



Research on Interactive Jewelry Customization Design Driven by Intelligent Technology

Xiaoke Wang^{a*}, Yi Wang^b, Xiaobo Bai^c

School of art and design, Xi'an University of Technology, Xi 'an, China

^{a*}774084518@qq.com; ^bwy2005@xuat.edu.cn;

^cxiaobo413@126.com

Abstract. The advent of the information age and the transformation of consumer demand have made the development of traditional handicrafts face more severe challenges. It is of great significance to play the role of the combination of 3D printing technology and jewelry design in jewelry creation. This study uses the parametric design method and characteristics to explore the method of applying intelligent technology to the jewelry customization industry, and considers the key elements required for jewelry customization in combination with digital printing technology. Grasshopper programming; 3D printing technology; Interactive Design; echnology art; digital design Based on relevant design practices, build a jewelry customization service system. Provide a certain reference for future digital jewelry design and customization services.

Keywords: Grasshopper programming; 3D printing technology; Interactive Design; technology art; digital design

1 Introduction

In the age of individualization, the development of jewelry art has already got rid of the implication of wealth, luxury and durability, and gradually turned to the study of materials, forms, colors and the relationship with the body Jewelry design is no longer limited to materials, innovation, conceptualization, intelligent jewelry and other forms make people no longer only focus on the material value of jewelry, and gradually began to explore the possibility of new jewelry [1]. The adoption of appropriate means and ways to coordinate with the digital technology line will promote the development of the entire jewelry customization industry [2].

Based on the needs of contemporary light and chemical groups for personalized accessories, this research builds a personalized custom design platform, uses interactive links to allow users to interact with the initial decoration design, and provides upgraded user experience through virtual wearing technology, combined with the existing 3D Printing technology to complete the customized design service of jewelry.



planting wax trees Pouring jewelry molding polishing plastering

Fig. 1. Traditional jewelry processing process

With the development of computer graphics and image technology, deep learning technology, and continuous breakthroughs in generation technology, many breakthroughs have been made in the intelligent design of jewelry, mainly including the generation of two-dimensional drawings and three-dimensional models of jewelry by artificial intelligence through deep learning. Sun Shuwei [7] and others use 4D printing technology to make jewelry that fits the human body more closely, so as to realize personalized jewelry customization. Hu Hao [8] and others used parametric design tools and technical means to provide new ideas for contemporary jewelry design. The team of Professor Chai Chunlei from Zhejiang University explored the jewelry custom design method and built a jewelry custom design website. At the jewelry molding level, there are currently many studios using 3D printing technology to produce artistic jewelry with different styles[9].

Although jewelry customization design has made some progress in the direction of intelligence, there are still some problems in the interaction with users, mainly manifested in the lack of user participation and poor experience.

3.2 Jewelry customization service design framework

Jewelry design and manufacturing need to be centered on customer needs, and customized designs must meet the physical and mental needs of consumers [10]. Therefore, when building a personalized custom design framework, it is necessary to consider issues such as product style serialization, product design parameterization, product design modularization, network interaction platform, product flexible manufacturing system, and jewelry try-on procedures.

In order to enable users to have a more convenient and fast customized service experience, this article proposes a new jewelry customized design process framework based on the study of the traditional jewelry customized service design process, and divides the customized system into APP end, back end and agile manufacturing unit (Figure 2).

There are three main modules in the back end of the service: the virtual wearing module, which mainly realizes functions such as user photo processing and automatic product position determination, etc., and it cooperates with the virtual wearing module on the APP side to realize virtual wearing work; the parametric design module and the jewelry design on the APP side. The modules cooperate to realize jewelry background parameter modification, real-time rendering and other work; the order processing

module cooperates with the order generation module on the APP side to realize the data extraction of jewelry production information.

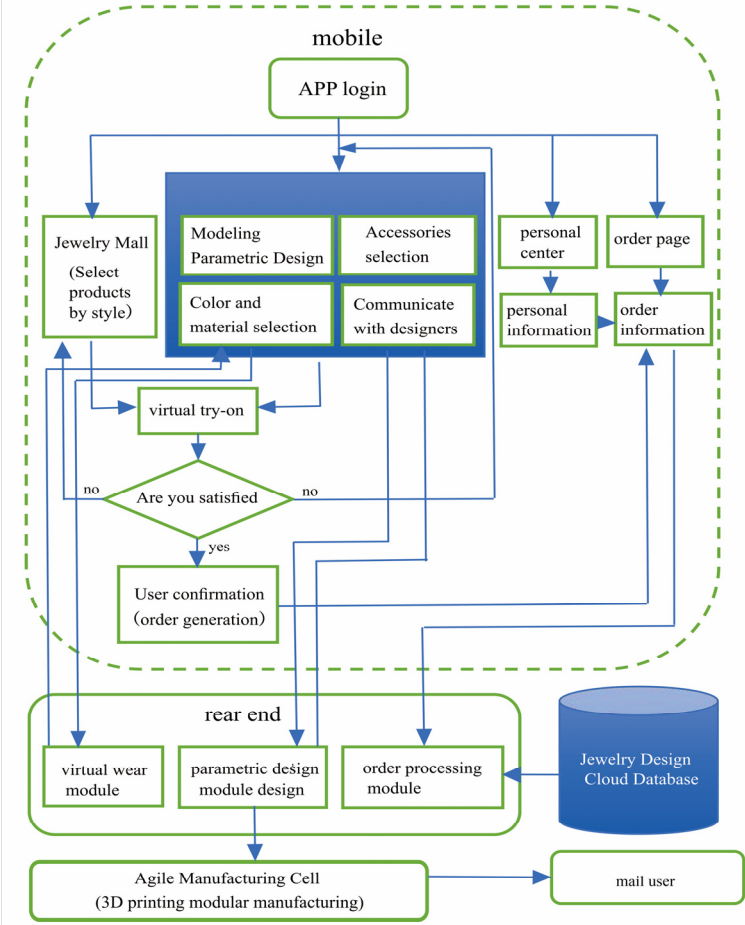


Fig. 2. Jewelry custom design process framework

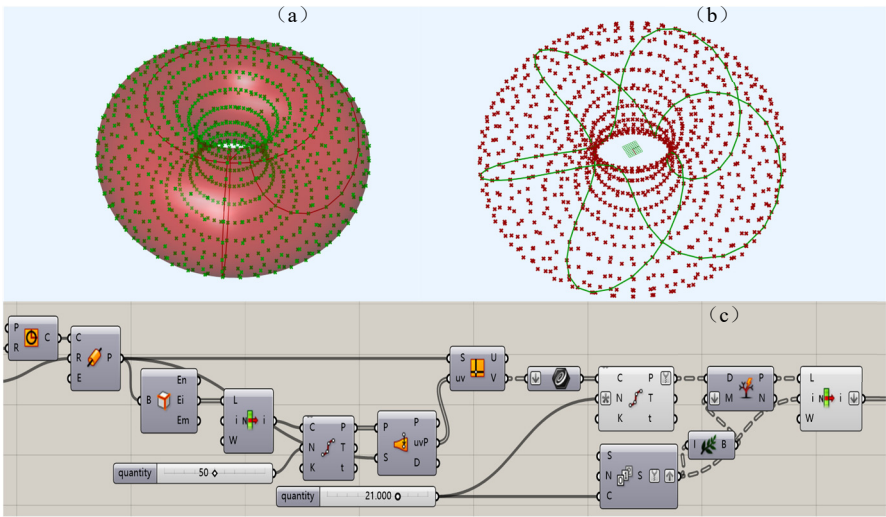


Fig. 3. Extraction of ring structure lines

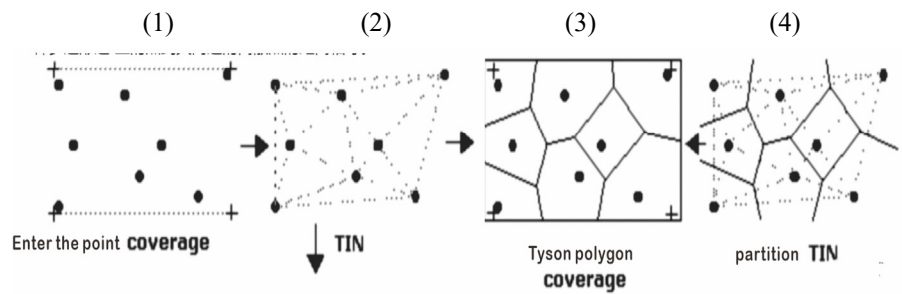


Fig. 4. Tyson polygon principle

4 Jewelry customization service design practice and interactive construction

4.1 Application Practice of Parametric Jewelry Design

This practice uses the parametric design method, which is a kind of intelligent technology, and uses the visualization software grasshopper as a platform to carry out related jewelry design practice. Take "Plum Blossom" as an example for jewelry design

(1) Establish a point set. Use the Rhino-Grasshopper platform to build a ring with a certain radius, select a horizontally distributed structure line on the surface of the ring, use the Divide Curve battery to divide the obtained structure line into a corresponding number of equal points, and extract the points through the average Longitudinal structural lines on the ring. The relevant battery diagram is shown in Figure 3-a.

(2) Establish structure lines (Figure 3-b). Use the Divide Curve battery to divide the structure line obtained in step 1 into several points, use the Split Tree battery to screen the obtained lattice according to the number of divisions to select a suitable number of lattices, and use the column item battery to orderly divide the points in the lattice. After the second division, use multiple straight lines to connect to get a small circle of polylines, rotate the resulting polylines to get the space line connected at the end, and convert it into a Nurbs curve. The program is shown in Figure3-c.

(3) Three-dimensional shape generation. The user enters the corresponding parameters, and the generated model is trained to automatically output different styles of shapes, and the three-dimensional jewelry shape is automatically generated through the grasshopper program [10] as shown in Figure 5.

(4) Three-dimensional texture generation based on Voronoi (Figure 4). The Thiessen polygon, also known as the Voronoi diagram, was proposed by the American climatologist A·H·Thiessen. Here, the Voronoi texture is added through the weaverbird plug-in to increase the hollowness and refinement of the jewelry (Figure 5).

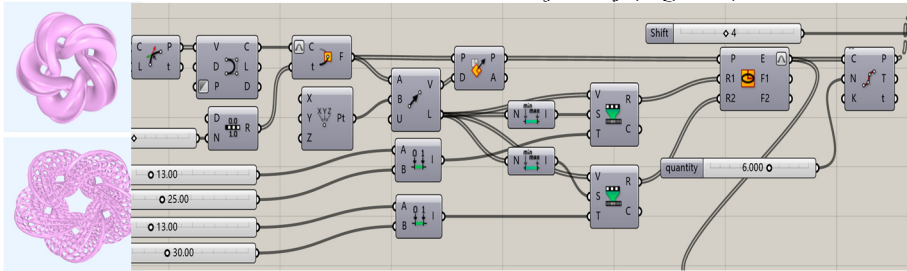


Fig. 5. Model results

4.2 Jewelry customization service design platform construction

The mobile customization platform mainly focuses on young women as the main consumer group, aiming to create a full-track jewelry customization design interaction form for users. According to the interactive customization framework built in the early stage, in line with the principle of user experience-centered design, the interface is intuitive, concise, and easy to operate UI design ideas to design part of the jewelry custom design interface (Figure 6). The main design is divided into 5 modules: Home, Square, Personal Center, Checkout, Shopping Cart.

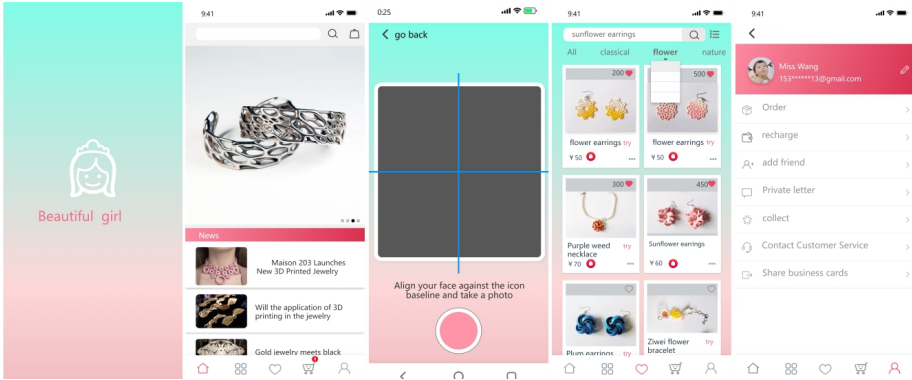


Fig. 6. Custom design interface

4.3 Interactive experience test

1. System background test

The customized service system is divided into two parts: one part is the jewelry design system, through the combination of grasshopper and rhino, the basic information input by the user on the front-end APP try-on interface can be linked with grasshopper to realize the real-time change of the design model, so as to realize the matching of jewelry shape and size (Figure 7). The other part is the try-on system, Python can also be used in Grasshopper to create custom components in more flexible Grasshopper definitions which will be developed on the platform of python language, using OpenCV and dlib library for face recognition and image processing, and PIL library for image loading and drawing [11] requires users to Upload photos at the front end, identify user feature points and match jewelry features to complete the try-on results. The system platform is still in the preliminary debugging stage and needs to be further modified and improved to achieve better interactive expected effects. The following are some code examples:

```
import cv2
import dlib
from PIL import Image, ImageDraw
# Load the face recognizer and key point detector
detector = dlib.get_frontal_face_detector()
predictor = dlib.shape_predictor('path_to_shape_predictor_68_face_landmarks.dat')
# Resize the jewelry image to fit the face
resized_jewelry = jewelry_image.resize((jewelry_width, jewelry_height))
# Get the key points of the face
shape = predictor(gray, face)
# Converts dlib's shape object to OpenCV's point coordinates
points = [(shape.part(i).x, shape.part(i).y) for i in range(shape.num_parts)]
# Convert the point coordinates of OpenCV to the point coordinates of PIL
pil_image = Image.fromarray(frame)
```



```
draw = ImageDraw.Draw(pil_image)
draw_jewelry(draw, shape)
```

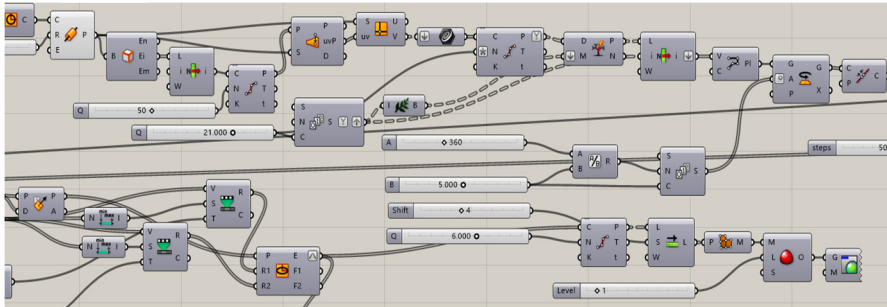


Fig. 7. Based on Grasshopper jewelry generation algorithm

2. Application effect test

According to the above design generation path and technology, the experiment and verification of specific application are carried out. Taking the Thiessen polygonal pattern as an example, develop jewelry 3D generation software. The software is divided into jewelry type database, generation program based on image science algorithm and Grasshopper algorithm, front-end interactive interface and other parts. Here, the article takes myself as the subject, adjusts and selects the corresponding data according to personal preferences, and after forming the corresponding shape, uses 3D printing (Figure 8). technology to make several jewelry products. The wearing effect is shown in Figure 9.



Fig. 8. 3D printing



Fig. 9. application effect display

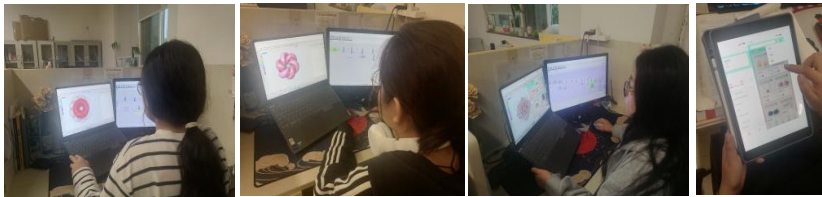


Fig. 10. User Satisfaction Test

4 users and 2 designers were randomly selected to test the fluency and operability of the interface design, and the system functions were all executed normally (Figure 10). Satisfaction tests are conducted on the testers. The test content includes interactive visual experience and try-on process experience. Users make evaluations based on their own satisfaction. The evaluation results are divided into 5 grades, represented by A, B, C, D, and E respectively. Satisfied, somewhat satisfied, moderate, somewhat dissatisfied, dissatisfied. The results obtained are shown in Table 1 below. It can be obtained from Table 1 that the user satisfaction with the customization system is above C, indicating that the jewelry customization system can basically meet the needs of users and improve the user's interactive experience when designing jewelry customization services. In the future, the interaction structure will be further optimized to achieve a better interactive experience.

Table 1. User satisfaction test records

Test content		user ID					
		1	2	3	4	5	6
Visual experience	visibility	B	A	C	A	A	B
	Color	A	B	B	B	A	C
	logic	A	A	B	B	A	B
smooth experience	efficiency	A	A	C	B	C	A
	fluency	A	B	B	C	A	B
	applicability	B	B	A	C	A	B

5 Conclusion

This article constructs a jewelry customization service design system and a customized jewelry generation path. Based on the parametric intelligent algorithm generation technology, an interactive jewelry customization service software is designed to realize the integrated process of jewelry customization from design to processing. Although the article has carried out relevant practical tests, there are still technical difficulties in printing small fine jewelry. In addition, a lot of algorithmic support is needed in the process of filling the relevant jewelry type database. Generative jewelry product design is based on personalized and customized design patterns to adapt to the rapid development of diversified consumption forms; At the same time, the use of intelligent, digital and other technologies to promote the rapid integration of traditional handicraft industries with the development of the industrial frontier provides more possibilities and reference value for the future intelligent manufacturing of jewelry.

References

1. Xie Jie, Zhang Guoxin. Analysis on the Current Situation and Development Direction of Intelligent Jewelry Design [J]. Light Textile Industry and Technology, 2020,49(09):152-153.
2. Hu Hao, Wang Liuzhuang, Peng Shengfang. Research on the application strategy of parametric design in jewelry customization [J]. Decoration, 2020(11):128-129.
3. Bai Xiaobo, Yang Qian, Zhao Xiaoya, etc. Facial Size Classification and Its Application to Glasses Mass Customization Design [J]. Mechanical Design, 2022,39(03):154-160.
4. Wang Ke, Liu Yang. 3D Printing Service Design for Customized Products [J]. Packaging Engineering, 2019, 40(14): 25-30.
5. Hu Hao, Wang Liuzhuang, Peng Shengfang. Research on the application strategy of parametric design in jewelry customization [J]. Decoration, 2020, No.331(11):128-129.
6. Shi Jian, Zhang Hui, Fan Yushuai. Application of Light-curing 3D Printing Technology in Jewelry Wax Model Making [J]. Mechanical Design and Research, 2020,36(01):158-160+168.
7. Sun Shuwei, Li Yan, Li Xingping. Preliminary Study on the Application of 4D Printing Ceramic Precursors in Personalized Jewelry [J]. Journal of Gems and Gemology (Chinese and English), 2022, 24(03): 52-61.
8. Fang Xiaowen. Current status and prospect analysis of modern jewelry production under 3D printing technology [J]. Shanghai Arts and Crafts, 2022, No.154(04): 79-81.
9. Zhao Pengfei, Chen Yitong. Analysis and Application of Emotionalization in Jewelry Design [J]. Design, 2023,36(07):124-126.
10. Zhang Fan, Su Yi, Cui Qiang, etc. Research on the Generation and Design of Traditional Costume Patterns [J]. Packaging Engineering, 2023, 44(04): 1-8+42.
11. CHEN Jiajia, QIU Xiaorong, XIONG Yuhao, et al. Research on face recognition technology based on Python[J]. Computer Knowledge and Technology,2023,19(08):34-36+39.

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

