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Article

Interactive motion graphics development: User experience design themed on the 24 solar terms integrating biological rhythms

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Abstract: This study aims to explore the development of interactive motion graphics themed around the "24 solar terms" from a biomechanical perspective, integrating user experience design with biorhythm concepts. Biorhythms refer to the biomechanical changes in humans, animals, and plants in response to different solar terms. The 24 solar terms, a significant part of traditional Chinese culture, not only reflect the ecological behaviors of animals and the biomechanical adaptations of plants to environmental changes but are also closely linked to the biomechanical variations in human physiological states. By incorporating biomechanical principles and bionic technology into motion graphic design, the study seeks to create interactive experiences that are more aligned with biological adaptability, catering to users' physiological needs and cultural identity. The study begins by analyzing the cultural significance of the 24 solar terms and their impact on human life, revealing their critical connection to the biomechanics of human physiological states, such as dietary habits, sleep patterns, and emotional conditions. Based on these findings, a novel motion graphic design method is proposed, leveraging deep learning techniques grounded in bionic principles (e.g., the VGG-19 model) to monitor and analyze users' biorhythms in real-time. This enables dynamic adjustments to graphic content and interaction modes, enhancing user immersion and engagement. Furthermore, the study explores how information modeling and reverse engineering techniques can digitize traditional cultural elements and biomechanical characteristics associated with different solar terms, creating interactive graphics that combine cultural depth with biological adaptability. This design not only improves user experience but also provides new perspectives and methods for the preservation of cultural heritage. The effectiveness of the proposed method is validated through analysis in terms of user satisfaction, interactivity, and information transmission efficiency.

Keywords: cultural heritage; 24 solar terms; bionics; biomechanics; biological rhythms; interactive dynamic graphics; deep learning

1. Introduction

Since the Convention for the Safeguarding of the Intangible Cultural Heritage (ICH) was ratified by UNESCO in 2003, there has been a great upsurge in global conversations about ICH's worth, definition, and character [1]. In contrast to the conventional "state-driven" operations, one of its major contributions was to stress the importance of community, group, and individual involvement in ICH activities and/or management. A "new paradigm" in protecting ICH as a model of pluralistic engagement for cultural communities, organizations, and people was introduced by the 2003 Convention, according to Blake [2]. To further limit the state's monopoly on ICH protection and identification, cultural groups were shifted to take a more central role in preserving. Different political, economic, and cultural systems in different nations cause the meanings of "community" and "participation" to be understood differently, even while the 2003 Convention language acknowledges a new role for social actors [3]. Thus, the 2003 Convention language continues to use an imprecise definition of community. It has been signed by several nations, including China, so far. On the other hand, when it comes to ICH in China, the government has the upper hand. In line with the 2003 Convention, the Chinese government has been slowly changing cultural policies that are important in order to decentralize authority within ICH in a way that is acceptable for communities.

The ancient arts and crafts of China, such as Xuan papermaking, the Dragon Boat Festival, and the beliefs and practices of the Mazu people, are rich in ICH materials. The General List of the Intangible Cultural Heritage of Humanity currently includes 42 Chinese ICH artifacts. An important milestone in the rise of Chinese ICH to international prominence was the 2001 recording of the Kun Qu opera in it. Academics have voiced serious reservations about ICH studies conducted in China in recent years. In their comparative study of “the Convention for the Safeguarding of the Intangible Cultural Heritage” implementation in China, Maags and Holbig looked at the power connection between elite and public participants [4]. When put into practice, it widened the gap in power between them and the powerful elites involved. Massing contrasted the work of Maags and Holbig by examining the Li ethnic group in Hainan and how their theme park protects ICH via interviews [5]. To further investigate the matter of authenticity in the ICH commercialization process, Skowron-Markowska and Nowakowska used the Chinese Shaolin Temple and Chenjiagou Village as case studies [6]. The legitimacy of martial art tourism has significantly declined, according to their investigation, whereas the practice at the Shaolin Temple demonstrated notable distinctions, as mentioned in the UNESCO publications.

The ICH with biomechanics characters provides scientific support for the preservation and transmission of traditional culture. Biomechanical technologies enable the quantitative analysis of key movements, postures, and mechanical principles embedded in ICH practices, such as the force trajectories in martial arts, the balance dynamics in dance, and the precision of handcraft operations [7,8]. These studies not only uncover the scientific principles underlying these skills but also facilitate digital preservation through motion capture and 3D modeling, enabling the standardization and sustainable transmission of traditional techniques. Additionally, biomechanics can analyze the long-term effects of training on the muscles and joints of ICH practitioners, offering health protection and occupational disease prevention strategies. In the future, this interdisciplinary field is expected to leverage technologies such as artificial intelligence and virtual reality to develop dynamic ICH databases and virtual teaching platforms, allowing more people to learn traditional techniques through immersive experiences. Cross-cultural comparative studies will further deepen the understanding of the biomechanical characteristics of different ICH practices, fostering global cultural exchange and integration. Through the scientific application of biomechanics, ICH preservation can become more precise and efficient, while simultaneously promoting the integration of traditional culture with modern technology. This approach injects new momentum into cultural transmission and ensures that ICH is safeguarded in a way that aligns with contemporary scientific and technological advancements.

New possibilities for the preservation and transmission of intangible cultural heritage have arisen as a result of the fast evolution of technologies like to improve their digital preservation and transfer. Our novel method combines CAD (Computer-Aided Design) and RL (Reinforcement Learning) in the last few years. New non-destructive testing, identification, and digital reproduction methods for cultural artifacts are made possible by cultural relic spectroscopy, a significant tool for digitally preserving cultural heritage. The function of cultural relic spectroscopy in the preservation and transmission of cultural heritage is anticipated to grow in significance as technology evolves and new application scenarios emerge. Simultaneously, there is a pressing need to enhance cultural artefact spectroscopy via study and practical application, ensuring that it is more accurate and reliable. This will allow for a greater contribution to the digital preservation and transmission of cultural property. Artifacts that have survived from previous eras serve as vital repositories for the rich tapestry of human culture and history. The passage of time and environmental circumstances, however, have caused cultural artifacts to endure varied degrees of degradation. Research and restoration efforts involving this cultural treasure need state-of-the-art technology tools for improved protection and inheritance. Cultural relic spectroscopy is a non-destructive diagnostic method that confirms the identity, preservation, and digital replication of cultural artifacts by revealing their chemical composition and internal structure [9]. Information modeling is a way to digitally describe and portray physical things, sceneries, or processes. The area of intangible cultural heritage may benefit from information modeling by creating digital models of intangible cultural aspects, which can then be preserved and shown online. However, in order to replicate, enhance, or innovate upon an existing product or thing, reverse engineering technology measures and analyzes it to gain its geometric shape, material qualities, and other information. Digital duplication and creative use of intangible cultural aspects may be achieved by combining information modeling with reverse engineering technology. Numerous fields might benefit from the digital architecture framework’s ability to represent intangible cultural components using reverse engineering techniques. In addition to preserving and passing on historical artifacts, it may spur creative growth in the building sector, boost regional economies, and facilitate cross-cultural understanding and appreciation [10]. Traditional dance and handicrafts are examples of intangible cultural artifacts that often possess dynamic and spatially rich qualities. A new digital method for preserving and displaying these aspects has emerged with the advent of 3D technology [11]. Nevertheless, three-dimensional data presents a barrier when trying to extract global aspects of intangible cultural components. Recurrent Neural Network (RNN) is capable of handling time-dependent data since it is a strong tool for sequence modeling. Rapid neural networks (RNNs) are able to extract more representative features by integrating attention processes, which allow them to concentrate more on important sections of the sequence. To find out what intangible cultural aspects look like in three dimensions, Han et al. [12] suggested an RNN model that uses attention. To start, we convert the three-dimensional information of immaterial cultural artifacts into a sequence of sequential views. Next, RNN is used to represent these sequence views and record how they evolve over time.

On the list of global intangible cultural heritage items, China's "24 solar terms" now appear, according to UNESCO. The 24-part solar calendar was used by the ancient Chinese. A unique "solar term" was assigned to each section. Chinese territory around the Yellow River is where the twenty-four solar terms element was first used. Seasonal shifts, astronomical events, and other local natural occurrences were used to formulate its criteria, which have since been gradually implemented throughout the country. It begins with the start of spring and finishes with the greater cold, following a cyclical pattern. This aspect has been passed down through many generations and is still used today as a benchmark for measuring time and guiding everyday activities [13]. For farmers, it is still a crucial tool for making decisions and carrying out tasks. Many ethnic groups in China use it, and it has been included into the Gregorian calendar, therefore it is extensively utilized by communities. Solar terms play an important role in some Chinese festivals and rituals, such as the Zhuang People's First Frost Festival and the Jiuhua People's Ritual for the Beginning of Spring. Rhymes, ballads, and proverbs that include the words may also appear. The element's versatility has increased its value as an intangible cultural asset and ensured its continued role in the community's identity formation. The element's knowledge is passed down via both official and informal educational channels [14].

The 24 solar terms reflect the changes in the natural world, and certain terms align with the periodic changes in human metabolism and circadian rhythms [15]. Environmental factors such as temperature, humidity and barometric pressure affect the functional performance of human muscles and joints. These changes influence people's dietary habits, sleep patterns, and emotional states. This biological connection provides inspiration for the biological adaptability of dynamic graphic design, allowing the design to better align with users' physiological needs, thereby enhancing user experience and interactivity.

One of China's intangible cultural assets are the 24 solar terms that make up the traditional lunisolar calendar. Here are the terms:

- Start of Spring;
- Rain Water;
- Awakening of Insects;
- Spring Equinox;
- Clear and Bright;
- Grain Rain;
- Start of Summer;
- Grain Buds;
- Grain in Ear;
- Summer Solstice;
- Minor Heat;
- Major Heat;
- Start of Autumn;
- End of Heat;
- White Dew;
- Autumn Equinox;
- Cold Dew;
- Frost's Descent;

- Start of Winter;
- Minor Snow.

2. Related work

Although it is still in its infancy, research indicates that digital image technology is now propelling the progress of Traditional Chinese Paper-cutting ICH. Traditional Chinese paper-cutting manuscripts are enlarged during the production process using digital imaging technology. This process may be subject to secondary innovation, according to the research. With some hands-on experience, you can optimize the craft processes to create digital pictures of fundamental manuscripts, which can then be used to create actual paper cuts. There are several facets to this that make it significant. To start with, it allows for wide-ranging improvements and innovations to ICH without compromising its originality, which is important since intangible cultural heritage is always evolving. Additionally, design software may be a great asset to heritage practitioners when it comes to creating regular and visually appealing graphics, improving paper-cutting pattern creation, and storing and retrieving original designs digitally. In addition, legacy practitioners may see the finished product before it's finished, which helps with customer alignment and lowers communication expenses. To sum up, computer image processing technology helps traditional crafters be more creative, increases production efficiency, and makes heritage practitioners' artworks more unique [16].

Present day instructional games have several issues and are deficient. The games aren't very instructive since they are either not entertaining to play or have nothing to do with culture. An instructional game on solar term culture was created and developed using Unreal Engine 4 in this research. As they navigate the four seasons and use different interaction mechanisms, players take on the role of a farmer and learn about the 24 solar words by interacting with eight of them. The game has gotten rave reviews for its educational value, user stickiness, and fun, according to the findings of user research. Looking at long term cultural education via the lens of user experience, this research investigates how game design may be used in this context. After much research and development, we can say with confidence that educational games are a viable option for teaching solar term culture. Discovering innovative approaches to effectively sharing traditional culture in the internet era has been a driving force and has great academic and pioneering importance. China has only just begun to explore the potential of instructional games. Important theoretical and practical questions include how to make games that really teach players anything while still having fun, and how to make games that people actually want to play [17].

Improving automated extraction and categorization methods for intangible cultural materials is the primary goal of this work, which aims to improve their digital preservation and transfer. Our novel method combines CAD and RL algorithms in order to account for the uniqueness and complexity of intangible culture. To automatically detect and improve the classification of intangible cultural aspects, our technique makes use of cutting-edge picture segmentation technology. To further improve the classifier's efficiency, we make use of the RL algorithm's adaptive learning features. We have performed an extensive comparison investigation and assembled a diversified dataset in our experimental area, including a wide range of intangible cultural aspects. The results show that the approach is more efficient and effective, and they also show that extraction accuracy and classification effectiveness are significantly improved. Based on these findings, it seems like it may have some real-world uses. All things considered, our method offers fresh perspectives and resources for digitally protecting and preserving intangible cultural assets, which are of great theoretical and practical value [18].

Digital techniques have been used to record cultural artifacts using metadata and high-quality images. Unfortunately, the lack of labeling or physical damage to certain historical artifacts makes them less appealing and causes them to lose value. In this research, we provide a novel framework for cultural data enrichment, an area where machine learning has shown to be elusive. With the use of cutting-edge deep learning classification and annotation techniques, this system automates the process of annotating and filling up information. Using a novel method of picture reconstruction based on supervised and unsupervised learning, it also deals with problems associated with physically damaged cultural artifacts. The authors test their methods using a database of artifacts gathered from museums and libraries all across the globe. In order to enhance the annotation quality and model accuracy, the authors of this work suggested and executed a hierarchical multimodal classifier. This classifier makes use of multitask multimodal learning to improve the annotation and classification processes. The suggested clustering-based approach outperforms state-of-the-art inpainting frameworks in terms of visual reconstruction of cultural material, thanks to its hybrid supervised and unsupervised learning capabilities [19].

Improving the cultural experience of urban residents and tourists can be achieved by incorporating the concept of intangible cultural heritage (ICH) protection into smart city construction. This study investigates an interactive design scheme of smart city application interface that applies ICH protection to meet the needs of protection and inheritance, realizing the organic integration of smart cities and cultural heritage. The Chongqing ICH is first organized and categorized. We looked at the market for ICH-related APP interfaces. Second, in order to achieve automated detection and introduction of ICH, an algorithm for ICH picture recognition based on deep learning (DL) technology is suggested and implemented in the APP. Lastly, in order to improve the user experience, a set of interaction design schemes for the app's interface is created using user habits and visual sensations. The experimental results demonstrate that: 1) The model for ICH image recognition using convolutional neural networks (CNNs) outperforms the model without CNNs in terms of recognition accuracy, recall, and $F1$ value; 2) the model's recognition accuracy, recall, and $F1$ value are even higher after TL is integrated into the model; 3) the Chongqing ICH APP interface system based on DL technology, user habits, and visual perception outperforms the competition in terms of usability, user experience, and other metrics provided by the survey. Using DL technology, user habits, and visual perception, this project intends to build an APP interface system for the Chongqing ICH. The goal is to enhance the usability and user experience. In order to make ICH even more efficient and accurate at identification, future studies might focus on improving picture recognition algorithms. The combination of new technologies, like Virtual Reality (VR), allows for a more immersive and participatory experience for consumers.

Graphic design has evolved into a cutting-edge scientific field thanks to the incorporation of visual communication principles into the field's pedagogy. Both the designer and the audience's visual memory are stimulated by the employment of narrative strategies in visual communication. Furthermore, in order to preserve cultural variety, it is critical to enhance cultural assets, such as historical photographs [20]. Automatic colorization of grayscale photographs into color images has recently been feasible because to advancements in deep learning (DL) and computer vision (CV) techniques. Additionally, there has been a rise in the use of visual communication design for APP interfaces. This paper presents the approach for wireless network-enabled visual communication, which is motivated by the need for improved deep learning-based automatic historical picture colorization [21]. In order to effectively transform the grayscale photos into color images, the EDL-AHIC method is being suggested. The shown EDL-AHIC method is able to extract both global and local characteristics. The model of the enhanced capsule network (ECN) is used for the extraction of global features. Lastly, the chrominance component of the input picture is determined by using the fusion layer and decoding unit. For the purpose of improving the EDL-AHIC method, a thorough experimental validation procedure is carried out. According to the results of the comparative research, the EDL-AHIC method is superior to the other new approaches.

Accurate identification of regional symbols and multi-person online collaborative design are made possible in this article via the application of the DL (Deep Learning) model based on bionics technology and CAD collaborative design platform. To begin, the study provides an overview of cultural heritage and the significance of regional symbol identification. It goes on to explain why new technology are needed to enhance the shortcomings of conventional design processes. Data processing and collecting, DL model building and training, and CAD collaborative design platform creation and application are some of the important phases in the study methodologies that follow. Experimental results show that the CNN (Convolutional Neural Network) used in this research outperforms PSO (Particle Swarm Optimization), RNN (Recurrent Neural Network), and BPNN (Back Propagation Neural Network) with F1 scores (Fill In) that exceed 90%. It is worth mentioning that the recall is 94% and the accuracy is about 92%. In addition, user reviews show that most people think this innovation makes it easier to find cultural knowledge from their area, which improves the design's efficiency and quality. The findings of this research provide strong evidence in favor of digitizing regional cultures and fostering their creative development. There are also new ideas and methods for improving technology and businesses in related fields that are highlighted.

As a priceless artifact of Western civilization, literature from the United Kingdom and the United States has long served as a conduit for the dissemination of ideas and values. Translation into other languages, particularly those spoken in nations where English is not the official language, may be fraught with difficulties. Not only do these difficulties arise from linguistic differences, but they also need profound emotional analysis, rhetorical strategies, and cultural interpretation. Because of these flaws, traditional machine translation systems can't handle these problems flawlessly. In order to tackle this problem, this paper delves into a DL (Deep Learning) based machine translation system for literary pieces written in English and American.

Finally, our method outperforms the other two in terms of translation quality assessment accuracy regardless of the statement count (1100, 1500, 2100, or 3300), according to the researched findings. Our method is more reliable, has specific practical use, and can achieve an accuracy of up to 95%. All things considered, this study offers a fresh and effective approach to the automated translation of literary pieces written in English and American. This not only showcases technological advancements but also paves the way for future cross-cultural communication and research.

Not only does intangible cultural heritage (ICH) contain the spiritual and cultural qualities of humans, but it also symbolizes the progress of human civilization. The use of CAD and VR in digital ICH protection may give more precise and efficient techniques of creating digital material. A method for artistic picture improvement using deep learning (DL) is suggested in this article. This method can restore colors and super-resolve images by using DL and art work characteristics extraction, creating high-quality picture resources for ICH digital protection. Strong evidence for digital preservation and promotion of ICH is provided by the findings, which show that this strategy improves graphic art quality and gives consumers an immersive creative experience. The benefits of this algorithm in real-world applications may be discovered by studying how the audience rates the digital ICH interactive experience.

Researchers in computer vision often focus on methods for restoring damaged images. In mural image editing, virtual reality, digital cultural heritage preservation, film and television special effects, and the automated recovery of lost material based on known content in mural pictures, it serves a useful function. There is a vast array of potential uses for the field. Contents that are relevant to the deep learning image restoration approach include the construction of the network and the selection of the loss function during training. There are benefits and drawbacks to each approach, as well as different areas of potential use. What may be done to make the repair outcome more semantically sound? Researchers have long focused on ensuring sex, structure, and detail accuracy. With this goal in mind, this article uses a variety of ways to highlight key features, current challenges, training sample needs, primary application domains, and references. Written code. Some noteworthy advancements have been achieved according to the study on deep learning mural picture restoration. The use of deep learning to restore mural images, however, is a relatively new field. Data pertaining to the mural picture itself that needs fixing is the bulk of the study's material. Hence, deep learning-based mural picture restoration remains a tough problem.

Biomechanical principles have been widely applied across various fields, demonstrating significant research potential not only in medical and sports domains [22,23] but also opening new directions in psychology, education, and finance [24–26]. Digital imaging technology has extensive applications in the field of biomechanics, providing high-precision motion capture, analysis, and visualization tools that have greatly advanced the depth and development of biomechanical research [27]. In the study of how digital imaging technology promotes the development of traditional crafts, the application of biomechanics and biology provides a new perspective for the digitization of cultural heritage. Biomechanics helps designers understand the dynamic characteristics of the natural world by analyzing the movement and structure of living organisms, allowing for a more realistic representation in digital works. Additionally, research in biology offers abundant material for the innovation of traditional crafts, aiding in the creation of works that align with biological adaptability.

3. Materials and methods

3.1. System model

Because of the delicate and ever-changing nature of modern verbal communication and handicrafts, the spread of ICH encounters several challenges. Skilled craftspeople's knowledge and experience may be lost to the world when they retire. Furthermore, ICH is in grave danger of extinction due to the relentless speed of technology. Consequently, computer-aided design and other contemporary technology must be immediately used to preserve and promote this invaluable legacy. The diversity and uniqueness of intangible cultural heritage, coupled with the complexity of biomechanical variations, present significant technical challenges for digitization.

But there's a new way to solve this problem using deep learning based on bionic principles, and CNN in particular [28]. Convolutional neural networks (CNNs) draw significant inspiration from bionics, especially in mimicking the biological visual system. One of the core concepts of CNNs, the convolutional layer, is inspired by the receptive fields of neurons in biological visual systems. In the visual cortex of living organisms, each neuron is sensitive to a specific region of the visual field, known as its receptive field. Similarly, when the convolutional kernel in CNNs slides across an image to perform convolution operations, it focuses on a specific local region of the image at a time. Just like the receptive field of a biological neuron, CNNs process only local information, enabling them to effectively capture the local features within an image. CNNs are very effective image processors and recognizers because, after extensive training, they dive into the fundamental aspects of pictures to get accurate identification. Combining CNN with CAD allows for the expert extraction of crucial ICH aspects, leading to a digital depiction of ICH culture that is both accurate and beautiful. Reviving interest in ICH and ambassadors requires a smooth integration of ICH into school courses. We can digitally display all the highlights of ICH culture by using CAD technology to build an immersive interactive visual learning environment [29]. With this fresh approach, ICH may be better understood, students' interest piqued, and the groundwork for its further development and improvement laid firmly.

3.2. VGG-19 model

In bionics, biological visual systems excel at efficiently extracting various features from the environment. For example, the human visual system can rapidly recognize the shape, color, texture, and other attributes of objects, even in complex backgrounds. This capability allows for accurate perception and understanding of visual information, showcasing the remarkable adaptability and precision of biological vision. The VGG-19 model, with its deep convolutional network structure, effectively extracts features from images. By simulating the visual effects of natural organisms, it introduces more natural colors, contrasts, and motion trajectories into the designed graphics, allowing users to experience a stronger sense of immersion while viewing [30]. VGG-19 extracts image features through the stacking of multiple convolutional and pooling layers. The convolution kernels in the convolutional layers can be regarded as detectors for local image features, akin to the way neurons in biological visual systems respond to specific visual stimuli. As the network depth increases, VGG-19 is able to extract progressively more abstract and higher-level features from images, much like the human visual system, which processes raw visual signals to derive more complex and meaningful information.

An abbreviation for a popular multi-layer deep Convolutional Neural Network (CNN) design is Visual Geometry Group. A "deep" neural network (NNN) contains several convolutional layers; NNGN-19 has nineteen and NNGN-16 has sixteen. Groundbreaking object recognition models are constructed using the VGG architecture. For a number of applications and datasets outside of ImageNet, VGGNet—a deep neural network—outperforms the state-of-the-art. Plus, it's one of the most widely used image recognition frameworks out there.

Although they share an identical principle, the VGG19 model (also known as VGGNet-19) supports 19 layers more than the VGG16 model. The model has two convolutional layers—"16" and "19"—that serve as weights. The layout of VGG-19 is shown in **Figure 1**. For comparison, VGG16 only has two convolutional layers, whereas VGG19 has three. This article will conclude with a more in-depth discussion of the VGG16 and VGG19 network features.

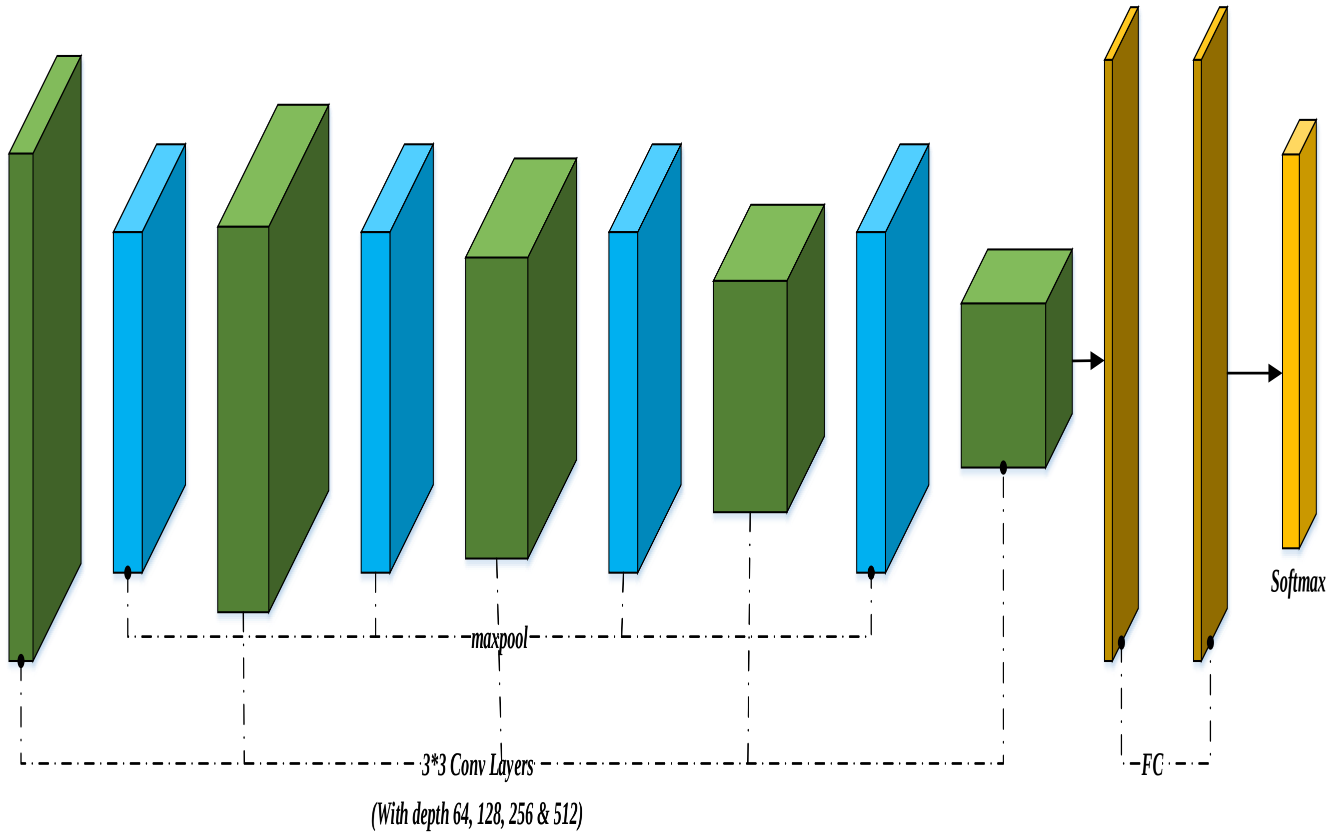

Figure 1. VGG-19 model.

- Here is VGG's design, simplified: Photos with a resolution of 224 by 224 pixels may be inputted into the VGGNet. The model's developers eliminated the central 224224 patches from all images to provide a consistent input size for the ImageNet competition.
- Convolutional Layer: With the lowest practicable receptive field of 33, VGG's convolutional layers record movement from left to right and up to down. Eleven convolution filters are used to further linearize the input. A ReLU unit, an upgrade to AlexNet that shortens training time, comes next.
- The Rectified Linear Unit Activation Function (ReLU) is a piecewise linear function that, when input is positive, returns the value of the input and, otherwise, returns zero. By setting the convolution stride to 1 pixel, the spatial resolution is preserved throughout the convolution process. In an input matrix, stride is the amount of pixel shifts. All of the hidden layers in a VGG network employ ReLU. Local Response Normalization (LRN) is not compatible with VGG since it increases training time and memory usage.
- Furthermore, it does not significantly enhance accuracy. The three layers that make up VGGNet all have one thing in common: They are fully connected. The first two levels have 4096 channels in all, whereas the third level has 1000 channels, one for per class.

The procedure for detecting crimes using VGG-19 is as follows:

- The network transformed an RGB image with a predetermined size of (224 × 224) into a matrix of the type (224, 224, 3).
- Removing each pixel's average RGB value from the training set was the only preprocessing step.
- The team was able to grasp the overall idea by using a 3 × 3 kernel with a stride size of 1 pixel.
- The spatial resolution of the picture was maintained by using spatial padding.
- The max pooling method made use of a 2 × 2 pixel window with a sride value of 2.
- The model's classification accuracy and processing time were both enhanced by adding non-linearity using the Rectified Linear Unit (ReLu). When compared to previous models that used tanh or sigmoid functions, this one was light years ahead. Implemented were a 4096-layer, a 1000-channel layer for 1000-way ILSVRC classification, and a softmax function.

Figure 2 shows the layers that make up the VGG19 model:

−−−−−−−Conv3x3 (64) −−−−−−−
−−−−−−−Conv3x3 (64) −−−−−−−
MaxPool
−−−−−−−Conv3x3 (128) −−−−−−−
−−−−−−−Conv3x3 (128) −−−−−−−
MaxPool
−−−−−−−Conv3x3 (256) −−−−−−−
−−−−−−−Conv3x3 (256) −−−−−−−
−−−−−−−Conv3x3 (256) −−−−−−−
−−−−−−−Conv3x3 (256) −−−−−−−
MaxPool
−−−−−−−Conv3x3 (512) −−−−−−−
−−−−−−−Conv3x3 (512) −−−−−−−
−−−−−−−Conv3x3 (512) −−−−−−−
−−−−−−−Conv3x3 (512) −−−−−−−
MaxPool
−−−−−−−Conv3x3 (512) −−−−−−−
−−−−−−−Conv3x3 (512) −−−−−−−
−−−−−−−Conv3x3 (512) −−−−−−−
−−−−−−−Conv3x3 (512) −−−−−−−
MaxPool
−−−−−−−Fully Connected (4096) −−−−−−
−−−−−−−Fully Connected (4096) −−−−−−
−−−−−−−Fully Connected (1000) −−−−−−
SoftMax

Figure 2. Component structure of the VGG-19 model.

3.3. VGG-19 based graphics design

Twelve sets of interwoven major (sectional) and minor (middle) solar terms make up the words: A whole solar cycle is represented by the 24 solar terms, which further split the cycle into 24 segments, each of which is about half a month long. There is seldom variation of more than a day or two between the solar and lunar calendars when it comes to the Gregorian date of each solar term, Please refer to Table 1 for an explanation of solar terms and meanings.

Table 1. Solar terms and meaning.

Solar Terms	Chinese	Month and Date	Remarks
Start of Spring	lì chūn 立春	Feb 4th	This is a very early spring in much of China; only in the far south is it officially spring, so the term is debatable.
Rain Water	yǔ shuǐ 雨水	Feb 19th	Since then, there has been an uptick in rainfall.
Awakening of Insects	jing zhé 惊蛰	Mar 5th	A rumble in the sky awakens the sleeping bugs.
Vernal Equinox	chūn fēn 春分	Mar 21st	Day and night are of equal duration.
Clear and Bright	qing ming 清明	Apr 4th	In the absence of precipitation, the sky is bright and clear, and a noticeable warmup occurs. Noun that is misleading, especially in southern China.
Grain Rain	gú yǔ 谷雨	Apr 19th	Shoots emerge from the first harvests.
Start of Summer	li xià 立夏	May 5th	Soon it will be summer (in the south of China).
Small Full (Grain)	xiǎo mǎn 小满	May 20th	Summer crop seeds are becoming plump, but they aren't mature quite yet.
Grain in Ear	máng zhǒng 芒种	Jun 5th	In southern China, the wheat ripens and summer planting begins.

Table 1. (*Continued*).

Solar Terms	Chinese	Month and Date	Remarks
Summer Solstice	xià zhì 夏至	Jun 21st	At this time of year, the days are the longest and the nights the shortest.
Minor Heat	xiǎo shǔ 小暑	Jul 6th	The start of the warmest part of the year.
Major Heat	dà shǔ 大暑	Jul 22rd	This time of year brings the longest days of sunlight, the warmest average temperatures, the heaviest rainfall, and the most frequent thunderstorms (in some regions of northern China).
Start of Autumn	lì qiū 立秋	Aug 7th	An outlier: This is not true anywhere. The "start of spring" is also around one month early.
Limit of Heat	chù shǔ 处暑	Aug 22nd	Hot summer is coming to a close.
White Dew	bái lù 白露	Sep 7th	As summer gives way to fall. Fall rains arrive, and the temperature plummets.
Autumnal Equinox	qiū fēn 秋分	Sep 22nd	Day and night are of equal duration.
Cold Dew	hán lù 寒露	Oct 8th	The temperature drops to a level where dew point is reached, but not frost point.
Frost Descent	shuāng jiàng 霜降	Oct 23rd	(In North China) The temperature drops, and frost starts to appear.
Start of Winter	li dōng 立冬	Nov 7th	The north of China experiences this, whereas the south experiences winter at a later date.
Minor Snow	xiǎo xuě 小雪	Nov 22nd	The temperature drops, and snow starts to fall.
Major Snow	dà xuě 大雪	Dec 6th	For the first time all year, northern China experiences heavy snowfall.
Winter Solstice	dōng zhì 冬至	Dec 21st	During this time of year, both the day and night are at their shortest.
Minor Cold	xiǎo hán 小寒	Jan 5th, 2024	The weather quickly drops to its lowest point.
Major Cold	dà hán 大寒	Jan 20th, 2024	"Big Chill" This time of year is the coldest.

How easy it is to use, how clear the information is, how quickly and accurately they get feedback, etc. are all aspects of a product's user experience. App interface design is becoming an integral part of the digital inheritance and protection process. New avenues for digital ICH protection have opened up because to the widespread use of DL technology. This section delves into the design scheme of a DL-based application interface with the goal of offering a fresh approach to ICH presentation, dissemination, and protection. The user experience is given by,

$$ES = \frac{V + U + B + SF}{4} \tag{1}$$

The user experience score (*ES*) is computed as the function of value (*V*) (i.e., usefulness of the graphics), usability (*U*), relevant biomechanical indicators (*B*) and satisfaction level (*SF*). Based on the *ES* value, the interface changes the scenery.

4. Results and analysis

4.1. Experimental setup

This part presents experimental evidence, both objective and subjective, that supports the performance and practicability of the VGG-based ICH image recognition method suggested in the preceding chapter. In addition to confirming the real effect of our proposed VGG algorithm, this experiment's design and execution shed light on the algorithm's potential applications in ICH protection. Accuracy, recall, $F1$ value, and other performance indicators may be measured in objective studies to demonstrate the algorithm's recognition capacity. Subjective trials may provide light on how individuals see and embrace modern technology, allowing researchers to better cater to users' requirements. Moreover, the advancement of ICH protection is aided by the outcomes of these trials, which have a direct impact on the enhancement and implementation of the interactive design of the non-legacy APP interface.

The sample dataset in this study consists of various images of intangible cultural heritage, which have been processed through center cropping to ensure that the main features are located in the central area, reducing the impact of background noise. The cross-entropy loss function is chosen for training the model to effectively measure the difference between the predicted probability distribution and the true label distribution. The goal is to classify the images into 10 different categories, thereby accelerating the model's convergence process.

A computer system with an Intel Core i7 8-core CPU and 16 GB of RAM served as the experimental setup for this investigation. A 1 TB solid-state drive (SSD) was also included for storing experimental data and models, and an NVIDIA GeForce RTX 2080 GPU was used to speed up the DL model's training and inference processes. Regarding the software environment, Windows 10 was used, with Python 3.8 set up as the primary programming language. To build and train the model, we used TensorFlow 2.5.0 and PyTorch 1.9.0 inside the DL framework. For data analysis, we also utilized Scikit-learn 0.24.2. The experimental code was written and executed using Jupyter Notebook 6.3.0, while GPU-accelerated computation was done using CUDA Toolkit 11.1. For tasks related to image processing, such as preparation and processing, OpenCV was used.

4.2. Result analysis

This research examines the performance of the VGG-based ICH image recognition model in recognition accuracy, recall, and $F1$ value in order to assess the Chongqing ICH APP interface system. Specifically, it aims to understand the influence of the image recognition module in the system on recognition accuracy and recall. The accuracy is one of these metrics; it is defined as the percentage of positive and negative samples that the classifier correctly predicted relative to the total number of samples. The recall rate, also known as the true case rate, is the percentage of positive instances that were correctly predicted by the classifier as a percentage of all positive cases. For datasets that are unbalanced, the $F1$ value may be used to balance the classifier's performance by taking recall and accuracy into account. **Figures 3–5** displays the results of the research that compared many models to determine the impact of an ICH image recognition model built on DL. The template matching technique, which is part of the classic recognition network approach, compares the input picture to a template, which is a sample image.

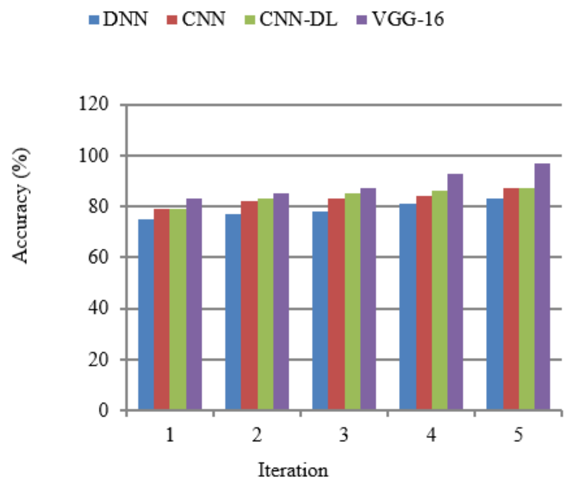

Figure 3. Comparative analysis of accuracy on dataset 1.

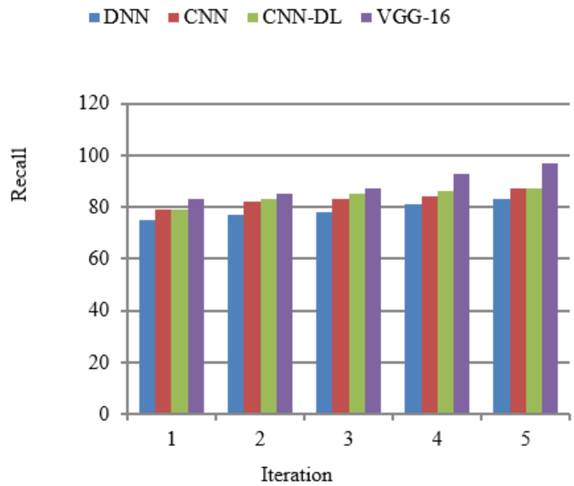

Figure 4. Comparative analysis of recall on dataset 1.

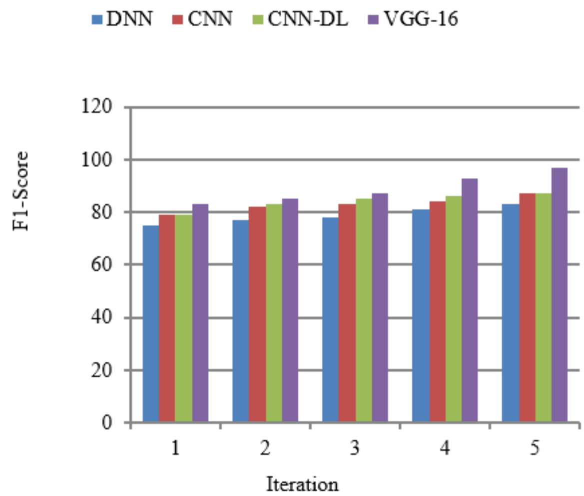

Figure 5. Comparative analysis of F1-score on dataset 1.

This work employs the K-fold cross-validation approach to assess the VGG model's performance, which enhances model verification. If you want your model to be more accurate and resilient, this is the way to go. To begin, the dataset is split into five subgroups and a plethora of experiments are run in this work. Every experiment has a verification subset and a training subset. Second, for each iteration, this procedure is repeated five times with a new subset serving as the validation set.This study uses five subsets to evaluate the model's performance in recognizing images related to the 24 solar terms. Sets 1 to 5 are sourced from natural collection, specialized collection, data augmentation, external datasets, and user-generated content, covering between 500 to 700 images. Refer to Table 2 for subset information.

Table 2. Subset information.

Subset	Data Source	Quantity (Images)	Content Description
Set 1	Natural Collection	500	Contains a variety of images related to solar terms, primarily derived from climate changes in natural environments, as well as the biomechanical changes of plants and the ecological changes of animals, testing the model's accuracy in diverse scenarios.
Set 2	Specialized Collection	600	Composed of images from specific solar terms, selected from traditional cultural materials and solar term celebrations, evaluating the model's ability to recognize specific cultural elements.
Set 3	Data Augmentation	550	Includes images that have undergone transformations such as rotation and flipping, testing the model's robustness when facing variations and noise.
Set 4	External Data	700	Covers solar term images from different regions, assessing the model's generalization capability.
Set 5	User-Generated	450	Contains images related to solar terms (Figure 6) shared by users on social media (Including the landscape and their own physiology, etc.), evaluating the model's performance in real-world application scenarios.

The input layer of the model consists of 128 neurons, with each layer containing 256 units, effectively capturing the temporal features of the images. The output layer uses the softmax activation function to classify the data into 10 different categories. During the training process, the Adam optimization algorithm is employed, with a learning rate set to 0.001 and a momentum parameter of 0.9. The training is conducted for a total of 100 epochs, with a batch size of 64 for each epoch.The final performance assessment findings are obtained by averaging the outcomes of these five tests, as shown in **Table 3**.

Table 3. Experimental results of K-fold cross-validatio.

Index	Set 1	Set 2	Set 3	Set 4	Set 5	Average value
Accuracy (%)	94	95	97	96	98	96
Recall rate (%)	94.7	95.8	97.2	96.3	97	96.2
*F*1 value (%)	95	94.8	97	97	98	96

Table 3 displays the results of the performance evaluations conducted on five separate data subsets, demonstrating that the ICH image recognition model suggested in this article has obtained rather consistent results. The model's great accuracy in recognizing ICH pictures is shown by the steady accuracy of these subsets, which averages 94.84%. Similarly stable are the FI value and recall rate, which average 94.58% and 94.70%, respectively.

24 Solar Terms for Dynamic Interface

Figure 6. Dynamic interface based on 24 solar terms.

The model's stability in performance across data subsets, as well as its efficacy and resilience in the ICH image identification task, are highlighted by the findings shown above.

All things considered, the many real-world benefits and uses highlighted by the conversation around the ICH image recognition model built on bionic technology and the Chongqing ICH APP interface system are clear. The area of digital cultural heritage preservation and inheritance receives substantial backing from this research, which offers new approaches and resources for this purpose. The area of digital inheritance and ICH protection is still facing challenges with administration and decision-making. Hence, this research offers a few recommendations. To begin, in order to better transmit and preserve traditional culture, managers should investigate methods to integrate technology with cultural transmission. This is particularly important in light of the potential of deep learning technology to safeguard and pass on ICH. Second, the needs of the end user must be prioritized in designing interfaces and applications for ICH. An increase in user engagement with cultural heritage may be achieved by ensuring the interface is attractive, easy to use, and matches user expectations. Furthermore, TL is a powerful tool for enhancing the model's performance. If people want to speed up model training and make picture recognition more effective, they should think about incorporating TL into the project. The effective preservation and transmission of ICH also depends on community engagement and collaboration. Managers should rally the troops and make sure everyone knows that protecting the neighborhood is everyone's business. Continuously researching and comparing various models and approaches, optimizing and adapting to varied application circumstances, and developing technology and procedures are all essential in order to enhance the preservation impact of cultural assets. Lastly, it is important to keep environmental and social concerns in mind when planning ICH preservation and legacy initiatives. This will help to guarantee that preservation efforts are in sync with economic and social progress and do not harm the environment.

The impressive effectiveness of the RL algorithm in generating classification decisions and the powerful image processing capabilities of CAD technology are the main reasons for this advantage. Additionally, the study presents the results of a comparison analysis using newly suggested DL-based approaches for intangible cultural element extraction and categorization. The results of the experiments show that this approach is quite accurate at classifications and has great stability and generalizability. The term "stability" describes how well this method works in different contexts, with different types of intangible cultural heritage (ICH) pictures, and different image quality standards. Because ICH images are inherently diverse and complicated, this is a critical component for guaranteeing dependability in real-world applications. Through an agent-environment interactive learning process, the RL algorithm is able to independently explore and modify the feature space. By doing so, we may extract traits that are more unique and robust, able to both capture the spirit of well-known intangible cultural aspects and skillfully deal with the obstacles offered by unknown ones. The RL algorithm's unique capabilities in improving feature extraction and classifier construction are largely responsible for these benefits. This article provides a thorough analysis and explanation based on the experimental results. The first thing to know about extraction effectiveness is that CAD technology is so well-suited to image processing that it has been widely used. Accurately capturing the particular qualities of intangible cultural aspects is made possible by precise picture segmentation and quick feature extraction. This provides substantial support for future classification tasks. Regarding classification accuracy, the RL algorithm's architecture allows for adaptive classifier modifications based on real-time feedback signals. To further improve classification accuracy, the agent is guided toward learning the most suitable classification judgments by continuous optimization of the classification strategy and logical definition of state space, action space, and reward functions.

The results of the experiments show that this approach is quite accurate at classifications and has great stability and generalizability. The term "stability" describes the performance of this method across different environments, various types of intangible cultural heritage (ICH), diverse biomechanical states, and varying image quality standards. Because ICH images are inherently diverse and complicated, this is a critical component for guaranteeing dependability in real-world applications. Through an agent-environment interactive learning process, the RL algorithm is able to independently explore and modify the feature space. By doing so, we may extract traits that are more unique and robust, able to both capture the spirit of well-known intangible cultural aspects and skillfully deal with the obstacles offered by unknown ones. The RL algorithm's unique capabilities in improving feature extraction and classifier construction are largely responsible for these benefits. This article provides a thorough analysis and explanation based on the experimental results. The first thing to know about extraction effectiveness is that CAD technology is so well-suited to image processing that it has been widely used. Accurately capturing the particular qualities of intangible cultural aspects is made possible by precise picture segmentation and quick feature extraction. This provides substantial support for future classification tasks. Regarding classification accuracy, the RL algorithm's architecture allows for adaptive classifier modifications based on real-time feedback signals. To further improve classification accuracy, the agent is guided toward learning the most suitable classification judgments by continuous optimization of the classification strategy and logical definition of state space, action space, and reward functions.

5. Conclusion

A byproduct of the Chinese people's historical precipitation, "24 solar terms" is the outcome of continuous transmission and advancement. It has been an important part of culture for 5000 years. To the Chinese people, this belongs as a priceless and unique cultural relic. "Culture is the soul of a country and a nation", states one phrase of the Chinese Communist Party Platform, as stated in the 19th National Congress report of the Communist Party of China. Engaging in cultural events is beneficial for both the country and its citizens. China will not be able to recover to its former glory unless its people have a great lot of cultural wealth and pride. Consider the "24 solar terms" as an excellent illustration of ancient Chinese culture in light of the importance of cultural exchanges and social building in the modern world. This study delves into both the cultural and comprehensive Chinese language teaching materials used in the field of international Chinese language education. Within the realm of International Chinese Language Education, it discovers that the "24 solar terms" are disregarded and nonexistent. Consequently, it takes a look at "24 solar terms" through the lens of its cultural identity and talks about how important and valuable it is.

In this study, we explored the application of computer graphics development and biomechanical theory in the context of the twenty-four solar terms. We employed a novel approach that integrates bionic technology, specifically VGG-16, with traditional cultural elements and the digitized biomechanical characteristics associated with different solar terms. This represents a powerful deep-learning model for creating interactive images based on intangible cultural heritage. Furthermore, in order to dynamically alter the visuals based on the user's wish, we took into account the user experience as the Experience Score (ES). Accuracy, precision, and recall are the overarching metrics by which the task is assessed. The suggested work improves upon the status quo in every way.

In this research, the potential of integrating the culture of the 24 solar terms into modern design is emphasized. The 24 solar terms are not only an important part of Chinese traditional culture but are also closely related to changes in the natural world and human physiological rhythms. By combining these cultural elements with biological rhythms, survival characteristics, and other factors, a more natural representation can be achieved in dynamic graphics, creating an interactive experience that is more biologically adaptive and culturally resonant. This work opens up a way to utilize the DL for cultural heritage visualization. In the future, we plan to improve the user experience with the use of NLP and Image Processing techniques. NLP technology can analyze user feedback and comments to extract users' needs and preferences regarding cultural heritage content, making it more aligned with their expectations. Image processing technology can be used to enhance image quality and visual effects, while combining it with image recognition technology allows for user interaction with the images. By clicking on the images, users can access relevant information or stories, thereby enhancing their sense of engagement and immersion.

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References

1. Labadi S. UNESCO, cultural heritage, and outstanding universal value: Value-based analyses of the World Heritage and Intangible Cultural Heritage Conventions. Rowman & Littlefield; 2013.
2. Blake J. UNESCO's 2003 Convention on Intangible Cultural Heritage: The implications of community involvement in 'safeguarding'. Routledge; 2008. pp. 59–87.
3. Bortolotto C. UNESCO, cultural heritage, and outstanding universal value: Value-based analyses of the World Heritage and Intangible Cultural Heritage Conventions. International Journal of Heritage Studies. 2015; 21(5).
4. Maags C, Holbig H. Replicating elite dominance in intangible cultural heritage safeguarding: The role of local government–scholar networks in China. International Journal of Cultural Property. 2016; 23(1): 71–97.
5. Massing K. Safeguarding intangible cultural heritage in an ethnic theme park setting–the case of Binglanggu in Hainan Province, China. International Journal of Heritage Studies. 2018; 24(1): 66–82.
6. Skowron-Markowska S, Nowakowska M. Chinese destinations related to martial arts tourism from the UNESCO perspective. Sustainability. 2021; 13(14): 7581.
7. Wang WF, Wu FS, Ji AH, et al. Advancement and prospect of bionic techniques in the conservation of the cultural heritage. Applied Mechanics and Materials. 2014; 461: 469–475.
8. Skublewska-Paszkowska M, Powroznik P, Smolka J, et al. Methodology of 3D scanning of intangible cultural heritage—The example of Lazgi dance. Applied Sciences. 2021; 11(23): 11568.
9. Pei Z, Huang YM, Zhou T. Review on Analysis Methods Enabled by Hyperspectral Imaging for Cultural Relic Conservation. Photonics. 2023; 10(10): 1104.
10. Huang H. Research on Novel 3D Modelling Methodology for Animation Design based on Computer Graphics Theory and Mathematical Analysis with Kinect Implementation. International Journal of Multimedia and Ubiquitous Engineering. 2015; 10(10): 147–158.
11. Zhang J. Design and Application of Culture Digital Display System Based on Virtual Reality Technology. In: Proceedings of the 2023 IEEE International Conference on Image Processing and Computer Applications (ICIPCA). 11–13 August 2023; Changchun, China. pp. 346–350.
12. Han Z, Shang M, Liu Z, et al. SeqViews2SeqLabels: Learning 3D global features via aggregating sequential views by RNN with attention. IEEE Transactions on Image Processing. 2018; 28(2): 658–672.
13. Pan J. Illustration design of the 24 solar terms. Highlights in Art and Design. 2022; 1(3).

14. Wang Y, Zhou L, Wang H. A Probe into the Path of Integrating "24 Solar Terms" into International Chinese Language Education from the Perspective of Cultural Communication. International Journal of New Developments in Education. 2023: 5(12).
15. Shen Y. Life Nurturing in the illustrated daoyin of the 24 solar terms (二十四节气). Chinese Medicine and Culture. 2019; 2(1): 6–14.
16. Tang D, Liu F, Yang Y, et al. Creative Development of Intangible Cultural Heritage Driven by Computer Graphics Techniques—A Case Study on the Design Phase of Traditional Chinese Paper-cutting Manuscripts. Advances in Computer and Communication. 2024; 5(1): 37–42.
17. Jin H, Wang H. Design and Development of an Educational Game Based on Human-Computer Interaction for Solar Terms. Atlantis Highlights in Computer Sciences. 2023.
18. Ma D, Pu P, Hao J, et al. Automatic Extraction and Classification of Intangible Cultural Elements Using Reinforcement Learning Algorithm. Computer-Aided Design and Applications. 2024; 21(S23): 51–68.
19. Belhi A, Bouras A, Foufou S. A Machine Learning Framework for Enhancing Digital Experiences in Cultural Heritage. Computer-Aided Design and Applications. 2023; 734–746.
20. Mei Y. Exploration on the Application of Dynamic Graphic Design Based on Digital Technology (Chinese). Footwear Technology and Design. 2022; 74–76.
21. Liu Q. Analysis of Teaching Methods for Dynamic Graphic Design in the Context of Digitalization (Chinese). Art Education Research. 2020; 136–137.
22. Lees A. Biomechanical assessment of individual sports for improved performance. Sports Medicine. 1999; 28: 299–305.
23. Lu TW, Chang CF. Biomechanics of human movement and its clinical applications. The Kaohsiung Journal of Medical Sciences. 2012; 28(2): S13–S25.
24. Savescu A, Simonet P. Interdisciplinary association between biomechanical analysis and occupational psychology: Challenges and procedures. In: Proceedings of the 20th Congress of the International Ergonomics Association (IEA 2018); 26–30 August 2018; Florence, Italy. pp. 243–249.
25. Sanders RH. Biomechanical analyses in physical education. Routledge; 2013. pp. 159–170.
26. Ye J. Modeling decision-making dynamics in financial management through biomechanical principles and bio-inspired analytical frameworks. Molecular & Cellular Biomechanics. 2024; 21(4): 703. doi: 10.62617/mcb703
27. Palanca M, Tozzi G, Cristofolini L. The use of digital image correlation in the biomechanical area: A review. International Biomechanics. 2016; 3(1): 1–21.
28. Huang G, Li J, Zhuo J, et al. Design and Implementation of Image Style Transfer Based on Convolutional Neural Network (Chinese). Modern Computer. 2022; 104–108.
29. Zhao Y. Research on the Application of Graphic Image Processing in Visual Communication Design (Chinese). Software. 2022; 127–129.
30. Xu Z, Hu Y, Lu W, et al. Chinese Painting Style Transfer Based on VGG-19 and MMD Convolutional Neural Network Models (Chinese). Modern Computer. 2024; 61–65+70.