



# Design of Parametric CAD System for Ceramic Products Based on Virtual Reality Technology

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**Abstract.** Aiming at the problem that the drawing of ceramic products designed and produced by the original system is low in definition, which leads to poor picture effect, this paper proposes the design of parametric CAD system of ceramic products based on virtual reality technology. Through sensor-mcu control system, complete data collection, build a computer control system platform, select the appropriate data transmission port, complete data transmission; Application of virtual reality technology, and through the data query, modify, and 3 d parametric regeneration to complete its structure system design work process, improve the search efficiency of menu file, according to user requirements, remove or add a menu item, calculating weights of the Bezier curve, design the user interface and high efficiency, adjust the memory image file, complete the system design. The comparison experiment is designed in CAD software, and the image effect of the system in this paper is compared with that of the traditional system. The ceramic products produced by the design system have higher clarity and better effect.

**Keywords:** Virtual reality technology · Ceramics · CAD

## 1 Introduction

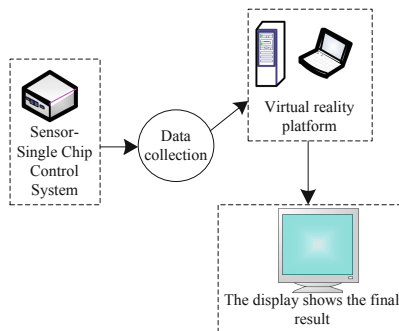
There are many types of ceramic products, and the shape and structure are complicated. At present, the development of new products for ceramic products still follows the traditional manual method, which is mainly based on imitation. This method has a long development cycle and high cost. Therefore, the application of advanced manufacturing technologies such as CAD to the development and production of ceramic products is an inevitable trend in the development of the ceramic industry, and an important aspect of transforming traditional industries with information technology [1]. Ceramic products are indispensable for modern families. The design, manufacture and use of ceramic products has a long history in China. Since the beginning of the year, the total output of China's ceramic products has ranked first in the world and has become a major producer and consumer of ceramics. However, in terms of product quality, China's ceramic products belong to the middle and low grades. The products produced by foreign-funded enterprises and joint ventures together with imported products occupy the main market of domestic high-end products. For the current hand-

workshop-based product development model of ceramics manufacturing, the application of technology to the design and development of ceramic products can improve product quality, shorten product development cycle, reduce development costs, and improve the company's ability to respond to the market and adaptability [2]. This is of great significance in promoting the standardization and informationization development of China's ceramic enterprises. How to make ceramic products meet the needs of modern society in terms of quality, variety, function and shape is the key to the development of China's ceramic industry. The traditional ceramic products and mold design and manufacturing process is long and complicated, and it has not been able to adapt to the increasingly fierce market competition. Therefore, the parametric CAD system design of ceramic products based on virtual reality technology is proposed. At present, advanced manufacturing technology represented by high-tech such as CAD/CAE/CAM/RP has developed to a new stage [3]. The use of high technology to transform the traditional ceramic industry is an inevitable trend of China's ceramic enterprises to adapt to the world's development trend. The development of CAD software for ceramic products is one of the important contents. Parametric design not only enables CAD system to have interactive drawing function, but also has automatic drawing function. The special product design system developed by parametric design means that designers can free themselves from a lot of tedious drawing work and greatly improve design efficiency. And reduce the amount of information stored.

## 2 Hardware Design of Parametric CAD System for Ceramic Products

### 2.1 Overall Structural Design

The system selects sense-mcu as the core console, selects the appropriate data transmission port, complete data transmission, applies virtual reality technology, and completes its structure design through data query and modification of 3-d parameter regeneration. The data acquisition of the simulation training system is completed by the sensor-single-chip microcomputer control system, and the collected signals are transmitted to the virtual reality platform, and the final operation result is displayed in the display. The specific design scheme is as follows (Fig. 1):



**Fig. 1.** Hardware system design

According to the overall structure, the structure of each part is designed separately. Firstly, the computer control system platform is built and the appropriate data transmission port is selected.

### 2.2 Data Transmission Port Selection

With the rapid development of computer hardware technology, the original system has been on the verge of being eliminated. This is an extremely fatal problem of the original system and urgently needs to be solved. The parallel port and serial port of the computer are common ports for transmitting data. Among them, parallel port programming is relatively simple, and it is more economical for building a computer control system platform, which makes the parallel port widely used in electronic control fields, such as robots. The field of single-chip programmers and home automation, and the serial port transmission speed is slower than the parallel port. Therefore, considering the actual requirements of the system for reading and writing the transmission port, the system control software module selects the parallel port of the computer as the data transmission port [4]. The parallel port is also the printer interface of the computer. Its main purpose is to connect the printer to the computer, and the mouth is also born. Therefore, the parallel port is often called the printer port, which is the female end of a needle. The 25 pins of the 25-pin parallel port are as follows (Fig. 2):

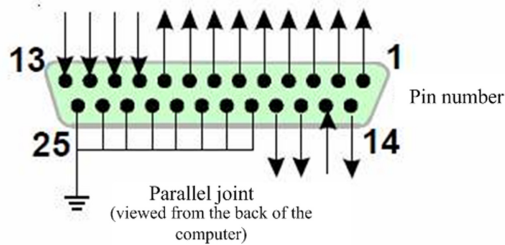


Fig. 2. 25-pin parallel pin map

The 25-pin parallel port is divided into a data area, a control area, and a status area. The data area transmits data, the control area controls the peripheral device, and the status signal returned by the peripheral device is transmitted to the computer through the status area. Data registers, control registers, and status registers are connected internally to these three areas. The specific information of each pin of the parallel port is shown in the Table 1.

**Table 1.** Parallel port 25 pin specific function list

Stitch	Function	Transmission direction	Register	Logic
1	gate	output	control channel0	Yes
2	data channel0	Input/output	data channel0	No
3	data channel1	Input/output	data channel1	No
4	data channel2	Input/output	data channel2	No
5	data channel3	Input/output	data channel3	No
6	data channel4	Input/output	data channel4	No
7	data channel5	Input/output	data channel5	No
8	data channel6	Input/output	data channel6	No
9	data channel7	Input/output	data channel7	No
10	data channel8	Input/output	data channel8	No
11	data channel9	Input/output	data channel9	No
12	affirm	Input	status channel6	No
13	busy	Input	status channel7	Yes
14	select	Input	status channel5	No
15	error	Input	status channel4	No
16	initialization	output	control channel1	No
17	select	Input	control channel2	No
18–25	–	–	–	–

As described above, the data area, the control area, and the status area of the parallel port are respectively connected to corresponding registers in the computer, so these registers are operated in the program. These registers, which can be found in the standard parallel port, include data registers, control registers, and status registers. The data register is connected to the data area, the control register is connected to the control area, and the status register is connected to the status area [5]. So writing different contents to these registers will cause the corresponding voltage in the corresponding area of the parallel port, and the specific voltage can be measured with a multimeter. Similarly, the voltage applied to the parallel port can also be read by the register.

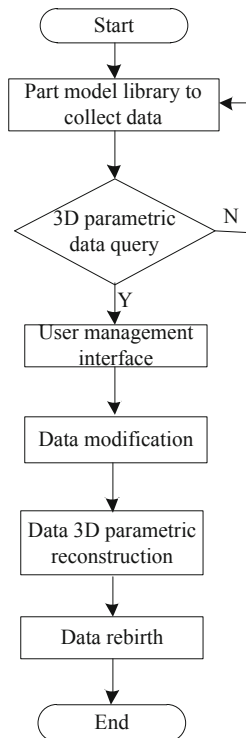
### 3 System Software Design Based on Virtual Reality Technology

The three-dimensional parametric CAD system is based on the actual needs of ceramic product design work, using computer software technology, designed and developed a set of engineering and technical personnel for ceramic production enterprises, based on computer systems, CAD system that is easy to operate and use [6]. Including the human-computer interaction interface design, three-dimensional parametric design, etc., above the system base layer and support layer is the application layer of the product parametric CAD system. The human-computer interaction interface design

refers to the application development tool to design the system menu, dialog box and toolbar, etc., requiring the human-computer interaction interface to be clear and intuitive, and the design result and the command appear in the same window.

### 3.1 Overall Structure Optimization

The data on ceramic products is deep and wide, and the mold mechanism is flexible. Not all data and design processes can be parameterized, and some must be determined by the experience of mold designers. In order to provide convenience for the designer and to make the system standardized and orderly, the system establishes a three-dimensional system with the following data types for query, modification and regeneration. The workflow of its structural 3D parameterization system is usually as shown in the following figure (Fig. 3):



**Fig. 3.** Work flow chart

The parameterized system soil consists of three parts: a three-dimensional parameterized part model library, a user-managed interface, and a main program of the system. Establish a design subsystem that optimizes the calculation of the local shape. Here, it is mainly for the flow channel of ceramic products, to establish a reasonable mathematical model of fluid dynamics, to use the computational fluid dynamics method

for flow channel analysis, to optimize the design, and to perform a simple overall analysis and verification of the established three-dimensional solid model. Model geometry and physical properties [7].

### 3.2 Menu Efficient Design

Careful menu design can significantly improve the efficiency of CAD operations. Through detailed analysis of the menu file structure, we can re-edit it according to certain grammar rules, not only can customize our own system interface, mainly including drop-down menus, toolbars, prompt information and other parts.

It is also possible to normalize most of the interfaces. Each menu section includes several menu items. Users can delete or add menu sections or menu items as needed. When deleting a menu section or menu item, you only need to delete all the corresponding menu section files; when adding, you should add the corresponding menu file to the source menu file according to certain grammar rules, but note that the total number of menus after adding must not exceed the system. Desired point. The menu items in the menu file are defined in the order of arrangement. If you want to change the position of a menu item, just adjust the position defined in the menu file [8]. Similarly, the user can redefine the access key and hotkey as needed, as long as the access key or hotkey letter in the corresponding file line in the menu file is modified, or the definition access key is added thereto, but in the process, Avoid duplication. When the drop-down menu is finished, the corresponding menu item in the menu file and the menu name or menu command of each sub-menu item are changed to Chinese, and the letter and hotkey command of the access key are reserved [9]. For ease of use, the toolbar can be modified in the menu file, or some of the command buttons can be deleted. Similarly, users can add menu files to create new toolbars or command buttons based on certain grammar rules. To normalize the toolbar, just change the names of all toolbars and command buttons in the toolbar menu file to Chinese. The user adds a new menu command or command button, and can add corresponding prompt information in the menu-specific help menu section file. It must be noted that the identifier of the prompt information should be the same as the identifier of the corresponding menu command or command button, and the Chinese prompt Information, customizing a more efficient system 3D solid modeling user interface.

### 3.3 Bezier Curve Weight Calculation

The shape of the curve is uniquely determined by the two endpoints of the curve and a number of points that are not on the curve. These two endpoints and several points are called the vertices of the Bezier feature polygon or the control points of the Bezier curve. Let  $n + 1$  vertices of a given spatial feature polygon,  $P_i (i = 0, 1, \dots, n)$ , define the vector function of the  $n$ -time Bezier curve as:

$$P(t) = \sum_{i=0}^n B_{n,i}(t)P_i \quad (1)$$

$B_{n,i}(t)$  of them are Bernstein's functions. Some properties of the Bezier curve can be obtained from the properties of Bezier curve equation and Bernstein root function. The end and end points of the curve pass through the starting point of the feature polygon respectively, and the derivative property of the  $B_{n,i}(t)$  function can be derived:

$$P(t) = n \sum_{i=0}^n (B_{n-1,i-1}(t) - B_{n-1,i}(t-1)) \tag{2}$$

According to the nature of the Bernstein function, the shape of the curve is unchanged after the control point is reversed, but the direction is reversed. The Bezier curve is located in the convex hull formed by its control vertices. If the plane control polygon is convex, the Bezier curve is also convex. The shape of the curve does not change with changes in the coordinate system. For a planar Bezier curve, the number of intersections between any line in the plane and the Bezier curve is not more than the number of intersections between the line and the control polygon. Normally, only three Bezier curves are used in the graphics package, which brings design convenience on the one hand, and avoids a large increase in computation due to high-order polynomials. The cubic Bezier curve is generated by four control points, and  $n = 3$  is substituted:

$$P(t) = (1-t)^3 \times P_0 + 3t(1-t)^2 \times P_1 + 3t^2(1-t) \times P_2 + t^3 P_3 \tag{3}$$

$$0 \leq t \leq 1$$

Write it as a matrix:

$$P(t) = [t^3 \quad t^2 \quad t \quad 1] \times M_{Bez} \times \begin{bmatrix} P_0 \\ P_1 \\ P_2 \\ P_3 \end{bmatrix} \tag{4}$$

$$0 \leq t \leq 1$$

Among them, the Bezier matrix is:

$$P(t) = [t^3 \quad t^2 \quad t \quad 1] \times M_{Bez} \times \begin{bmatrix} P_0 \\ P_1 \\ P_2 \\ P_3 \end{bmatrix} \tag{5}$$

$$0 \leq t \leq 1$$

It can be seen from the above calculation that only the control points of each curve are adjusted, and each control point is drawn as a hollow circle, and the shape of the curve changes when the mouse clicks on the movement control point.

### 3.4 Memory Image File

A memory image file allows a disk file to be mapped to a specific range of memory addresses. The application obtains the file on disk by using a pointer in memory instead of executing a traditional file read function. More importantly, applications can use this mechanism to share memory. Normally, in Windows, each application runs in its own address space, and all memory allocations are made in this space. This space is private to the process and cannot be used by other processes. Using a memory image file allows multiple processes to access the same data file at the same time. Memory image file data is not actually read from disk except when it is accessed in memory. Therefore, it requires less physical memory and disk operations, and is more efficient; only the file segments that are actually changed are Write back to disk, reducing the number of disk operations and improving execution performance; accessing only one linear address space, the code is simple and clear; you can share a file between processes. When programming a memory image file, creating a memory image file can be done either in the editor process or in the master process. The implementation method should be decided by the programmer according to the requirements of the system integration [10]. If the size of the file exceeds the mapped image, then only the mapped range is valid and the rest of the file cannot be updated: if the file mapping object is larger than the file, the file end flag on the disk will be expanded to fit the file object Size; if you plan to extend the length of a file, it is necessary to estimate the maximum size of the file, create a file map large enough, and a large enough file image; finally, because the image is only in-memory data, if the length of the file When changes occur, it is necessary to call SetFilepointer and SetEndofFile before closing the file to adjust the end of file flag.

## 4 Simulation Test

In order to verify the effectiveness of the above-mentioned parametric CAD system of ceramic products based on virtual reality technology, a simulation experiment was designed. The ceramic model rendering effect of the designed system is compared with the original effect, and the experiment is completed.

### 4.1 Experimental Preparation

The CAD software used in this experiment has higher requirements on the operating system. To ensure the smooth progress of the experiment, the following conditions must be met: (Table 2)

**Table 2.** Experimental platform requirements

Name	Parameter
CPU	Intel core dual core or above
Internal storage	More than 8 GB DDR4
GPU	NVIDIA GT 740 M, 830 M, 930 M The above and similar products
Network	Minimum 512 Kb, recommended 2 Mb and above network configuration
Hard disk	18 GB (including temporary swap space) Recommendation: Intel 540(480 GB) SSD

Under the premise of meeting the above requirements, the semi-finished products of ceramic products that have not been rendered are randomly selected as follows:

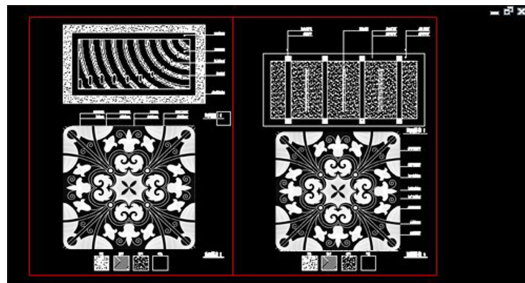
**Fig. 4.** Ceramic product not rendered

Figure 4 shows an unrendered semi-finished product of a ceramic tile product. Comparative experiments were performed under otherwise identical conditions.

## 4.2 Experimental Result

After the above preparations are completed, the designed system and the original system are used, and the ceramic product renderings are modified and designed, and the results are simultaneously magnified by the same multiples. The comparison results are as follows (Figs. 5 and 6):

According to the comparison results in the above figure, it can be clearly seen that the product map obtained by the original system has lower definition and the image is more blurred, and the obtained product map has poor effect, which has an impact on subsequent operations and requires the designer's later stage. Repair, resulting in a waste of human resources. The effect diagram obtained by the designed system is clear and clear, and the obtained product map has a good effect and can meet the user's needs.

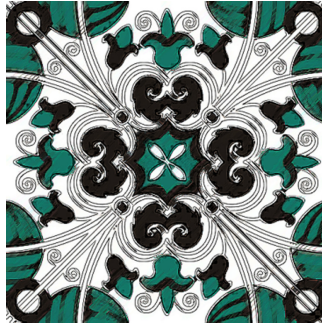


Fig. 5. Original system result



Fig. 6. Designed system results

Making product images in a fixed time, the generation time period of the traditional system and the system in this paper is intercepted in the simulation environment, and the same pixel quality of the graph is compared separately, and the results are shown in Fig. 7.

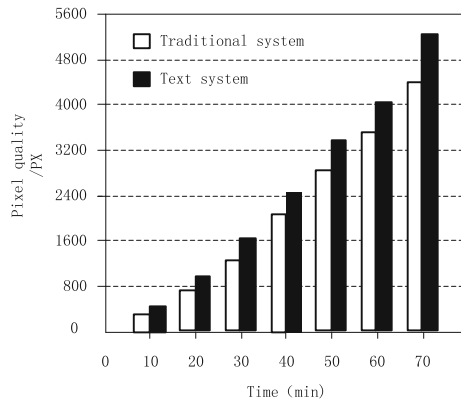


Fig. 7. Image quality testing

According to the data of Fig. 7, it can be clearly seen that the image generation quality of this system is higher than that of the traditional system in a fixed period of time. After the actual calculation can be affirmed, the specific efficiency increase ratio of more than 15%.

## 5 Conclusion

The development and application of the system solves the problems of automatic parameter design and product realism display of ceramic products, avoiding the repeated labor of designers, and the designer can quickly and easily obtain the required design results, which will greatly shorten the product development cycle. Reduce development costs and improve the market competitiveness and economic benefits of enterprises.

## 6 Fund Project

Research results of Wuhan Business School “Engineering Animation Design and Application Research team”, subject number 2018TD016.

Wuhan Business School <Digital Creative and Design Research Center> Research Results, Project No. 2018 YJZX.

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