Improvement of Underwater Vehicle Remote Control Environment with Parallel Link Operation Base

Kimiyo Inabe, Etsurou Shimizu, Masanori Ito and Junnichiro Tahara

Tokyo University of Marine Science and Technology,
2-1-6 Etchujima,Koto-ku,Tokyo,135-8533,Japan
(Tel:+81-3-5245-7426;Fax:+81-3-5245-7426)
(inabe@giga.ocn.ne.jp, shimizu@kaiyodai.ac.jp, itom@kaiyodai.ac.jp)
and
Japan Agency for Marine-Earth Science and Technology
2-15 Natsushima-cho, Yokosuka 237-0061 Japan
(Tel:+81-46-867-9412,Fax:+81-46-867-9375)
(tahara@jamstec.go.jp)

Abstract: This research is connected with ROV's remote control, and is carried out to solve ROV's operator's severe se asickness caused by disagreement between mother ship's motion and the image including ROV's motion from under water vehicle expressed at the station.

Keywords: ROV, Remote Control, Seasickness**.**

I. INTRODUCTION

Now, there are two types of underwater vehicle, that is, manned and uninhabited type.

Former is superior in activeness and function, for an operator and a researcher ride together, but because of lack of safety, latter is the mainstream. This includes ROV which needs remote control by man, and AUV which chooses movement by itself.

ROV doesn't need complicated control because of human handling and can be observed with real time processing, viewing images which has high resolving power, be manipulated. And electric power is provided from mother ships, and it is free from limitation of time, but it's range of action is limited by length of cable.

On the other hand, it is still hard to make AUV carry out minute work with manipulator and hand.

This research is connected with ROV's remote control, and carried to solve ROV's operator's severe seasickness caused by disagreement between mother ship's motion and the image including ROV's motion from underwater vehicle expressed at the station .

The principle of the research is to make environment as if an operator rides on the underwater vehicle with getting rid of ship's motion and unite with motion of underwater vehicle,

To recreate this situation in laboratory by a Stewart type parallel link system, as an operation base, and show him(or her) the image which was taken on the vehicle, we measured the level of seasickness. And then, we moved the parallel link with same motion to the vehicle.

On these experiments, we compared the level of seasickness. we can develop the system which reproduces a vibration of underwater vehicle separated from that of a ship, including a series of handling and indication ,as new remote control environment of underwater vehicle.

Fig.1 Remote Control of Underwater Vehicle

Fig.2 Station for Remote Control on Mother Ship

II. Environment of Remote Control

As an example, we show the rolling and pitching motion of Shioji-maru in Fig. 3, which is the training ship of our university. Under those motions, operator moves underwater vehicle with watching monitor display. we calculate the length of six legsof the parallel link operation base from the angles of roll and pitch changing every time, and reproduce the motion of the ship by their expand and contracting.

At first, I can't help operating by appointing length of six legs changing every second by signals from AD/DA converter,but in the future I want to master to operate automatically by retrieving Excel's Data in C language program.

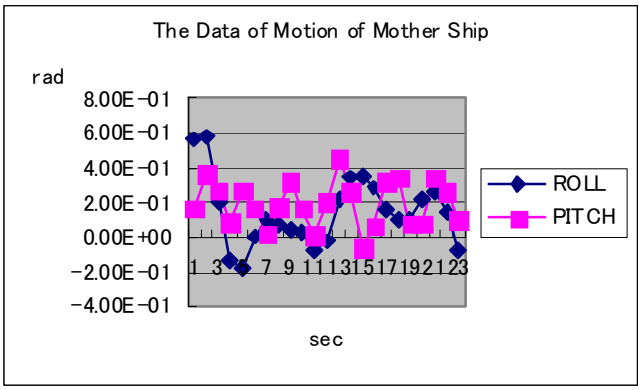


Fig.3 Motion of Mother Ship

III. IMPROVED OPEATION SYSTEM

1. BASIC CONCEPT

This research is carried out to solve seasickness caused by disagreement between motion of mother ship and that of an image seen through underwater camera, which has long been significant problem among ROV's operators.

The main purpose of this research is to make situation as if an operator rides underwater vehicle by getting rid of ship's motion and fitting that of underwater vehicle.

2. SYSTEM CONSTRUCTION

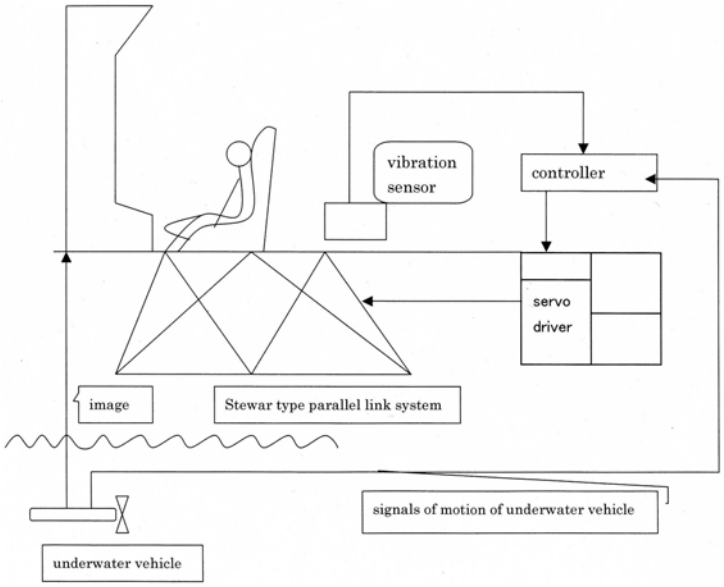


Fig. 4 New Operation System

Stewart type parallel link operation system which has six legs moved by oil pressure.
Monitor and underwater camera
AD/DA converter which change from analog signal into digital one, or from digital to analog.

IV. CONFIRMATION OF THE EFFECT

1. Outline of Experiments

In this experiment, we reproduce motion of the mother ship by Stewart type parallel link system, and ask a subject to sit on it, show him(or her) th e image added the motion of the vehicle apart fro m the mother ship, and measure the level of sea sickness. After getting rid of motion of the ship, and reproduce that of the underwater vehicle, we show the subject the same image, and compare the level of seasickness.

2. Equipments of Experiment

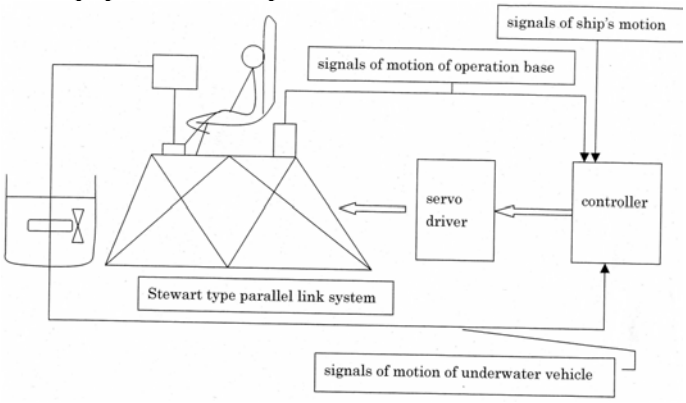


Fig.5 Outline of Experimental System

Fig.6 Experimental System

3. Control System

We calculate length of the six legs by means of Back-function-Theory, that is, make the operation base move contrary to motion of the ship.
In other words, we need equations to invalidate the following one.

3.1 Control Algorithm

The length of six legs of the operation base

L1=sqrt((H+0.866*R*sin(b)+0.5*R*sin(c))*(H+0.866*R *sin(b)+0.5*R*sin(c))+(r*r-r*R+R*R))……(1)

L2=sqrt((H-0.866*R*sin(b)+0.5*R*sin(c))*(H-0.866*R*sin(b)+0.5*R*sin(c))+(r*r-r*R+R*R))……(2)

L3=sqrt((H-0.866*R*sin(b)+0.5*R*sin(c))*(H-0.866*R*sin(b)+0.5*R*sin(c))+(r*r-1.25*r*R+R*R))……(3)

L4=sqrt((H-R*sin(c))*(H-R*sin(c))+(r*r-r*R+R*R) …(4)

L5= sqrt((H-R*sin(c))*(H-R*sin(c))+(r*r-r*R+R*R)…(5)

L6=sqrt((H+0.866*R*sin(b)+0.5*R*sin(c))*(H+0.866*R*sin(b)+0.5*R*sin(c))+(r*r-1.25*r*R+R*R)) …(6)

L1～L6：the length of Leg1～Leg6

r:the radius of the base plate

R:the radius of the platform

H:the hight of the operation base

4. RESULT OF THE EXPERIMENT

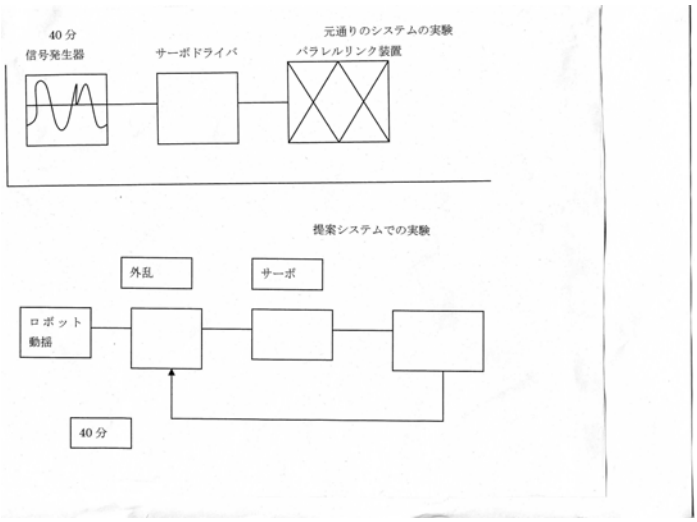
4.1 Seasickness Level Evaluation

We will use the following four-grade-evaluation.

Grade0:Don't feel seasickness at all.
Grade1:Feel slight discomfort, but can live as usual
Grade2:Feel discomfort, and hard to work.
Grade3:Feel severe discomfort, nausea, can't work

4.2 Comparison with Conventional System and Improved System

We will compare the two type of system, that is conventional and suggested system(improved one). Former is carried out under the recreated motion of mother ship, and latter is after getting rid of the previous motion and make modification as the motion of the underwater vehicle.



We suppose that the user can't operate more than 30 minutes because of the difference between the motion of the vehicle and the ship, before getting rid of motion of the ship. But after it, he(or she) can operate much more longer.

V. CONCLUSION

I want to make sure result of the experiment is true as a subject

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