Design of Simulation Verification Platform for Ship Sub Assembly Digital Production Line Control System

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Abstract. The early verification of the control system of the sub assembly production line plays an important role in the efficiency and quality of the production line. The traditional control system verification is based on the actual production line and the cost is high. This paper proposes a simulation verification platform with data interaction with the control system, which can verify the control system at low cost. It can enable the ship sub assembly laboratory to have the ship sub assembly production line simulation, testing, and development capabilities to meet the research needs of the ship sub assembly production line.

1. Introduction
In order to ensure the welding quality and production efficiency of the sub assembly, it is also required that the welding equipment can be processed with quality and quantity, and the station beat is automatically controlled to transport and load and unload the sub assembly [1].

On the production line, each station equipment is arranged in order, connected by an automatic conveying device, and the control system is used to coordinate and unify the modules so that they work automatically according to control commands [2]. The performance of the control system determines the efficiency and production cost of the sub assembly line production, so the sub assembly line control system is very important for the assembly line production. The sub assembly line has a long production cycle, consumes large resources in the production process, and has a small number of research samples, which is not conducive to the research of the production line control system. Combined with the virtual production line simulation to verify that the control system can solve this contradiction well [3].

This paper uses Visual Components (VC) to verify the control system of the sub assembly digital production line.

2. Integration and implementation of experimental verification platform
Based on Visual Components (hereinafter referred to as VC) simulation software, a simulation platform is built, which integrates discrete event simulation, human-machine collaboration simulation, robot offline programming development and virtual debugging (PLC) on one platform, communicates with
the control system, and drives the production line. The production line of the model system assembly is simulated and relevant data is obtained. Follow-up work based on these data, such as analysis and decision-making of production lines, quality control, equipment monitoring, and gradually realize multi-dimensional, shrinking simulation, to provide a strong foundation for the construction of production lines [4].

The control system program first performs data interaction with the PLC. The PLC transmits the servo motor that needs motion and its speed, stroke and other data to the VC. The VC's program script is received and the corresponding program is executed. The VC sends the feedback signal back to the PLC. The PLC sends the feedback signal to the control system to determine the next action and transmits the data to the VC. VC enables the corresponding virtual device to perform simulation actions according to the program.

3. VC combined with PLC simulation

3.1. Principle of two-way communication between VC and PLC

Program by VC simulation software or add script driver, set processing path, compile work instructions through PLC controller, PLC controller interacts with VC server through control server (such as Beckhoff), that is, through external The PLC trigger signal controls the processing of the sub assembly digital production line.

The simulation platform created based on the simulation software needs to simulate all the resources, interfaces, and instruction systems of the sub assembly digital production line, and at the same time simulate the actual environment of sub assembly manufacturing. The entire simulation system needs to be able to simulate the exchange of information between the group intelligent manufacturing production line and external models, so that the entire simulation process is close to the real operating environment.

There are many choices of communication methods between VC simulation software and PLC according to different PLCs. For non-Beckhoff PLCs, OPC UA can be used for data exchange. For Beckhoff PLC, in addition to OPC UA, ADS communication can also be performed directly through TWINCAT [5].

![Figure 1. Data communication method between VC and PLC.](image)

The control system is connected to the main control PLC. During the control system verification process, some stations use VC, and the other uses physical objects. When the PLC controller gives a signal to the control server, the control software in the control server will convert the signal and transfer it to the VC simulation platform server, driving the sub assembly production line built by the digital model to simulate and obtain the relevant data [6].

3.2. Verification of simulation-PLC bidirectional data flow

To verify the feasibility of the simulation-PLC two-way data flow, a cutting machine model is now used for verification. Connected with Beckhoff PLC through VC, the target performance is that after the PLC sends a signal, VC starts to simulate the model to perform a predetermined action, and communicates with the PLC after the specified action to change the value of the corresponding variable in the PLC. That is, verify that the PLC can change the variables of the VC real-time simulation in the
host computer and change the corresponding actions of the simulation; the VC can change the variables in the PLC and change the corresponding actions of the PLC.

PLC uses Beckhoff CX5210 and TWINCAT3. The communication between PLC and control system uses ADS communication module, and the communication between PLC and VC adopts variable matching method.

The AMS Net ID corresponding to the PLC in the VC is set to 169.254.1.2.1 and port 851.

Match the start variable in VC with the path Start variable in PLC. When path Start is true, the simulation starts. After the end of a simulation cycle, the end in VC changes from false to true, and matches the path End variable in the PLC, which also becomes false. Variable matching in VC is shown in the figure.

![Figure 2. Variable matching in VC.](image)

The program flow in the PLC is shown in the figure.

![Figure 3. Program flow in the PLC.](image)
The program flow in the VC is shown in the figure.

![Program Flow Diagram](image)

**Figure 4.** Program flow in the VC.

In actual verification, when the variable Path Start in the PLC is true, the simulation starts, and the effect is shown in the figure.
After a simulation work cycle, the end variable in VC becomes true accordingly, as shown in the figure.

Figure 5. Simulation effect diagram.

Figure 6. Variable tracking in VC and PLC.
4. Conclusion
The verified running results prove that VC can perform bidirectional data exchange with PLC, and the delay is small, which can achieve the desired effect.

The plan in this article can make the sub assembly laboratory have the sub assembly production line simulation, testing, and development capabilities, and meet the research needs of the sub assembly production line.

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