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Research Article

Intelligent Industrial Design System Based on Spatial Digital Technology

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In order to improve the effect of intelligent industrial design, this paper combines the spatial digital technology to construct the system structure of the intelligent industrial design community. Considering the existence of the identification diffusion angle, this paper analyzes the refraction of light when it enters the workpiece and lists the calculation methods of the refraction angle of different media. Moreover, considering that the various conditions of the workpiece detection surface will make the calculation of the refraction of the identification light more complicated; this paper analyzes the specific parameters of the identification light, which lays a theoretical foundation for the accurate calculation of the subsequent wavefront arc. In addition, this paper studies defect reconstruction methods based on circle, ellipse, and polygon models. Finally, through experimental research, this paper verifies that the intelligent industrial design system based on spatial digital technology has a good effect in industrial design and can effectively improve the intelligence of modern industrial design.

1. Introduction

In the industrial production process, the data acquisition system mainly collects and processes parameters such as liquid level, inclination angle, pressure, temperature, humidity, and acceleration at the production site. The staff can obtain real-time industrial field data through the data acquisition system and then can monitor and analyze the production environment and production equipment remotely or on-site, which is of great significance for improving product quality and reducing production costs [1]. Wireless communication is a communication method that can complete information exchange without arranging complicated connecting lines. In the production process, wireless communication can be used in production sites with complex and harsh environments and cannot be wired to ensure the effectiveness of industrial data transmission [2]. Industrial wireless communication technology is not only the organic combination of communication technology and industrial production but also the progress and expansion of communication technology and industrial production. Moreover, it can make the instruments, instrumentation equipment, and control system in the industrial field realize information exchange in the harsh industrial environment. Therefore, once it came out, it led the field of industrial automation to develop towards flexibility, portability, simplicity, and low cost [3].

Industrial design was established with enterprises as media. Industrial design today has a content and nature closely related to enterprise management. The advantages and disadvantages of design management have a direct impact on the operation of the enterprise and its results. Design management has become an aspect of achieving enterprise target management. It plays an important role in the design industry, the role of comprehensive management of various elements of the center. The scope of design management is related to enterprise decision-making; that is, the practical management of design to express the purpose, culture, and management policy of the enterprise through design includes design planning, schedule planning, personnel management of designers, education, and coordination with other departments [4].

The design plan not only is decided by the design department but also has to exchange information with the technical department, the manufacturing department, and the management department. The design scheme is gradually clarified through product development meetings and planning meetings [5]. The purpose and function of the design plan are as follows: design to improve trademark image, design based on social trends and demand forecast, design based on technology development and technology forecast, design based on product life cycle forecast, design to adapt to market competition, design based on demand, the design of changes and the diversification of values, and the design to reduce the cost, etc.; due to various unexpected problems encountered during the implementation of the design plan, the design plan, especially the schedule plan, must be revised at any time [6].

To achieve the goals of the design department, we must rely on designers. And each designer's way of thinking, way of life, and motivation to the design department are different. Managers in design management are required to have the ability to coordinate the relationship between managers and the entire design department, as well as the ability to effectively mobilize the enthusiasm of designers to achieve goals, because the specific implementation of all design goals needs to be carried out by designers, so in a sense. The management of designers is the most important aspect of design management [7].

Designers have shifted from the concept of modeling experts to coordinators who are organically connected with all departments of the entire enterprise, from professionals to general managers of the enterprise or talents with both qualities. To this end, designers not only need to have modeling education and training but also need to be trained as planners who can understand future changes and have the ability to adapt, as well as industrial designers with knowledge of "operation management" and "finance," "economics," and other aspects of education and training [8]. Foreign enterprises all carry out vocational training for designers who have just taken up their jobs, such as Hitachi, Panasonic, and other large enterprises; the training period is one year. The content includes performance technology, business purpose, management, workshop labor, marketing practice, and design practice (training of drawing, sketch rendering, model making, etc.). Arrange jobs for different positions according to grades. Generally, companies require designers to work for 3-5 years after graduation before they can design independently. The design of automobiles requires designers to have more than 10-15 years of long-term training [9], in order to make the enterprise invincible. The design departments of many enterprises also set up full-time education personnel, who are specially responsible for regular reeducation of in-service personnel, for example, an example of designer education in a large company: 3 weeks of induction education for designers who have joined the company, mainly to understand the company's purpose, policy, and organization and strengthen training on modeling performance techniques; about half a year for designers who have worked for 3 years and creativity development training, through idea development and model making, to strengthen modeling imagination, planning ability, and creative ability [10].

The official operation of a real-time linkage industrial design information system software within the enterprise marks the basic maturity of industrial design informatization, but complete independent maintenance and expansion still require certain steps to complete. In this case, the easy maintenance and scalability of the system are very challenged, and these two indicators need to meet high requirements [11]. After decades of development, the real-time linkage industrial design information system developed abroad has great advantages in terms of ease of maintenance and scalability. Its maintenance cost is very low, the workload is also small, and nonprofessionals, for example, designers, can perform better independent maintenance after a short period of training [12]. At the same time, foreign systems have good compatibility, and it can integrate with various proprietary systems such as ERP, financial and online reimbursement interfaces, and other management interfaces and achieve good results. Foreign system suppliers have a huge number of users all over the world, and they themselves attach great importance to product development. The investment in this aspect is often very large. This investment is often much larger than the investment in other market activities. A well-documented development plan is formulated, and a series of work is implemented according to the annual plan. Therefore, its product development speed is unimaginable, and its scalability has been greatly improved [13].

The real-time linkage industrial design information system adopts the popular SQL Server database management system. Between the server layer and the reference system layer in the information system, the direct access of the application interface server to the database server is realized through ASP/ADO technology. The application system layer is a relatively vague and abstract concept. Of course, it is also the core of our information system construction and the difficulty [14]. The key functions are establishing a unified corresponding data environment, such as subject database, shared database, establishing data association, and other environments. At the same time, the subsystem of the information system and the general information query system should also be established. It is usually necessary to establish some relatively complete information query systems and subject databases, which are also an important part of the information system, such as industrial design basic knowledge module, industrial design market information, ergonomics module, and industrial design and manufacturing information [15]. The end user layer provides the operation interface of the industrial design information system for various users, which is what we call the browser web page. In this layer, we mainly solve problems involving human-computer interaction, so that different users can obtain reasonable and useful information at the fastest speed in a relatively short period of time [16].

During the whole process, designers and product users will constantly inquire and refer to corresponding knowledge in different fields according to their own needs. This knowledge includes market information (such as market demand information, enterprise resource information, and manufacturing resource information), industrial manufacturing information (such as process materials, manufacturing technology), and basic knowledge of industrial design (such as related aesthetic laws, industrial design history, and formal beauty laws). The structure and expression are organized, classified, and analyzed, so we divide the data domain of the real-time linkage industrial design information system into four aspects: ergonomics-related knowledge, basic knowledge of industrial design, market information of industrial design enterprises, and industrial manufacturing information [17].

In the real-time linkage industrial design information system, it contains many types of information. This information is very complex, and it is not easy to express and realize. Therefore, the focus and difficulty of establishing an instant linkage industrial design information system are mainly focused on the relevant information, collection, sorting, analysis, and processing above. The implementation of the required specific technology is to use E-R (law entity connection method) and 3NF (third normal form) to carry out database design in different knowledge fields and information levels. Among them, E-R (law entity relationship method) provides different expression methods for information users that are not bound by any DBMS. It is widely used as a data modeling tool in database design at this stage, and third normal form. It is required that a database table does not contain nonprimary keys that are already contained in other tables. After determining the entity of each subject database, optimize the relationship between each other's entities, and establish a related database in the corresponding SQL Server. This is the design method of the main database [18].

As far as product design is concerned, accurate and efficient extraction of knowledge and information has become the key to successful product development. The information and standards involved in design activities are numerous, complex, and difficult to find. It is estimated that designers spend an average of 30-40% of their time searching for appropriate information rather than engaging in specific design tasks. Because knowledge and information are flooded into the entire design and manufacturing process, including early conceptual design, detailed design, and manufacturing. In fact, the innovation of a product does not mean that all the components that make up the product are completely new [19]. Statistics show that the development of a new series of products may inherit the achievements of 80% of the old products. Through effective management and full use of product information, the speed of product innovation will be greatly accelerated and product costs will be reduced. Therefore, a unified knowledge platform is urgently needed to realize the resource sharing of design information. With the continuous development of industrial design, the increasingly complex design activities involve professionals in different fields, rather than the ability of one person. It requires different designers and people from different aspects to form a design project team to cooperate. These related personnel are often scattered all over the world, and the network is just a convenient way to provide information resources and communication [20].

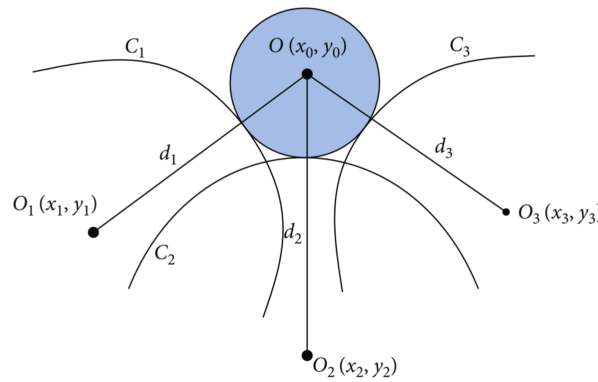


Figure 1: Principle of circular defect reconstruction.

This paper combines the spatial digital technology to construct the system structure of the intelligent industrial design community to improve the intelligent effect of industrial design.

2. Spatial Recognition Algorithm for Intelligent Industrial Design

2.1. Reconstruction Method of Tangent Boundary Based on Circular Model. The porosity defect inside the workpiece is one of the most common defects in production. It has different sizes of circles, rectangles, and irregular shapes. The shape of circular pores is standard, which is easy to analyze and reconstruct. Therefore, the reconstruction method based on the circular model is studied first.

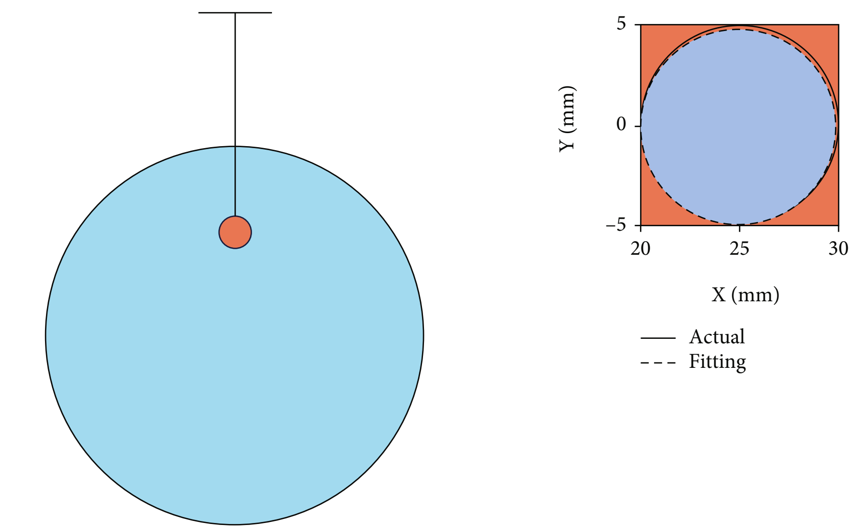
The standard equation of the circle is shown in formula (1). If it is assumed that the defect can be reconstructed with a circular model, the parameters that need to be determined for the model include the center $O(x_0, y_0)$ and the radius.

$$(x - x_0)^2 + (y - y_0)^2 = r^2. \quad (1)$$

The circular defect and the three wavefront arcs tangent to it are shown in Figure 1. In the figure, $O_1 \sim O_3$ is the center of the wavefront arc calculated according to the defect echo information, $d_1 \sim d_3$ is the distance from the mirror emission point to the defect boundary, and c_j is the wavefront arc $(j = 1, 2, 3)$ with o_j as the center of the circle and d_j as the radius. According to the principle of tangent between two circles, the following equations can be listed:

$$\begin{cases} (x_0 - x_1)^2 + (y_0 - y_1)^2 = (r + d_1)^2, \\ (x_0 - x_2)^2 + (y_0 - y_2)^2 = (r + d_2)^2, \\ (x_0 - x_3)^2 + (y_0 - y_2)^2 = (r + d_3)^2. \end{cases} \quad (2)$$

In theory, x_0, y_0 and r can be calculated by directly solving the system of equations (2). However, the defect in the actual workpiece cannot be a standard circle, and the error of the results obtained by only using three sets of wavefront arc data is relatively large. The wavefront arc data of each defect is much larger than three groups. If multiple groups



(a) Ultrasonic simulation model of circular defect (b) The result image of circular defect reconstruction

Figure 2: Schematic diagram of circular defect.

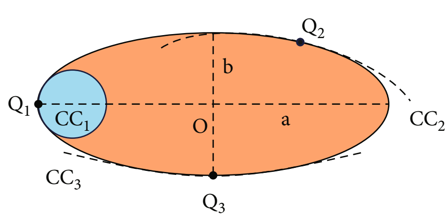


Figure 3: Schematic diagram of circular arc approximating elliptical arc.

of wavefront arc data are substituted as much as possible, the optimal solution of the circle can be fitted by the least square method, so the deformation fitting equation can be written as

$$d = \sqrt{(x - x_0)^2 + (y - y_0)^2} - r. \tag{3}$$

In the formula, $d = [d_1, d_2, \cdots d_k]$, $x = [x_1, x_2, \cdots x_k]$, $y = [y_1, y_2, \cdots y_k]$, and K is the number of defect wavefront arc data.

The simulation model shown in Figure 2 is established with CIVA. The diameter of the cylindrical workpiece in the model is 100 mm, and the workpiece material is aluminum. Ultrasonic detection was carried out by the method of water immersion detection. The probe was 40 mm away from the surface of the cylinder, the diameter of the probe was 12.7 mm, the ultrasonic frequency was set to 5 MHz, and the sampling frequency was 100 MHz. The defect is an eccentric hole with a radius of 5 mm, and the center of the defect is 25 mm from the center of the cylinder.

In the case that the known defect is a circular defect, the defect is reconstructed by the reconstruction method based on the circular model, and the reconstruction result obtained is shown in Figure 2(b). The reconstructed circular defect position is at (25.10, 0.14). The maximum position error is 0.14 mm, the radius is 5.09 mm, the absolute error with the actual defect is only 0.09 mm, and the relative error is 1.8%. It can be seen that the reconstruction method has high reconstruction accuracy, and the reconstruction method based on the circular model is effective to reconstruct circular defects.

2.2. Reconstruction Method of Boundary Tangent Based on Ellipse Model. The actual stomatal defect will rarely be a standard circle, and since we collect data from a single section, if the stomatal defect is at an angle to the axis of symmetry, the cross-section will be an ellipse rather than a circle. Theoretically, the reconstruction of the ellipse model is more universal than the circle, and the circle can also be regarded as an ellipse with coincident focus.

The standard equation of ellipse is divided into two cases; when the focus is on the axis, the equation is shown in equation (4), and when the focus is on the axis, the equation is shown in equation (5).

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1 \quad (a > b > 0), \tag{4}$$

$$\frac{y^2}{a^2} + \frac{x^2}{b^2} = 1 \quad (a > b > 0). \tag{5}$$

But the actual defect position is arbitrary, the center of the ellipse is not necessarily the center of the workpiece, and the position of the focus is not necessarily on the coordinate axis, so two parameters, the center of the ellipse $O(x_0, y_0)$ and the inclination angle θ, are introduced to represent the ellipse defect. In this case, the general equations for ellipses are more applicable. The general equation of the ellipse in the Cartesian coordinate system can be written as

$$Ax^2 + Bxy + Cy^2 + Dx + Ey + 1 = 0. \tag{6}$$

In the formula, A, B, C, D, and E are the parameters of the equation, and A and E are not zero. Using these five parameters, the center of the ellipse $O(x_0, y_0)$, the major semiaxis a, the minor semiaxis b, and the inclination angle θ can be expressed as follows:

$$\begin{cases} \theta = \dfrac{\arctan\left[B/(A-C)\right],}{2} \\ x_0 = \dfrac{BE-2CD}{4AC-B^2}, \\ y_0 = \dfrac{BD-2AE}{4AC-B^2}, \\ a = \sqrt{\dfrac{2\left(Ax_0{}^2 + Cy_0{}^2 + Bx_0y_0 - 1\right)}{A+C-\sqrt{(A-C)^2+B^2}}}, \\ b = \sqrt{\dfrac{2\left(Ax_0{}^2 + Cy_0{}^2 + Bx_0y_0 - 1\right)}{A+C+\sqrt{(A-C)^2+B^2}}}. \end{cases} \tag{7}$$

Therefore, theoretically, as long as five or more defect wavefront arc data can be found, the five parameters of the ellipse can be calculated by a fitting method similar to the circular model, and the ellipse equation can be fitted. In the case of known circle and ellipse, parameters such as the coordinates of the tangent point can be solved numerically. However, when the ellipse equation is unknown, the ellipse cannot be directly solved mathematically by circumscribed circle parameters. In order to solve this problem, the tangent of the circle and the circle can be used to approximate the tangent between the circle and the ellipse, and the circles of different radii can be used to approximate the arc segments at different positions of the ellipse. After that, the tangent point between the approximate circle and the wavefront arc is obtained, and an ellipse is fitted using the data of the tangent point. Figure 3 is a schematic diagram of approximating an elliptical arc with a circular arc. At points Q_1, Q_2, and Q_3, circular arcs CC_1, CC_2, and CC_3 with different radii can be used to approximate an elliptical arc. This method has good approximation accuracy when the elliptical arc approximated by the circular arc is short enough.

Next, the reconstruction method based on the ellipse model is introduced in detail. For an elliptical defect, there are d groups of adjacent defect echo valid data, and the data includes the mirror emission point $A_1 \sim A_L$, the radius $d_1 \sim d_L$, the wavefront arc $C_1 \sim C_L$, and other information. By taking out the data of the $1 \sim L$th group, a circle (the center point is O_1) is fitted according to the method of formula (3), and the tangent points of the circle and all L wavefront arcs are determined. Since the circle is solved by the least square method, CC_1 cannot have tangent points with all wavefront arcs. At the same time, since the defect boundary must be on the wavefront arc C_j, the intersection point of the wavefront arc C_j and $A_j O_1$ can be approximated as the tangent point of the wavefront arc C_j and the circle CC_1. By analogy, by taking the $2 \sim (L+1)$th group, the $3 \sim (L+2)$th group, …, and the $(K-L+1) \sim K$th group, respectively, the circle $CC_1, CC_2, \cdots, CC_{K-L+1}$ is fitted, and the approximate tangent point B_{ij} between the corresponding reconstructed circle and the wavefront arc is obtained. In this way, each wavefront arc C_j has at least 1 and at most L corresponding tangent points, and the distribution of all approximate tangent points B_{ij} is shown in the following formula:

$$B_{ij} = \begin{bmatrix} B_{1,1} & B_{1,2} & \cdots & B_{1,L} & 0 & \cdots & 0 & 0 & \cdots & 0 & 0 \\ 0 & B_{2,2} & \cdots & B_{2,L} & B_{2L+1} & \cdots & 0 & 0 & \cdots & 0 & 0 \\ & & \ddots & & & \ddots & & & & & \\ \vdots & \vdots & & \ddots & & & \ddots & & & \vdots & \vdots \\ & & & & \ddots & & & \ddots & & & \\ & & & & \ddots & & & \ddots & & & \\ 0 & 0 & \cdots & 0 & 0 & \cdots & B_{K-L,K-1} & B_{K-L,K-L+1} & \cdots & B_{K-L,K-1} & 0 \\ 0 & 0 & \cdots & 0 & 0 & \cdots & 0 & B_{K-L+1,K-L+1} & \cdots & B_{K-L+1,K-1} & B_{K-L+1,K} \end{bmatrix}. \tag{8}$$

By taking the middle point of all tangent points on the same wavefront arc C_j as the final tangent point $B_j d$, K tangent points $B_j(j-1 \sim k)$ can be finally obtained from the K group of defect echo data. Then, by using the data of these tangent points, the final solution of the fitted ellipse is obtained by the least square method. The ellipse defect reconstruction flowchart is shown in Figure 4.

On the basis of the circular defect simulation model, without changing the parameters of the cylindrical workpiece and the detection method of the probe, only the shape of the defect is changed to an ellipse, and the simulation model shown in Figure 5(a) is established. The long axis of the ellipse defect in the model is 6 mm long, the short axis length is 3 mm, and the center of the defect is still 25 mm from the center of the cylindrical workpiece.

Defects are reconstructed using the above-mentioned fitting method of ellipse defects, and the reconstruction result obtained is shown in Figure 5(b). The reconstructed ellipse

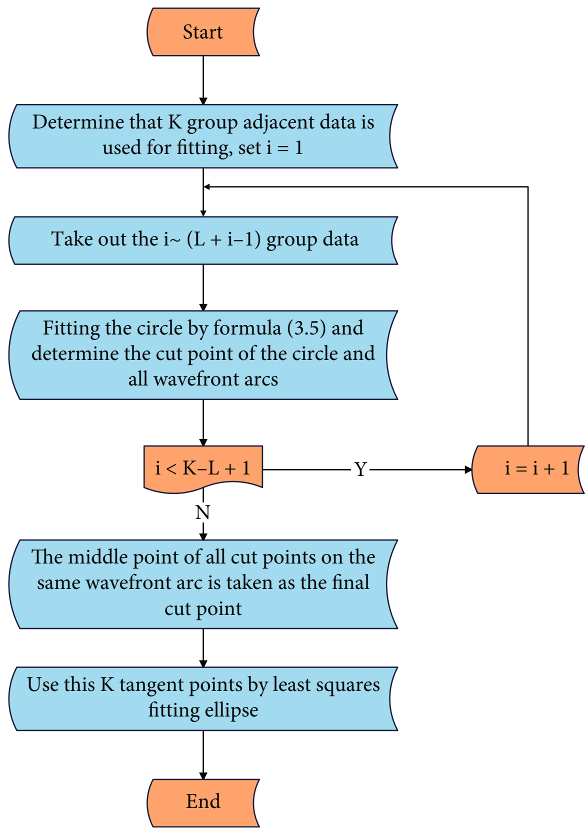


Figure 4: Flow chart of reconstruction of tangent elliptical defect boundary.

has a major axis length of 7.12 mm, a minor axis length of 2.80 mm, and the center position at (24.90, 0.04). Compared with the actual defect, the major axis error is 1.12 mm, the minor axis error is 0.20 mm, and the position error is 0.1 mm. It can be seen that the short-axis error of the reconstructed ellipse is small, the long-axis error is large, and the overall reconstruction accuracy is high. The reconstruction method based on the ellipse model is effective to reconstruct ellipse defects. The reconstruction effect of elliptical defects has some gaps in the accuracy of the effect of circular defects. The reason is that the ellipse defect reconstruction method is more complicated, and there will be larger errors in the calculation process. Moreover, the size of the elliptical defect is smaller than that of the circular defect, which will affect the amplitude of the echo signal of the defect, thereby affecting the reconstruction result.

2.3. Reconstruction Method of Boundary Tangent Based on Polygonal Model. The polygon is a plane figure composed of three or more line segments. The crack defect can be approximated as a polygonal defect, and the reconstruction of the polygonal defect is to study the tangent of the wavefront arc to the straight line. As long as multiple straight lines tangent to the wavefront arc are fitted, the area enclosed by the straight lines is the polygonal defect area.

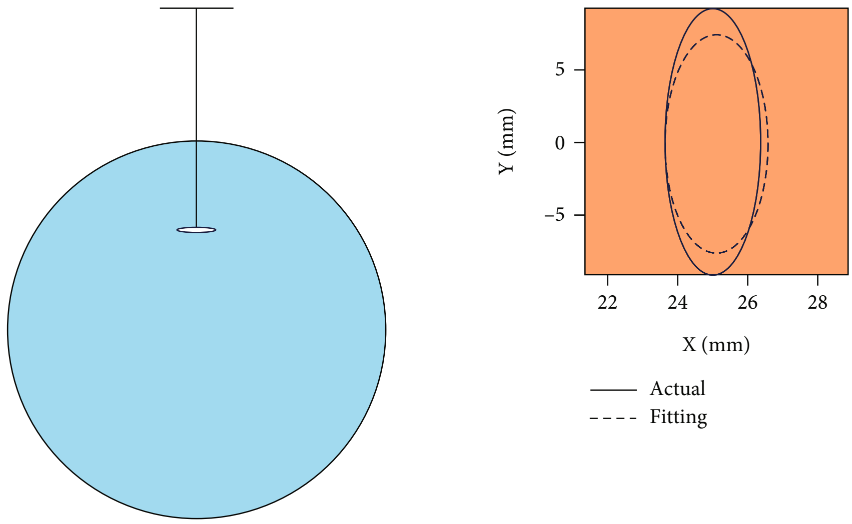
As shown in Figure 6, the equation of a line is $y = kx + b$, the center of a circle is x_0, y_0, the radius is a, the circle is tangent to the line, and the tangent points are x_q and y_q, which can be obtained from mathematical knowledge:

$$\begin{cases} x_q = x_0 + r_0 \cos\theta, \\ y_q = y_0 + r_0 \sin\theta, \\ k = -\cot\theta. \end{cases} \tag{9}$$

By substituting equation (9) into the straight line equation $y = kx + b$, we can get:

$$r_0 = -x_0 \cos\theta - y_0 \sin\theta + b \sin\theta. \tag{10}$$

Equation (10) is the fitting equation of one side of the polygon defect. There are only two unknown parameters in the formula, and theoretically, the equation can be solved only by the data of two sets of wavefront arcs. Referring to the reconstruction method based on the circular model, multiple sets of defect echo information are substituted, and the optimal solution of the straight line is fitted by the least square method; that is, a boundary of the polygonal defect is fitted. When the polygonal defect is in the center of the workpiece, the probe can receive echo signals around the workpiece, and by analogy, multiple boundaries can be fitted. However, when the defect is eccentric, due to the limited echo information, the wavefront arc is only tangent to part of the boundary of the defect, and only part of the boundary of the polygon can actually be fitted. Taking rectangular defects at different positions as an example, the



(a) Ultrasonic simulation model of elliptical defect (b) The result image of elliptical defect reconstruction

Figure 5: Schematic diagram of elliptical defect.

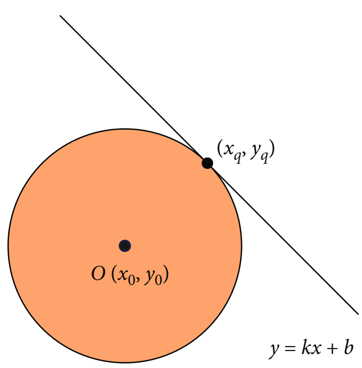


Figure 6: Schematic diagram of the tangent between a circle and a straight line.

corresponding wavefront arcs are drawn as shown in Figure 7, which shows that this method is only suitable for the case where the defect is in the center of the workpiece.

Triangles and rectangles are the simplest polygons and are easy to analyze, so the reconstruction effect is analyzed by taking triangle defects and rectangle defects as examples. On the basis of the circular defect simulation model, only the position, shape, and size of the defect are changed, and the polygonal defect simulation model shown in Figure 8 is established. The rectangular defect in the model is 30 mm long and 4 mm wide, the three sides of the triangular defect are all 4 mm long, and the center of the defect is in the center of the workpiece.

Defects are reconstructed using the above fitting method, and the reconstruction results obtained are shown in Figure 9. The coordinates of the three vertices of the reconstructed triangle in the figure are (2.64, -0.04), (-2.21, 2.89), and (-2.19, -2.79), and the coordinates of the three vertices of the actual triangle defect are (2.3, 0), (-1.15, 2), and (-1.15, -2); the maximum error is only 1.06 mm. Due to the existence of reconstruction error, the reconstructed defect in the figure is not a standard rectangle but a quadrilateral. The coordinates of the four vertices of the quadrilateral are (2.78, 15.32), (2.77, 15.32), (2.65, -15.32), and (2.64, -15.32), respectively, and the maximum error compared with the ideal defect vertex position is 0.78 mm. It can be seen that the reconstruction method based on polygonal model is effective to reconstruct triangular defects and rectangular defects. Although the reconstructed result of a rectangular defect is a quadrilateral, it is unlikely that the defect is a standard rectangle during actual inspection. Therefore, no angle correction is required for the vertices.

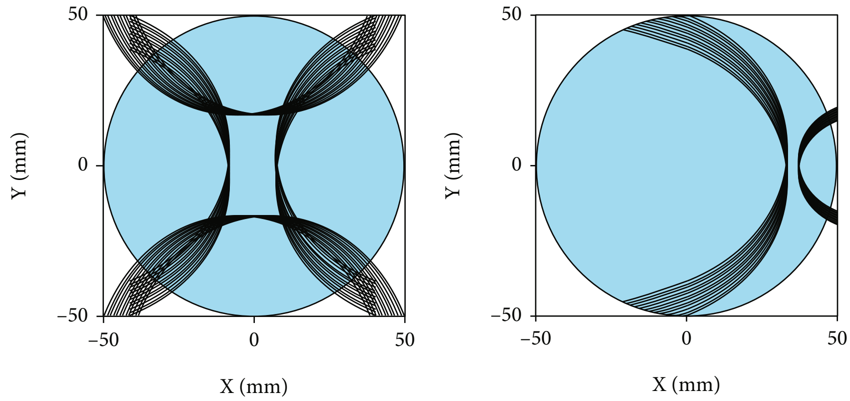
3. Intelligent Industrial Design System Based on Spatial Digital Technology

The development trend of computer-aided industrial design technology is still mainly concentrated in product design research, computer application technology research, and computer-aided industrial design application technology research, so as to provide technical support for the entire process of industrial design as a whole. The overall frame diagram of the specific computer-aided industrial design is shown in Figure 10.

Figure 11 shows the overall frame diagram of the auxiliary design platform.

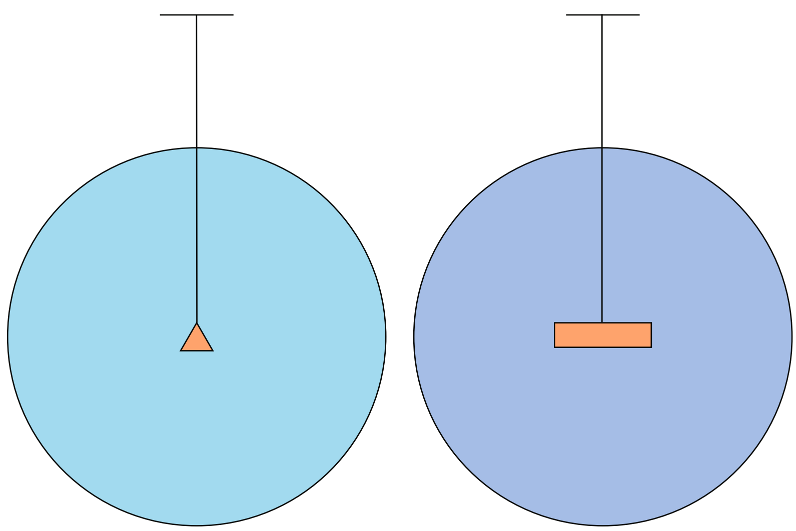
After constructing an intelligent industrial design system based on spatial digital technology, the effect of the system proposed in this paper is verified, the feasibility of industrial design of the system in this paper is counted, and the simulation results shown in Figure 12 are obtained through the simulation test.

Through the above research, it is verified that the intelligent industrial design system based on spatial digital technology has a good effect in industrial design and can effectively improve the intelligence of modern industrial design.



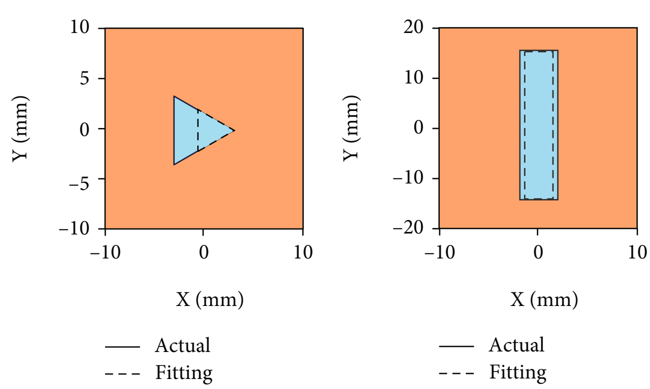
(a) Defects are in the workpiece center (b) Defects are not in the workpiece center

Figure 7: Wavefront arcs of rectangular defects at different positions.



(a) Triangle defects (b) Rectangular defects

Figure 8: Model diagram of polygon defect simulation.



(a) Triangle defects (b) Rectangular defects

Figure 9: The result diagram of polygon defect reconstruction.

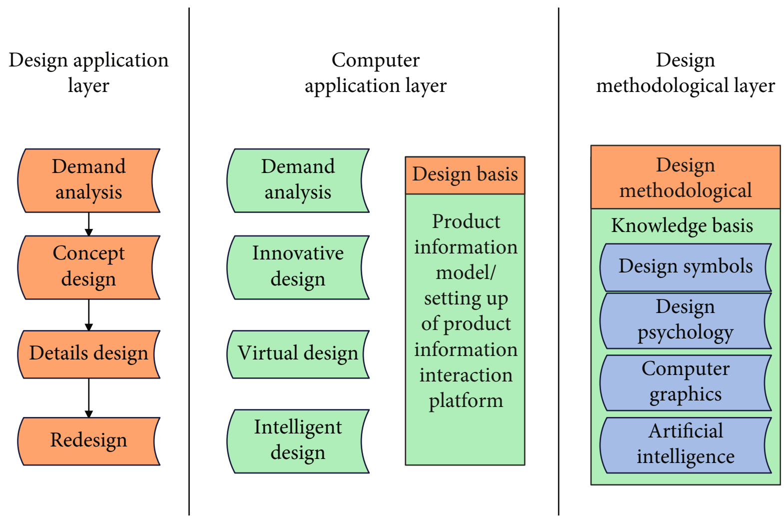


FIGURE 10: Overall frame diagram of computer-aided industrial design.

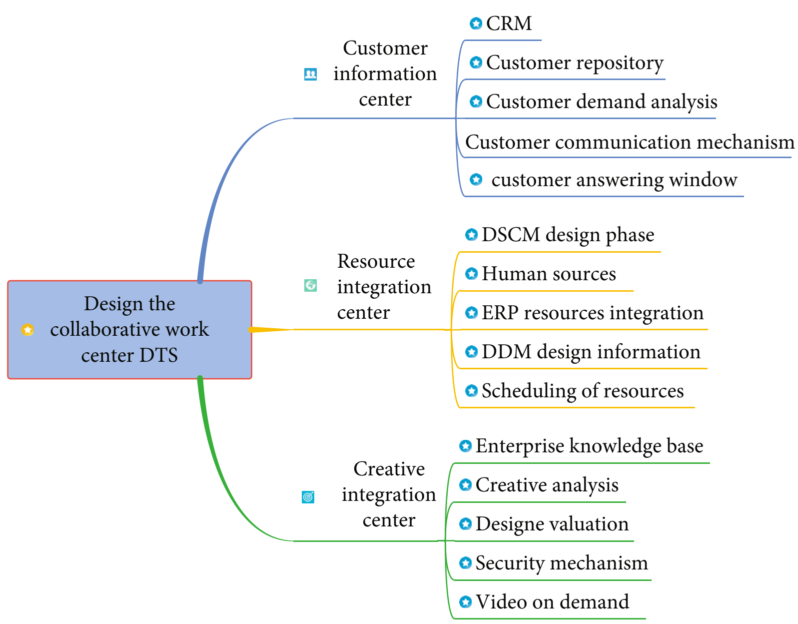


FIGURE 11: Overall frame diagram of the auxiliary design platform.

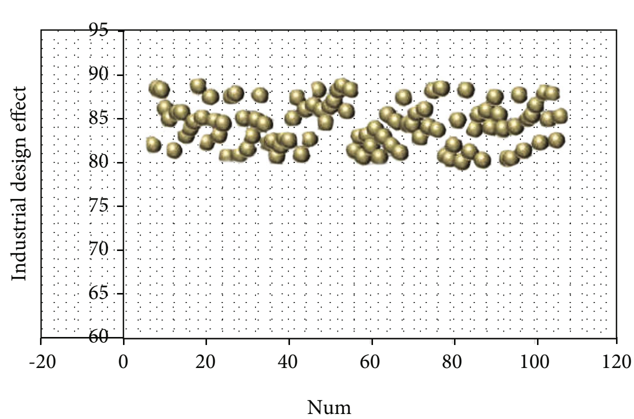


FIGURE 12: Effect evaluation of intelligent industrial design system based on spatial digital technology.

4. Conclusion

Under the background of the continuous development and popularization of global information technology and the gradual deepening of the process of enterprise informatization, the research field of computer-aided industrial design has become increasingly active. However, the research on real-time linkage industrial design information system has just begun. In terms of design performance, product 3D simulation, and system integration, there are not many computer-aided researches on industrial design from the aspects of information resources and interaction design. Moreover, there is almost no information system based on the needs of industrial designers and product customers and interactive design, and the application of this information system in enterprises is even in a blank area. This paper combines the spatial digital technology to construct the system structure of the intelligent industrial design community to improve the intelligent effect of industrial design. Through experimental research, it is verified that the intelligent industrial design system based on spatial digital technology has a good effect in industrial design and can effectively improve the intelligence of modern industrial design.

Data Availability

The labeled dataset used to support the findings of this study is available from the corresponding author upon request.

Conflicts of Interest

The authors declare no competing interests.

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