Simulation of Automatic Conveying System for Steel Frame of Bridge Box Girder

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Abstract. Aiming at the inefficiency of processing steel frame of the bridge box girder, to improve the automation degree of the production process, the intelligent manufacturing is applied to the automatic conveying system. The configuration control technology is used to simulate the automatic conveying system for the steel frame of bridge box girder. The control layer based on the PLC and the monitoring layer based on the WinCC communicates through TCP-IP protocol. The monitoring layer includes screen configuration, data monitoring, alarm designing, and other functions. Through the system coordination, the simulation of the automatic conveying system for the steel frame of the bridge box girder is carried out.

1. Introduction
With the development of intelligent manufacturing technology, the quality requirements of prefabricated box girders are more stringent in bridge construction engineering, and the construction period of prefabricated box girders is higher [1-5]. In making a prefabricated box girder, the construction of the steel skeleton of the box girder is a key and important link, which directly affects the construction period of the prefabricated box girder. At present, in the construction industry at home and abroad, the steel skeleton of box girder mainly depends on the traditional way of manual conveying a steel bar, which not only is inefficient and time consuming, but also it directly affects the subsequent reinforcement positioning, binding and even concrete pouring process [6-8]. To improve efficiency and make full use of the existing intelligent manufacturing technology, the intelligent manufacturing of steel skeletons is carried out.

2. System Function Design
According to the actual engineering requirements, the controlled object of the automatic conveying system is a steel bar [9-11]. The purpose of the control is to make the steel bar complete the mechanical conveying through intelligent control, and the simulation system meets the simulation of the automatic conveying process. Based on the WinCC configuration development platform, the automatic conveying system carries on the system simulation design [12-15]. The system functions mainly include completing the communication configuration, picture configuration, data monitoring, and alarm design between the control layer and the monitoring layer [16-18].

3. Communication Configuration
In the practical application, the preliminary investigation must be carried on, which determines the system configuration mode. The communication configuration of the simulation system connects the
WinCC industrial control computer to the PLC control terminal with a single user system configuration [9-10]. The control layer adopts Siemens S7 in WinCC configuration single-user project 300 series control, and the corresponding driver protocol. The communication mode consistent with the actual physical connection is selected in the channel unit. In this project, industrial Ethernet is used to complete the communication configuration of WinCC and PLC through the IP address, frame number, and other information in the protocol.

4. Variable Configuration
During the process of variable creation, the internal variables and the external variables are created according to the requirements of the configuration function, in which the data address and data type of external variables are consistent with the data in the PLC. The external variable is the carrier of WinCC and PLC data transfer, and the creation of the external variable requires WinCC authorization points. A variable corresponds to an authorized number of issues, independent of the data type carried by the variable. External variables are created in the connection unit under the channel correspondence of the communication drive protocol, the internal variables are created directly under the variable manager, and the system variables are called now by the WinCC system. The new structure type is built at the WinCC end, the structure variable is used for data transmission, and the PLC layer data is stored in the DB1 database, which can not only take into account the convenience of later maintenance or system transplantation, but also improve the working efficiency.

5. Picture Configuration
Screen configuration design is the key and primary work of simulation system, including login screen, main monitoring screen, data monitoring, alarm, and other monitoring screen composition. For each picture, the static, dynamic, and event properties of the object are configured to WinCC the picture configuration.

Login screen configuration process, through the user manager for user creation and user rights configuration settings, and then in the project properties for login, exit, and hard copy screen shortcut configuration. Combined with the user permission settings entering the monitoring system, the authorized user name and password can enter the main monitoring screen.

According to the central monitoring screen, the intelligent object of the picture window is used to realize the function of picture-in-picture switching. The different pictures connected to the WinCC can be viewed through the fixed window. It mainly presents the simulation of the automatic conveying process, including conveying platform, starting and stopping control, forward and reverse control, speed control, emergency stop, fault alarm, and so on. According to the actual geometric size, the conveying platform can be dynamically adjusted according to the exact size in the WinCC monitoring screen. A type steel bar conveying slot with the equal spacing adjacent slot is used on the surface of the conveying platform, and the slot position is set up. The start and stop control can realize the opening and closing of the equipment in the monitoring layer, the positive and negative control can change the direction of transportation artificially in the process of automatic transit, and the speed control can adjust the speed of the steel bar process. Emergency parking can provide alarm warning for the trigger of preset alarm information during automatic transportation systems.

6. Data Monitoring
In the automatic conveying system, the production state can be monitored in real-time by a monitoring screen. Through the real-time data output control, the number of finished and unfinished steel bars can be viewed, and the progress of steel skeleton production can be grasped at any time. The query of historical data is also provided in the data monitoring, including the original historical data in the output of the completed steel skeleton and the statistics of the completed total amount. Both real-time and historical data can be output in the form of data tables and trend maps.

For the query output of historical data, it is necessary to configure the data archiving in the variable record editor and activate the variable record running system before the data archiving can be
completed and stored in the SQL database. Call historical data in the monitoring screen, re-read the stored historical data from the SQL database.

7. Alarm Design
During the automatic operation of the automatic conveying system, when there is an abnormal situation caused by the failure of the control system or the interruption of communication, the system will appear alarm, and save the alarm information to the SQL database for archiving. Can provide data support for later system upgrade optimization or troubleshooting. In the configuration process, it is necessary to configure the alarm message in the alarm record editor, including system message configuration and single message configuration, call the alarm record control in the monitoring interface to output the alarm message, and activate the alarm record running system. In the alarm configuration design, the trigger alarm action is configured. Once the alarm information with a high priority level occurs, the monitoring window sends out alarm information, and early warning is carried out through the color flicker of the graphic object of the monitoring screen. Remind the operator to process the alarm information in time.

8. Systems Alignment
This subject adopts WinCC V7.0 and STEP7 V5.6 to coordinate through the PLCSIM. The communication configuration of the monitoring layer, the control layer, and the operating system is consistent to ensure the regular communication logic connection. Keeping STEP7 and PLCSIM working with debugging mode, WinCC automatic transport system simulation can be activated, and then the login interface is opened as shown in figure 1.

![Login Interface](image)

**Figure 1. Login interface.**

After login in the main monitoring screen, the functions of the system can be tested. Keeping in line with the actual engineering requirements, the automatic transportation system simulation completes the designed process. The central monitoring screen is shown in figure 2.
9. Conclusions
By WinCC configuration control technology, this paper completes the simulation of the bridge box girder steel skeleton automatic conveying system, provides the simulation demonstration for the realization of the system function, and presents the automatic conveying process intuitively and vividly. According to the actual engineering requirements, it can optimize the production process. It can also be directly applied to the actual project to complete the monitoring function, and can provide technical support for the next step of physical hardware design and debugging. In the simulation design of the bridge box girder steel bar automatic conveying system, the interactive design parameters will be optimized. The report design, system security, and remote control will be further optimized to improve the bridge box girder steel skeleton automatic conveying system.

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