中国石油大学
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国际溢油应急技术研讨会
International Oil Spill Response Technical Seminar

Simulated Training System for Undersea Oil Spill Emergency Response

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OUTLINE

Emphases

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1. ABSTRACT

This paper describes a **simulated training system** supported by Virtual Environment in real time for undersea oil spill emergency response, which provides all the functionalities to **train emergency workers.**

This system aims to establish **a highly immersed sense of 3D** oil spill interactive environment.

The research in this paper provides **a new solution** for undersea oil spill accident treatment.

2. INTRODUCTION

As the offshore oil and gas field operations into the era of deep-water and ultra-deep-water, its engineering equipment also gradually turns to the subsea production system with the high-risk of oil spill and high-difficulty of oil spill recovery.

Multiple types of oil spill were slowly changed from sea surface caused by the dock and ship collision to seabed caused by the blowout and the pipeline leakage.

At present, most studies focus on the oil spill on the sea surface, especially domestic, less study on undersea oil spill simulation.

Fig1. The Deep-water Horizon oil spill in the Gulf of Mexico

2. INTRODUCTION

But compared with the oil spill on the sea surface, pipeline leakage and blowout or geologic oil spill bring higher challenge for oil seal and greater harm for marine environment.

On the other hand, the related researches on marine oil spill visualization mostly tend to 2D, but 3D aspects there still exist many defects in physical model, simulation effect and system functions aspect.

Fig2. Oil spill from Seabed in Penglai 19-3 Oilfield Area

Fig3. Oil tanker gather oil by the tow

3. SYSTEM ARCHITECTURE DESIGN

It was mapped into the oil spill emergency response training system to structure the entire system, as shown in Fig. 4, and come up with the following three components: Input Module, Service Module, and Output Module.

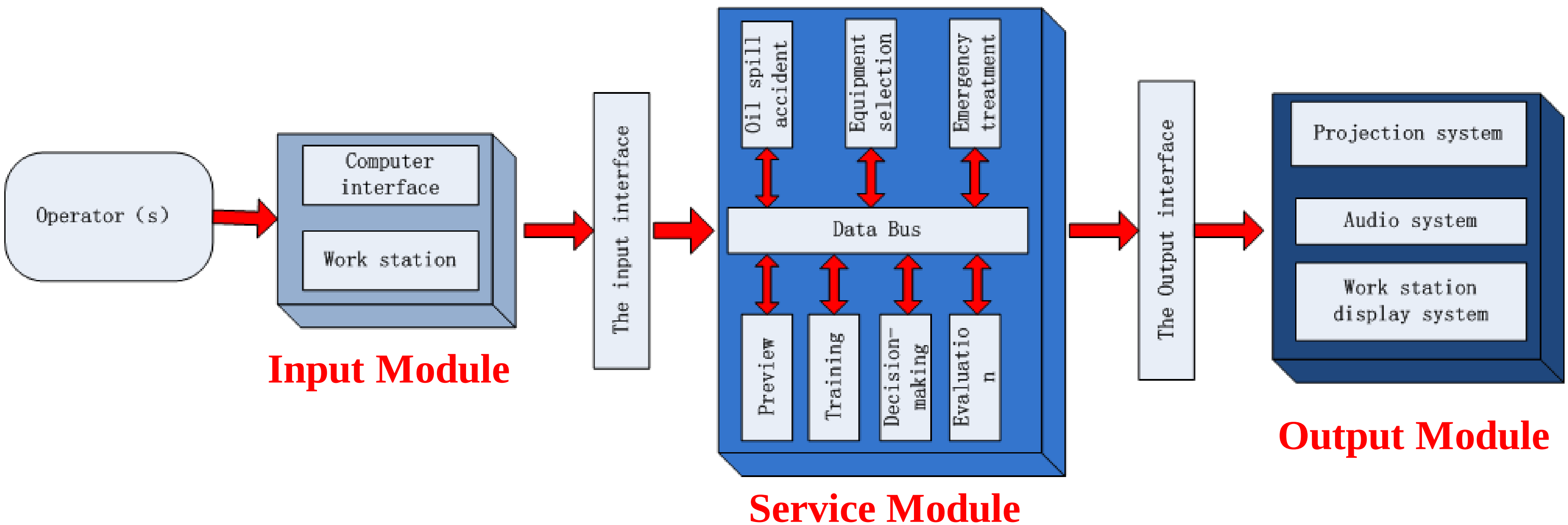

Fig4. System architecture of the undersea oil spill training system.

3. SYSTEM ARCHITECTURE DESIGN

Input Module: Mainly includes computer interface and work station. An input device should be convenient and comfortable for an operator to send orders to the computer, and should be designed from an understanding of the operation to be performed and the objective of the operator.

Service Module: Mainly includes system requirements and functional description. The logical process of entire training system needs to be detailed design base on the treatment of real oil spill accidents.

The system includes the following four functions: (1) preview undersea oil spill accident, (2) training of emergency treatment, (3) help leaders make decisions for undersea oil spill accidents, (4) examination and assessment of training personnel. **And** its function should be extensible for a successful system.

Output Module: Mainly includes projection system, audio system, work station display system. The virtual reality(VR) system involving human operators requires interactive interface devices to maximize the sense of presence and immersion.

4. HARDWARE STRUCTURE DESIGN

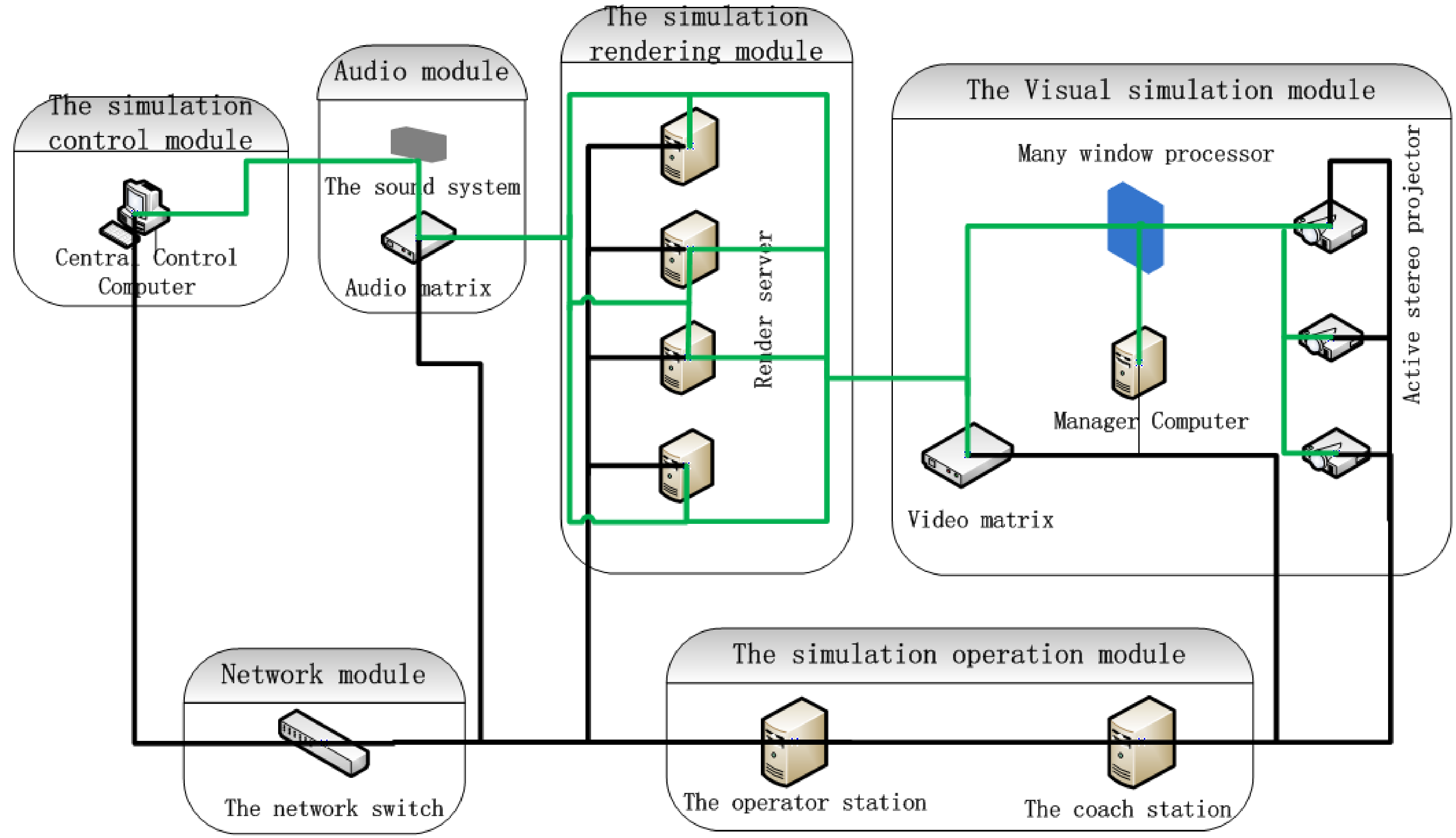

Fig.5 The connection between each module of the system hardware

4. HARDWARE STRUCTURE DESIGN

The hardware structure of the undersea oil spill emergency response training system is composed of six sub-modules, their names and functions are shown in table 1:

Table 1. The sub-modules of the system hardware structure

NO.	Sub-module	Function
1	The simulation control module	Control the output of sound and video signal.
2	The simulation operation module	Generate the instruction of the scene.
3	The simulation rendering module	According to the instructions of the simulation operation module, generate the corresponding visual simulation, pass visual image to visual simulation module at the same time.
4	The visual simulation module	Display real-time scene
5	Audio module	Synchronously output the sound in the scene.
6	Network module	Ensure the communication among the various modules.

5. SOFTWARE PLATFORM DESIGN

In order to achieve the functional requirements of the simulation system, an integrated software platform utilized in the development of the simulator system proposed in this study. This software platform mainly includes three parts: **Vortex**, **Vega Prime (VP)**, and **Creator**.

Table 2. The related modules in **Vortex** for this system

NO.	Modules	Description
1	Vortex Editor	Create and modify Vortex components at different levels.
2	Vortex Kernel Permanent Developer	Basic package of permanent development
3	Vortex Cable Developer	Develop cable system
4	Vortex Particle Developer	Develop physical particle system
5	Vortex Snap	Object Snap
6	Vortex Interface with VP	Interface with VegaPrime
7	Vortex Application Runtime	Authorization of application release

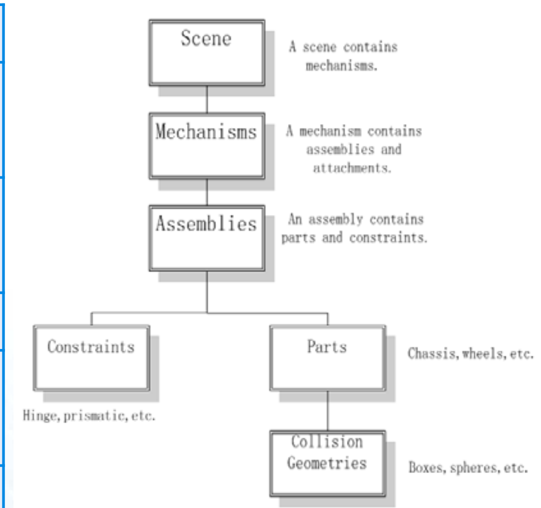

Fig.6 Vortex hierarchy

5. SOFTWARE PLATFORM DESIGN

Table 3. The related modules in **Vega Prime** for this system

NO.	Modules	Description
1	Development version of basic module	Drive VP three-dimensional scene, including GUI development interface and API function library.
2	Running version of basic module	
3	Development version of Marine module	Used to produce various effects associated with ocean, such as waves, boat wake, etc
4	Running version of Marine module	
5	Development version of multichannel module	Used to support multi-channel projection system
6	Running version of multichannel module	
7	Development version of DIS/HLA for VP	Can significantly reduce development time
8	Running version of DIS/HLA for VP	

5. SOFTWARE PLATFORM DESIGN

Creator: The whole geometric models and terrain models for visual simulation are established by using Multigen Creator. The models are of high fidelity, and meet the real-time requirements.

In order to meet the requirements of real-time, LOD (Level of Detail) and DOF(Degrees Of Freedom)will be used in the system. The simulation models should include at least: ROV, cap, bop, oil boom, carrousel oil machine type collection.

Fig.7 The ROV is looking for the source of submarine pipeline leakage

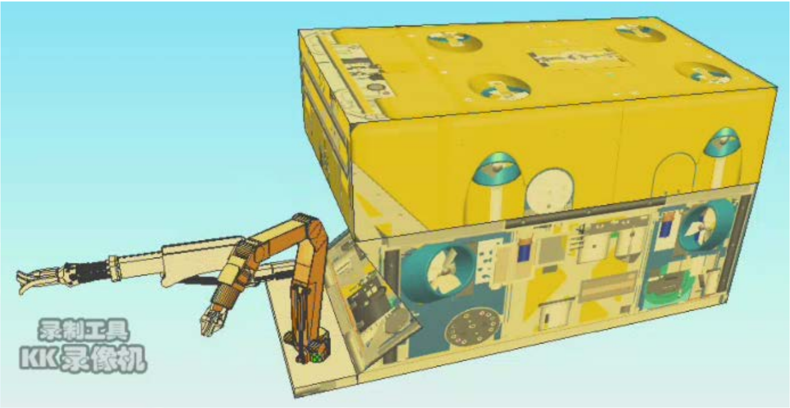

Fig.8 The ROV created by Creator

6. INTERFACE DESIGN

The interface design of system specifies the ways of data transmission and transfer relations among the various modules.

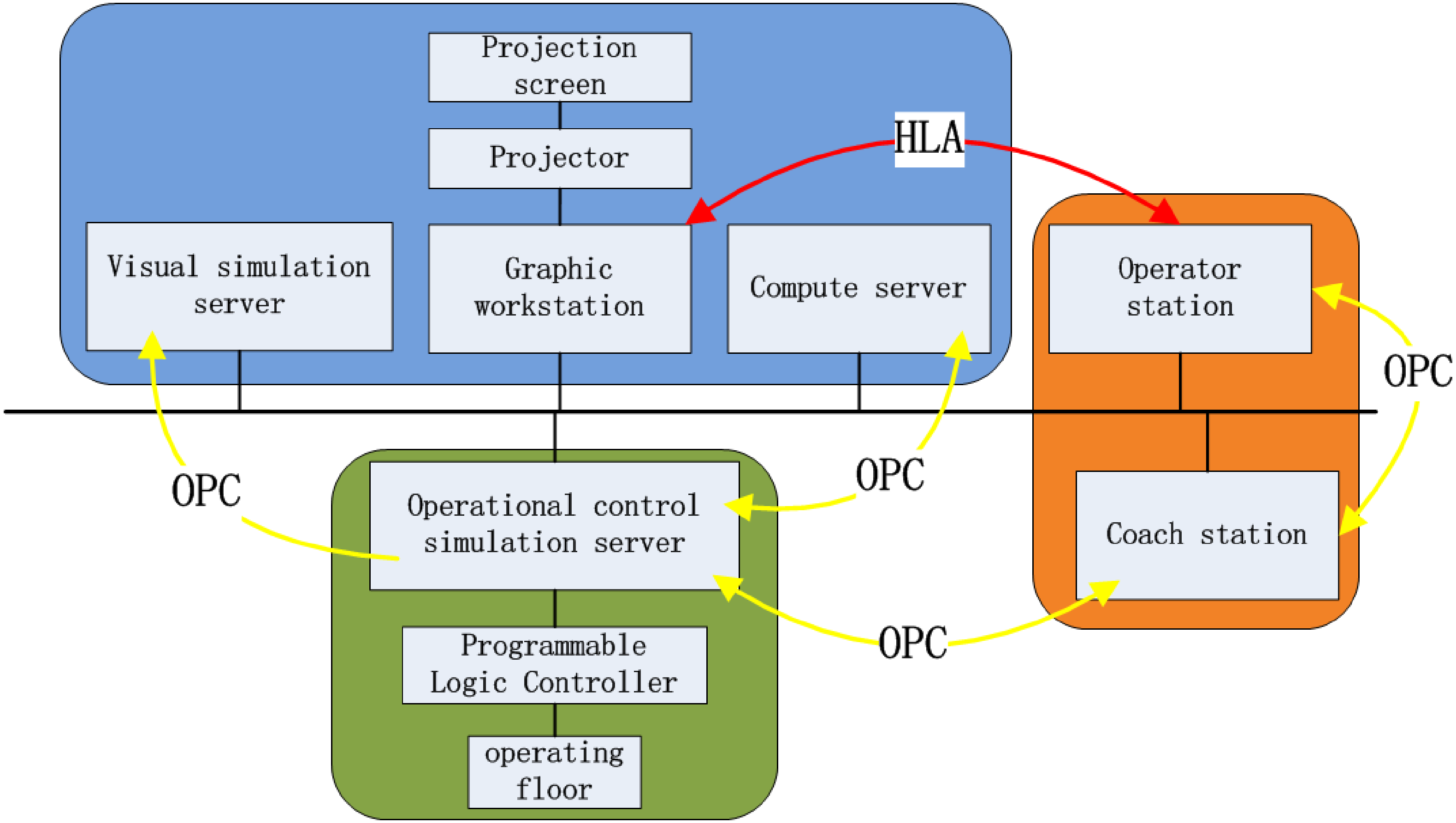

Fig.9 The overall design of the interface design

6. INTERFACE DESIGN

HLA(The High Level Architecture): It makes distributed simulation components concertedly operate in a unified simulation time and simulation environment through computer network, and can be repeated use. **In this system**, the data between operator station and graphic workstation is based on HLA. In order to satisfy the requirements of this system, need to buy the following related modules, as shown in table 4.

Table 4. The related modules in HLA for this system

NO.	Modules	Description
1	HLA p-RTI 1516	Providing simulation support environment.
2	HLA Visual OMT 1516	A powerful tool to develop the entity simulation model.

OPC (OLE for Process Control): OPC includes a set of the standard set of interfaces, properties and methods for process control and automated manufacturing systems. **In this system**, the real-time operating data among the various modules is based on OPC. In addition, developing an OPC client with C++ can be ensure data perfectly combined with Vortex.

7. CONCLUSIONS

(1) Most work of the system design is based on "The semi physical simulation system of undersea emergency maintenance". The study clearly designed that an undersea oil spill emergency response training system such as the one involved. However, the system is only in the stage of the overall design.

(2) In the future, it also needs to carry out a large number of specific work to solve a lot of practical difficulties. In addition, whether marine oil spill emergency response training is correct or effective, depends on the prediction of the dynamic behavior, as well as the correct analysis and judgment after the accident.

(3) Therefore, it is very significant how to get the high precision of forecasting model combined with commercial software. Through further theoretical research and experimental work on the way to make undersea oil spill emergency response training system become mature and practical, to play an active and productive role.

ACKNOWLEDGEMENTS

The present work was supported by China National Science and Technology Major Project , “The semi physical simulation system for undersea emergency maintenance” (Grant No. 2011ZX05027-005).

The valuable comments and advice from Professor Menglan Duan of China University of Petroleum are also greatly appreciated.

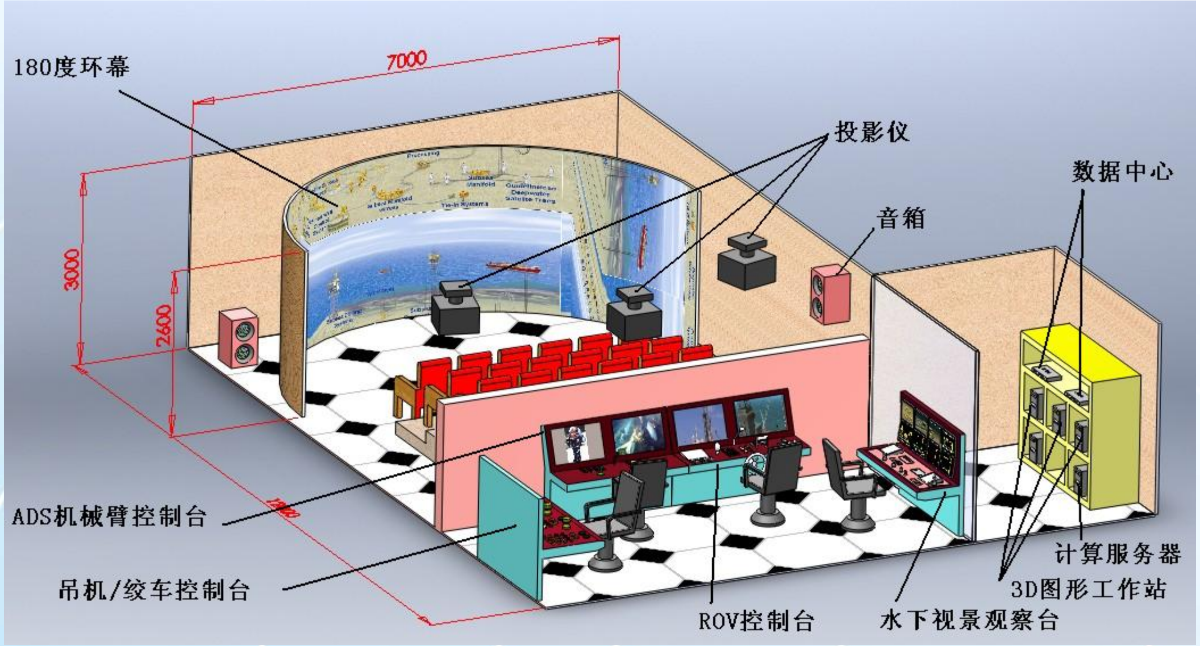

Fig.10 The overall layout of the semi physical simulation system for undersea emergency maintenance

THANKS

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