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Portal Crane virtual assembly system based on Virtools

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Abstract: Portal Crane with its large parts is inconvenient to achieve physical prototype assembly in design process because of its large span and high precision space assembly needs. Considering virtual assembly system can provide designers with specific modules library, person interactive experience and reliable assembly simulation, this paper modularized the MQ4025 Portal crane based on analysis of assembly needs, and accomplished corresponding modules modeling by Solidworks, developed a virtual assembly platform by Virtools, realized collision simulation between components and parts by Collision Detection Building Blocks in Virtools, performed a virtual assembly experiment on the platform. Result shows that the platform completes Portal Crane assembly in a shorter time than physical prototype assembly, and it completes the assembly simulation faster than other CAD software by invoking compositive modules library of Portal crane.

Introduction

Portal crane is a huge mechanical structure seen from the overall perspective. Any improper assembly may cause the entire assembly to failure, which results in unexpected losses. As a consequence, assembly simulation in design process is essential.

However, Physical prototype with large parts like Portal crane is inconvenient to implement assembly simulation. Virtual assembly can help achieve that. Modular modeling idea can greatly improve design efficiency. Product constituted by modules and module unit mode will greatly reduce the complexity of modeling parameters. At the same time, the program error can be limited in the relevant module and interface, thereby enhancing the software adjustable and reliability.

Design of Virtual assembly system framework

In this paper, a virtual assembly system for a portal crane (VAC) is brought up. Based on the needs of assembly, modularize MQ4035 and complete modeling various parts into modules by Solidworks according to the modular analysis for assembly. In order to create better experience for operating staff, VAC use Virtools as virtual reality development platform, use 3dsMAX and Solidworks as modeling software to put forward VAC for portal cranes.

Crane modeling

This paper sets MQ4035 cranes as an example; it has the maximum lifting capacity of 40t, the width extent range from 35m maximum to 13m minimum. The maximum lifting height is 28m, the maximum decline in the depth is 14m, tail swing radius is 7.65m, and complete machine has the weight of 328 t. It has installed capacity of 390kw.

3.1 Modular analysis

MQ4035 is composed of cylindrical portal, cable winding device, ladder and railing system, turntable assembly, machine room and cab, luffing mechanism, propeller and balance system, the boom system, hoisting mechanism, slewing mechanism, hook set , running gear, anchoring device, anti-creep device and various connecting piece. 4 leg notch flanges is bolt fastening with gate leg joints on the running trolley balance beam components. Rotating platform and the base ring is connected by shaft, which helps complete the crane 360° rotation. Between and rotating platform is pin connection, but propeller strut is fixed on the rotating platform with no relative motion.

3.2 Module partition results

On the basis of assembly analysis, the crane is progressively broken down into a number of a sub-assembly module, a sub-assembly module contains a number of sub-assembly modules and components and so on, the rest may be deduced by analogy, in this way we completed the modular modeling of the portal crane. The first level modular structure is as shown in Figure 1.

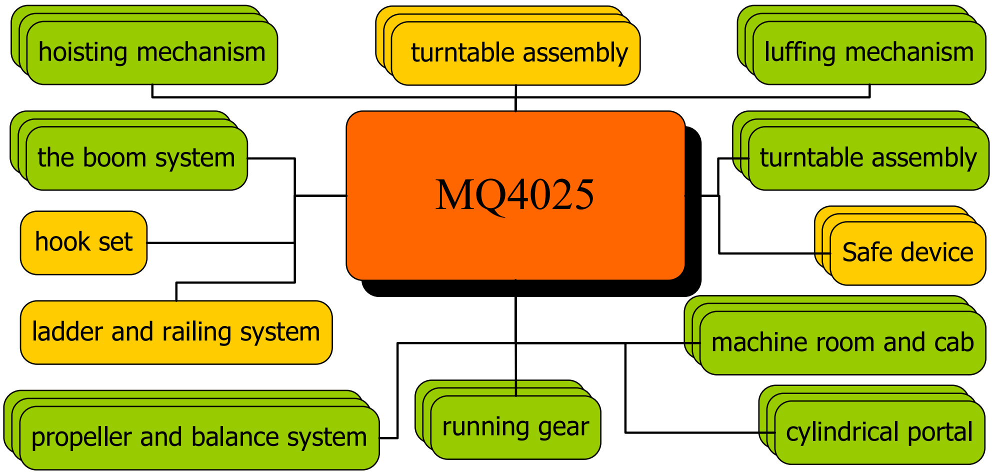

Fig.1 First level modular structure

The first level modular structure includes a cylindrical portal and cable winding device, ladders, ladder and railing system, turntable assembly, machine room and the cab, luffing mechanism, propeller and balance system, the boom system of crane ,hoisting mechanism, slewing mechanism, the hook set, running gear, safety device this 12 modules. On behalf of the modules of the three-dimensional frame containing a subset, of the subset of the plan boxes represent modules with no subset.

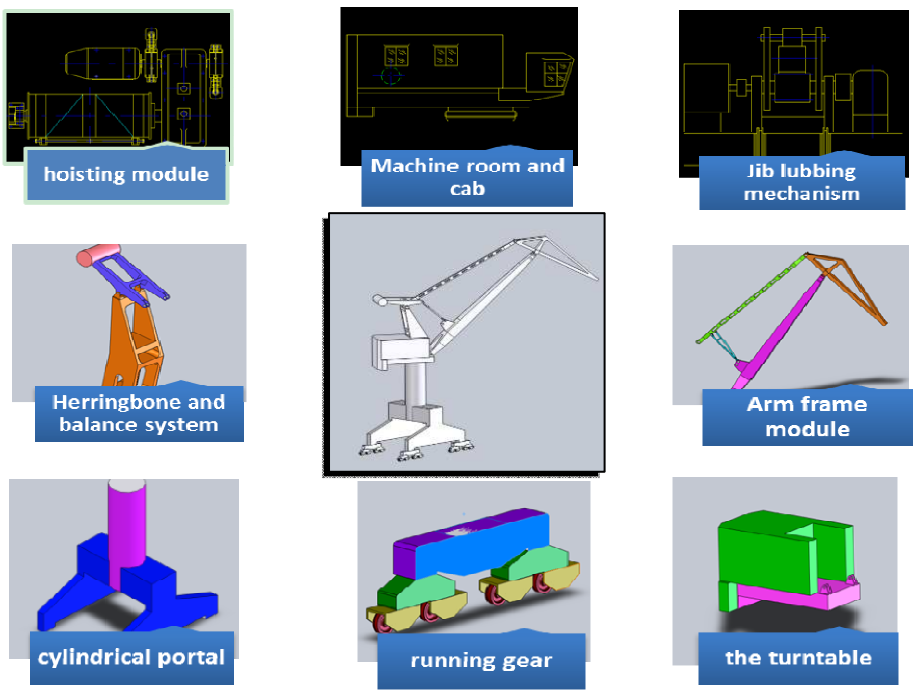

Fig.2 Modular Assembly

The running gear modular which is one of the first level modular is composed of run driver module, run support module, run safety module as well as the sub-modules to their own. The hoisting mechanism in the first level modular includes run driver module, wire rope winding module, extract device module, security protection devices as well as the sub-modules to their own.

There are other sub-modules of a module structure is relatively simple, we do not discuss the details in this part. The corresponding Solidworks model and the whole assembly model are as shown in Figure 2.

Interactive system development based on Virtools

In this paper, we mainly discussed the following three aspects: Interface design, collision detection process design and interactive assembly design. Because the whole assembly processes between different parts of the crane have many similarities, we take the assembly and demonstration process of cylindrical portal and the turntable as example to describe some important details of the VAC production development. The regular development of interface and texture effects is not present here.

4.1 Interface design

During the dynamic assembly process, there should be different text display in the different states. We can achieve this mainly by using the Camera in conjunction with the Text inside Virtools. The introductory text above the animation interface is corresponding to different assembly process while different process is undergoing. Schematic script in Virtools is as shown in Figure 3. The Building Blocks we used here are as follows:

(a) Set As Active Camera—Cameras/Montage/Set As Active Camera

(b) Text Display—Interface/Text/Text Display

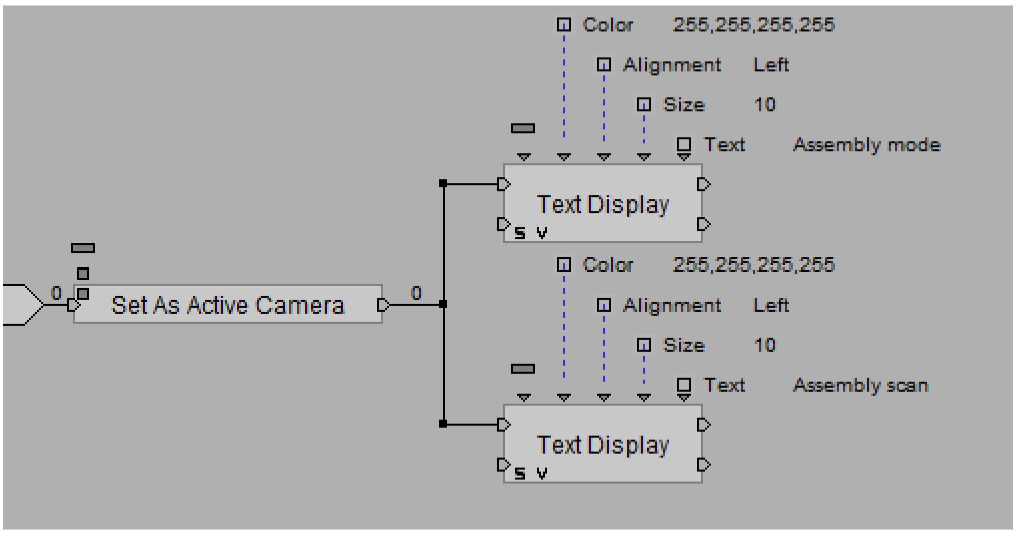

Fig.3 Interface design

4.2Interactive assembly design

Next comes to the design of the assembly and collision detection process. Its assembly process includes three aspects. When the key is active, it triggers the turntable move to connect pieces of cylindrical pin. When a collision is detected turntable stop motion. When motion stops which is the symbol of the end of the assembly it active the output of turntable rotational motion around the cylinder pin. The schematic graph is as shown in Figure 4. The Building Blocks we used here are as follows:

(a) Key Event—Controllers/Keyboard/Key Event
(b) Identity—Logics/Calculator/Identity
(c) Bezier Progression—Logics/Loops/Bezier Progression
(d) Interpolator—Logics/Interpolator/Interpolator

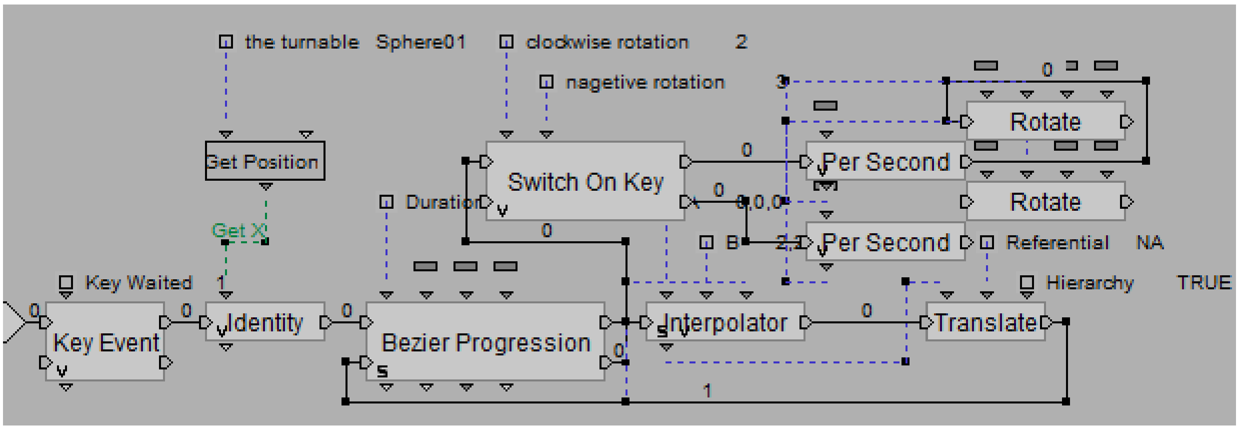

Fig.4 Interactive assembly design

4.3 Collision detection design

Assembly process should stop when parts collide. To solve this problem we introduced Collision Detection module. Apply the Collision detection schematic to fixed turntable. Collision Detection: Setting Geometry Precision-Automatic; Detection Tests-8; Safe Position Tests-8, and set the Touched Obstacle by pOut output variables as the variable Dest for Building Blocks-Send Message. Send Message: transmitting messages. Set the message name Message-stop assembly; the input receiving messages by pIn objects Dest-turntable. After sending message take Out output for recycling message across, so as to detect the next collision. The schematic graph is as shown in Figure 5.

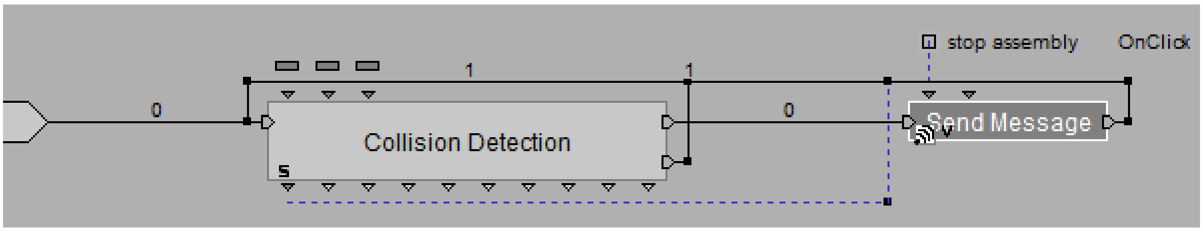

Fig.5 Virtools Schematic graph

When the assembly ends up, it will turn into the assembly browse mode. Available keys can control the whole assembly zoom as well as the observation camera to change perspective.

After platform establishment, we perform the assembly process on it. The result is as shown in Figure 6.When operating on the VAC system; the start interface is as shown in the first graph. Click on the Instruction icon, we can get the operating instructions of VAC, click on the modular scan icon, we can get all the modular information of portal crane. And the third graph shows the final assembly of the crane in VAC.

Fig.6 Demonstration of VAC

Conclusions

From the overall point of view, portal crane belongs to the large mechanical structure; the space assembly of its main components needs large span and high accuracy. A slightly mismatch may cause the entire assembly to failure thus causing huge loss. By Virtual assembly, you can verify that the assembly design and operation is correct or not, thereby reducing the difficulty of actual assembly and guarantee the quality of assembly as a consequence. In order to reduce the difficulty of design and speeding the development cycle of the system, this paper presents a virtual assembly of human-computer interaction VAC, which is also well integrated with human interactive experience.

Acknowledgements

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