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Research on the Aided Design System of Linear Conveyor Equipment based on Haochen CAD

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Abstract: In the design process of linear conveyors, in order to ensure the accuracy of the specifications and dimensions of each product, a large amount of drawing design work is required. In order to improve drawing efficiency and reduce human errors, this paper designs a parametric auxiliary design system for linear conveyors. By organizing and analyzing the non-standard size change rules of aviation logistics transportation equipment, and based on the .net4.8 framework, using C# language for secondary development of CAD software, in response to the call for national industrial software localization, this study selected the domestic CAD software Haochen CAD as the platform. Through system testing, this system can quickly generate non-standard part drawings through parameter input, improving drawing efficiency while reducing drawing error rates.

Keywords: CAD Secondary Development; .Net Framework; Haochen CAD; Parameterization; Aided Design.

1. Introduction

In recent years, with the rapid development of the economy and the arrival of the era of speed economy, more and more regions have recognized the increasingly prominent role of airports as engines for promoting regional economic development, and air freight is constantly shifting towards air logistics. In the foreseeable future, China's aviation logistics industry has great potential for development. At the same time, China's civil aviation industry has entered a period of rapid development, and new airports are being built across the country, relying on airports for airport economic development planning, with aviation logistics as one of the major development directions. With the continuous development of aviation logistics, the demand and usage of linear conveyors have greatly increased, making the design of linear conveyors particularly important.

In the design process of linear conveyors, due to the need for products to meet the specific usage scenarios of customers, most of the equipment is custom-made. This means that there will be multiple specifications of aviation logistics transportation equipment in the same project, and except for some specific non-standard design parts, other structural dimensions are the same. However, although similar, in order to ensure the accuracy of each product's specifications and dimensions, a large amount of drawing design work is still required, which is a huge workload for designers. In the design process of linear conveyors, due to the need for products to meet the specific usage scenarios of customers, most of the equipment is custom-made. This means that there will be multiple specifications of aviation logistics transportation equipment in the same project, and except for some specific non-standard design parts, other structural dimensions are the same. However, although similar, in order to ensure the accuracy of each product's specifications and dimensions, a large amount of drawing design work is still required, which is a huge workload for designers.

In the field of linear conveyor design in China, traditional AutoCAD computer-aided design software plays a dominant role, while traditional AutoCAD design efficiency is low. In order to further improve the level of intelligence and automation, research on secondary development of CAD software to meet different industry standards and parameterized design through customized development methods is deepening. In order to improve drawing efficiency and reduce human errors, it is particularly important to organize and analyze the non-standard size change rules of aviation logistics transportation equipment, and to achieve intelligent generation of non-standard transportation equipment drawings through secondary development of CAD drawing software.

Xu Dan, a student at Liaoning University of Engineering and Technology, developed a dynamic design software by establishing a dynamic model using finite element method, which can display dynamic parameters in both 2D and 3D graphics. Li Dazhi, a student at Shanghai Normal University, developed a design and analysis software for belt conveyors and achieved integrated design and analysis. Yi Binggang, Zhang Zhe, Qiu Lei, and Zhang Liangyou have studied the parameterized design of the belt conveyor transmission system and achieved parameterized modeling and automatic assembly of the components of the belt conveyor transmission system. The above research mainly focuses on the design and analysis of 3D models, and it has not been found that the design of non-standard parts of linear conveyors developed by domestic CAD software cannot effectively improve design efficiency.

2. Fundamentals of Technical Implementation

AutoCAD is a computer-aided design (CAD) software developed by the American company Autodesk. It is one of the widely used professional drawing tools worldwide, widely used in fields such as architecture, civil engineering, and mechanical design. The main function of AutoCAD is to draw and modify 2D and 3D graphics through a computer. The advantage of AutoCAD lies in its broad user base and rich feature extensions. Many professionals in the industry are accustomed to using AutoCAD for design and drawing work, making it one of the industry standards. In addition, AutoCAD also has a large number of third-party plugins and

applications that can be extended and customized according to user needs, further improving work efficiency.

The secondary development tools of AutoCAD mainly include AutoLISP, ActiveX/COM, Object ARX, and NET API, etc. AutoLISP is a programming language built into AutoCAD, with simple syntax and ease of learning, but relatively limited functionality, mainly used for simple automation tasks. The ActiveX/COM interface can interact with multiple programming languages, but its functionality is relatively limited and its integration with AutoCAD is relatively low. Object ARX is a C++programming interface that provides more advanced functional extensions and flexibility, but the development and debugging process may be relatively complex. Based on The. NET platform supports multiple languages (such as C#, VB.NET, etc.) and provides powerful programming capabilities and object-oriented development models. It can directly call the object model of AutoCAD, achieve functional extension and customization, and greatly improve development speed.

Domestic CAD technology originated from secondary development based on foreign CAD platform technology. On the basis of secondary development, some top domestic CAD developers have gradually explored CAD models that are suitable for China's development and demand. The rapidly rising domestic brands such as Haochen CAD and Zhongwang CAD are among them, and they all have high compatibility and are recognized by users. In response to the call for national industrialization software localization, this article selects Haochen CAD software for secondary development and design of a parametric auxiliary design system for linear conveyors.

The tools used for the secondary development of Haochen CAD include GstarLISP, ActiveX, Object ARX, .NET API, etc. Due to the support of multiple languages on the .Net platform and high development efficiency, this article uses the. Net4.8 framework and C# language for development.

3. Design Work Characteristics and Requirements Analysis

The design of non-standard parts for linear conveyors has the following characteristics:

Customization requirements: Linear conveyors are usually designed and manufactured according to the specific needs of users, so non-standard part design work needs to be customized according to the special requirements of each project. This may involve very specific dimensions, shapes, materials, and other requirements, which means that there will be multiple specifications of aviation logistics transportation equipment in the same project.

Similar structure: In the design process of non-standard parts of linear conveyors, except for some specific non-standard design parts, all other structural dimensions are the same.

Large workload: In order to ensure the accuracy of the specifications and dimensions of each product, although non-standard parts have similar structures, a large amount of drawing design work is still required.

High error rate: Due to the general similarity of the structure, most designers make modifications based on the original part drawings by stretching and shrinking, which inevitably leads to design errors during the design process. The traditional non-standard design process is shown in Fig.1:

By analyzing the characteristics of traditional design, CAD secondary development can be carried out on the design process of linear conveyors, which mainly includes adjusting the size of non-standard parts, deploying parts such as bed reinforcement ribs, nuts, circular holes, and labeling each size. By formulating non-standard design rules for linear conveyors in the program, the system can generate non-standard part drawings based on the input of non-standard part parameters and according to predetermined rules. This will greatly improve the design efficiency of designers while reducing the error rate in non-standard designs.

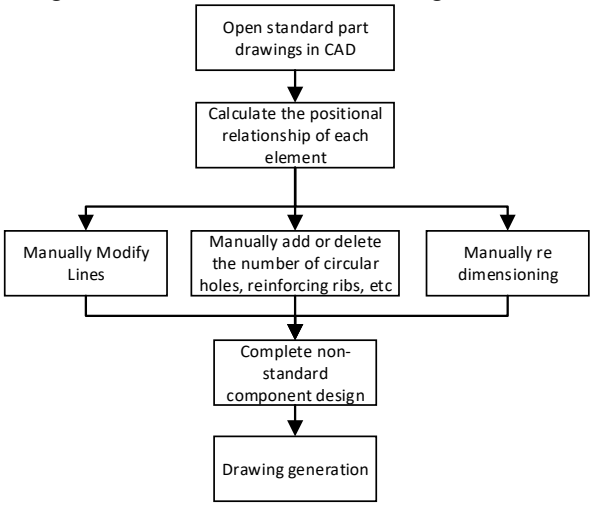

Fig 1. Traditional non-standard design flowchart

4. Development of Aided Design System

4.1. System Development Environment

The linear conveyor auxiliary design system adopts C# language and is based on the. net4.8 framework for secondary development of Haochen CAD. C# language has powerful functions and high development efficiency, which can efficiently develop software with related functions based on Haochen CAD. In Haochen CAD, the drawing of graphics is mainly achieved by calling corresponding functions to generate individual graphic objects. The following basic steps need to be followed:

1) Obtain a graphical database for creating objects;

2) Create an entity class object in memory;

3) Open the block table of the graphics database;

4) Open a block table record that stores entities, all model space entities are stored in the "model space" record of the block table;

5) Add objects to block table records.

The structure of the graphic database is shown in Fig.2.

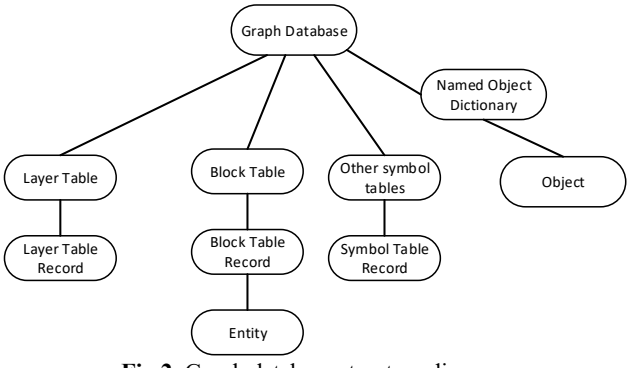

Fig 2. Graph database structure diagram

4.2. System Design Route

The design idea of this system is to combine the traditional linear conveyor design with CAD secondary development technology, and convert the operations that originally needed manual modification into non-standard part drawings automatically generated by the system according to design rules by inputting design parameters. The specific design roadmap is shown in Fig.3, which includes changes in the size of the part drawings, changes in the number of reinforcing ribs, changes in the number of circular holes, and changes in the size labeling of the part drawings.

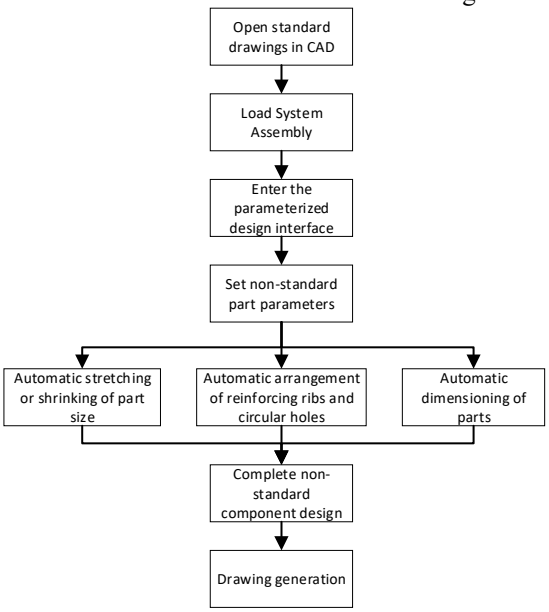

Fig 3. System Design Roadmap

4.3. Analysis of the Positional Relationship of Component Elements

Table 1. Analysis Table of Element Position Relationship

Part Name	Non-standard Dimensions	Rule Description	Notes
Guard Board	Length L	Length=Equipment length - Head and tail roller components length - Power section length - Head section length - Standard section length * n.	500≤L≤2000 Head and tail roller components length=200, Power section length=1400, Head section length=400, Standard section length=2500
	For bottom installation φ 11 Number of circular holes	When the overall length of the protective plate exceeds 1200, it is necessary to add one installation circular hole in the middle of the corresponding supporting plate	Increase the opening position to be consistent with the opening position of the support plate
Support Boards	Length L	Length=Equipment length - Head and tail roller assembly length * 2- Power section length - Head section length - Standard section length * n	300≤L≤1800
	For top installation φ 11 Number of circular holes	When the overall length of the protective plate exceeds 1200, it is necessary to add one installation circular hole in the middle of the support plate.	Increase the position of the opening to be consistent with the position of the protective plate opening
	bottom φ 11 Number of circular holes	First φThe positioning distance from the center of the 11 circular holes to the back of the tray is 250, and the last one φThe distance from the center of the 11 circular holes to the front end of the tray shall not be less than 250, and the number of single sided circular holes shall not be less than 2, with a distance of 100 from the center of the holes.	1. This circular hole is used to install the roller component. If there is only one circular hole on one side, it cannot meet the usage requirements; 2. When the length of the support plate is less than 600, the circular hole may not be machined.
Sliding bed board	Number of welding nuts	When the overall length of the protective board exceeds 1200, it is necessary to add one installation circular hole in the middle of the supporting board. After welding into a sliding bed board, a welding nut should be welded below the circular hole.	
	Number and spacing of bed board reinforcing ribs	The distance from the center of the reinforcing ribs of the bed board to both ends of the bed board is 90, and the spacing between the reinforcing ribs does not exceed 500, with a maximum value close to 500.	

This system consists of a total of five series of linear conveying. Each series requires the design of non-standard parts, including guard boards, support boards, and bed boards. Each different non-standard part has its own design rules. Due

to the similarities in the design ideas of the five series, this article will analyze the position of non-standard part elements using one of the series of conveyors. The specific analysis is shown in Table 1.

4.4. Linkage Design of Non-standard Parts

In the previous design, a single part in a series has been designed, but there is no correlation between different non-standard parts in the same series, and each part parameter needs to be input separately. In order to further reduce the workload of designers and improve design efficiency, based on the original design, the relationship between different non-standard parts of the same series is analyzed, and the parameters of each part are established through existing relationships, in order to achieve linkage between different non-standard parts.

4.5. System Testing

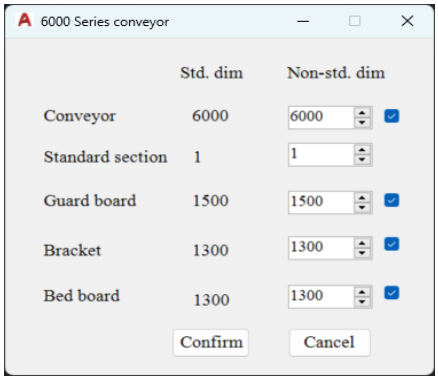

Fig 4. Parameter setting interface

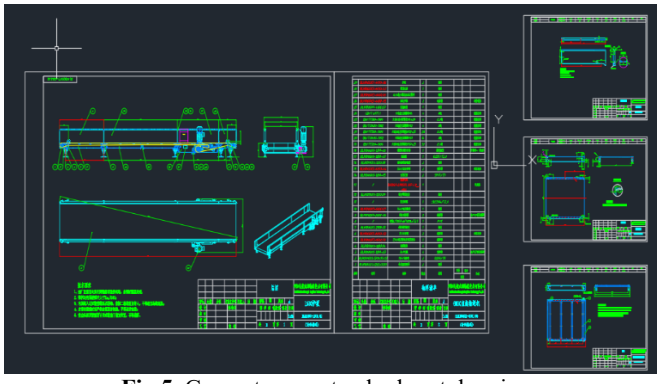

Fig 5. Generate non-standard part drawings

The design interface of this system uses command line input for operation, which is very convenient to use. Users enter the design series selection interface by entering commands, and then click to select the series to be designed. The series parameter setting interface pops up, as shown in Fig.4. After setting the relevant parameters, users can click the OK button to generate corresponding non-standard part drawings according to the design requirements, as shown in Fig.5. Through verification, the non-standard part drawings generated by the linear conveyor system meet the design requirements.

5. Conclusion

The linear conveyor system is based on the design characteristics of non-standard parts of the linear conveyor. Based on the. net4.8 framework, the domestic CAD software Haochen CAD is redeveloped using C# language. It realizes the function of automatically generating non-standard part drawings through parameter settings, greatly reducing the workload and error rate of designers, and improving design efficiency. To a certain extent, the intelligent and parameterized design of non-standard parts for linear conveyors has been achieved.

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