VR-Based Navigation Simulator Using VRML

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Presentation Outline

I . INTRODUCTION
II . SYSTEM DESIGN METHOLOGY
III. SYSTEM STRUCTURE
IV. VR SHIP SIMULATOR (VRSS)
V . AtoN SIMULATOR
VI. EXPERIMENTS & RESULTS
VII. SUMMARY
    Demonstration
    - VRSS
    - AtoN Simulator

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I . INTRODUCTION

■ Purpose of the Study

To develop a low-cost, readily available VR-Based Navigation Simulator for training entry-level cadets to reduce the amount of sea-time training
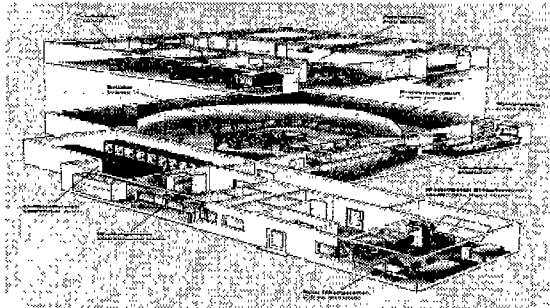
■ Goal of this Work

- To search for the best implementation methods in VR-Based Navigation Simulator
- To testify the VR-based Navigation Simulators, developed in VRMAsim, MMU, Korea

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I . INTRODUCTION

■ Demerits of a conventional ship simulator

General Overview of Nautical Ship-Handling Simulator, ATLAS Electronic.

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I . INTRODUCTION

■ Merits of Computerized Simulator Training
- Compress years of experience into a few weeks
- Reduce accidents and improve efficiency
- Give knowledge of the dynamic and interactive processes typical for the real ship handling
- Give the deck officers the necessary experience and confidence in their job situation

■ Benefits of VR Technologies
- No need a huge bridge mock-up system and large visual presentations
- Enhances user's ability to understand, analyze, and communicate with real-like experience much as might experience in the physical world

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I . INTRODUCTION

What is the Virtual Reality ?
■ Human Interactive with 3D Objects
■ Stereoscopic View
■ Amazing
■ Using Virtual tools
■ Safety, Flexibilities
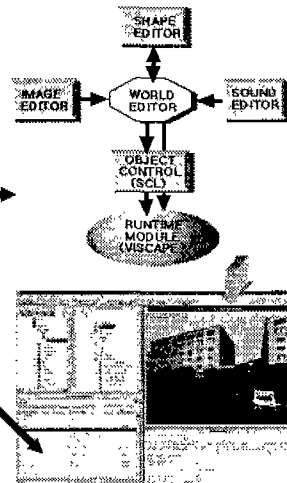■ Multi-User Capabilities
■ Economic

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I . INTRODUCTION

■ Authoring Tools
- Multigen VEGA
- World Tool Kit
- VRT / 3D Webmaster ➡

■ Virtual Reality
  Modeling Language
  (VRML)
- VRML 97 or, 2.0

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I . INTRODUCTION

Purpose of VRML

- It is a file format for describing interactive 3D objects and worlds

- It is designed to be used on the Internet, intranets, and local client systems

- It is also intended to be a universal interchange format for integrated 3D graphics and multimedia

- It may be used in a variety of application areas such as engineering and scientific visualization, multimedia presentations, entertainment and educational titles, web pages, and shared virtual worlds

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I . INTRODUCTION

Design Criteria of VRML

VRML has been designed to fulfill the following requirements:

- Authorability ; Enable the development of computer programs capable of creating, editing, and maintaining VRML files, as well as automatic translation programs for converting other commonly used 3D file formats into VRML files.

- Composability ; Provide the ability to use and combine dynamic 3D objects within a VRML world and thus allow re-usability.

- Extensibility ; Provide the ability to add new object types not explicitly defined in VRML.

- Be capable of implementation on a wide range of systems.

- Performance ; Emphasize scalable, interactive performance on a wide variety of computing platforms.

- Scalability ; Enable arbitrarily large dynamic 3D worlds.
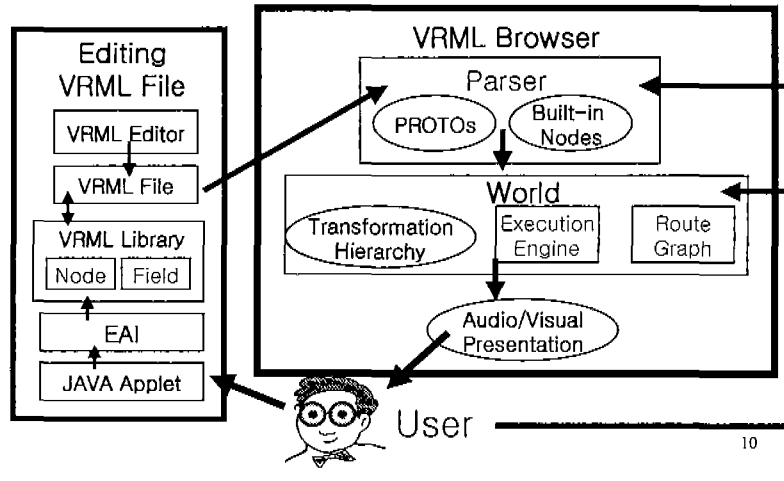
8

I . INTRODUCTION

Characteristics of VRML

- Capable of representing static and dynamic 3D and multimedia objects with hyperlinks to other media such as text, sound, movies, and images

- VRML browser, as well as authoring tools for the creation of VRML files, are widely available for many different platforms

- Supports an extensibility model that allows new dynamic 3D objects to be defined allowing application communities to develop interoperable extensions to the base standard
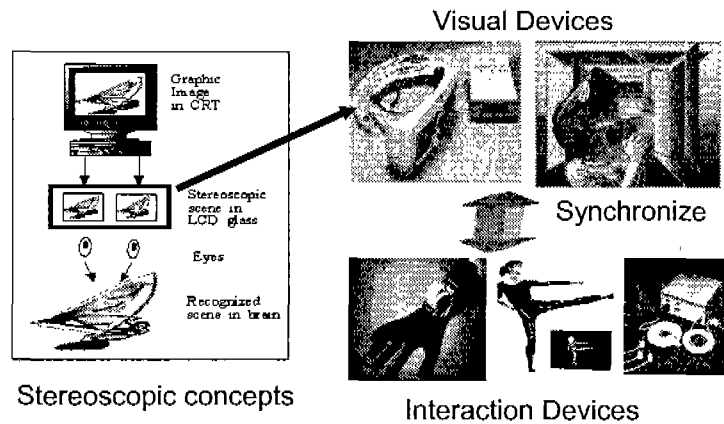
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Ⅰ. INTRODUCTION

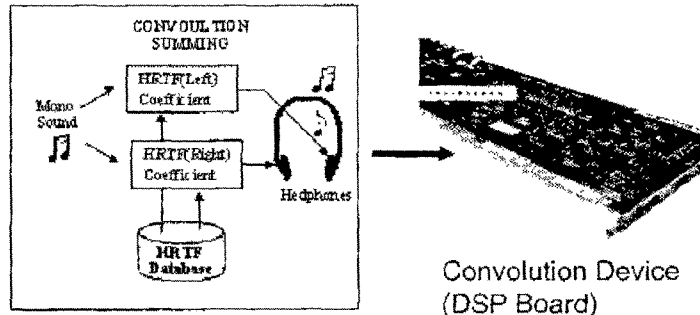Interactive Virtual World Creation by VRML File & Browser

Ⅰ.

INTRODUCTION
Principle of Stereoscopic View
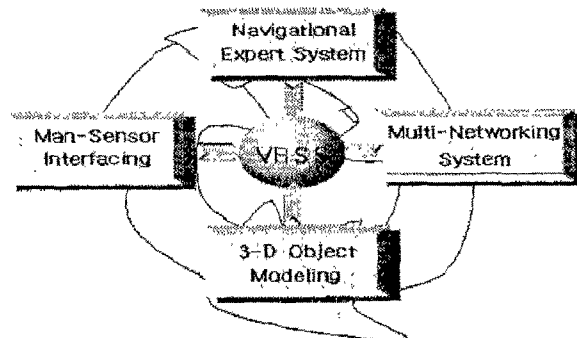
Ⅰ. INTRODUCTION

Principle of 3D Auditory

CONVOULTION SUMMING

HRTF(Left) Coefficient

Mono Sound

HRTF(Right) Coefficient

Hedphones

HRTF Database

3D sound reproduction concepts

Convolution Device
(DSP Board)

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Ⅱ. SYSTEM DESIGN METHOLOGY

Core Technologies to Implement VR-Based Navigation Simulator

Navigational Expert System

Man-Sensor Interfacing

VRS

Multi-Networking System

3-D Object Modeling

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II. SYSTEM DESIGN METHOLOGY

Virtual World Creation Procedures

SHAPE EDITOR — VRML File Editor

IMAGE EDITOR → WORLD EDITOR ← SOUND EDITOR

OBJECT CONTROL (SCL) — Control File Editor

RUNTIME MODULE (VISCAPE) — VRML Browser
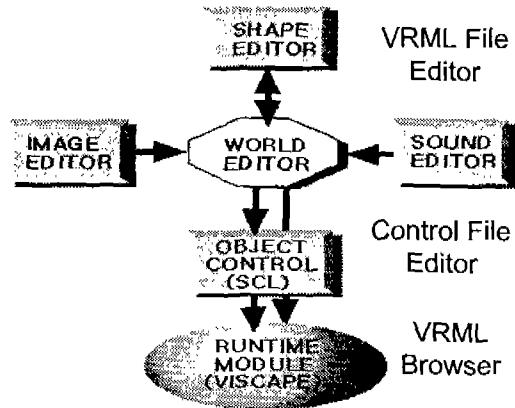
14

II. SYSTEM DESIGN METHOLOGY

Multi-User VR On-Line Network System

Server

Hub

TCP/IP

Internet

Client #1 Client #2 . . . Client #N
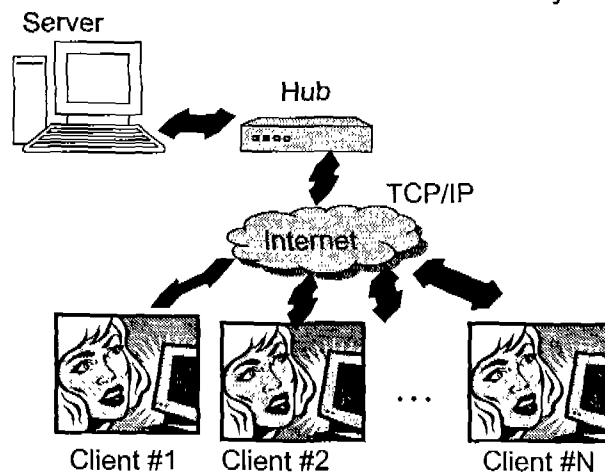
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II. SYSTEM DESIGN METHOLOGY

Nautical Charts to make terrain shapes & AtoN Model
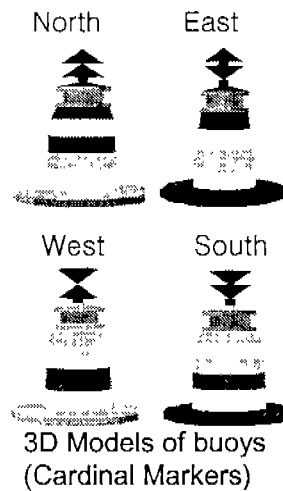

Nautical Chart
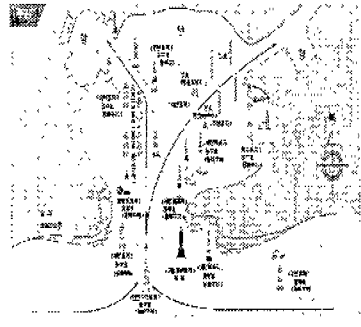
Fictitious Chart having
AtoN Shapes

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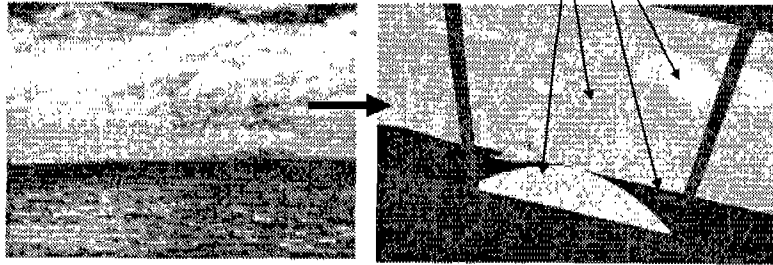# II. SYSTEM DESIGN METHOLOGY

3D AtoN Modeling

North   East

West   South
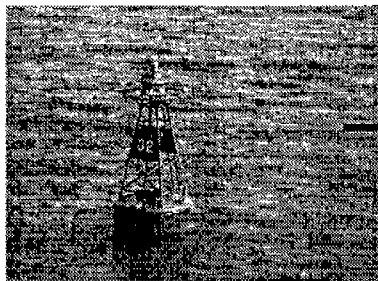
Real Light buoy shape

3D Models of buoys
(Cardinal Markers)   17

II. SYSTEM DESIGN METHOLOGY

3D Scene Modeling
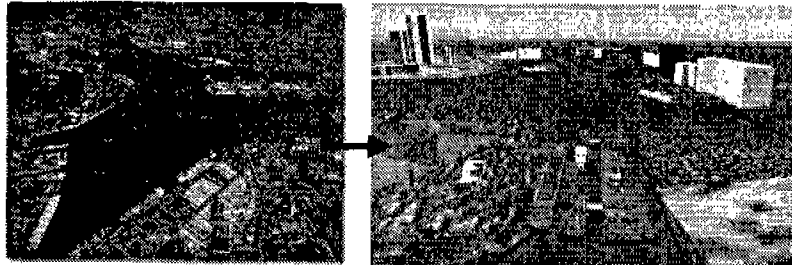
Controllable through EAI

Real Sea and Sky   Modeled Sea and Sky

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II. SYSTEM DESIGN METHOLOGY

3D World Modeling

Real scene of
INCHON inner port,
Korea

Modeled INCHON
inner port, Korea
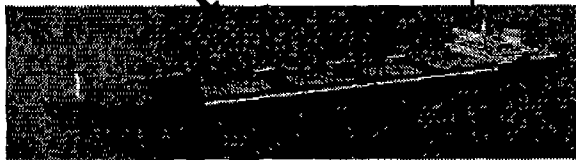
19

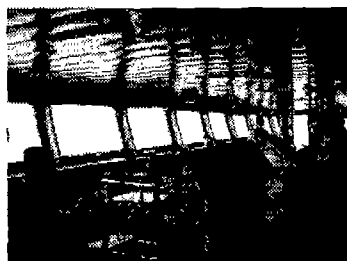# Ⅱ. SYSTEM DESIGN METHOLOGY
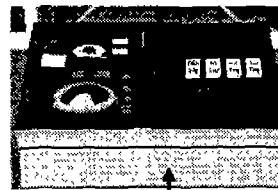
3D Modeling of objects

Enlarged Bridge

Real Ship

Modeled Ship
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Ⅱ. SYSTEM DESIGN METHOLOGY

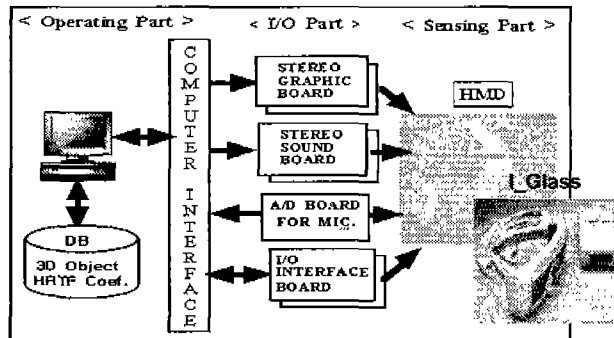## 3D Bridge Modeling

Control Panel

Real Bridge
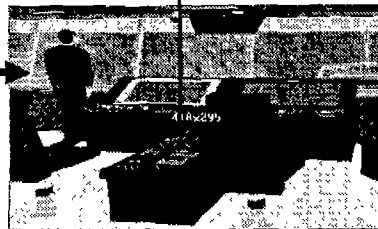
Modeled Bridge
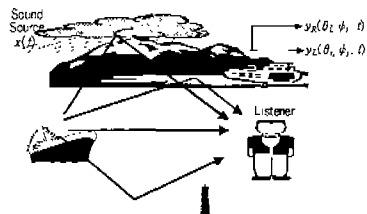21

II. SYSTEM DESIGN METHOLOGY

VR-Based Simulator System

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II. SYSTEM DESIGN METHOLOGY

3D Sound Reproduction in VR World

Sound propagation
concepts at sea

■ To feel 3D sound
 – Sound Localization using HRTF
 – Spaciousness by Reverberation
 – Distantness by Relative Intensity
   (Direct/Reflect)
■ Hearing Methods
 – Binaural hearing using
   Headphones
 – Trans-aural hearing using
   Speakers (need Cross-talk
   canceller by inverse filters)

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III. **SYSTEM STRUCTURE**

VR On-line Multi-user System

User #1   User #2

■ Enable Multi-User participation in a same Virtual World

■ Multi-User means that; Captain, 1/O, 2/O, 3/O, Q/M etc.

LAN

User #3

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III. SYSTEM STRUCTURE

Stereoscopic System Using HMD

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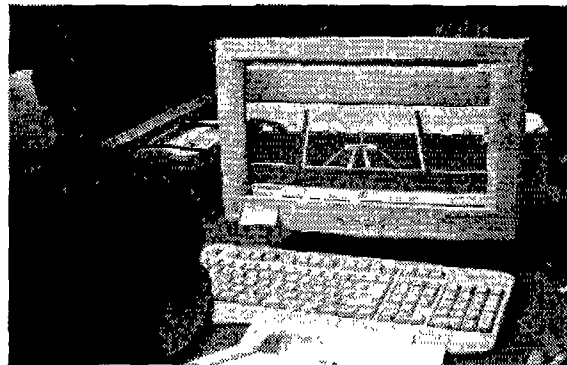# III.SYSTEM STRUCTURE

Virtual Control Devices in Virtual World

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III. SYSTEM STRUCTURE

Single-User Simulator

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IV. VR SHIP SIMULATOR
The VRSS System, Developed in 2000

Ship Tracking Area   Simulation Area

Sea-state Reproduction Area
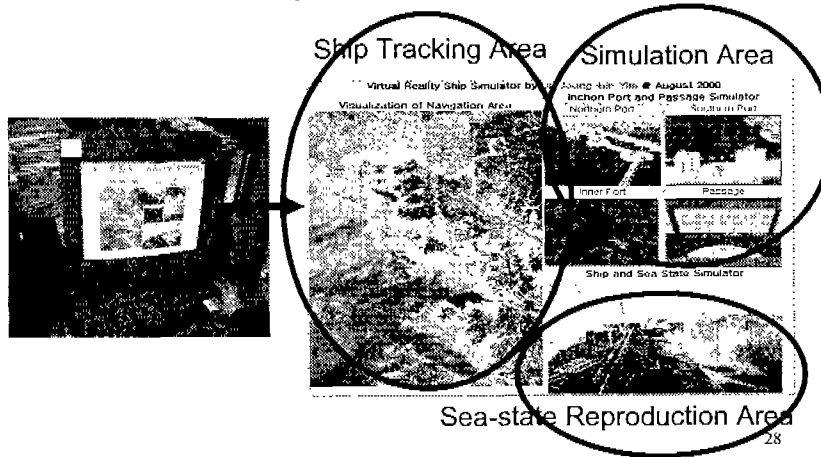
IV. VR SHIP SIMULATOR
Construction of Virtual World
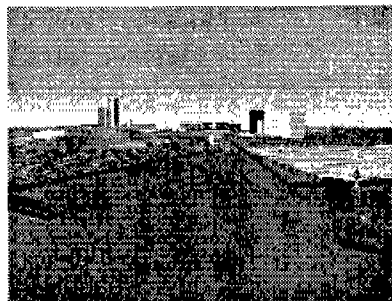
Virtual World of INCHON port, Korea
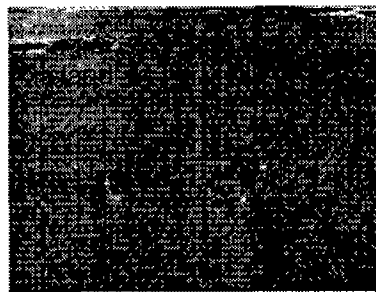
Virtual Approaching Passage of INCHON-port, Korea

IV. VR SHIP SIMULATOR

Simulation Results

Following ship, make
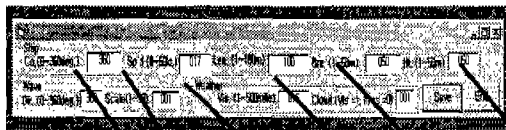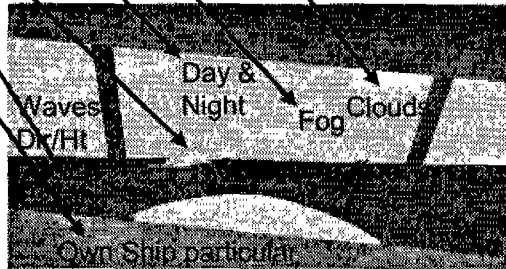Overtaking sound

Own ship make
agree sound

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IV. VR SHIP SIMULATOR

Sea-state Reproduction Function

Sea-state control
Parameter Table

Day &
Night

Waves
Dr./Ht

Fog   Cloud

Controllable scene
by Parameters

Own Ship particular

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V . AtoN SIMULATOR

Target of the AtoN Simulator, developed in 2001

o become familiar with the principals of the IALA System

o be able to interpret IALA system

o recognize the characteristics of buoys, daybeacons, and lights

o be able to relate a visible IALA to its charted symbol and locate its position on a nautical chart 32

Kin-CIN Joint Symposium 2001, Korea

V . AtoN SIMULATOR

Operating (Start -> Menu -> Learning related subjects)

Main Page

Menu Page

Learning Module

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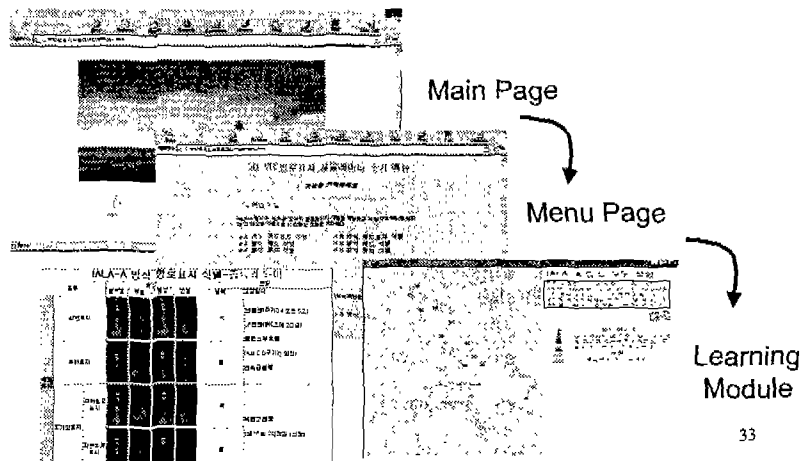
V. AtoN SIMULATOR

Exercise with Simulation Module (IALA-A)

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VI. EXPERIMENT & RESULTS

■ EXPERIMENTAL ENVIRONMENTS

(1) Scenario-based simulation experiment according to the International Regulations for Preventing Collisions at Sea

(2) Subject-based assessment with men and women who have onboard carrier more than 6 months

(3) SDMPA(Semantic Differential Method with Psychological Assessment) is developed and applied to test the VR-based Navigation Simulators

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VI. EXPERIMENT & RESULTS

■ ASSESSMENT RESULTS

(1) Most of subjects were reported that comfortable and natural-like virtual world scene was seen

(2) Very interesting simulation was experienced by interaction with cybernetic 3D object characteristics

(3) Enable easy learning of navigational rules which are required entry-level cadets

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Further Works

History of this work;

1998 3-D Sound Reproduction System to adopt VR
1999 Designing VR Ship Handling Simulator
2000 Prototype VRSS system using HMD
2000 Situation Visualizing System for NMPA, Korea
2001 Prototype AtoN Simulator

Further works;

■ VR Ship Handling Simulator in Calm Sea & Waves
■ VR AIS Simulator with RADAR and ECDIS
■ Visualization System of Marine Casualty Situation

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VII. SUMMARY

- We explored the application of VR technologies to implement VR-Based Navigation Simulator Using VRML.

- VR Ship Simulator gave some useful functions such as maneuvering ship with ease of learning the International Conventions to Preventing Collisions at sea.

- AtoN Simulator can give attractive and interesting experiences with ease of learning the rules of IALA system and ease of comprehension of Aids to Navigation characteristics in various weather conditions

- Results from tests, it became apparent that the developed VR-based Navigation Simulator could be adequate to next generation ship simulator.

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Demonstration of VR-Based Navigation Simulators Developed by VRMA*Sim* Lab., MMU, Korea

1. VRSS

2. AtoN Simulator

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