

# **A Large Screen Coordinating Equipment with Six Degrees of Freedom**

## **FIELD OF THE INVENTION**

The present invention relates to a large screen coordinating equipment. In particular, it relates to a large screen coordinating equipment with six degrees of freedom.

## **BACKGROUND OF THE INVENTION**

Currently, the video display that have large-screen and large-scale six degrees of freedom is not commercially available. Three screens that can move with high coordination precision and can accomplish various movement combinations of multi-difficulty have not been seen yet. The maximum weight load of six degrees of freedom with high-precision control is 15000N/m. However, the maximum weight load of the display that have six degrees of freedom is low, thus largest effective display area thereof is decade meters. That results in poor viewing experience in large showing places like grand theaters. In addition, the LED screen of a large screen in the prior art can not achieve the movement with six degrees of freedom, letting alone the coordination movement of several combined screens.

## **DESCRIPTION OF THE INVENTION**

The purpose of the present invention is to solve the defects in the prior art and provides a large screen coordinating equipment with six degrees of freedom that can achieve the movement of the large screen with six degrees of freedom, and achieve even the coordination movements of several combined large screens.

To achieve the aforementioned purposes, the large screen coordinating equipment with six degrees of freedom is characterized in that it comprises three same robot arms arranged in parallel at equal distance. Each of the robot arms comprises a column,

wherein a column rotation kinematic pair that can rotate around the Y axis is provided on the top and bottom surface of the column that is set vertically, respectively; a stretch arm, one end of which is connected with the lateral side of the column via a stretch arm rotation kinematic pair; a first rotation arm, which is connected and matched with the free end of the stretch arm via the first rotation kinematic pair; the second rotation arm, which is connected and matched with the free end of the first rotation arm via a second rotation kinematic pair; a third rotation arm, which is connected and matched with the free end of the second rotation arm via the third rotation kinematic pair; and the third rotation arm which is connected and matched with a display screen via a screen rotation kinematic pair. The stretch arm rotation kinematic pair, the first rotation kinematic pair and the second rotation kinematic pair are arranged parallel with each other. The second rotation kinematic pair, the third rotation kinematic pair and the screen rotation kinematic pair are arranged perpendicularly with each other.

Preferably, all of the stretch arm rotation kinematic pair, the first rotation kinematic pair and the second rotation kinematic pair rotate around the axis parallel to Z axis. The third rotation kinematic pair rotates around the axis parallel to Y axis and the screen rotation kinematic pair rotates around the axis parallel to X axis.

Preferably, a counterweight device is provided on the first rotation arm.

Preferably, a counterweight device is provided at the front end of the stretch arm.

Preferably, a distance sensor is provided around the display screen.

Preferably, a mechanical device is provided around the display screen to avoid collision.

The beneficial effects of the present invention are that the large screen coordinating equipment with six degrees of freedom can be applied to achieve the movement of LED screen of the large screen with six degrees of freedom so as to achieve the coordination movement of several combined screens. In addition, a counterweight device is provided

on the first rotation arm to reduce the power for running, which leads to the effect of energy-efficiency. In addition, the addition of a counterweight device at the front end of the stretch arm can reduce the power and drawing force of the oil cylinder. A servo frequency converter can be used as the drive so as to improve the screen conjugating precision, improving the viewing experience.

## BRIEF DESCRIPTION OF THE FIGURES

Figure 1 illustrates the front view of a large screen coordinating equipment with six degrees of freedom as provided in the present invention.

Figure 2 illustrates the top view of the large screen coordinating equipment with six degrees of freedom as shown in Figure 1.

Figure 3 illustrates the left view of the large screen coordinating equipment with six degrees of freedom as shown in Figure 1 and the schematic diagrams of this coordinating equipment at three different positions.

## EXAMPLES

The present invention is further illustrated in details by combining with the following drawings and specific embodiments.

As shown in Figures 1-3 (labels A and B in Figure 3 indicates the schematic diagrams of the robot arm when the display is at two different sites in the space), the large screen coordinating equipment with six degrees of freedom comprises three robot arms arranged in parallel at equal distance. The structures of these three robot arms are the same. Each of the robot arms comprises a column 2, a stretch arm 5, the first rotation arm 9, the second rotation arm 11 and the third rotation arm 14. In particular,

Said column 2 is set vertically. A column rotation kinematic pair 1 that can rotate around the Y axis is provided on the top and bottom surface of the column 2, respectively.

The column rotation kinematic pair 1 is driven by a motor reducer so that the column 2 can rotate around the stage horizontally. In that way, the display screen 3 can rotate around column 2 within a wide range, and can also move towards left and right.

One end of the stretch arm 5 is connected with the lateral side of the column 2 via stretch arm rotation kinematic pair 4. The first rotation arm 9 is connected and matched with the free end of the stretch arm 5 via the first rotation kinematic pair 8. The stretch arm rotation kinematic pair 4 and the first rotation kinematic pair 8 can both rotate around an axis parallel to Z axis. Stretching oil cylinder or other stretching equipments are provided at the place on stretch arm 5 which is close to the first rotation arm 9 so that the stretch arm 5 can rotate within the plane vertical to the horizontal plane and around the stretch arm rotation kinematic pair 4 which is connected with the column 2. The axis of the column 2 and axis of stretch arm 5 get through the said plane. In this way, the display screen 3 can rotate in the vertical plane, and can also move up and down, front and back within the vertical plane. Further, a counterweight device 7 is provided on the first rotation arm 9, i.e. the first rotation arm 9 is consisted of a supporting arm and a counterweight arm. The first rotation kinematic pair 8 is driven by a motor reducer or a hydraulic motor. In order to reduce the torsion and power of the motor reducer, a counterweight device 7, like a counterweight arm and a counterweight, is added to achieve the energy-efficient effect.

The second rotation arm 11 is connected and matched with the free end of the first rotation arm 9 via the second rotation kinematic pair 10. The third rotation arm 14 is connected and matched with the second rotation arm 11 via the third rotation kinematic pair 12. The third rotation arm 14 is connected and matched with a display screen 3 via a screen rotation kinematic pair 13. The second rotation kinematic pair 10, the stretch arm rotation kinematic pair 4 and the first rotation kinematic pair 8 are arranged in parallel with each other, and the second rotation kinematic pair 10, the third rotation kinematic pair 12 and the screen rotation kinematic pair 13 are arranged perpendicularly with each other. Preferably, the first rotation kinematic arm 8 and the second rotation kinematic pair 10 both rotate around an axis parallel to the Z axis. The third rotation

kinematic pair 12 rotates around an axis parallel to the Y axis and the screen rotation kinematic pair 13 rotates around an axis parallel to the X axis. Thus, the first rotation arm 9 can also rotate within the vertical plane, and the combination of the first rotation arm 9 and the stretch arm 5 enable the display screen 3 to move in large range with three degrees freedoms of translational motions in the space. Moreover, the rotation of display screen 3 with three degrees of freedom can be achieved by the perpendicular arrangement of the second rotation kinematic pair 10, the third rotation kinematic pair 12 and the screen rotation kinematic pair 13. Thus, each robot arm can achieve movement with six degrees of freedom, and this coordinating equipment with six degrees of freedom can be achieved by computer and relevant synchronization control technology.

Furthermore, the display uses light-weight LED screen with an area of (11.28m x 6.74m) square meters per screen. The support of the display screen 3 uses light-weight steel structure 15. The total weight of the display screen 3 and the steel structure 15 is controlled below 6500kg. The screen rotation kinematic pair 13 is driven by an electric motor, and an annular gear rotation is used as the support. A servo motor is used as the electric motor. A servo frequency converter is used as the frequency converter. The third rotation kinematic pair 12 is driven by an electric motor, and an annular gear rotation is used as the support. A servo motor is used as the electric motor. A double motor reducer is used to disperse the drive force of the gears. A servo frequency converter is used as the frequency converter. The second rotation kinematic pair 10 is driven by a servo motor, and an annular gear rotation is used as the support. A servo motor is used as the electric motor. A double motor reducer is used to disperse the drive force of the gears. A servo frequency converter is used as the frequency converter.

The first rotation arm 9 of a box beam structure with large section is used to increase its rigidity. The section from root to the front end gradually decreases to reduce the weight. The box beam uses sheet iron. The holes are punched on the lateral plates and so on. The first rotation kinematic pair 8 is driven by a servo motor, and an annular gear rotation is used as the support. A servo motor is used as the electric motor. Four servo motor reducers are used to disperse the driving force of gears. A servo frequency

converter is used as the frequency converter. The stretch arm 5 of box beam structure is also selected. In order to save space for the counterweight arm of the first rotation arm 9, slotting is opened in the middle of the upper and lower plates of stretch arm 5 along the direction of Y axis so that the counterweight arm of the first rotation arm 9 can pass through. The stretch arm 5 is stretched by two oil cylinders. A pulling spot of counterweight is provided on the front end of said stretch arm 5 to reduce the pulling force and power of the oil cylinders, as shown in the stretch arm counterweight 16 and the steel wire rope 17 thereof in Figure 2. The steel wire rope 17 bypasses a fixed pulley and is connected with the stretch arm counterweight 16. Another safety protection function of this stretch arm counterweight 16 is that: when this robot arm stops running and folds up, a fixed pin can be added on the counterweight end so as to reduce the pulling force of the oil cylinder when it stops running. In addition, the large arm will not drop down if the oil cylinder has some malfunctions. The bottom end of column 2 is supported by a rotation support with heavy bearing capacity. An external gear rotation support is used. A servo motor is used as the electric motor. Two servo motor reducers are used to disperse the driving force of gears. A servo frequency converter is used as the frequency converter. A column rotation kinematic pair 1 having the same axial with the bottom rotation support should be also provided on the top of column 2. Since two column rotation kinematic pairs 1 have long distance, the upper column rotation kinematic pair can be changed to a knuckle bearing that can move slightly in order to overcome the un-smooth rotation caused by the error resulting from the steel structure manufacture. It is also necessary to release the freedom degree on the Y direction.

In order to achieve the precise coordinating action of the three robot arms with the same structure, a high-performance central controller is used. An encoder with high precision is used to detect the speed of each kinematic pair. A closed-loop control of the speed and the position is formed with the controller. A proportional valve with high precision is used for the electromagnetic valve of the oil cylinder. Each control system is coordinated with a mechanical system so that it can run rapidly with predetermined

program to achieve the desired performance effects.

To avoid an accident during the running of this equipment, a distance sensor is also provided around each display screen 3 and can emit alerting signal when the display screen 3 gets close. In addition, a mechanical device is provided around the display screen to avoid collision, guaranteeing the screen's safety during the operation.

All embodiments described herein are the preferred embodiments of the present application and do not intend to limit the scope of the present invention. All equivalent changes and modifications made in accordance with the claimed scope of the present application are within the technical scope of the present invention.

## CLAIMS

1. A large screen coordinating equipment with six degrees of freedom, characterized in that it comprises three same robot arms arranged in parallel at equal distance; each robot arm comprising:

a column, wherein a column rotation kinematic pair that can rotate around the Y axis is provided on the top and bottom surface of the column that is set vertically, respectively;

a stretch arm, one end of which is connected with the lateral side of the column via a stretch arm rotation kinematic pair;

a first rotation arm, which is connected and matched with the free end of the stretch arm via the first rotation kinematic pair;

a second rotation arm, which is connected and matched with the free end of the first rotation arm via the second rotation kinematic pair;

a third rotation arm, which is connected and matched with the free end of the second rotation arm via the third rotation kinematic pair; and

the third rotation arm is connected and matched with a display screen via a screen rotation kinematic pair; the stretch arm rotation kinematic pair, the first rotation kinematic pair and the second rotation kinematic pair are arranged parallel with each other; the second rotation kinematic pair, the third rotation kinematic pair and the screen rotation kinematic pair are arranged perpendicularly with each other.

2. A large screen coordinating equipment with six degrees of freedom according to claim 1, characterized in that all of the stretch arm rotation kinematic pair, the first rotation kinematic pair and the second rotation kinematic pair rotate around the axis parallel to Z axis; the third rotation kinematic pair rotates around the axis parallel to Y axis and the screen rotation kinematic pair rotates around the axis parallel to X axis.

3. A large screen coordinating equipment with six degrees of freedom according to claim 1 or 2, characterized in that a counterweight device is provided on the first rotation arm.

4. A large screen coordinating equipment with six degrees of freedom according to claim 1 or 2, characterized in that a counterweight device is provided at the front end of the stretch arm.

5. A large screen coordinating equipment with six degrees of freedom according to claim 1 or 2, characterized in that a distance sensor is provided around the display screen.

6. A large screen coordinating equipment with six degrees of freedom according to claim 1 or 2, characterized in that a mechanical device is provided around the display screen to avoid collision.