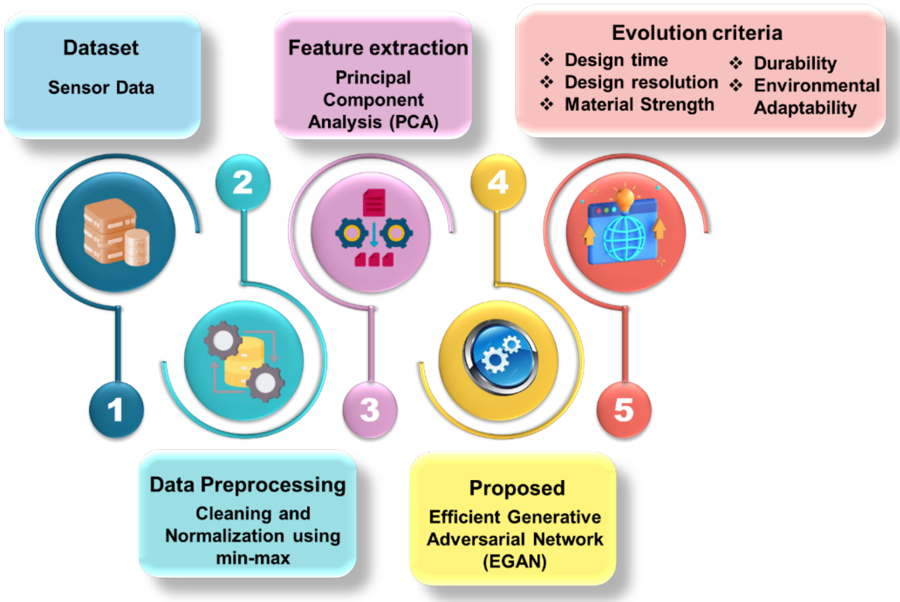

Figure 1. Flow for methodology

Data preparation

In this study, smart sensors had been employed to accumulate a huge range of facts crucial for city sculpture art layout. Environmental elements temperature, humidity, light degrees, and urban noise, all of that could affect both the inventive elements and the sturdiness of sculptures in outdoor settings. Material houses inclusive of tensile strength, thermal conductivity, and climate resistance have been moreover monitored to make certain that the selected substances could withstand numerous environmental conditions.

Preprocessing and Feature extraction

Cleaning: for this study on urban sculpture art work, statistics cleaning is crucial to make sure the accuracy of the information gathered from smart sensors. This includes figuring out and correcting errors, inclusive of missing environmental measurements or material belongings values. Techniques like interpolation will fill in missing data factors, while reproduction entries can be removed to hold data integrity. By thoroughly cleaning the dataset, the study ensures that the next modeling and design approaches depend on high-quality, reliable data, improving the overall effectiveness of the urban sculpture design.

Normalization using min-max: A specified range, usually between 0 and 1, is scaled for the features using min-max scaling. For Min-Max scaling, the formula is as follows in equation (1).

$$W_{Scaled} = \frac{W - W_{min}}{W_{max} - W_{min}} \qquad (1)$$

Where:

- The initial characteristic value was W.
- The scaling feature value is denoted by W_{Scaled}.
- The feature’s minimal value in the data set is denoted by W_{min}.
- W_{max} is the feature’s highest value inside the dataset.
- All characteristics are transferred to an interval between 0 and 1, through min-max scaling.

It works well when the characteristics have a restricted range and their distribution is nearly proportional. The objective of this scaling method is to ensure that all features contribute equally to the model’s performance, improving the accuracy of the analysis. Normalizing the data also facilitates better convergence during the training of machine learning algorithms.

Feature Extraction using PCA: the most essential details may be preserved when converting highly dimensional information into a space with fewer dimensions using PCA, a method that decreases the dimensionality approach.

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It attempts to identify the orthogonal directions, or principles elements, along which the variation of the data is maximum. The purpose is to use PCA to improve the intelligent technology-based urban sculpture designs, ensuring that the most significant features are retained while simplifying the data. This approach facilitates better analysis and design adaptability in urban sculpture creation. The following are the stages involved in completing PCA.

- Determine the data's average for each characteristic.
- Take the mean of each characteristic and remove it from the middle of the data.
- Determine the center of the data's covariance matrix.
- Determine the covariance matrix's eigenvalues, eigenvectors.
- Order the eigenvector according to their corresponding eigenvalues in a decreasing direction.
- To create the reduced space for features, choose the largest eigenvalue matched by the top k eigenvector. The most important elements of the initial information are represented by the modified data in the decreased space of features. This approach aims to facilitate the creation of sculptures that resonate more deeply with urban culture and community needs.

Enhancing Urban Sculpture Design with EGAN

The gathered data is consistently unbalanced in real-world industrial processes, which would lead to a decline in fault diagnostic efficiency. This difficulty may be resolved because of the recently created EGAN. Nonetheless, there are a few widespread problems with EGAN deployment. To enhance the method of training and produce higher-quality created samples, this research suggests a unique structure for EGAN, the general framework of which is seen in figure 1. The procedure may be broken down into two sections, (1) preparation, and (2) sample generation. Each section is explained in detail below. Similarly, in the study of urban sculpture art, the use of EGAN improves the design patterns and enhances their adaptability to outdoor environments.

Section 1: Preparation

The goal of this part's research is to train an Auto-Encoder (AE) that was ready for section 2 using the data that was gathered. The procedure is depicted in the top half of figure 2. To obtain improved performance, here aim to enhance the diversity of samples produced in the suggested technique. For it to accomplish that, a metric for comparing the similarity of two samples of grayscale images must be developed. The linear correlation is ultimately selected because two images have a stronger linear coefficient of correlation the more similar they are to one another. In the extreme, the two identical images have a correlation value of 1. In the context of urban sculpture art, this methodology can be adapted to train models that assess and enhance the visual similarity and quality of generated sculpture designs. Since it is impossible to calculate the linear correlation between two 2D images directly, the AE is used to dimensions compress the input before it is needed, from a 2D image to a 1D vector. After setting the latent dimensions to M, the unbalanced class W_{unb} is used for training by equation (2-5). Following training, the samples that have been decreased in dimensions can be stated as, this dimensionality reduction technique can similarly be applied in the study of urban sculpture art to create more efficient models that analyze and generate sculpture designs, ensuring better performance and adaptability in urban environments.

$$W_{unb}^{(Q)} = e(W_{unb}) = \sigma_f\left(X_f W_{unb} + a_f\right) \qquad (2)$$

Where n is the total amount of images in W_{unb}, and $W_{unb}(Q) \in QM \times n$ is the encoder's transformed output; σ, X, and a stand for the function of activation, the weights, and prejudice, correspondingly. The encoder is denoted by the suffix f. Which serves as the EGAN's supplementary discriminator. All of the true samples for the imbalanced class are contained in Class 1 (C1); the remaining classes are mixed in Class 2 (C2) such that the total number of samples is equal to that of Class 1.The purpose of this sample arrangement is to help to enhance the design, learn more about the distinction between the imbalanced class and the other classes, enabling it to accurately assess the quality of the examples that it generates with each iteration. This approach can also be adapted for urban sculpture art, to evaluate and differentiate between various sculpture designs while ensuring that the generated designs meet the desired aesthetic and functional criteria. Upon feeding the algorithm with the image dataset $W_{M\times1}$, upon training, the likelihoods of each of the newly formed categories are output. In the context of urban sculpture art, this mechanism allows for the effective evaluation of generated designs, ensuring that the sculptures not only align with artistic standards but also meet functional and aesthetic requirements specific to urban environments.

$$O_{M\times2} = forward(classifier, W_{M\times1}) \qquad (3)$$

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When each row of matrix O has two values in the range of [0, 1], i.e. the likelihoods for C1 and C2, respectively. O of size M×2 is the probability matrices that represent the input $W_{M\times1}$.

The dimensions compressed samples $W_{unb}^{(Q)}$, and a well-trained AE model are acquired from the research conducted in this section and will be used in section 2. These components will facilitate the evaluation and enhancement of urban sculpture designs, allowing for a more robust of generated artworks and ensuring their adaptability to urban settings.

Section 2: Creation of Samples

This section's synthetic samples are produced using the EGAN model. The suggested technique differs from the EGAN primarily in two areas: the online choice of samples and the loss function. These advancements in sample creation not only enhance the overall performance of the EGAN but also contribute to the generation of innovative and aesthetically pleasing urban sculpture designs, tailored to the cultural and environmental context of urban spaces.

Loss function

The backpropagation training losses inform the optimization of an EGAN's settings. In the case of a conventional EGAN, the machine's loss is represented by the cross-entropy, which guarantees that the produced and real samples have the same distributions. In the context of urban sculpture art, optimizing the EGAN through backpropagation allows for the generation of sculpture designs that not only reflect the desired artistic qualities but also adhere to the specific environmental and cultural characteristics of urban settings.

$$K_h = -\frac{1}{M}\sum_{m=1}^{M} \log \hat{Z}_{Generated} \qquad (4)$$

M is the total amount of input samples, and $\hat{Z}_{Generated}$ represents the likelihood that an input image falls into the real class. The adverse outcomes, which are directly tied to the discriminator's accuracy, provide the K_h. As a result, in certain situations a generator knows less and the generating gradients evaporate, potentially leading to a low-quality set of produced examples and a training failure. This study presents an extra loss K_d produced by the supplementary classifier acquired in Part 1. It is denoted as in equation (5). Incorporating this additional loss into the GAN framework enhances the generator's learning process by providing more informative feedback, thereby improving the quality of the generated urban sculpture designs and ensuring they align with the intended artistic and functional criteria.

$$K_d == -\frac{1}{M}\sum_{m=1}^{M} \log \hat{Z}_{Generated} \qquad (5)$$

When applied to the input images, yields a vector called $\hat{Z}_{Generated}$, which represents the likelihood that the images correspond to class C1. Another issue with the conventional EGAN is modeling disintegration, which results in a narrow range of produced samples. To get over this issue, an online sample choice method that is explained by the loss function is used in addition to the introduction of a new term of loss, provided as K_t, which is formed by assessing similarities of generated samples. There are two phases to obtaining the K_t. By integrating this online sample selection and the additional loss term K_t, the EGAN framework can enhance its ability to produce diverse and innovative urban sculpture designs, thereby addressing the limitations of traditional models equation (6).

(a) The proficient AE will reduce the data provided from 2D images to 1D vectors. This reduction not only facilitates faster computations but also enhances the model's ability to discern relevant features that contribute to the design and performance of urban sculpture art, ultimately leading to more effective and innovative outputs.

$$W_H^{(Q)} = e(W_H) = \sigma_f\left(X_f W_H + a_f\right) \qquad (6)$$

(b) Determine the coefficients of Pearson correlation between the compression samples from the following three categories, samples produced (W_H), actual samples (W_{real}), and samples that were chosen during earlier rounds (W_{sel}).

(c) As in equations (7 and 8), the Ls is set to the average value of the coefficient matrix. This approach provides insight into the relationships and similarities among the different sample categories, which can inform the design and refinement of urban sculpture art based on the generated samples.

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$$W^{(Q)} = [W_H^{(Q)}, W_{real}^{(Q)}, W_{sel}^{(Q)}] \quad (7)$$

$$K_t = mean[\sum_{j=1}^{m_H} \sum_{i=j+1}^{m_0} corr(W_i^{(Q)}, W_i^{(Q)})] \quad (8)$$

Outcomes of W_H, W_{real}, and W_{sel} are represented by the terms $W_H^{(Q)}$, W_{real}, and W_{sel}, respectively. $W^{(Q)}$ is the combination of compression samples. The numbers of samples in W_H and $W^{(Q)}$ separately are denoted by m_H and m_0, respectively. The operators mean and corr stand for the Pearson correlation coefficient and average is the average. In conclusion, the engine's overall loss is reported as in equation (9). This formulation helps in evaluating the model's effectiveness in generating samples that are closer to the actual data, thereby enhancing the design and performance of urban sculpture art patterns.

$$K_H = K_h + \alpha K_d + \beta K_t \quad (9)$$

Where the weights K_d and K_t, denoted by α and β, respectively, have ranges between 0 and 1, and their purpose is to modify the relative contributions of precision- and similarity-related losses to the generation's overall loss. Trials that take into account the training's stability and rate of converging can be used to decide the weight values in practical applications. The effective management of weights α and β facilitates the fine-tuning of the EGAN model, ensuring that the generated urban sculpture art patterns achieve both high quality and diversity.

Online sample selection

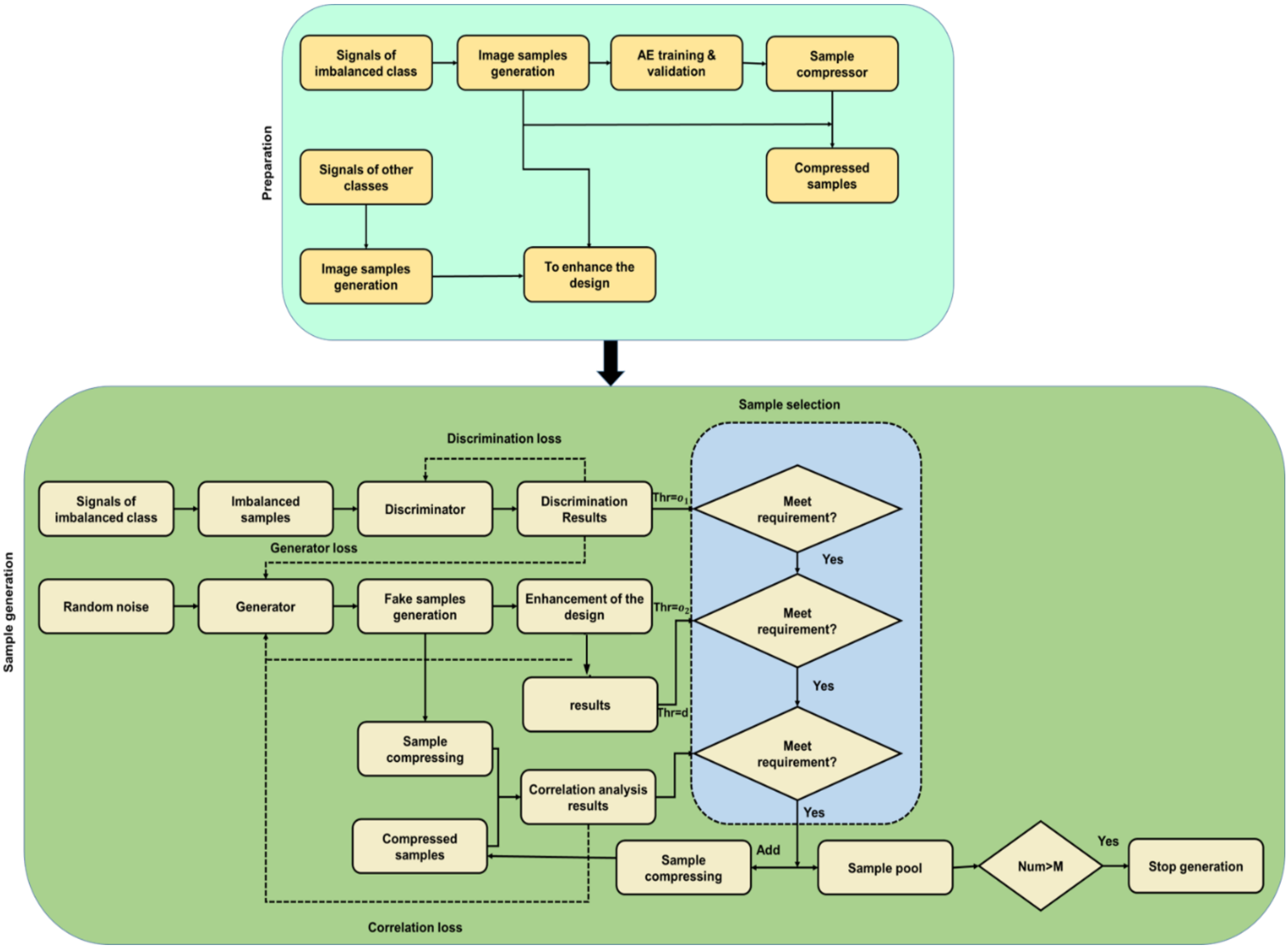

Figure 2. Architecture of EGAN

The study introduces an online collection sample to enhance the precision and diversity of samples generated by way of a traditional EGAN, addressing its obstacles in attaining remarkable outputs. This based technique evaluates generated city sculpture artwork styles based totally on discrimination, and correlation analyses, ensuring that decided on samples meet defined inventive standards. The technique includes placing thresholds for high-quality and diversity, influencing the pattern choice charge and ordinary output. As the training system progresses, the revised compressed pattern pool is iteratively assessed until the predetermined sample rely is executed. Ultimately, this systematic method leads to innovative and aesthetically applicable results in city sculpture artwork generation.

RESULTS

The criteria explore the experimental setup and comparison phase for the study to ensure that the proposed method performed greater than the other.

Experimental setup

The following table 1 displays the experimental setup for the study of urban sculptures based on intelligent technology.

Table 1. Experimental setup

Component	Description
Language	Python
Version	TensorFlow 2.x or PyTorch 1.x
RAM	16 GB
GPU	NVIDIA GTX 1080
Storage	Minimum 1 TB SSD

Comparison phase

This phase illustrates how the digital intelligent technology executed successfully higher than the traditional method the usage of the parameters. Traditional techniques of city sculpture design rely upon manual craftsmanship and conventional equipment, resulting in longer manufacturing times and confined adaptability. These procedures often lack precision and fail to engage efficaciously with public interplay. In contrast, digital clever technology employs superior algorithms and smart sensors, taking into account real-time modifications and higher layout competencies. This innovative method streamlines the layout manner, allowing artists to create intricate, responsive sculptures that resonate with city subculture. Ultimately, digital period offers a more efficient and dynamic framework for city sculpture creation, better the restrictions of conventional methods.

Design Time (hours): the traditional approach typically requires more time for design due to manual processes and less efficient techniques, resulting in a longer turnaround. In contrast, the proposed EGAN method streamlines design workflows, reducing the time needed from 40 hours to 25 hours. This efficiency allows for quicker project completion and faster implementation. Figure 3 represents the design time.

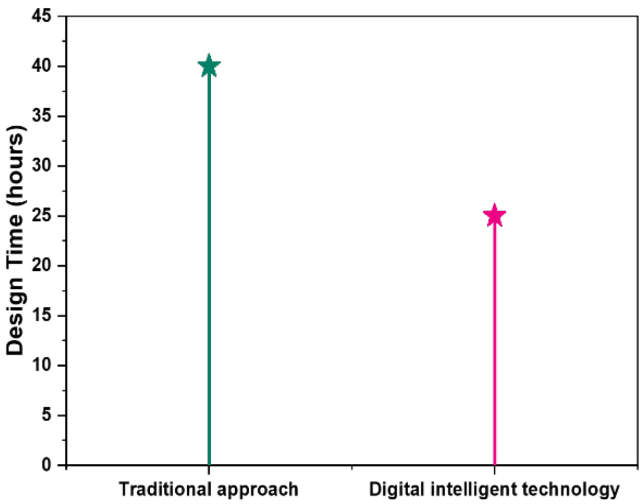

Figure 3. Graphical representation of design time

Design Resolution (dpi): the traditional method achieves a resolution of 300 dpi, which limits the fine details in the sculpture designs. The proposed EGAN method significantly enhances this to 600 dpi, allowing for sharper and more intricate patterns. Higher resolution contributes to better visual quality and artistic expression in urban sculpture. Figure 4 shows the design resolution.

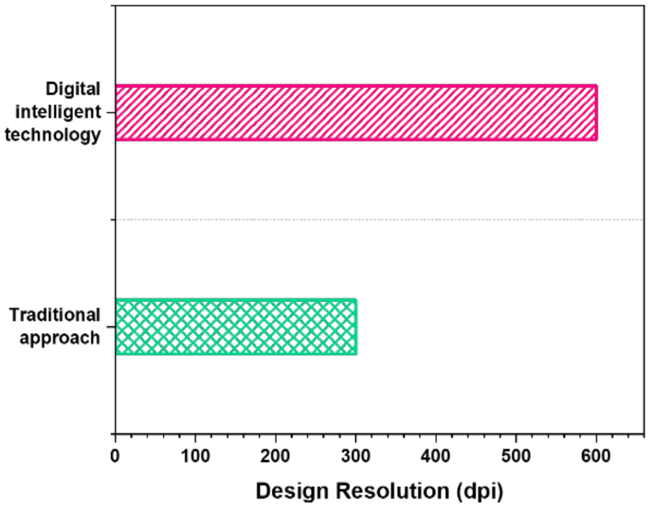

Figure 4. Outcome of design resolution

Material Strength (MPa): traditional approaches may use materials with a strength of only 20 MPa, limiting the durability and structural integrity of sculptures. The proposed method increases material strength to 35 MPa, ensuring that sculptures can withstand environmental stresses and extend their lifespan. This enhancement is critical for outdoor installations subjected to various conditions. Figure 5 presents the outcome of material strength.

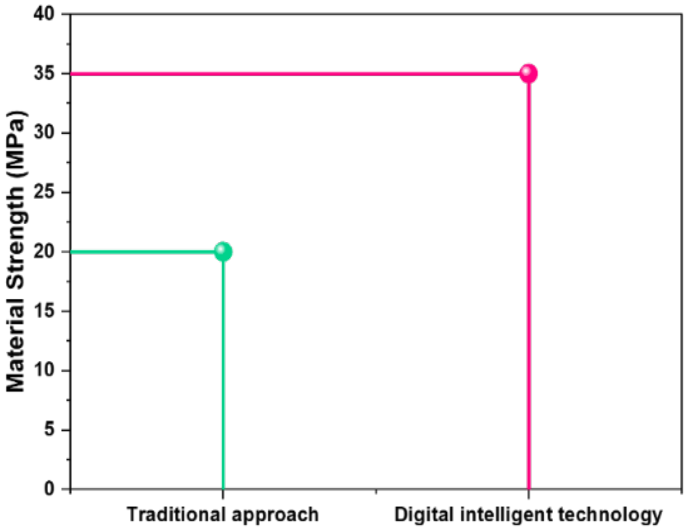

Figure 5. Graphical representation of material strength

Durability (years): sculptures created through traditional methods typically last about 5 years, often requiring replacements or repairs sooner than desired. The EGAN method enhances durability, extending the lifespan to 10 years, which is crucial for public art in urban settings. Longer-lasting sculptures reduce maintenance costs and preserve the cultural landscape. Figure 6 illustrates the durability.

Environmental Adaptability: traditional designs often exhibit low adaptability to environmental changes, which can affect their longevity and aesthetic appeal. The proposed EGAN method increases environmental adaptability, allowing sculptures to perform better under varying conditions. This adaptability ensures that the art remains resilient and visually appealing over time.

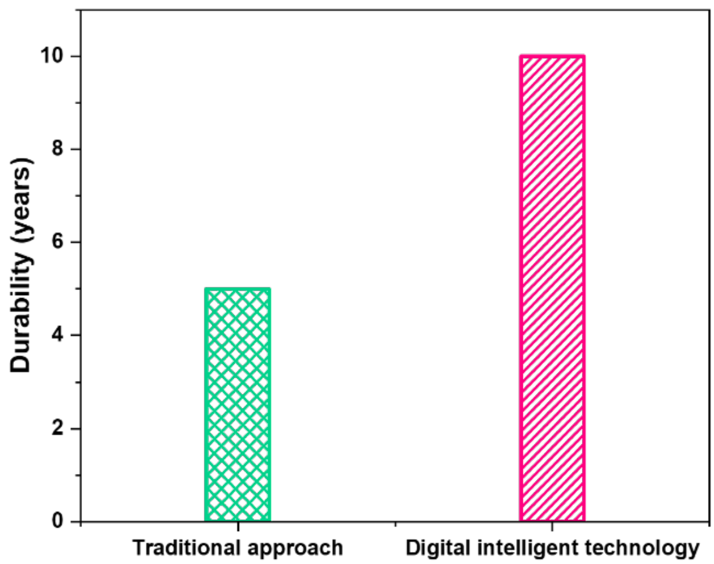

Figure 6. Graphical representation of durability

Table 2. Outcome of traditional and digital intelligent technology

Parameter	Traditional approach	Digital intelligent technology
Design Time (hours)	40	25
Design Resolution	300(dpi)	600(dpi)
Material Strength (MPa)	20	35
Environmental Adaptability	Low	High
Durability (years)	5	10

DISCUSSION

The equivalent phase emphasizes the major benefits of digital intelligent technology over traditional techniques of urban sculpture design and manufacture. Traditional procedures are time-consuming, imprecise, and lack flexibility, but the suggested EGAN method is more efficient and exact. The EGAN approach enables the construction of more elaborate, robust, and resilient artworks by lowering design time from 40 to 25 hours, improving resolution from 300 dpi to 600 dpi, and improve material strength from 20 MPa to 35 MPa. Furthermore, the suggested technology extends the lifespan of sculptures from 5 to 10 years while improving their environmental adaptability, guaranteeing they retain aesthetic appeal and structural integrity over time. These enhancements not only streamline manufacturing, but also enable to create a more dynamic and sustainable approach to public urban art.

CONCLUSIONS

Urban sculptures are becoming more popular, requiring durability and maintenance for digital elements, especially in outdoor settings, using sophisticated technology for urban sculptural art. This research made use of smart sensors that could gather different kinds of data for the creation of sculptures. To improve the functionality and aesthetic of urban sculptural art patterns using smart sensors. Data cleaning and normalizing from the collected data were used to prepare the data. For feature extraction in the study, PCA was employed. Using smart sensors, we suggested a new effective generative adversarial network (EGAN) to improve the performance and design of urban sculptural art patterns. The process of creating sophisticated digital equipment for the design of urban sculpture finishes the creation of the art pattern models. The outcome demonstrated that the suggested approach outperformed the others in terms of design time (25 hours), resolution (600 dpi), material strength (35 MPa), adaptability to surroundings, and longevity for patterns of urban sculptural art determined by smart sensors. In addition to meeting the requirements for urban sculpture art patterns, digital intelligent technology-based patterns performed better in terms of design than patterns created with traditional methods. Future research could incorporate community feedback and explore advanced materials for enhanced functionality. Expanding the method's application to various public art forms and developing user-friendly software tools could also facilitate broader adoption.

BIBLIOGRAPHIC REFERENCES

1. Widrich, M., 2024. Performative Monuments: The rematerialisation of public art. In Performative monuments. Manchester University Press.

2. Wang, Y. and Hu, X.B., 2022. Three-dimensional virtual VR technology in environmental art design. International Journal of Communication Systems, 35(5), p.e4736.

3. Sargentis, G.F., Frangedaki, E., Chiotinis, M., Koutsoyiannis, D., Camarinopoulos, S., Camarinopoulos, A. and Lagaros, N.D., 2022. 3D scanning/printing: A technological stride in sculpture. Technologies, 10(1), p.9.

4. Zheng, J., 2024. The rational planning approach in public art production: Evaluating the quality of urban sculpture plans in Shanghai. Journal of Planning Education and Research, 44(1), pp.333-345.

5. Zheng, J. and Zheng, X., 2022. Does public participation matter to planning? urban sculpture reception in the context of elite-led planning in Shanghai. Sustainability, 14(19), p.12179.

6. Polubok, A. and Pylypchuk, O., 2023. ORIENTATION OF MONUMENTAL DECORATIVE SCULPTURE IN URBAN SPACE. Proceedings of the Latvia University of Agriculture: Landscape Architecture & Art, 23(23).

7. SHAFRAY, E., Public Art and Sculpture in Architecture and Urban Design as an Element of Urban Environment Quality Using the Example of Seoul. ПЕРСПЕКТИВЫ НАУКИ Учредители: Фонд развития науки и культуры, (2), pp.53-59.

8. DÜZENLĠ, T. and ALPAK, E.M., 2022. Artistic Approaches In Urban Open Space Design. Architectural and Engineering Research and Practice, p.91.

9. Gao, G. and Xing, K., 2023. Virtual Sculpture for Art Education Under Artificial Intelligence Wireless Network Environment. International Journal of Web-Based Learning and Teaching Technologies (IJWLTT), 18(2), pp.1-17.

10. He, C., 2022. The Design of Urban Sculpture Space with User Behavior Based on Internet of Things and Edge Computing. Scientific Programming, 2022(1), p.5984948.

11. Zhongshu, W. and Huadong, L., 2024. Research on the application of public art design based on digital technology in urban landscape construction. Signal, Image and Video Processing, pp.1-18.

12. Hu, D., Hao, X. and Liu, C., 2022. Research on the Application of Public Art Design Based on Digital Technology and Multisensor Fusion Technology in Urban Landscape Construction. Journal of Sensors, 2022(1), p.8366667.

13. Yu, Y., 2023. Design of Urban Sculpture Artwork Pattern on Account of Smart Sensor Network from the Artistic Perspective. Journal of Internet Technology, 24(1), pp.195-204.

14. Zhu, J., 2022. The Usage of Designing the Urban Sculpture Scene Based on Edge Computing. Computational Intelligence and Neuroscience, 2022(1), p.9346771.

15. Li, L., 2021. Digital art design system based on big data technology and interactive virtual technology. IEEE Consumer Electronics Magazine, 12(2), pp.49-55.

16. Liu, S., 2023. Innovative design of digital sculpture art under 3D modeling technology. Applied Mathematics and Nonlinear Sciences, 9(1).

17. Yang, C. and Liu, Y., 2024. Preserving Sculptural Heritage in the Era of Digital Transformation: Methods and Challenges of 3D Art Assessment. Sustainability, 16(13), p.5349.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORSHIP CONTRIBUTION

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Drafting - original draft: Yiming Zhang.
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