

Possibilities of Integrating Machine Learning with Interactive Devices

by Reviving Traditional Chinese Culture

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<https://github.com/RunqiZhao21031188/Runqi-Zhao-Final-Project>

Abstract

This project, featuring the re-creation of historical Chinese culture, such as the Chinese zodiac, is an interactive image installation based on machine learning. It is our sincere expectation that the traditional culture which is gradually neglected will regain its popularity, and meanwhile, get more people to enjoy the heritage of Chinese culture.

With regard to the theoretical structure of this paper, the necessity of re-creating traditional Chinese historical culture including paper-cutting and shadow puppets, led by the zodiac, is elucidated first. The elements of the zodiac are analyzed in terms of background, unique aesthetic value and folklore stories related to them, legendary stories, and extraction of key information graphically, respectively. The traditional Chinese cultural elements are presented, incorporating ancient Chinese legends and art forms such as shadow puppets, paper cuttings, and the zodiac. Secondly, the techniques and concepts utilized for machine learning are elaborated. Additionally, design methods of iterative modeling, usability testing, and user feedback analysis are leveraged in the subsequent design process. With feedback based on user testing, this study optimizes it in terms of interactivity, convenience, feasibility, and stability. Meanwhile, several deep learning models are compared in terms of their advantages, disadvantages, and accuracy in this study. A summary of the research results is presented with suggestions and proposals for its future development.

To shatter the monotony of traditional Chinese culture (zodiac, shadow puppet, paper cutting, etc.), this project is designed with modern design methods and cultural connotations. By using machine learning tools to interact with the participants, the project revives the traditional Chinese zodiac culture and traditional culture in a new form. It fully reflects the strong collision between tradition and modernity and endows traditional culture with a new romantic visual experience.

Key words: Interactive Installation, ResNet

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1 Introduction

This is a Real-time interactive installation regarding the use of machine learning technology and an attempt to encourage people to interact with traditional Chinese culture to promote cultural regeneration. During the interaction of this project, users can find their own Chinese zodiac sign and engage with the installation through a zodiac hand shadow. The project uses a ResNet model for real-time image recognition, and summons the Chinese zodiac sign when the hand shadow is accurate for interaction. An immersive experience of traditional Chinese culture is offered in this project.

1.1 Background

Many folk cultures and traditions may gradually evaporate in the process of urbanization. I used to have a somewhat limited perception of traditional things, assuming that the transformation of traditional matters is not conducive to cultural transmission and that following tradition is a reflection of respect for tradition. Chinese society, however, for quite some time in the past does not provide a good environment for the reinterpretation of traditional culture. As cultural intermingling gains momentum today, not much attention has been paid to traditional Chinese culture, leading to its progressive decline and disappearance.

While artists, designers, and developers seek more interactivity and player immersion in their creative works, there appears to be a genuine need for more ways and means to create. Machine learning makes it possible for creators to use their own material for creative purposes by accurately classifying it, extracting features, and then identifying corresponding information from incoming data before generating it. It offers a broad range of artists and designers new creative possibilities. In addition, real-time video interactive installation artworks with vivid narratives, combined audio-visual forms, and a variety of content meanings have emerged as a rather popular art form nowadays. Interactive installation works with real-time video are more interactive and immersive, thereby delivering a more diverse audio-visual experience to visitors (Chao Wang, 2022).

Through modern design techniques combined with the connotation concept of zodiac culture and finally through the dynamic display of machine learning technology, the input of traditional culture can be promoted to a certain extent and the new interest of contemporary teenagers in the traditional zodiac culture can be stimulated (Dan Zhang, 2015).

1.2 Research significance

Fewer interactive installations combining traditional Chinese culture and machine learning are available, which will provide new ideas for other artists to create in the future.

By reconstructing the traditional cultural elements in modern language and breaking the traditional expression of a single tone, the traditional culture returns to people's daily life. The use of machine learning is a way to maximize the flexibility and diversity of the Chinese zodiac so that it can once again show its new dynamism and vitality. To promote Chinese traditional culture instead of leaving it to be fading in history.

From an artistic design perspective, this study intends to summarize the design process of real-time interactive video installations based on machine learning and form a certain theoretical research framework. Real-time imaging technology and interactive installation art are studied from a broader perspective. The trend of integration of technology and art and the future development direction of this application prospect.

1.3 Aim and questions

Looking at the traditional Chinese cultural elements, I have made attempts to probe into ways in which the cultural stories of the past can be told with more distinctive visual language, given the collision of contemporary classical and modern elements.

In recent years, an increasing number of people, including several young generations, have acknowledged the importance of this issue. Hence how to inject a new era of vitality into the Chinese culture in today's society has become a hot topic in many fields. It seems to me that shattering the stereotypes of what the majority of people think about traditional things is extremely valuable. How to attract the attention of the younger generation while promoting traditional Chinese culture has become the focus of this project. Additionally, how to make the installation more interactive and immersive with the addition of machine learning is the central point of this project.

1.4 Structure

The specific use and design of this interactive device are analyzed in this study from four aspects: visual design, interaction design, and code design, respectively. It explores the reflection and future application of the fusion of interactive device art and machine learning, as well as the prospect of future development.

2 Related Work

Due to the global nature of modern culture, visual symbols of the Chinese zodiac are rife in many foreign products, and products featuring the Chinese zodiac also emerge in one of the Chinese zodiac years. For example, Swatch produced a Zodiac Rat watch in the Chinese Year of the Rat(see figure1), paired with a cheese outer packaging. However, this product failed to cater to the consumption habits of the Chinese people, or it was simply a product designed by foreign designers according to their own understanding. In graphic design, there are also many foreign designers to devise many visual symbols of the zodiac. However, since the 12 zodiac signs are traditional Chinese culture, we should connote them with more spiritual significance and add more ethnic and meaningful elements to them, instead of just concentrating on the superficial image(J. Yu,2021).



Figure 1 Swatch produced a Zodiac Rat watch and a cheese outer packaging



Figure 2 Sample images generated by CAN, ranked as highly plausible by human experts

According to Givanno Castellano in his paper, the most relevant deep learning methods for pattern extraction and recognition, such as CNN, RNN, etc., can be applied to art such as painting and illustration(see Figure3) (Elgammal et al., 2017).

The applications of artificial neural networks today are innumerable and range from healthcare (Miotto et al., 2018) to bioinformatics (Min, Lee and Yoon, 2017), from biometrics (Sundararajan and Woodard, 2018) to cyber-security (Xin et al., 2018), and so on. This year, with advances in deep learning and computer vision, the growing popularity of large collections of digital visual art, and the deepening integration of programming and the art world, new design concepts and effects can be created through code to assist the art world (Castellano and Vessio, 2021). His paper critically points out the concerns about the quality of images using machine learning to create works, while leading me to discover more possibilities for combining machine learning with art. During this process, I learned how paintings are extracted elements and recognized in machine learning.



Figure 3 Move Mirror: You move and 80,000 images move with you

In 2018, Google conceived a machine learning-based program called "Move Mirror", a webcam-based technology. It captures various types of human movements, and makes countless photos simulate human movements by matching the user's movements with a database of images of people doing similar actions. The project demonstrates computer vision techniques (e.g., pose prediction techniques) and brings them to life with intriguing features. It demonstrates the advancement of machine learning and shows me the possibility of applying machine learning to interactive images.

training data	07+12	07++12
test data	VOC 07 test	VOC 12 test
VGG-16	73.2	70.4
ResNet-101	76.4	73.8

Figure 4 Object detection mAP (%) on the PASCAL VOC 2007/2012 test sets using baseline Faster R-CNN. See also Table 10 and 11 for better results

metric	mAP@.5	mAP@[.5, .95]
VGG-16	41.5	21.2
ResNet-101	48.4	27.2

Figure 5 Object detection mAP (%) on the COCO validation set using baseline Faster R-CNN.

Those two figures(see figure 4 and figure 5) show the object detection baseline results on PASCAL VOC 2007 and 2012 (M. Everingham, L. Van Gool, C. K. Williams, J. Winn, and A. Zisserman,2010) and COCO (T.-Y. Lin, M. Maire, S. Belongie, J. Hays, P. Perona, D. Ramanan, P. Dollar, and C. L. Zitnick,2014). We adopt Faster R-CNN (S. Ren, K. He, R. Girshick, and J. Sun,2015.) as the detection method. Here we are interested in the improvements of replacing VGG-16 (K. Simonyan and A. Zisserman,2015.) with ResNet-101. The detection implementation of using both models is the same, so the gains can only be attributed to better networks. Most remarkably, on the challenging COCO dataset we obtain a 6.0% increase in COCO's standard metric, which is a 28% relative improvement. This gain is solely due to the learned representations(He, K., Zhang, X., Ren, S. and Sun, J,2015). In this paper, after several experiments and data, the author proved that ResNet was superior in calculation speed and accuracy, making ResNet the optimal choice for this project.



Figure 6 The Monkey King

As the first colorful animated feature film in China, The Monkey King is a mix of traditional Chinese art elements such as Peking Opera, shadow puppets, paper-cutting, sculptures, and murals. This animated film is interspersed with many traditional Chinese cultures and contains a unique Chinese cultural flavor. Each of these

elements integrates very harmoniously, which is of great help to me in designing the image of the 12 zodiac signs.

3 Methodology

First of all, by referring to relevant books, papers and reports, I learned about the culture of the zodiac from various angles, the folk tales, legends and related customs behind each animal, and the application of machine learning technology in interactive installations. Then, by summarizing the above information, the target object is determined for the project and relevant application cases are analyzed. According to the relevant cases, the modelling elements of the zodiac and the maximum feasibility of combining the traditional zodiac culture with machine learning are summarized.

Secondly, starting from conceptual design, iterative design was carried out, including code debugging, interactive experience interviews with testers to improve the interaction difficulty and effect of the device, etc.

An iterative design approach is implemented in this design, after self-testing and summarizing feedback from several user tests, targeted optimization is carried out regarding recognition accuracy, dataset completeness, experience immersion, interaction difficulty, etc.

In addition, I selected 5 testers to experience the project. I collected them in the form of conversations after the test projects' experiences, and the results were quantitatively analyzed. Understand the participants' understanding and experience feedback of the device, so as to make iterative improvements.

4 Design Process and Findings

4.1 Inspiration

It comes primarily from the traditional Chinese culture that I was brought up with. With an incredibly keen interest in national culture, I hope to narrate the stories of the past in a unique contemporary language. I endeavor to interpret traditional culture in combination with digital tools, to break the stereotypes people have about traditional things, and to obtain more diversified and personalized interpretations.

Teenagers' cognition of the chinese zodiac still stays in the category of animals or simply know the attributes of their own zodiac. The main reason is that most detailed records of the zodiac culture are rather boring words, and most aspects of modern design inheritance stay in the image characteristics of the zodiac itself, and the

upgrading and transformation of the image of the zodiac has not been realized to meet the aesthetic needs of modern people (Elgammal et al., 2017).

4.2 Background Research

The Chinese Twelve Zodiac Signs

People born in the same year have an exclusive Chinese zodiac sign, derived from a total of twelve animals, which are the twelve Chinese animals that match the twelve Earthly Branches to the year of a person's birth. The twelve zodiac signs are Rat, Ox, Tiger, Rabbit, Dragon, Snake, Horse, Goat, Monkey, Rooster, and Pig(see figure7). The origin of the zodiac is related to animal worship.



Figure 7 The Chinese Twelve Zodiac Signs

Each animal is associated with a distinct year in the Chinese calendar. The zodiac was used to foresee one's future (Denisenko and Zheng Yu Xu, 2021) and to identify personality traits. Each animal has its own unique attributes and traits that make it a good match for a specific personality type (Li, 2020).

In addition to the image of the zodiac itself, it embodies deeper cultural meanings, and folk tales, and confers many auspicious meanings, and people put their hopes for the future in each animal.



Figure 8 Paper Cut

Paper Cut

It is the art of openwork(see figure8), one of the ancient folk arts of the Chinese Han people. It has a visual sense of translucency and artistic enjoyment. The carrier of paper cutting can be paper, gold or silver foil, bark, leaves, cloth, leather, etc. It is a folk-art form with a long history and wide circulation in China. The creation and circulation of this sort of art is intimately related to Chinese festive customs. During New Year's Eve, people put beautiful and bright paper cutouts on snowy white walls or bright glass windows, doors, lanterns, etc., and the festive atmosphere is rendered remarkably festive.



Figure 9 Shadow puppet

Shadow puppet

Shadow puppet is an ancient and simple folk traditional art in China(see figure9), the progenitor of present-day film and television art, the essence of which is made by processing and carving animal skins into props for shadow puppets. It embodies a rich and colorful art form, from which one can even learn a lot about carving, painting, sound, acting, etc. Shadow puppet was once active throughout China, but nowadays,

as the pace of life accelerates, many traditional arts like it are being weakened and the art is slipping out of our view. Aiming to give it the power of rebirth, many scholars and related workers have started to explore how this ancient art can be better inherited and carried forward.



Figure 10 'A Thousand Miles of Rivers and Mountains'

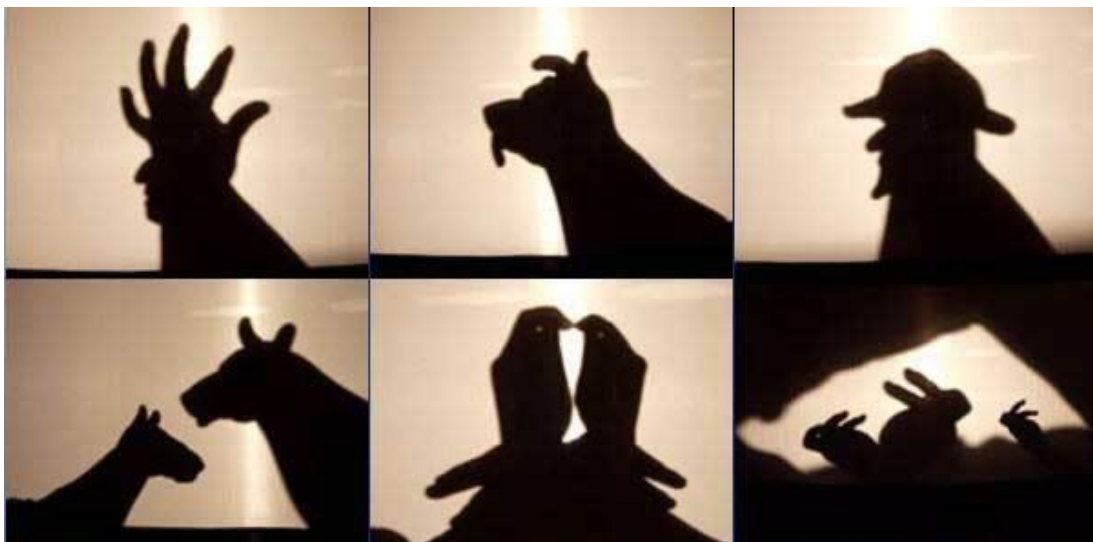


Figure 11 Hand shadowing

'A Thousand Miles of Rivers and Mountains'

This painting is a famous Chinese painting(see figure10). Based on tradition, the painting is a long scroll of a meticulous picture, with the smoky river and the rolling hills posing a wonderful landscape in the south of the Yangtze River. The static scenes of fishing villages, pavilions, huts and cottages, and long bridges are interspersed with dynamic scenes of fishing, sailing, playing, and bazaars, with a delicate combination of movement and tranquility. The characters in this work are portrayed with great delicacy and vividness, and the flying birds are depicted with a light touch of the brush, soaring with wings.

Hand shadowing

Hand shadowing(see figure11) relies on hand gestures to communicate what is to be shown. It allows all the contents of the performance to be changed by hand movements to form various images with special lighting effects. With one hand in the black shadow, it can change various expressions, words, icons, patterns, and every facet of the world.

4.3 Design Element Extraction

Traditional paper cutouts on animal subjects fall into two categories: the delicate realistic style or the abstract style, both of which incorporate the characteristics of each animal's image. Typically, the paper cutouts have a hollowed-out design on the surface, symbolizing the hope of prosperity and peace while being aesthetically pleasing. Traditional hollow design and the traditional color (red) of paper-cutting are still retained in the design of this project, and the animal images are designed to be more lovely and distinctive.

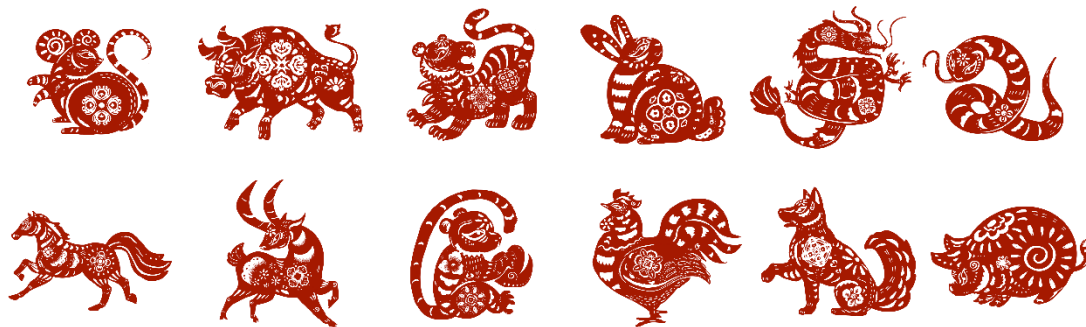


Figure 12 Zodiac visual design

The figures in traditional shadow puppet theater are mainly composed of the head, body, and limbs, with movable joints and side profiles only. However, to create the 'Chinese Zodiac Shadow Puppet Show', the design sets fixed points at the joints of the limbs, the tail, and the head and body to simulate the movement characteristics of the shadow puppet show.

The animal shapes of the project are designed with the habits and characteristics of each animal, and the characteristics of each animal are distinctively displayed in front of the participants(see figure12).

The background of each Chinese zodiac sign is unique, derived from the picture of Thousand Miles of Rivers and Mountains, with the inclusion of cranes, auspicious

clouds, high mountains and flowing water, and other elements that symbolize good fortune and happiness in traditional Chinese painting and calligraphy. At the same time, I make use of the traditional negative space in Chinese painting in the background design, which refers to the absence of any brushwork to highlight the focus while making things in the painting look nebulous. This approach provides room for the audience's imagination while adding rhythm and context to the image, allowing participants to experience traditional Chinese culture in a fully immersive way.

4.4 Soundtrack and voice-over

As participants approach the space, they are immediately drawn to the gentle and rhythmic sounds of a melody. It is a celebrated piece played on the traditional Chinese instrument, the guzheng, illustrating the infinite longing for one's hometown triggered by the sound of rain beating on bananas amidst the tranquil and deep night. It is poetic, graceful, exquisite, elegant, and full of picturesque images, resembling a scroll of a magnificent Chinese landscape. With this piece, I hope to elevate the sense of immersion by taking participants into ancient times and starting a journey into a traditional culture.

Once the hand shadow is accurately identified, the corresponding Chinese zodiac sign will appear on the screen and a voiceover will echo. This dubbing is read aloud in Cantonese and refers to the earthly branches of each Chinese zodiac sign (in ancient China, the twelve earthly branches were used to chronicle the hours and months. (In ancient China, the twelve branches of the earth were used to chronicle the time of the month and the day was divided into 12 periods, which were represented by the Twelve Earthly Branches).

4.5 Coding

The thrust goal of the project is to elevate people's interest in traditional Chinese culture, which necessarily requires the use of new and innovative approaches. As such, I used machine learning as a tool to explore a new form of interaction.

First of all, the code of this project processed the data and converted the data set of video files into a code recognizable format, i.e., images. Then ResNet was used for training, and after the successful completion of training, Video.py was applied to interact with the camera, namely to play the corresponding Chinese zodiac animation text and music after recognizing the corresponding image.

In the dataset, I created 14 types of files according to the twelve zodiac categories (in addition to "cancel" and "blank"). Each file is a multiple 2-3 minute video of the corresponding zodiac hand shadow. To ensure the accuracy of the recognition, the

camera used to shoot the dataset should be the same as the final device camera (same resolution and aspect ratio).(see figure1)

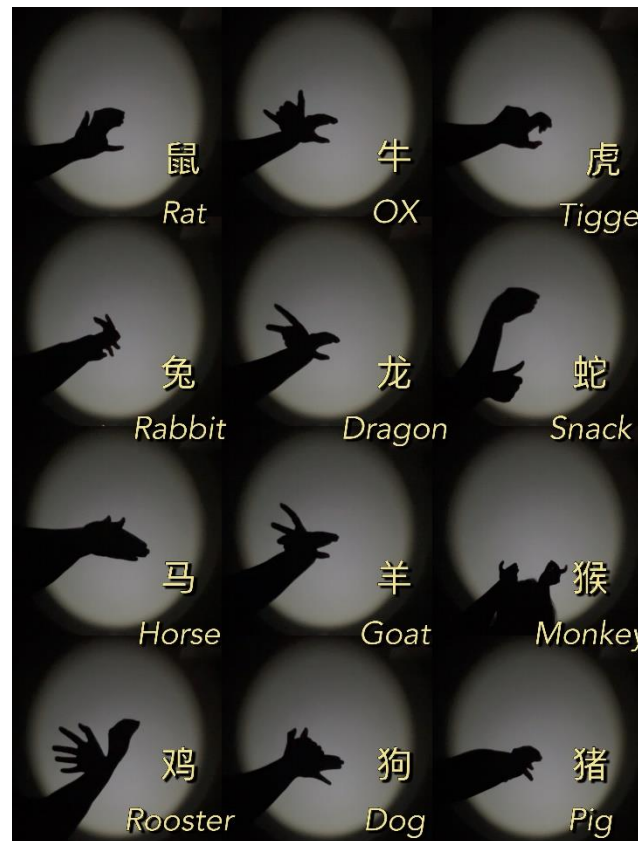


Figure 13 Zodiac machine learning dataset

Data processing phase: videos of the dataset were converted into images and split into a training set, validation set, and test set in the ratio of 60%, 20%, and 20%, and then the processed images were stretched and mirrored to expand the data volume of the training set and enhance the prediction accuracy of the model.

The model was trained using ResNet with a Torch architecture. Microsoft put forward this model in 2015. Compared with other CNN models, this structure is deeper and the overall performance is improved. Based on the short-circuit connection path part, no other parameters are introduced to increase the computational complexity. Therefore, even if the number of model layers is increased, the training speed of the model can be accelerated and the training effect of the model can be improved(Song Yang,2022).

Effect phase: The interaction logic was designed and feedback effects were produced.

Testing phase: I invited testers to participate in the interaction of the project according to the prompts, and the recognition was more accurate and all received positive feedback.

4.6 Iterative Design Process

Difficulty of interaction: From the feedback collected from the test participants, it can be found that most of them were unable to complete the zodiac hand shadow gesture at first because they generally thought that it was difficult to pose properly. Therefore, I optimized the gesture of hand shadow, and the subsequent testers were more satisfied.

Code call: During the code part I experimented to extract the features in the image by convolution, i.e. transfer learning operation, after which the features are input to the neural network VGG16, and finally the neural network delivers the results. However, by calculating the model on two computers at the same time, it can be seen that the training results vary greatly on different computers regarding the values of loss rate and accuracy, resulting in very unstable test results. Therefore, I used the ResNet model for the subsequent operation.

Dataset creation: It takes as much data as possible to keep the number of datasets consistent in dataset acquisition. As well as pay attention to the consistency of the camera angle. Initially, the project encountered unclear data identification, and it was found that except for the small amount of data set, the instability would incur when there was a large difference in the number of collections in some category files.

Code debugging: In the image recognition stage, I expect that when the program recognizes the correct image, the screen will play the corresponding animation and music. Therefore, at the very beginning, the camera was checked once for each frame to see whether the corresponding image was recognized. However, during the test, it was found that the recognition frequency of each frame was too fast, which resulted in the interruption before the zodiac animation was finished. After continuous testing, the recognition frequency was adjusted to the appropriate one

4.7 Interaction and Environment

Resonance is composed of five parts: computer, camera, projector, light source and microphone. It uses ResNet for real-time computing to identify images. The site of the project is set as a dark space, and the black environment makes people focus on the installation in front of them.

The melodious sound of the guzheng will be heard when people approach the installation. Upon entering, visitors can learn their Chinese zodiac sign and the corresponding gesture for interacting with the device by referring to the reference table. By using hand shadows to simulate animal images for interaction, the project is more like a childhood game than hand shadows, putting the experience at ease and brimming

with joy. When ResNet recognizes the corresponding image (hand shadow), a specially designed animation and sound of the corresponding zodiac sign will be displayed on the screen.

The audience is immersed through physical interaction with visual and auditory sense, leaving the audience wanting more. Resonance features a complete feedback and reward system. Among them, the feedback mechanism allows the audience to judge whether they are right or wrong to imitate the hand shadow, and the reward mechanism refers to the interactive feedback between sound and vision after recognizing the correct action. Different animals correspond to different animations, visual effects and sounds, inspiring the audience's desire to complete the next gesture.

5 Evaluation

Participants were interviewed, and they were asked questions about the experience of the installation. Their impressions of the project are summarized as follows:

1. This project is very interactive, and the interaction between the project and the hand shadow is novel, which reminds me of my childhood.
2. This project can feel the strong elements of Chinese traditional culture, which seem to come alive and appear in front of my eyes.
3. The hand shadow was a bit difficult to imitate and it took me a while to get my hand in place, but it was fun.

5.1 Advantages and Disadvantages

Resonance combined with machine learning, participants can know their own zodiac through the poster, imitate the hand shadow of corresponding zodiac through the prompt, use ResNet for real-time recognition of the image, and summon the corresponding zodiac. With the combination of ancient Chinese design elements, people feel as if they have entered another world.

Resonance breaks away from the traditional single way of expression and combines its profound cultural connotation in a way more suitable for modern people's aesthetic appreciation. Finally, through modern new media technology, Resonance presents the unique Chinese zodiac culture in a more vivid digital form.

The project uses machine learning to create real-time interactive installation to interact with people, increase their sense of participation and enhance their fun. At the same time, dynamic graphic information transmission can be more acceptable to

the people than static graphic information, that can quickly and accurately convey key information, and can arouse the audience's interest in a certain probability, so as to change from passive to active to understand the traditional Chinese zodiac culture. Therefore, the zodiac culture should continue to be inherited in the information age. Not only its own form needs to follow the modern aesthetic, but also needs the support of new media technology to spread.

Nevertheless, there are still considerations to be made for this project. An example is the high environmental requirements for the placement of the project, which needs to be done in a darker space. From the conversation with several testers, I concluded that the next optimization can be set to full-body motion recognition instead of "hand shadow interaction", thus further increasing the interactivity and enjoyability of the project. In addition, the construction of the dataset in this project is not complete. Only the hand-shadow changes of a few people were used as the dataset, and the data samples were not abundant, which led to the occurrence of misidentified targets in individual cases. Moreover, due to the small sample database of dataset, it is necessary to retune and train the device when it is placed in a new site, which results in many inconveniences

6 Conclusions & Future Work

This paper summarizes the design process of the project. It combines modern technology, modern design, traditional culture, and traditional carriers. The combination of innovation and tradition, with the help of machine learning, reveals the charm of traditional culture more vividly in modern design.

The key information extracted will be graphically redesigned, with new modern presentation methods to innovate and extend the tradition in modern design. It is crucial to refrain from letting modern science and technology overshadow the traditional culture but to manifest the interdependence and collaboration between tradition and modernity.

It focuses on leveraging machine learning to increase interactivity and bring back a culture that has been fading into oblivion. My project is generally satisfactory because people are willing to interact with the project and have a deeper understanding of Chinese traditional culture after the interaction. In addition, the machine learning module used in the project was naturally integrated into the project, with image recognition and other technologies contributing to the interactivity and playfulness of the project. It has further profited my workflow of integrating traditional culture and machine learning and has greatly enriched my research and exploration of the possibilities of integrating machine learning into my life. As a result, I will devote greater emphasis than before on how to apply what I have learned to the general public, making it possible for more people to experience the joy of machine learning in their lives. Furthermore, it has been found that people take a lot of pleasure when they interact with the project. These interactive installation always inspire people to

discover and interact with the device without realizing it, which is a great joy to people in their routine life.

Design should focus on both "inside" and "outside". Real-time interactive installation as a "rational" technology, it is real, objective and has a clear function. Interactive installation art, as a new form of art, has a "perceptual" aesthetic. It is a cultural, spiritual and emotional resonance. In the future design of interactive installations with traditional culture as the theme, cultural connotations should be taken into account as far as possible, and the common point of everyone's emotions should be seized for creation. In addition, in the interaction with participants, try to mobilize their body (body or hand) movements, set goals and good feedback mechanisms for participants, and the use of sound, light and image will fully mobilize the enthusiasm of players and achieve immersion.

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