Optimization of Projection Tracking Scheme in the Stage Performance

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A Case Study of Marco Polo/Take Marco Polo as An Example

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***Abstract*—Taking the opera Marco Polo as an example, We introduced the scheme to realize the tracking of stage projection on the moving stage design device and put forward the concrete measures to optimize the scheme.**

Keywords-projection; tracking; protocol; performance; motion description

I. INTRODUACTION *(HEADING 1)*

With the wide application of multimedia technology on the stage, video projection is more and more frequently participated in the performance, the ways of participation gradually diversified, the technical requirements are increasing, the technical difficulties are also increasing. Projection has developed from being used simply for veil curtains and backdrop to precise projection on various relatively static sets and stages, and now it has begun to be attempted in dynamic stage design devices. This paper explores the technical problems of projection on dynamic stage design devices.

II. STAGE DESIGN DEVICES

The perfect combination of stage performance and stage design device is very important. In all kinds of modern stage performance design, through the perfect combination of stage performance and stage design device, the unique language of stage performance art can be used to render the atmosphere of stage art and improve the stage performance aesthetic feeling, deepen the audience's cognition. On the other hand, through the combination of stage performance and device, to achieve a high degree of harmony, to a certain extent, can satisfy the public aesthetic complexity, and to raise the status of stage performance in the modern art system, to provide sufficient support for the sustainable development of stage performance art. [1]

The stage design for the original opera Marco Polo by the Silk Road International Federation of Theatres was created by Luke Halls (director of the stage design for the closing ceremony of the London 2012 Olympic and Paralympic Games). In the stage design scheme, there are two parts, a revolve with a diameter of 16 meters and 18 scrolls with a length of about 2 meters. A staircase with a diameter of 14 meters is concentric placed on the revolve. The revolve is driven by the motor to realize the rotation of the stairs. The reel is driven by a three-phase asynchronous motor and a turbine reducer through the traditional structure of gears, so as to realize the drawing and releasing of the curtain attached to the roller. The revolve controller and each reel controller are connected to the mechanical motion console by a switch.

The four projectors are divided into two groups (see the picture) according to the projection area. The two projectors installed in the auditorium are responsible for the projection screen of 9 scrolls in the front area and most of the staircase, with the projection distance of 39m. The two projectors installed above the stage are responsible for the projection screen of 9 scrolls and part of the staircase in the rear area, with a projected distance of 13 meters.

III. HOW TO ACHIEVE PROJECTION TRACKING

A. *Collection and Feedback*

Mechanical console through the switch is connected to the video console and the servers. Through a variety of protocols, such as Art-NET, RTTrPM will send the current position and speed to disguise accurately in time, and disguise feedback data real-time acquisition, realization of software in the scene movement data and real data matching, the disguise automatic tracking system to realize frame synchronization.

B. *Send and Execute*

The mechanical console is connected to the video console and server through the network port and switch, and the current position, current speed and other data can be sent to the disguise and stage design device at the same time through various ways such as Art-NET and RTTrPM, so as to realize the matching of the motion data in the software scene with the real data. The picture synchronization can be realized through disguise automatic tracking system.

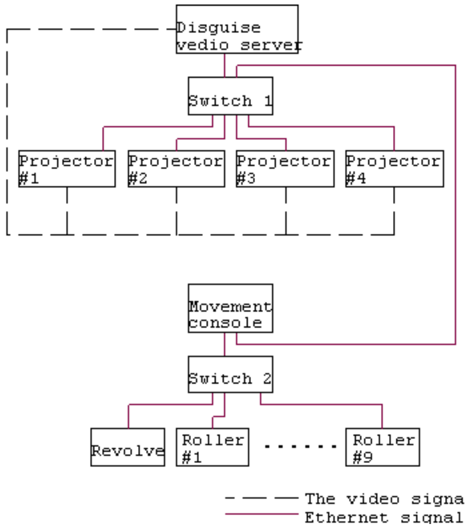

Figure 1. System hardware configuration block diagram

IV. HOW TO SOLVE THE PROBLEM IN SYNCHRONIZATION

But we find that the projected screen sometimes lags or jitters in the rehearsal. Therefore, in order to realize the synchronization of the picture, it is necessary to solve the problem of motion state description, and try to eliminate the static error and reduce the dynamic error.

A. Motion state description

- Since the rolling of the curtain is achieved by the rotation of the scroll, the precise positioning of the height at the bottom of the curtain can be obtained from the motion data of the scroll.
- RTTrPM is the protocol that is used to stream to third party listeners that are interested in the position and orientation of a tracking point, relative to the origin of the coordinate system (as defined by the user). The RTTrPM protocol should be sent at a fixed rate. However, if there is no motion data available, then RTTrPM should stop sending (unless a form of heartbeat is implemented).
- The Art-NET protocol can only describe the location data, but RTTrPM can describe not only the location but also the speed data. In this way, the motion trajectory can be predicted, and the smoothness is better than the Art-NET discrete sampling.
- The motion involved in this case is mostly the change of a single attribute which is relatively simple, so the Art-NET method is adopted for synchronization.

B. Static error

- Since the curtain has a certain thickness, the motion data of the scroll will be affected by the diameter change of the roller, so there is a certain nonlinear relationship between the height of the bottom of the curtain and the encoder value. In order to accurately obtain the height of the bottom of the curtain, nonlinear compensation calculation needs to be carried out according to the data of the curtain thickness and the diameter of the roller.

Figure 2. Scroll structure diagram

According to the principle of calculus, the calculation formula of the height L from the ground at the bottom of the reel can be derived:

$$L = \frac{a^2 * t}{4\pi} + a * r + c$$

"a" is the drum Angle, "t" is the curtain thickness, "r" is the drum radius, and "c" is the offset constant.

- The staircase is rotated along with the turntable, so the staircase can be directly calculated according to the encoder value of the rotation Angle of the staircase.

C. Dynamic error

There are two reasons leading to the dynamic deviation of projection, one is the delay of data transmission itself, the other is the delay of video projection system processing, which accounts for a large proportion.

To solve the problem of slight wobble in the projected screen, we printed out the data sent to the video server to a test machine for observation and analysis, and found that for a scroll device moving at a constant speed, the relationship between the position sent by the mechanical control software to the video sub-weapon and the time of the packet is shown in Figure 3:

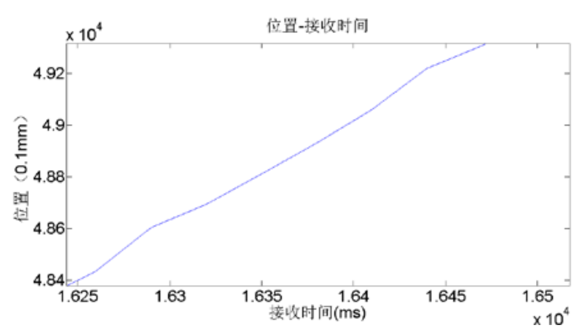

Figure 3. Graph of position data and packet receiving time

It shows the characteristics of nonlinear, location and time through the further analysis to find the reasons, found that mechanical control software to send packet interval has not been able to maintain strict fixed time, leading to reach the video processor data present a certain mutation characteristics of packets at intervals and send diagram as shown below:

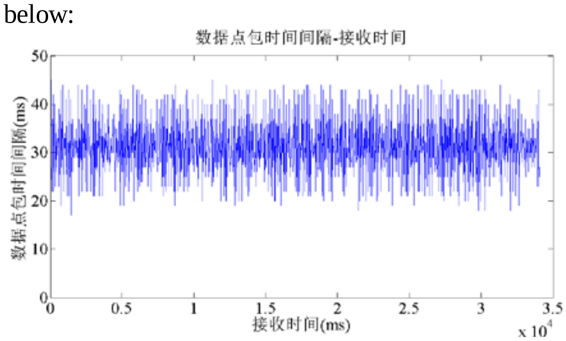

Figure 4. Diagram of the time interval between packets and packet receiving time

Images for delays, we first try to through the video server software compensation is set in advance to improve, through the relevant operation found that increasing the software compensation coefficient in advance, can improve the dynamic difference between picture and mechanical equipment, but increase the lead compensation at the same time also can make image dithering phenomenon more obvious, disguise software with DMX data synchronization method, direct access to the feedback data only the location of the device properties, unable to direct access to the device, the speed of its internal calculation lead compensation related operations are calculated by the location of the access to the data, Therefore the location data will be in strict accordance with fixed cycle to send for lead compensation effect has obvious influence, in addition to the inverter driven mechanical equipment, in the process of the movement is limited by the mechanical transmission structure itself, even with the equipment movement speed of speed loop control is also hard to avoid can some small fluctuations, these will affect the lead compensation effect. In the end, we used the real-time execution speed of equipment feedback in the mechanical console software to calculate the advance compensation and achieved good compensation effect. (A graph comparing the command speed and the actual sampling speed can be added here). The advance compensation method is as follows: compensated position = current position + compensation time coefficient * execution speed.

To send time interval is not fixed position data to track frame jitter problem, through the relevant information, the Windows programming timer compared with embedded real-time operating system timer, there is a big difference on the precision, embedded programming timer usually can easily do us level, and under the Windows system usually timer accuracy in a few milliseconds, Windows will be reduced by optimizing the number of thread to be awakened, timing will be much more time to deal with, cause deviation within the timing interval timer. Therefore, special treatment is needed for the application requiring accurate timing. For how to obtain the timer accurate to milliseconds, it is not the same under different programming language environments, which can be solved by query-related data, which will not be repeated in this paper. By improving the precision of timer, the projection tracking effect can be improved obviously. After the improvement, the feedback position and the feedback time of the equipment in uniform motion show a good linearity, as shown in FIG. 5:

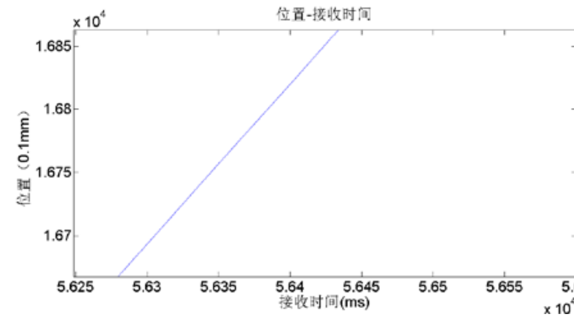

Figure 5. The relationship diagram between position data and receiving time after the improvement

The corresponding feedback packet interval time control is more accurate, and the interval error is basically controlled within 1ms, as shown in Figure 6:

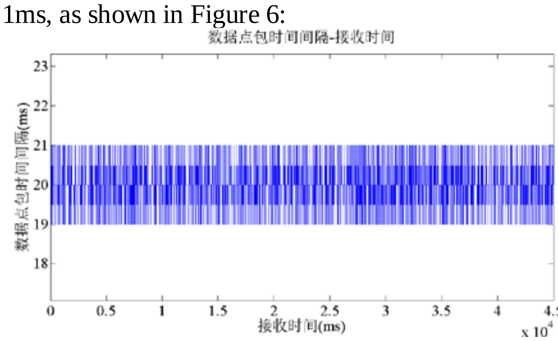

Figure 6. the relationship diagram of location packet and packet receiving time after the improvement

Through the above improvement measures, the projection tracking effect has been significantly improved, and the following effect and fluency of the projection screen have achieved good results.

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[3] https://rttrp.github.io/RTTrP-Wiki/RTTrPM.html

[4]

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