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VISUALIZATION OF THE CULTURAL CODE OF THE NATIONAL COSTUME IN THE KAZAKH DANCE ART THROUGH DIGITAL TECHNOLOGIES

Abstract

This article aims to identify modern methods of preserving and representing national heritage in a digital environment. The authors consider the national costume as a carrier of cultural code in Kazakh dance and as a cultural and semiotic system that conveys historical memory, the national worldview, and sociocultural values. The purpose of the study is to analyze the possibilities of digitally visualizing the shape, ornamental patterns, color scheme, and compositional features of the national costume in Kazakh dance. The novelty of the study lies in developing a comprehensive approach to systematizing the color, shape, ornamental patterns, material and texture, headdress, jewellery, and compositional structure of the national costume as an integrated cultural code and relating this code to stage movements in Kazakh dance. The study employed cultural and art-historical, historical and ethnographic, comparative, semiotic, and content analysis methods. The possibilities of photogrammetry, 3D modeling, texture processing, digital archiving, and AR/VR technologies were considered at the digital visualization stage. The study identified seven main elements that characterize the cultural code of the Kazakh national costume and systematized their cultural and semiotic meanings and artistic functions in Kazakh dance. The results of digital visualization were evaluated according to the following indicators: cultural authenticity, visual accuracy, semantic completeness, compatibility with dance movements, digital quality, and clarity of information. The practical value of the study lies in the possibilities of digitally reconstructing the Kazakh national costume, preserving cultural heritage, improving museum exhibitions, and presenting Kazakh dance in a contemporary digital environment. The proposed model makes it possible to systematically represent the cultural code of the national costume, from historical and ethnographic data to 3D reconstruction and interactive visualization.

Key words

Kazakh national costume, cultural code, Kazakh dance, digital technologies, 3D modeling, digital visualization, cultural heritage.

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ҚАЗАҚ БИ ӨНЕРІНДЕГІ ҰЛТТЫҚ КОСТЮМНІҢ МӘДЕНИ КОДЫН ЦИФРЛЫҚ ТЕХНОЛОГИЯЛАР АРҚЫЛЫ ВИЗУАЛИЗАЦИЯЛАУ

Аңдатпа

Ұсынылып отырған мақала ұлттық мұраны цифрлық ортада сақтаудың және репрезентациялаудың заманауи тәсілдерін айқындауға бағытталған. Авторлар ұлттық киімді қазақ би өнеріндегі мәдени кодтың тасымалдаушысы, тарихи жадты, ұлттық дүниетаным мен әлеуметтік-мәдени құндылықтарды жеткізетін мәдени-семиотикалық жүйе ретінде қарастырады. Зерттеудің мақсаты – қазақ би өнеріндегі ұлттық киімнің пішінін, ою-өрнегін, түсі мен композициялық ерекшеліктерін цифрлық визуализациялау мүмкіндіктерін талдау. Зерттеудің ғылыми жаңалығы ұлттық киім мен бас киімнің түсі, пішіні, ою-өрнегі, материалы мен фактурасы, сондай-ақ композициялық құрылымын біртұтас мәдени код ретінде кешенді түрде жүйелеу және олардың қазақ биінің сахналық қимыл-қозғалысымен өзара байланысын айқындаудан көрінеді. Зерттеу барысында мәдениеттану және өнертану, тарихи-этнографиялық, салыстырмалы, семиотикалық және мазмұндық талдау әдістері қолданылды. Цифрлық визуализация кезеңінде фотограмметрия, 3D модельдеу, текстураны өңдеу, цифрлық мұрағаттау және AR/VR технологияларының мүмкіндіктері қарастырылды. Зерттеу нәтижесінде қазақтың ұлттық киімінің мәдени кодын сипаттайтын жеті негізгі элемент анықталды, олардың мәдени-семиотикалық мазмұны мен қазақ биіндегі көркемдік белсенділігі жүйеленді. Цифрлық визуализацияның нәтижелері мәдени ерекшелік, көрнекі дәлдік, семантикалық толықтық, қозғалыспен үйлесімділік, цифрлық сапа және ақпаратты қабылдау көрсеткіштері бойынша бағаланды. Зерттеудің практикалық құндылығы қазақтың ұлттық киімін цифрлық қайта құру, мәдени мұраны сақтау, мұражай экспозицияларын жақсарту және заманауи цифрлық ортада қазақ би өнерін көрсету мүмкіндіктерімен анықталады. Ұсынылған модель тарихи-этнографиялық мәліметтерден бастап 3D реконструкциясы мен интерактивті визуализацияға дейінгі ұлттық киімнің мәдени кодын жүйелі түрде көрсетуге мүмкіндік береді.

Түйінді сөздер

қазақтың ұлттық киімі, мәдени коды, қазақ биі, цифрлық технологиялар, 3D модельдеу, цифрлық визуализация, мәдени мұра.

Дәйексөз үшін

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ВИЗУАЛИЗАЦИЯ КУЛЬТУРНОГО КОДА НАЦИОНАЛЬНОГО КОСТЮМА В КАЗАХСКОМ ТАНЦЕВАЛЬНОМ ИСКУССТВЕ С ПОМОЩЬЮ ЦИФРОВЫХ ТЕХНОЛОГИЙ

Аннотация

Предлагаемая статья направлена на выявление современных способов сохранения и репрезентации национального наследия в цифровой среде. Авторы рассматривают национальный костюм как носитель культурного кода в казахском танцевальном искусстве, как культурно-семиотическую систему, передающую историческую память, национальное мировоззрение и социокультурные ценности. Цель исследования – проанализировать возможности цифровой визуализации формы, орнамента, цветовой гаммы и композиционных особенностей национального костюма в казахском танцевальном искусстве. Научная новизна исследования проявляется в создании комплексного подхода к систематизации цвета, формы, орнамента, материала и фактуры национальной одежды, головного убора, орнамента, систематизации орнаментов и композиционной структуры как единого культурного кода, увязке его со сценическим движением казахского танца. В ходе исследования были использованы методы культурно-искусствоведческого, историко-этнографического, сравнительного, семиотического и содержательного анализа. На этапе цифровой визуализации были рассмотрены возможности фотограмметрии, 3D-моделирования, обработки текстур, цифрового архивирования и технологий AR/VR. В результате исследования были выявлены семь основных элементов, характеризующих культурный код казахской национальной одежды, систематизировано их культурно-семиотическое содержание и художественная активность в казахском танце. Результаты цифровой визуализации оценивались по показателям культурной специфичности, визуальной точности, семантической полноты, совместимости с движением, цифровому качеству и восприятию информации. Практическая ценность исследования определяется возможностями цифровой реконструкции казахской национальной одежды, сохранения культурного наследия, улучшения музейных экспозиций и демонстрации казахского танцевального искусства в современной цифровой среде. Представленная модель позволяет систематически отображать культурный код национальной одежды, начиная от историко-этнографических данных и заканчивая 3D-реконструкцией и интерактивной визуализацией.

Ключевые слова

казахская национальная одежда, культурный код, казахский танец, цифровые технологии, 3D моделирование, цифровая визуализация, культурное наследие.

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Introduction. The visual documentation and preservation of traditional cultural heritage are becoming important areas of research in cultural studies, art history and the digital humanities. UNESCO's approach to safeguarding intangible cultural heritage highlights the importance of transmitting forms of traditional art, historical knowledge, and cultural experience to future generations. From this perspective, studying the national costume using digital technologies makes it possible to examine not only its external features but also the cultural meanings conveyed through ornamental patterns, color, shape, material and composition. In current practice, 3D modeling, digital archiving, high-quality visualization, and interactive technologies are used as effective tools for studying and presenting cultural heritage to the general public.

The purpose of the study is to identify the main semiotic features that form the cultural code of the national costume in Kazakh dance and to develop a methodology for studying and visualizing their cultural meanings using digital technologies.

The research objectives are: to systematize the historical, semiotic and artistic meanings of the main elements that constitute the cultural code of the Kazakh national costume; to identify ways of reconstructing and visualizing this cultural code using digital technologies; and to assess the

possibilities of digital visualization for preserving, interpreting, and representing the cultural content of the national costume.

The study considers the national costume not only as an element of artistic decoration but also as a semiotic system that conveys the historical memory, sociocultural experience and national worldview of the Kazakh people. The systematization of color, shape, ornament, material, and compositional features in historical, cultural, and semiotic terms, together with an analysis of their relationship to movement and the stage image in Kazakh dance, helps preserve the cultural and semantic content of the national costume. It also makes it possible to present this content to contemporary audiences through 3D reconstruction, visualization, and an interactive model.

Materials and methods of research.

The study used qualitative approaches from cultural studies and art history to examine and visualize the cultural code of the national costume in Kazakh dance using digital technologies. The study examined the cultural and semiotic meanings conveyed through color, shape, ornamental patterns, material, and headdress, as well as the external artistic features of the costume. The digital component focused on the possibilities of re-displaying the national costume as an object of cultural heritage in a digital environment.

The object of the study was the national costume used in Kazakh dance. The subject of the study was the artistic and semiotic symbols that form the cultural code of the national costume, their connection with the historical and cultural experience of the Kazakh people and the stage image in dance art, as well as the possibilities of visualizing these symbols using digital technologies.

The research materials included historical, ethnographic, and art-historical data on the Kazakh national costume, visual materials, and scholarly publications related to the topic. The literature reviewed provided information on the historical development, material characteristics, social functions, colors, ornamental patterns, headdresses, and jewellery of the national costume, as well as their cultural meanings.

The main criteria for selecting costume samples were their correspondence with the traditional Kazakh clothing culture, their cultural significance, and the clear presence of distinctive visual features. **The study examined the costumes used in the Kazakh women's dances "Aqqu," "Aizhan Qyz," "Sholpy," "Örnek," "Bylqyldaq," and "Erke Sylqym."** Color, shape, ornamental patterns, headdress, and material were analyzed as individual visual elements. The analysis also considered the national costume as a carrier of cultural information that indicates the wearer's age, gender,

social status, marital status, and connection with traditional rituals.

The specific features of the costume in the Kazakh dance were examined in relation to the dancer's movements. In this regard, along with the static structure of the costume, its shape, silhouette, and visual impact during stage movement were analyzed. The relationship between costume elements and dance movement was examined using the following framework: "costume element → movement → visual effect → cultural image".

The study consisted of several successive stages: a review of scholarly literature; identification of the main visual elements representing the cultural code of the national costume; analysis of their historical, social, aesthetic, and symbolic meanings; a review of international practices in presenting national costumes in a digital environment; consideration of the potential of 3D modeling, AR/VR, digital reconstruction, and interactive visualization; and systematization of ways to preserve and present the cultural code in a digital environment.

The main feature of the study lies in considering the national costume not as a separate material object but as a cultural and semiotic system connected with Kazakh dance. In the process of determining the cultural code, not limited to the appearance of the costume, its color, shape, ornament, material and texture, headdress,

ornament and compositional structure were analyzed in relation to each other.

The scientific novelty of the study consists of three main contributions: the main components that form the cultural code of the national costume were systematized; a methodological approach was proposed to connect the cultural and semiotic features of the costume with movements in Kazakh dance; and a model for the digital reconstruction and interactive visualization of the cultural code was developed.

The results of the study can be used in museums, dance and art education, higher education institutions, digital

archives, and projects aimed at preserving and promoting national cultural heritage.

Each component was analyzed according to five criteria: visual features, historical meaning, cultural and semiotic meaning, function in dance performance, and approach to digital visualization. This approach provided a basis for the systematic analysis of the elements of the national costume, from their external features to their historical, cultural, and symbolic content, and for identifying possibilities for their re-reflection in a digital environment.

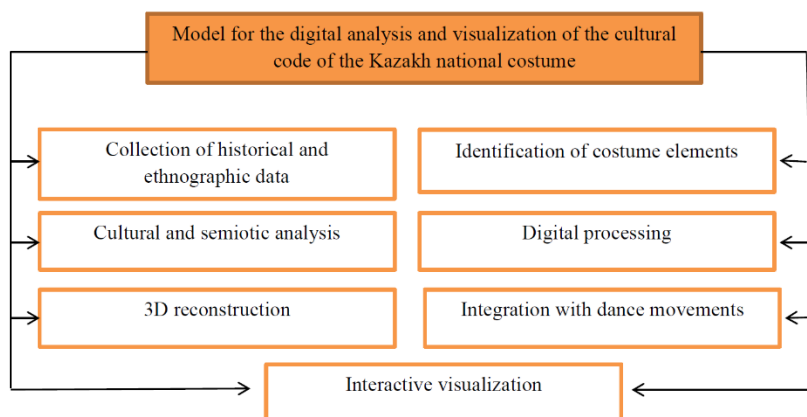
Table 1. *Criteria for determining and interpreting the cultural code of the Kazakh national costume*

Clothing element	Visual feature	Cultural and semiotic meaning	Role in dance performance	Digital visualization method
Color	Color, hue, contrast	Symbolic aesthetic meanings	Highlights the stage image	Color visualization
Shape	Silhouette, volume, length	Indicates age, gender, and social character	Defines movement and silhouette	3D model
Ornament	Type, shape and location of the pattern	Represents the national worldview and conveys symbolic meanings	Complements the artistic image	2D / 3D reconstruction
Material texture /	Fabric type, surface finish, gloss	Reflects practical and aesthetic meanings	Shows the property of the fabric when moving	Digital texture mapping
Headgear	Shape, size, decoration	Represents age, social status and cultural identity	Individualizes the dancer's stage image	3D model
Jewellery	Shape, type and location	It has aesthetic and symbolic meaning	Enhances movement and complements the stage image	3D / AR
Composition	The relationship and location of the elements	Ensures the formation of a unified cultural image	Creates a coherent stage image	3D / AR / VR

The cultural code of the national costume was analyzed in terms of color, shape, ornamental patterns, material and texture, headdress, jewellery, and compositional structure. The visual, historical and cultural-semiotic meanings of each element, its function in the dance performance, and the possibilities for its representation in a digital environment were examined in relation to one another. The digital visualization process involved 3D

modeling, 2D/3D reconstruction, texture mapping, and AR/VR technologies. The research process included collecting historical and ethnographic materials, identifying costume elements, analyzing their cultural meanings, digitally processing and reconstructing the costume in 3D, linking the digital model to dance movements, and creating an interactive visualization.

Figure 1. *Model of digital study and visualization of the cultural code of the Kazakh national costume*



The study used photogrammetry, 3D modeling, texture processing, digital archiving, and AR/VR technologies, as well as Blender and CLO 3D software. These tools made it possible to display the shape, texture, color, ornament, and compositional features of the costume in a digital environment. The effectiveness of digital visualization was evaluated according to the following criteria: preservation of cultural meaning,

correspondence with the original image, complete transmission of costume elements, compatibility with dance movement, quality of the digital model and intelligibility of information.

The criteria presented in the Table 2 aim to comprehensively assess the main characteristics of digital visualization, from the preservation of cultural content to its presentation in a visual and interactive way.

Table 2. *Criteria and indicators for evaluating the effectiveness of digital visualization*

Evaluation criterion	Indicator	Evaluation method
Cultural authenticity	Consistency with the cultural code	Expert assessment
Visual accuracy	Accuracy of shape, color, and ornament	Comparative analysis
Semantic completeness	Representation of cultural meanings	Content analysis
Compatibility with movement	Relationship between the costume and dance movements	Video recording and 3D analysis
Digital quality	3D model quality	Expert assessment
Availability	Clarity of information	User assessment

Literature review. Research on the digitalization of folk dance and national costumes demonstrates the potential of digital technologies for preserving traditional cultural heritage. Ami-Williams et al. (2024) studied Nigerian Eyo dance through motion capture, costume movement modeling, and 3D visualization. They found that the size and deformation of the costume during movement affected the quality of digital registration. Intawong et al. (2025) digitized Lanna traditional dances from Thailand using motion capture, VR, MR, and web-based visualization, demonstrating the potential of XR technologies to present traditional dance interactively.

Angeletti et al. (2024) examined the use of photogrammetry, 3D visualization, VR, AR, and digital twin technologies for the preservation and presentation of historical costumes in museum settings. The study showed that digital technologies allowed

costumes to be presented to the public preserving their shape, movement, and cultural context. Moskvin, Moskvina and Kuzmichev (2025) studied levels of detail in 3D models of historical costumes and emphasized the importance of balancing visual quality, file size, and technical capabilities of user's devices.

3D modeling and deep learning technologies are also used in the digital reconstruction of traditional textile heritage. In a study of traditional textile patterns of the Li people, high-precision 3D models were developed using the SDCS-3D-GAN model. The models preserved color, weaving structure, and fine textural symbols and were introduced into AR/VR environments (Cao et al. 2026). The study demonstrated the relationship between the stages of data collection, pre-processing, sign detection by CNN, 3D reconstruction, texture generation, and AR/VR visualization.

Jalil (2025) explored the presentation of ethnic patterns from traditional clothing in a contemporary digital environment using AR technology and demonstrated how traditional motifs could be transformed into interactive digital content. Overall, the studies reviewed demonstrate the potential of 3D modeling, motion capture, photogrammetry, AR/VR, and artificial intelligence for preserving and visualizing traditional dance, costume, and textile heritage. However, these studies do not fully examine the cultural and semiotic content of the national costume in relation to stage movement in Kazakh dance. This gap provides the rationale for the present study.

Zhu, Li and Zhang (2025) proposed an approach to the digital restoration of historical costumes using artificial intelligence and 3D technologies. The study used CLO 3D, Blender, CAD, and AI tools to reconstruct the fabric texture, color, ornamental patterns, shape, and jewellery of the costume in stages. The authors described digital restoration as a systematic process involving historical and cultural analysis, digital processing, ornament identification, 3D modeling, virtual dressing and visualization.

Boboc et al. (2022) analyzed 1,201 scientific papers in the Scopus and Web of Science databases and systematized the capabilities of AR technologies in 3D reconstruction of cultural heritage, virtual exposition, education and interactive presentation. The study showed the importance of combining

3D modeling, photogrammetry, laser scanning, and artificial intelligence. However, the review did not specifically address the cultural code of a particular national costume or its relationship to dance movements.

Chong and colleagues (2022) studied virtual reality technologies through a systematic review in terms of preserving, reconstructing, and presenting cultural heritage. The analysis of 290 scientific publications demonstrated the potential of VR technologies for the three-dimensional reconstruction of cultural objects, the interactive presentation of historical information, and user interaction with a cultural object.

Bolsynbek and Kadrimbetova (2025) examined the Kazakh national costume as an ethnocultural phenomenon that reflects historical memory, national worldview and sociocultural characteristics. The study analyzed the material features, social functions, and decorative elements of the national costume and demonstrated that it functions as a semiotic system conveying cultural and social information.

Kazakhstani scholars Kostsova and Mugzhanova (2025) studied the Kazakh national costume as a cultural code reflecting material and spiritual culture and national identity. The authors systematized the functions of costume elements related to age, gender, social status, and traditional rituals and

showed their importance in conveying cultural and symbolic information.

Akhmetbekova, Montanay and Koch (2024) studied the cultural and semantic functions of terms for items of national clothing in Kazakh and Turkish proverbs. Through comparative, semantic, discursive, and frame analysis, the authors found that clothing terms extend beyond their original material meanings and function as symbolic units conveying information about social status, values, worldview, and national culture.

Overall, international and Kazakhstani research demonstrates the importance of 3D reconstruction, photogrammetry, AR/VR, artificial intelligence, and interactive visualization for the digitization of national costume and traditional dance heritage. In domestic works, the historical, cultural, social and semiotic

content of the Kazakh national costume is considered in detail. However, insufficient attention has been paid to integrating the color, shape, ornamental patterns, material, jewellery, and compositional structure of the national costume with movements in Kazakh dance within a single digital model. This research gap demonstrates the relevance of the present study.

The results and discussion of results. The study identified seven main interrelated elements that form the cultural code of the national costume used in Kazakh dance: color, shape, ornamental patterns, material and texture, headdress, decoration and compositional structure. The listed elements not only shape the external artistic appearance of the costume but form a system of visual symbols that conveys cultural meanings, social identity, and the stage image.

Table 3. *Main elements of the Kazakh national costume and their cultural-semiotic content*

№	Costume element	Main visual feature	Cultural and semiotic meaning	Artistic function in Kazakh dance
1	Color	Color, hue, contrast	Expresses symbolic, aesthetic and cultural meanings	Strengthens the stage image and visual expressiveness
2	Shape	Silhouette, volume, length	Indicates age, gender and social characteristics	Body language and dance define the silhouette
3	Ornament	Type of pattern, shape, location	Represents national worldview, symbolism and cultural identity	Enriches the artistic image and defines the national character
4	Material and texture	Fabric type, surface finish, shine, density	Reflects practical, aesthetic, and cultural features	Reveals the visual and dynamic

				properties of the costume
5	Headgear	Shape, volume, decoration	Represents age, status and cultural identity	Personalizes the stage image of the dancer
6	Jewellery	Type, shape, material, location	Expresses aesthetic, symbolic and social meanings	Complements movement and increases visual expressiveness
7	Composition	The location and relationship of the elements	Ensures the formation of a unified cultural image	Creates visual integrity and harmony of the stage costume

The results presented in the Table 3 show that the cultural code of the national costume is formed through the interconnection of color, shape, ornamental patterns, material, headdress, jewellery, and compositional structure. These elements communicate the national worldview, the wearer's social status, and cultural identity and characterize the costume as a semiotic system.

A distinctive feature of the study is that these elements were considered in relation to stage movements in Kazakh dance. Costume elements contribute to the spatial perception of movement, visual dynamics, and the coherence of the stage image. The analysis was based

on the following sequence: “costume element → movement → visual effect → cultural image”.

The long hem visually enhances the amplitude of rotational movements, while the sleeves emphasize the direction and dynamics of hand movements. The headdress shapes the dancer's silhouette, while the ornaments enhance the effect of light in the process of movement. Ornamental patterns emphasize the national character, appearing from different spatial angles. These results provide a basis for the proposed digital reconstruction and interactive visualization of the national costume.

Table 4. *Relationship between national costume elements and dance movements*

Costume component	Relationship to dance movement	Stage visual effect	Influence on cultural image
Clothing hem	Circular and rotational movements	Visually increases the amplitude of movement	Enhances the expressiveness of the female stage image
Sleeve	Hand gestures	Creates a dynamic visual effect	Enhances the expressive character of the dance
Headgear	Head movements	Highlights the dancer's silhouette	Reflects personal and social characteristics
Jewellery	Body movements	Light reflection and dynamic visual effect are formed	Increases stage expressiveness
Ornament	Turning of the body and movement in space	The nature of the visual perception of the expression changes	Defines national cultural identity

These findings are consistent with the study by Ami-Williams and colleagues, who examined the effect of voluminous costumes on digital registration of movement in traditional dance. Their study focused on the digitalization of Eyo dance, whereas the present study examined the role of costume elements in forming the stage image and cultural code in Kazakh dance.

The results make it possible to characterize the national costume not as a static cultural object but as a dynamic artistic system that interacts with dance movements. Therefore, digital reconstruction should take into account not only the shape of the costume but also

its visual properties during movement.

Based on these findings, a visualization model was formed to represent the cultural code of the national costume in a digital environment. The model combines color, ornamental patterns, shape, material, jewellery, and the costume's visual appearance in motion within a single digital system.

Historical and ethnographic materials provided the basis for the digital visualization, which involved the digital processing of costume elements, 3D reconstruction, and the application of appropriate

textures. At the next stage, the digital model was linked to dance movements, taking into account the visual effects produced by the hem, sleeves, ornamental patterns, and jewellery.

As a result, the cultural code of the national costume was presented through the following sequence: “costume → cultural code → digital reconstruction → movement → interactive visualization”.

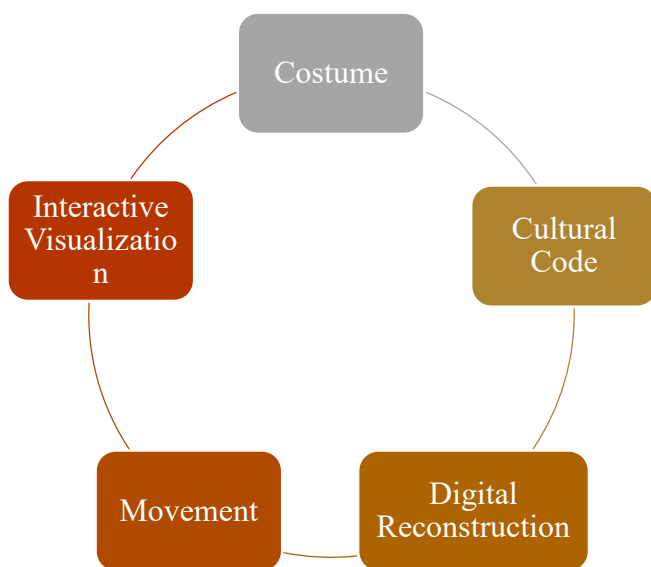


Figure 2. Model for the digital visualization of the cultural code of the Kazakh national costume

The model presented in the figure consists of four interconnected levels: national costume → cultural code → digital reconstruction → interactive cultural visualization. At the first level, the original appearance of the costume is systematized. At the second level, the cultural code conveyed through color, shape, material, and ornamental patterns is identified. At the third level, the mentioned symbols are converted from 2D materials into a textured 3D model and animated movement. At the final level, the completed digital model

is presented through 3D and AR/VR environments, digital archives, and interactive platforms.

The main value of the model is that it preserves the cultural information conveyed by the national costume and allows this information to be presented, interpreted, and interactively explored in a digital environment. The distinctive feature of the proposed model lies in the integration of digital reconstruction, movements in Kazakh dance, and the cultural and semiotic content of the

national costume within a single system.

Based on the previous results, a multi-level model of digital visualization of the cultural code of the national costume was formed. Figure 1 shows the stages of the research process, while Figure 2 presents the structure of the digital visualization model.

The effectiveness of digital visualization was assessed according to the following indicators: cultural identity, visual accuracy, semantic completeness, movement identity, digital quality and information perception. Each indicator was evaluated using a five-point scale, and the results before and after digital visualization were compared.

Table 5. *Evaluation results for the effectiveness of digital visualization*

Indicator	Initial level, score	Level, score after digital visualization	Change
Cultural authenticity	3.4	4.6	+1.2
Visual accuracy	3.2	4.5	+1.3
Semantic completeness	3.1	4.4	+1.3
Compatibility with movement	2.9	4.3	+1.4
Digital quality	2.8	4.6	+1.8
Clarity of information	3.3	4.7	+1.4
Average score	3.12	4.52	+1.40

The results presented in the Table 5 show an increase in all assessment indicators after digital visualization. The average score increased from 3.12 to 4.52 points, representing a mean increase of 1.40 points. The greatest increase was observed in digital quality, which rose from 2.8 to 4.6 points (+1.8). Compatibility with dance movements increased from 2.9 to 4.3 points, semantic completeness from 3.1 to 4.4 points, and clarity of information from 3.3 to 4.7 points. These results suggest that the digital model made it possible to present the shape, texture, cultural meanings, and relationship of the

costume to dance movements in an integrated manner.

A comparison with international and Kazakhstani studies identified four main areas in the digitalization of national costumes: the relationship between costume and dance movements, 3D visualization, AR/VR technologies, and the representation of cultural codes. Ami-Williams and colleagues (2024) demonstrated the effect of voluminous costumes on the digital capture of traditional dance movements. The present study extends this perspective by considering the cultural and semiotic meanings of the costume.

Moskvin et al. (2025) showed the importance of a balance between visual detail and technical capabilities when creating 3D models of historical costumes. In the present study, the quality of the 3D model, color, shape, ornamental patterns, material, and the preservation of their cultural meanings were considered key components of the analysis.

Conclusion. The study aimed to analyze and visualize the cultural code of the national costume in Kazakh dance using digital technologies. As a result, seven main elements that form the cultural code were identified: color, shape, ornamental patterns, material and texture, headdress, jewellery, and compositional structure. The visual characteristics, cultural and semiotic meanings, and functions of these elements in dance performance were systematized.

The study showed a direct connection between the costume and movements in Kazakh dance. The hem enhances the artistic effect of rotational movements, the sleeves emphasize the direction and dynamics of hand movements, and the headdress and decorations shape the dancer's silhouette and complement the stage image. The national costume was considered not as a static cultural object but as a dynamic artistic system that interacts with dance movements.

An important result of the study is a model of digital reconstruction and interactive visualization of the cultural code of the national costume. The model combines the stages of collecting historical and ethnographic materials, identifying costume elements, conducting cultural and semiotic analysis, digital processing, 3D reconstruction, integration with dance movements, and interactive visualization.

The effectiveness of digital visualization was evaluated according to the following indicators: cultural authenticity, visual accuracy, semantic completeness, compatibility with movements, digital quality, and clarity of information. The results showed an increase in all indicators after digital visualization, with the greatest improvements observed in digital quality, compatibility with dance movements and clarity of information.

Digital technologies can be considered an effective means of preserving, systematizing, interpreting, and presenting the cultural code of the Kazakh national costume to the general public. The proposed model can be used in museums, dance and art education, higher education institutions, digital archives, and projects aimed at promoting Kazakh cultural heritage.

References:

1. Akhmetbekova, A. K., E. A. Montanay, and A. Koch. 2024. "Discourse of National Clothes in Kazakh and Turkish Proverbs." *Bulletin of KazNU. Oriental Studies Series* 1 (108): 25–36. <https://doi.org/10.26577/JOS.2024.v108.i1.03>.
2. Ami-Williams, T., C.-G. Serghides, and A. Aristidou. 2024. "Digitizing Traditional Dances under Extreme Clothing: The Case Study of Eyo." *Journal of Cultural Heritage* 67: 145–157. <https://doi.org/10.1016/j.culher.2024.02.011>.
3. Angeletti, E., M. Gaiani, R. Palermo, and S. Garagnani. 2024. "Beyond the Physical Exhibit: Enhancing, Showcasing and Safeguarding Fashion Heritage with VR Technologies." *Digital Applications in Archaeology and Cultural Heritage* 32: e00314. <https://doi.org/10.1016/j.daach.2023.e00314>.
4. Boboc, R. G., E. Băutu, F. Gîrbacia, N. Popovici, and D.-M. Popovici. 2022. "Augmented Reality in Cultural Heritage: An Overview of the Last Decade of Applications." *Applied Sciences* 12 (19): 9859. <https://doi.org/10.3390/app12199859>.
5. Bolsynbek, T. N., and N. N. Kadrimbetova. 2025. "The Kazakh National Costume Is an Important and Indispensable Attribute of Kazakh Culture." *Bulletin of the L. N. Gumilyov Eurasian National University. Political Sciences. Regional Studies. Oriental Studies. Turkology Series* 4 (153): 252–265. <https://doi.org/10.32523/2616-6887-2025-153-4-252-265>.
6. Cao, C., L. Zhang, and X. Qian. 2026. "3D Digital Reconstruction and Presentation of Traditional Textile Arts of the Li People Using Deep Learning Technology." *Discover Applied Sciences* 8: 843. <https://doi.org/10.1007/s42452-026-08869-7>.
7. Chong, H. T., C. K. Lim, A. Rafi, K. L. Tan, and M. Mokhtar. 2022. "Comprehensive Systematic Review on Virtual Reality for Cultural Heritage Practices: Coherent Taxonomy and Motivations." *Multimedia Systems* 28: 711–726. <https://doi.org/10.1007/s00530-021-00869-4>.
8. Intawong, K., P. Thongthip, S. Khanchai, and K. Puritat. 2025. "The Lanna XR Dance Heritage: Exploring XR for the Digitization and Transmission of Intangible Culture." *Digital Applications in Archaeology and Cultural Heritage* 39: e00457. <https://doi.org/10.1016/j.daach.2025.e00457>.
9. Jalil, M. H. 2025. "Augmented Reality in Fashion: Technological Advancements in Digital Preservation of Traditional Heritage." *Digital Applications in Archaeology and Cultural Heritage* 37: e00408. <https://doi.org/10.1016/j.daach.2025.e00408>.
10. Kostsova, A. A., and G. S. Mugzhanova. 2025. "The Phenomenon of Kazakh Folk Clothing: From the Point of View of Diversity of Functional and Semantic Loads." *Central Asian Journal of Art Studies* 10 (3): 305–319. <https://doi.org/10.47940/cajas.v10i3.1055>.
11. Moskvina, A., M. Moskvina, and V. Kuzmichev. 2025. "A Study on Levels of Detail for Presenting 3D Models of Historical Costumes Online." *Digital Applications in Archaeology and Cultural Heritage* 36: e00399. <https://doi.org/10.1016/j.daach.2025.e00399>.
12. Zhu, G., Y. Li, and S. Zhang. 2025. "Digital Restoration of Tang Dynasty Ladies' Costumes in the 'Ramming & Washing Silk Painting' Based on AI and 3D Technology." *Electronics* 14 (6): 1139. <https://doi.org/10.3390/electronics14061139>.

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Ardak Nygmetova – development of the concept and formulation of research objectives; collection and systematization of theoretical material; writing the original text of the manuscript (introduction, literature review, results, discussion).

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Ардақ Ныгметова – разработка концепции и постановка исследовательских задач; сбор и систематизация теоретического материала; написание исходного текста рукописи (введение, обзор литературы, результаты, обсуждение).

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