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Manufacture of Flexible Automatic Assembly Platform for Aircraft Component Level

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Abstract. This paper describes the composition and working principle of aircraft parts flexible automatic assembly platform, and gives the detailed analysis and design of flexible automatic assembly platform of mechanical structure and motion adjusting control system. The two types of multi plane assembly shows that automatic assembly platform automatic adjusting is reliable, operation control system and motion mechanism runs stable, this system can meet the various needs of automatic assembly platform of aircraft components, and it realizes the work mode of assembly and products in one to many during the aircraft components Assembly process.

Introduction

The aircraft structure is complex, a large number of spare parts and low rigidity, and deformation is easy to occur during assembly. Therefore, in order to guarantee the final product assembly precision, in aircraft assembly process special assembly tools are used (including jig and fixture)[1-3]. In the traditional assembly model, represent rigid tooling is mainly applied to the frame, tooling and aircraft structure components are as "one to one" mode, which is a part of aircraft structure assembly corresponds to a rigid frame, the assembly model in aircraft assembly production preparing cycle is long, and tooling covers the bigger area[4]. With the development and progress of technology, the increasingly fierce competition of aircraft manufacturing, production demand toward the small batch and multi varieties direction development, and shortening the product development cycle, and the traditional assembly methods cannot meet the above requirements. In order to overcome the disadvantages of traditional assembly methods, modern aircraft assembly manufacturing mode develops toward digitalization, flexibility and automation direction[5,6]. Based on the aircraft fuselage components as the research object and the use of digital measuring and multi axis control technology, this paper develops a set of aircraft component level flexible automatic assembly platform.

The Composition and Working Principle of the Automatic Assembling Platform Mechanical Components

Automatic assembly platform has automatic adjusting function according to the assembly of different products, through the use of a set of assembly platform which can be completed more than two kinds of products, and the platform may realize the aircraft assembly platform and structure from “one to one” mode to upgrade the assembly mode of “one to many”. The assembly platform is mainly composed of a mechanical actuator, the motion control system, measurement system and data driving software. The adjusting shape and location of the automated assembly platform transfer based on digital assembly data, the adjusting shape data are input to the operation control system using data driving software. The motion control system controls the mechanical actuator in accordance with the adjustment shape data, realizes assembly adjustment motor assembly platform of X, Y, Z three-dimensional direction, and drives the aircraft assembly tooling each positioning unit moving with sequence and determined velocity. At the same time, during the assembly platform adjusting shape, the use of digital measurement system completes real-time monitoring, and the movement control system feedback monitoring data forms a closed loop in real time data. At the last, the accurate adjusting shape and assembling parts localization of assembly platform are completed.

The mechanical structure of automatic adjusting assembly platform for is shown in Fig. 1. The assembly platform adopts the whole bridge structure, whose main structure consists of 6 upright of frame, 4 frame beam, 5 group, 5 group of moving beam under moving cross beam, 40 positioning columns, 4 sets of X axis coordinate mobile car and 10 YZ coordinate the mobile trolley.

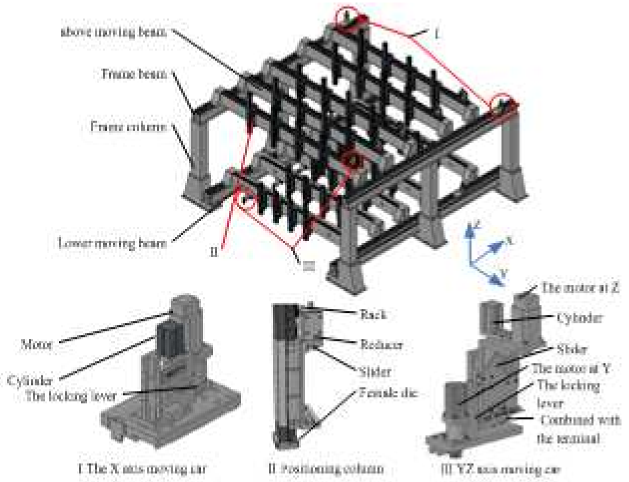

Fig.1 The automatic assembly platform mechanical components

Automatic Assembly Platform Control System Design

The Composition and Principle of CAN Bus Control System Based on. Automatic assembly platform control system completes motion control on X, Y and Z three directions, according to the received position information the locator is adjusted in place, the control system has the signal processing interfaces for pressure sensing, and the online measurement system and the assembly driver data realize coordination and integration. The control system needs to control nearly 100 axis, and it is difficult to achieve with conventional CNC system. Therefore, using ELMO multi axis servo drive control technology of CAN field bus controls the automatic assembly, connected by a multi axis control manager, digital servo controller, AC servo motor and the periphery of a variety of input and output switch, and its electrical control system is shown in fig. 2. Independent development is CAN bus control system based on CAN bus, using CANopen communication protocol realizes the communication between DSP and PC CAN card, and the rapidity, accuracy and real-time control of the motor is assured through the information transmission reliability based on CAN bus control system.

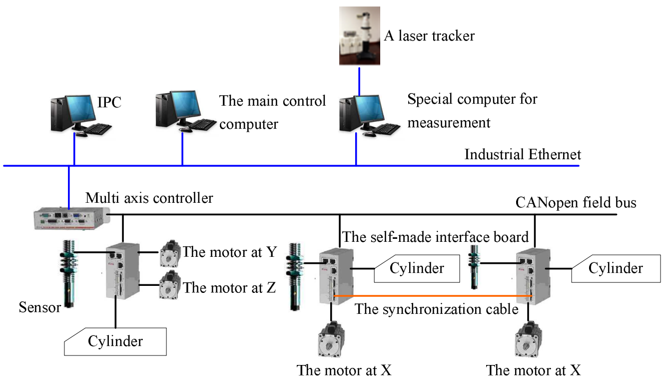

Fig.2 The assembly platform control system structure

Control Network Construction Based on CAN Bus. In the CANopen control network one of the nodes performs the master node in NMT function, and all other nodes is as slave nodes in NMT, namely the network system includes two parts of a master and slave station. The master station reads from the slave station data displayed on the CRT. ELMO series I/O module is as a CANBUS slave station, and it mainly completed field data collection and the necessary control. In CAN network construction, each CAN node need to be assigned a ID number and a name of axis, each node controls a motor to achieve different functions, the control network construction of CAN bus is completed, and assembly platform automatic adjusting function is realized.

The Design of Control System Software. According to the three layer control structure of the control system automatic assembly platform, the software design of the control system is divided into three layers, and its concrete structure is shown in fig. 3. The top of the control system software includes HMI interactive software and host server database software, interactive software mainly consists of automatic assembly platform equipment back to zero, the positioning column positioning, components under the frame and the laser measuring system, the host database software mainly realizes the equipment data, log storage and backup. The middle layer of multi axis manager software uses Elmo Studio programming environment to write, using the state machine realizes the equipment control, control command parsing and issuing, the bottom control data acquisition and upload, error information processing. The underlying driver software mainly realizes the axial back to zero, coordinate mobile car to find the target function, and it is the foundation of multi axis control system software.

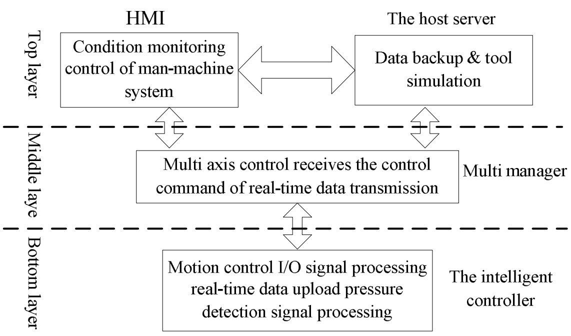

Fig. 3 Control software structure diagram

Automatic assembly platform adjusting shape data flow. In order to make full use of automatic adjustment shape equipment technical superiority and speed up the automatic assembly platform for the cycle, from the aircraft CAD mathematical model to automatic assembly platform shaped command data stream the automatic assembly platform plays an important role as a bridge. The adjusting shape instruction fetch is based on the design of aircraft parts CAD model, all kinds of special positioning joints are designed based on aircraft components assembly feature, which is automatic assembly platform specific structure module. Automatic assembly platform CAD model is imported, the assembly platform is adjusted to the planned position, the column cross adaptor plug bottom surface is as the base, the positioning column is moved in place, the automatic assembly platform and aircraft design coordinate system is in a unified form adjustment, all are as the source instruction fetch, adjusting the data flow diagram is shown in Fig. 4.

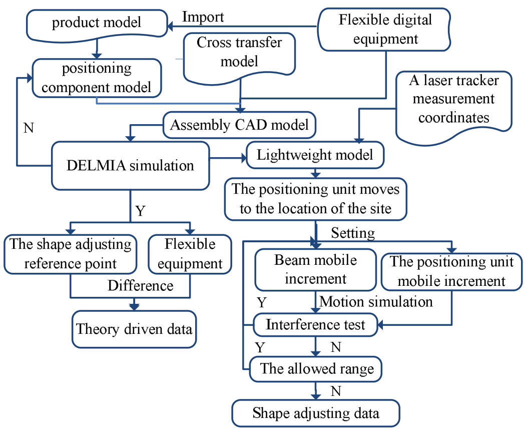

Fig. 4 Automatic assembly platform data flow diagram

Engineering Application

Flexible automatic assembly platform in this research is, the test Standard of the positioning column loading 3000N load, using the laser tracker on device X, Y and Z to a single coordinate positioning accuracy and measurement accuracy of repeatability location, and the results are t ±0.1mm and ±0.05mm. Based on the feedback of a laser tracker measurement, positioning precision assembly platform can be controlled in ±0.05mm. Based on Flexible automatic assembly platform, researchers have successfully completed the aircraft fuselage assembly of two types. In the application process, the adjusting shape data calculated by the software can successfully be received by IPC, assembly platform shaped positioning accuracy can meet the requirements of aircraft assembly process. In the replacement of the product model, the bolt of positioning upright post cross connector can be loosened, the special module is replace of new models and completes the automatic adjustment shape, and it has the advantages of simple operation and convenient.

Conclusions

The assembly experiments of multi planes in two types show: the automatic adjustment shape of automatic assembly platform is reliable, operation control system and mechanism are stable, the body part automatic assembly platform with various needs is met, “one to many” work mode is achieved during aircraft parts assembly and products. In the save tooling development costs at the same time, the failure rate is reduced, to the advantages of automatic adjusting shape are given full play in the flexible automatic assembly platform, and digital research work of the aircraft parts is realized from product design to assembly location.

Acknowledgements

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