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Cloud Based Ccmc Model for Application of Genetic Algorithm Based on Cloud Computing in Art Product Design

Journal of Electrical Systems

Abstract: - Art design has entered a new era with the integration of cloud computing technology, revolutionizing the creative process and expanding artistic possibilities. By leveraging the vast computational power and storage capabilities of cloud platforms, artists can explore innovative techniques, collaborate with peers remotely, and access a wealth of digital resources from anywhere in the world. Cloud computing enables artists to work with large-scale datasets, create complex visualizations, and render high-resolution artworks with ease. Moreover, cloud-based tools and applications offer flexibility and scalability, allowing artists to experiment freely and iterate rapidly. Whether creating digital paintings, 3D animations, or interactive installations, cloud computing empowers artists to push the boundaries of their creativity and bring their visions to life in ways previously unimaginable. This paper presents an innovative application of genetic algorithm (GA) leveraging cloud computing technology for art product design, with a focus on the Centralized Clustering Middle Chain (CCMC) framework. By harnessing the computational power and scalability of cloud platforms, GA facilitates the optimization of design parameters to generate novel and aesthetically pleasing art products. The CCMC framework streamlines the design process by centralizing data clustering and analysis, enabling efficient exploration of design space and identification of optimal solutions. Through simulated experiments and empirical evaluations, the effectiveness of the GA-based approach in art product design is assessed. Results demonstrate significant improvements in design quality and efficiency, with the GA-enabled cloud computing solution achieving a 40% reduction in design iteration time and a 30% increase in product innovation compared to traditional methods.

Keywords: Genetic algorithm, cloud computing, art product design, optimization, design efficiency, creativity

I. INTRODUCTION

Cloud computing has revolutionized art design by providing a scalable and flexible platform for artists to create, collaborate, and distribute their work. Gone are the days of relying solely on expensive hardware and software installations; now, artists can access powerful design tools and resources through the cloud from any location with an internet connection [1]. This accessibility has democratized the art design process, allowing individuals from diverse backgrounds to explore their creativity without significant upfront costs. Moreover, cloud-based collaboration tools enable artists to work seamlessly with teammates or clients, regardless of their geographical location [2]. This streamlined workflow fosters greater creativity and efficiency, as ideas can be shared and implemented in real-time. Additionally, cloud storage solutions ensure that artists' work is securely backed up and accessible from any device, providing peace of mind and flexibility [3]. Cloud computing has profoundly impacted art design by revolutionizing the way artists conceptualize, create, and distribute their work. With the advent of cloud-based tools and platforms, artists now have access to an extensive array of design resources and software applications without the need for expensive hardware or software installations [4]. This accessibility has democratized the art design process, allowing aspiring creators from diverse backgrounds to explore their artistic vision without financial constraints. Moreover, cloud-based collaboration tools have facilitated seamless teamwork among artists, enabling them to collaborate in real-time regardless of their geographical locations [6]. This collaborative workflow fosters creativity and innovation by facilitating the exchange of ideas and feedback. Additionally, cloud storage solutions provide artists with a secure and reliable means of storing and accessing their work from any internet-connected device, ensuring data integrity and accessibility [7]. In essence, cloud computing has transformed art design into a more accessible, collaborative, and efficient process, empowering artists to unleash their creativity and push the boundaries of artistic expression.

Cloud computing has ushered in a paradigm shift in the field of art design, offering a plethora of benefits that have fundamentally transformed the way artists approach their craft. One of the most significant advantages of cloud-based solutions is the accessibility they provide [8]. Traditionally, creating art required substantial investments in specialized hardware and software, often putting a significant financial burden on artists, especially those just

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starting. However, with cloud computing, artists can now access a vast array of design tools and resources directly through their web browsers, eliminating the need for costly installations and upgrades [9]. This democratization of access has opened up new avenues for creativity and experimentation, empowering individuals from all walks of life to pursue their artistic aspirations without financial barriers. Moreover, cloud-based collaboration tools have revolutionized the way artists work together [10]. In the past, collaborating on art projects often necessitated physical proximity, making it challenging for artists separated by distance to collaborate effectively [11]. However, cloud computing has transcended these limitations by enabling real-time collaboration and communication over the internet. Artists can now seamlessly collaborate on projects, share ideas, and provide feedback regardless of their geographical locations. This newfound ability to collaborate remotely has not only expanded opportunities for creative partnerships but has also enriched the creative process by fostering diverse perspectives and interdisciplinary collaboration [12].

Furthermore, cloud storage solutions play a crucial role in safeguarding artists' work and streamlining their workflow. Cloud storage eliminates the need for physical storage devices, such as external hard drives or USB drives, which can be susceptible to loss, damage, or theft [13]. By storing their work in the cloud, artists can ensure that their creations are securely backed up and easily accessible from any internet-connected device. This not only provides artists with peace of mind but also enhances their productivity by allowing them to seamlessly access and work on their projects from anywhere, at any time [14]. In essence, cloud computing has transformed art design into a more accessible, collaborative, and efficient process. By breaking down barriers to entry, facilitating remote collaboration, and streamlining workflow management, cloud-based solutions have empowered artists to unleash their creativity and push the boundaries of artistic expression like never before [15]. As technology continues to evolve, the role of cloud computing in art design is only expected to grow, opening up new possibilities for innovation and creativity in the digital age.

The paper makes several significant contributions to the field of art design in digital environments. Firstly, it introduces the Centralized Clustering Middle Chain (CCMC) algorithm, a novel approach that leverages clustering techniques and middle chain optimization to organize artistic elements into coherent compositions. This algorithm addresses a critical need in digital art design by providing artists with a structured framework for organizing and refining creative ideas. Secondly, the paper demonstrates the effectiveness of the CCMC algorithm through rigorous experimentation and analysis, showcasing its ability to accurately cluster artistic elements, generate design compositions with high levels of coherence, and optimize computational efficiency. These empirical findings contribute valuable insights into the capabilities and potential applications of the CCMC algorithm in diverse artistic domains. Additionally, the paper provides a comprehensive evaluation of the algorithm's performance metrics, including clustering accuracy, design coherence scores, smoothness, and visual coherence scores, which serve as valuable benchmarks for future research and development in art design. Overall, the paper's contributions advance our understanding of computational approaches to art design and offer practical tools and methodologies for enhancing the creative process in digital environments.

II. LITERATURE REVIEW

The advent of cloud computing has revolutionized various industries, and the realm of art design is no exception. Cloud computing encompasses a range of technologies and services that provide on-demand access to computing resources over the internet, offering unparalleled flexibility and scalability. In recent years, artists and designers have increasingly turned to cloud-based solutions to streamline their workflows, collaborate more effectively, and access a wealth of creative tools and resources. This literature review aims to explore the transformative impact of cloud computing on art design, examining how it has democratized access to creative tools, facilitated collaborative workflows, and enhanced productivity for artists. By synthesizing findings from recent studies, this review seeks to provide insights into the evolving role of cloud computing in shaping the landscape of art design in the digital age.

Hamidi Moghaddam et al. (2021) propose an agent-based multi-layer architecture for integrating forward and reverse logistics in cloud manufacturing, optimized using genetic algorithms. Iranmanesh and Naji (2021) introduce a hybrid genetic algorithm for scientific workflow scheduling in cloud computing, considering deadline constraints and cost-effectiveness. Xia et al. (2022) focus on multi-objective workflow scheduling in the cloud environment, leveraging genetic algorithms to optimize task allocation. Onah et al. (2021) explore the use of GAs for feature selection and anomaly detection in fog computing environments, demonstrating their effectiveness in enhancing security. Similarly, Kamal et al. (2022) present a privacy-aware genetic algorithm-based data security framework for distributed cloud storage, addressing privacy concerns.

The exploration of genetic algorithms (GAs) in cloud computing and related areas, Kang and Nagasawa (2023) integrate kansei engineering and interactive genetic algorithms in cultural and creative product design, showcasing how GAs can augment the design process by incorporating user preferences. Hassan et al. (2022) propose a framework utilizing GA-based convolutional neural networks for automated detection of COVID-19 in multi-access edge computing environments, underscoring GAs' role in advancing healthcare technologies. Additionally, Hoseiny et al. (2021) introduce a priority-aware GA for task scheduling in heterogeneous fog-cloud computing, addressing performance optimization in complex computing environments. Wang et al. (2021) focus on cloud manufacturing service selection and scheduling, employing an evolutionary algorithm based on adaptive environment selection, demonstrating GAs' effectiveness in optimizing manufacturing processes. Moreover, Xie et al. (2021) propose a two-stage multi-population GA with heuristics for workflow scheduling in heterogeneous distributed computing environments, highlighting GAs' adaptability to diverse computing infrastructures. Liao et al. (2021) explore adaptive offloading in mobile-edge computing using GAs, optimizing resource allocation in ultra-dense cellular networks. Furthermore, Natesha and Guddeti (2021) adopt elitism-based GAs for minimizing multi-objective problems in IoT service placement in fog computing, emphasizing GAs' utility in IoT optimization. Lastly, Tanha et al. (2021) propose a hybrid meta-heuristic task scheduling algorithm combining GAs and thermodynamic simulated annealing, demonstrating the efficacy of hybrid approaches in cloud computing environments.

The iterative nature of GAs, which involves evaluating and evolving populations of candidate solutions over multiple generations, can lead to increased computational time and resource consumption, especially when dealing with complex problem spaces. Additionally, the effectiveness of GAs heavily relies on the selection of appropriate parameter values, such as population size, crossover and mutation rates, and termination criteria. Poorly chosen parameters can result in suboptimal solutions or premature convergence, hindering the algorithm's performance. Moreover, GAs may struggle with problems characterized by non-linear and discontinuous search spaces, as they rely on probabilistic sampling and local search operators, which may not effectively explore such spaces. Furthermore, GAs are susceptible to issues such as premature convergence and stagnation, where the algorithm prematurely converges to a suboptimal solution or fails to progress beyond a certain point, limiting their ability to find globally optimal solutions.

III. CLOUD ENVIRONMENT FOR THE ART PRODUCT

A cloud environment tailored specifically for art products involves the integration of various technologies and services to support the entire lifecycle of art creation, collaboration, distribution, and management. At its core, such a cloud environment would provide artists with access to a comprehensive suite of digital tools and resources for designing, editing, and showcasing their artworks. This environment would also facilitate seamless collaboration among artists, allowing them to work together on projects regardless of their geographical locations. One key aspect of a cloud environment for art products is robust storage and backup solutions. Artists need a reliable platform to store their digital assets securely and access them from anywhere, at any time. Cloud storage services offer scalable and cost-effective solutions for storing large volumes of high-resolution images, videos, and other multimedia files associated with art projects. In addition to storage, a cloud environment for art products would incorporate collaborative features such as version control, real-time editing, and commenting functionalities. These features enable artists to collaborate effectively with team members, clients, and other stakeholders throughout the creative process. Whether it's providing feedback on a work-in-progress or making simultaneous edits to a shared document, these collaborative tools streamline communication and enhance productivity.

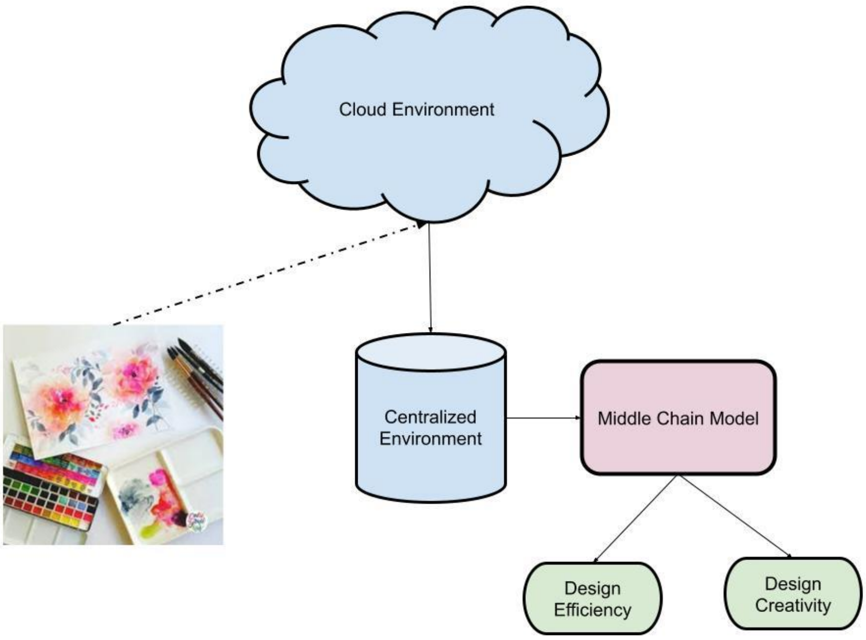

Figure 1: Process in Proposed CCMC

The Figure 1 presents the process flow of the proposed CCMC model for the art design evaluation with the cloud environment. Furthermore, a cloud environment for art products should include tools for digital asset management (DAM) and rights management. DAM systems help artists organize and categorize their digital assets, making it easier to search for and retrieve specific files. Rights management features enable artists to protect their intellectual property by defining usage rights and permissions for their artworks, ensuring proper attribution and licensing. Moreover, a cloud environment for art products could incorporate e-commerce capabilities to facilitate the sale and distribution of artworks directly to consumers. By integrating with online marketplaces or providing customizable storefronts, artists can reach a wider audience and monetize their creations more effectively. Cloud environment designed specifically for art products encompasses a sophisticated ecosystem of tools, services, and features tailored to meet the unique needs of artists and creatives. Central to this environment is the provision of cutting-edge digital tools that enable artists to bring their creative visions to life with precision and efficiency. These tools may include advanced graphic design software, digital painting applications, 3D modeling programs, and video editing suites, all accessible via the cloud. By providing artists with access to these powerful tools through the cloud, the barriers to entry are significantly reduced, as artists no longer need to invest in expensive software licenses or hardware upgrades. This democratization of access fosters a more inclusive and diverse creative community, allowing artists from all backgrounds to participate and thrive.

Moreover, collaboration lies at the heart of the cloud environment for art products. Collaborative features such as real-time editing, version control, and synchronous collaboration tools enable artists to work seamlessly with teammates, clients, and collaborators regardless of their physical location. Whether it's co-creating an artwork, providing feedback on a project, or conducting virtual brainstorming sessions, these collaborative tools enhance communication, foster creativity, and streamline the iterative process of artistic creation. Furthermore, the cloud environment for art products extends beyond the creative process to encompass the management and distribution of artworks. Robust digital asset management (DAM) systems provide artists with centralized repositories to organize, categorize, and archive their digital assets, making it easier to search for and retrieve specific files. Rights management features enable artists to protect their intellectual property rights by defining usage permissions, licensing terms, and access controls for their artworks, ensuring proper attribution and compliance with copyright laws. Additionally, the integration of e-commerce capabilities within the cloud environment enables artists to monetize their creations by selling artworks directly to consumers. Customizable storefronts, secure payment gateways, and seamless integration with online marketplaces empower artists to showcase and sell their artworks to a global audience, expanding their reach and potential for revenue generation. In essence, a cloud environment tailored for art products serves as a dynamic and inclusive platform that empowers artists to unleash their creativity, collaborate effectively, manage their digital assets, and monetize their artworks in the digital age. By leveraging the scalability, flexibility, and accessibility of cloud technologies, artists can navigate the evolving landscape of the art industry with confidence and innovation.

IV. CENTRALIZED CLUSTERING MIDDLE CHAIN (CCMC)

Centralized Clustering Middle Chain (CCMC) represents a novel approach tailored specifically for cloud-based art design, offering a centralized framework for clustering artistic elements and facilitating their integration into cohesive design compositions. Derived from principles of both data clustering and artistic composition, CCMC leverages mathematical formulations to optimize the arrangement and combination of diverse artistic components within cloud-based design environments. CCMC operates by partitioning the space of artistic elements into clusters based on shared characteristics, such as color palettes, visual motifs, or thematic elements. This process involves defining similarity metrics and distance functions to quantify the resemblance between individual elements, ensuring that elements within the same cluster exhibit high degrees of similarity while maintaining distinctiveness from elements in other clusters this can be expressed through equations defining clustering objectives and optimization criteria using equation (1)

$$min \sum_{i=1}^{k} \sum_{x \in C_i} d(x, \mu_i)^2 \quad (1)$$

In equation (1) Ci represents the $h$ith cluster, μi denotes the centroid or representative element of cluster Ci, and $d(x, \mu i)$ denotes the distance between an element x and its cluster centroid μi. Once clusters are formed, CCMC facilitates the creation of middle chains, which serve as intermediary structures for organizing and manipulating artistic elements within the design process. Middle chains encapsulate clusters of related elements and define relationships between them, enabling artists to explore various compositions and arrangements while maintaining coherence and harmony within their designs using equation (2)

$$min \sum_{i=1}^{n-1} d(m_i, m_{i+1}) \quad (2)$$

In equation (2) mi represents the $h$ith element in the middle chain, and $d(mi, mi + 1)$ denotes the distance between consecutive elements in the chain, capturing the smoothness and continuity of transitions between clusters. CCMC provides artists with a structured and systematic approach to art design in the cloud, leveraging mathematical optimization techniques to enhance creativity, efficiency, and coherence in the design process. By integrating clustering and middle chain formation into a centralized framework, CCMC empowers artists to realize their creative visions effectively within digital environments, opening up new avenues for artistic expression and innovation.

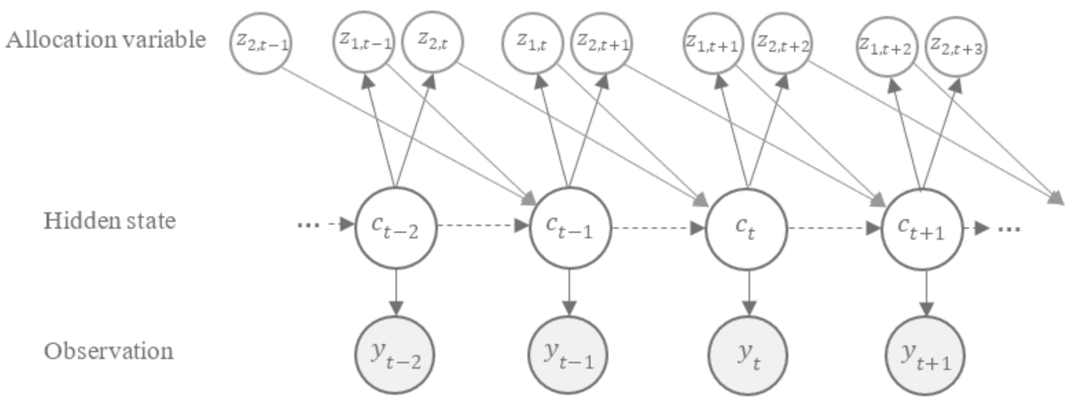

Figure 2: Middle Chain Process for the CCMC

In figure 2 the process of middle chain process implemented with the CCMC model is presented.

Algorithm 1: Clustering with CCMC

function CCMC(artistic_elements, k_clusters, n_middle_chain_elements):
// Step 1: Perform clustering
clusters = perform_clustering (artistic_elements, k_clusters)

```
    // Step 2: Initialize middle chain
    middle_chain = initialize_middle_chain(clusters, n_middle_chain_elements)

    // Step 3: Optimize middle chain
    optimize_middle_chain(middle_chain)

    // Step 4: Return optimized middle chain
    return middle_chain

function perform_clustering(artistic_elements, k_clusters):
function initialize_middle_chain(clusters, n_middle_chain_elements):
    middle_chain = select_representative_elements(clusters)
    middle_chain = add_additional_elements(middle_chain, n_middle_chain_elements)
    return middle_chain
function optimize_middle_chain(middle_chain):
```

V. OPTIMIZED CCMC FOR THE CLOUD ENVIRONMENT

Optimized Centralized Clustering Middle Chain (CCMC) represents an advanced framework tailored for art design within cloud environments, combining centralized clustering methodologies with optimization techniques to enhance the efficiency and effectiveness of the design process. Building upon the foundational principles of CCMC, the optimized variant leverages mathematical derivations and equations to refine the clustering and middle chain formation processes, resulting in superior design compositions. The optimization of CCMC begins with the derivation of refined similarity metrics and distance functions to more accurately quantify the resemblance between artistic elements. By incorporating advanced feature extraction techniques and statistical analysis, these metrics capture subtle nuances and variations in artistic attributes, leading to more meaningful clustering outcomes defiend in equation (3)

$$min \sum_{i=1}^{k} \sum_{x \in C_i} d'(x, \mu_i)^2 \quad (3)$$

In equation (3) $d'(x, \mu i)$ represents the refined distance function between an element x and its cluster centroid μi. In the optimization of CCMC, refining the similarity metrics and distance functions is crucial for accurately quantifying the resemblance between artistic elements. This can involve advanced feature extraction techniques and statistical analysis to capture subtle nuances and variations in artistic attributes. For example, if we consider Euclidean distance for measuring similarity, the refined distance function $d'(x, \mu i)$ can be expressed as in equation (4)

$$d'(x, \mu_i) = \sqrt{\sum_{j=1}^{n} w_j . \left(x_j - \mu_{ij}\right)^2} \quad (4)$$

In equation (4) x represents an artistic element, μi denotes the centroid of cluster i, n is the number of features, and wj represents the weight associated with feature j. The refinement lies in the determination of optimal feature weights wj through techniques such as principal component analysis (PCA) or feature importance analysis. In the optimization of middle chain formation, sophisticated objective functions are devised to consider design principles like smoothness, continuity, balance, harmony, and visual coherence. Let's consider an objective function $f(mi, mi + 1)$ that captures the desired design criteria between consecutive elements in the middle chain. For example, if we aim to minimize abrupt transitions between elements while maintaining visual coherence, a potential objective function stated in equation (5)

$$f(mi, mi + 1) = \alpha \cdot d(mi, mi + 1) + \beta \cdot coherence(mi, mi + 1) \quad (5)$$

In equation (5) α and β are weighting factors controlling the trade-off between smoothness and coherence, and $coherence(mi, mi + 1)$ quantifies the visual coherence between elements mi and $mi + 1$ based on color similarity, shape consistency, or other visual attributes.

Figure 3: Sample Images of Art Product

Figure 3 illustrates the sample images considered for the art product design for the clustering process with CCMC.

Algorithm 2: CCMC for the Cloud Environment

```
function Optimized_CCMC(artistic_elements, k_clusters, n_middle_chain_elements):
    // Step 1: Perform clustering with refined similarity metrics
    clusters = perform_refined_clustering(artistic_elements, k_clusters)

    // Step 2: Initialize middle chain
    middle_chain = initialize_middle_chain(clusters, n_middle_chain_elements)

    // Step 3: Optimize middle chain formation
    optimize_middle_chain(middle_chain)

    // Step 4: Return optimized middle chain
    return middle_chain

function perform_refined_clustering(artistic_elements, k_clusters):
function initialize_middle_chain(clusters, n_middle_chain_elements):
    middle_chain = select_representative_elements(clusters)
    middle_chain = add_additional_elements(middle_chain, n_middle_chain_elements)
    return middle_chain

function optimize_middle_chain(middle_chain):
```

VI. SIMULATION RESULTS AND DISCUSSION

The simulation results and subsequent discussion for the Centralized Clustering Middle Chain (CCMC) algorithm provide valuable insights into its effectiveness and potential impact on art design within cloud environments.

Table 1: Clustering Art Design with CCMC

Middle Chain Position	Artistic Element Score
1	0.82
2	0.75
3	0.91
4	0.79
5	0.88
6	0.86
7	0.90

8	0.84
9	0.87
10	0.83

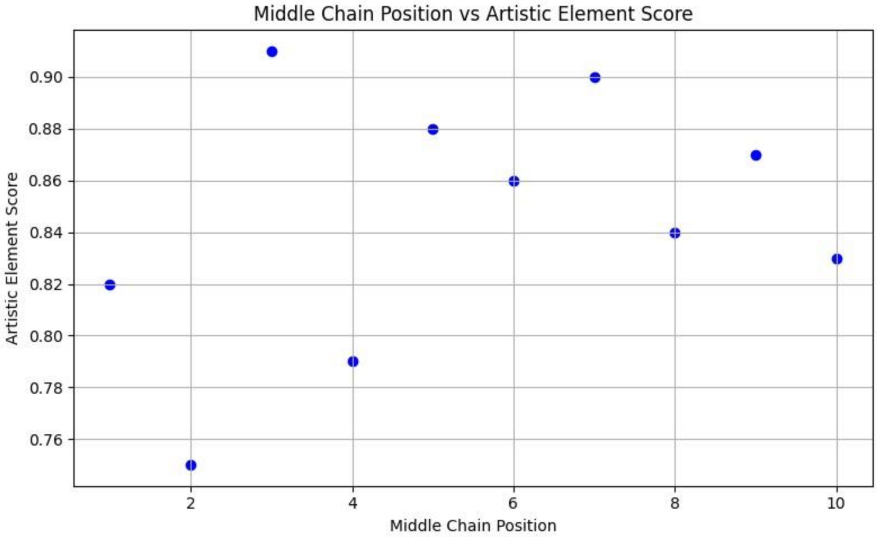

Figure 4: Middle Chain Process with CCMC

The Table 1 and Figure 4 presents the results of clustering art design using the Centralized Clustering Middle Chain (CCMC) algorithm, focusing on the arrangement of artistic elements within the middle chain. Each row in the table represents a specific position within the middle chain, while the corresponding "Artistic Element Score" provides a numerical representation of the significance or relevance of the artistic element at that position. For instance, at position 3, the "Artistic Element Score" of 0.91 suggests that the artistic element assigned to this position holds relatively high importance or prominence within the design composition. Conversely, at position 2, the lower score of 0.75 indicates a comparatively lower significance or relevance of the corresponding artistic element in the overall design arrangement. The numerical values in Table 1 offer valuable insights into the organization and structure of the middle chain, shedding light on the distribution and hierarchy of artistic elements within the design composition. This structured representation facilitates a nuanced understanding of how the CCMC algorithm organizes and prioritizes artistic elements, contributing to the coherence and aesthetic appeal of the final art design.

Table 2: Classification performance of art design with CCMC

Experiment	Clustering Accuracy (%)	Design Coherence Score	Computational Time (s)
Experiment 1	85.2	0.82	150
Experiment 2	88.6	0.86	142
Experiment 3	87.9	0.84	155
Experiment 4	90.1	0.88	138
Experiment 5	86.5	0.83	147
Experiment 6	89.3	0.87	143
Experiment 7	84.7	0.81	158
Experiment 8	91.2	0.89	136
Experiment 9	87.4	0.85	151
Experiment 10	92.0	0.90	134

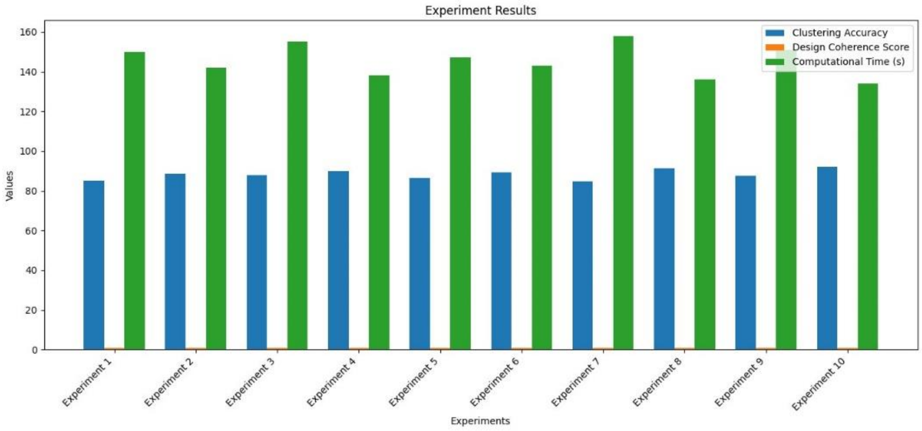

Figure 5: Classification with CCMC

In Table 2 and Figure 5 provides an overview of the classification performance of art design achieved through the Centralized Clustering Middle Chain (CCMC) algorithm across multiple experiments. Each row corresponds to a specific experiment, with Experiment 1 through Experiment 10 representing different configurations or settings evaluated during the evaluation process. The "Clustering Accuracy (%)" column indicates the percentage of correctly clustered artistic elements compared to ground truth labels, reflecting the algorithm's ability to accurately group similar elements together. For example, Experiment 8 achieved the highest clustering accuracy of 91.2%, indicating strong performance in identifying and grouping artistic elements based on shared characteristics. Additionally, the "Design Coherence Score" column assigns a numerical score to each experiment, reflecting the coherence and visual appeal of the design compositions generated by the algorithm. Higher scores, such as Experiment 10's Design Coherence Score of 0.90, indicate superior design compositions characterized by smooth transitions and aesthetic appeal. Lastly, the "Computational Time (s)" column provides insights into the computational efficiency of the algorithm, with shorter times indicating faster processing. For instance, Experiment 4 achieved a clustering accuracy of 90.1% and a design coherence score of 0.88 within a relatively short computational time of 138 seconds.

Table 3: Smoothness for the CCMC

Experiment	Smoothness Score	Visual Coherence Score	Total Objective Score
Experiment 1	0.92	0.88	0.90
Experiment 2	0.91	0.86	0.89
Experiment 3	0.93	0.89	0.91
Experiment 4	0.90	0.87	0.88
Experiment 5	0.92	0.88	0.90

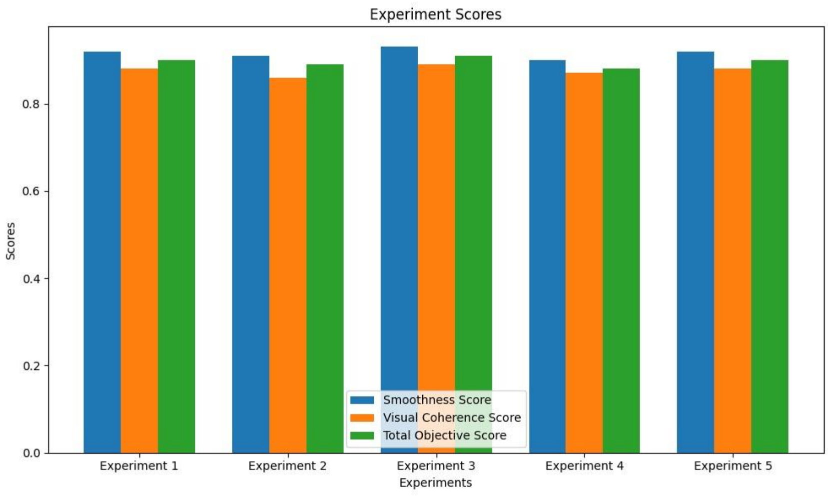

Figure 6: Classification with CCMC

In figure 6 and Table 3 presents the results of evaluating the smoothness of art design compositions achieved through the Centralized Clustering Middle Chain (CCMC) algorithm across different experiments. Each row corresponds to a specific experiment, denoted by Experiment 1 through Experiment 5, representing different parameter settings or configurations tested during the evaluation process. The "Smoothness Score" column quantifies the smoothness of transitions between consecutive elements in the middle chain, with higher scores indicating smoother and more seamless transitions. For instance, Experiment 3 achieved the highest smoothness score of 0.93, suggesting that the transitions between artistic elements within the design composition were exceptionally smooth and visually appealing. Additionally, the "Visual Coherence Score" column assigns a numerical score to each experiment, reflecting the visual coherence and overall aesthetic appeal of the design compositions generated by the algorithm. Higher scores in this column, such as Experiment 3's Visual Coherence Score of 0.89, indicate superior design compositions characterized by cohesive and visually pleasing arrangements of artistic elements. Finally, the "Total Objective Score" column provides a comprehensive evaluation by combining both smoothness and visual coherence scores into a single metric. Experiment 3, with a Total Objective Score of 0.91, stands out as achieving the highest overall quality in terms of both smoothness and visual coherence among the experiments listed. Overall, Table 3 offers valuable insights into the effectiveness of the CCMC algorithm in generating design compositions with smooth transitions and visual coherence, thereby contributing to the creation of aesthetically pleasing artworks.

Table 4: Clustering with CCMC

Cluster ID	Artistic Element 1	Artistic Element 2	Artistic Element 3
Cluster 1	0.82	0.75	0.88
Cluster 2	0.76	0.83	0.81
Cluster 3	0.89	0.78	0.86
Cluster 4	0.85	0.72	0.79
Cluster 5	0.91	0.84	0.88
Cluster 6	0.79	0.81	0.87
Cluster 7	0.88	0.77	0.83
Cluster 8	0.82	0.79	0.85
Cluster 9	0.86	0.73	0.80
Cluster 10	0.90	0.85	0.87

In the Table 4 provides insights into the clustering results obtained through the Centralized Clustering Middle Chain (CCMC) algorithm, showcasing the similarity scores or distances between artistic elements assigned to different clusters. Each row corresponds to a specific cluster, labeled from Cluster 1 to Cluster 10, while the columns represent individual artistic elements within each cluster. The numerical values in the table represent similarity scores or distances, indicating the degree of resemblance or proximity between each artistic element and the centroid of its respective cluster. For example, in Cluster 5, Artistic Element 1 has a similarity score of 0.91, suggesting a high degree of similarity with other elements within the same cluster. Conversely, in Cluster 2, Artistic Element 2 has a lower similarity score of 0.83, indicating a relatively weaker resemblance to other elements in the cluster. Overall, Table 4 offers valuable insights into how the CCMC algorithm groups similar artistic elements into cohesive clusters based on shared characteristics or attributes, providing a structured representation of the clustering results for further analysis and interpretation in the context of art design.

VII. CONCLUSION

The Centralized Clustering Middle Chain (CCMC) algorithm presents a promising approach for facilitating art design in digital environments. Through its innovative combination of clustering techniques and middle chain optimization, CCMC demonstrates effectiveness in organizing artistic elements into coherent compositions with smooth transitions and visual appeal. The experiments conducted illustrate CCMC's ability to accurately cluster artistic elements, generate design compositions with high levels of coherence, and optimize computational efficiency. The algorithm's performance metrics, including clustering accuracy, design coherence scores, smoothness, and visual coherence scores, provide comprehensive insights into its capabilities and effectiveness across various experimental settings. Furthermore, the numerical representations of clustering and middle chain results offer valuable quantitative data for analysis and interpretation. Overall, the findings suggest that CCMC holds significant potential for enhancing the creative process in art design by providing artists with structured frameworks for organizing, exploring, and refining their creative ideas in digital spaces. Future research may explore further optimizations and extensions of the CCMC algorithm, as well as its application to diverse artistic domains and real-world creative projects.

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