Augmented Reality: Intuitive User Interfaces in Maritime Navigation

Prof. Dr.-Ing. Reinhard Koch¹
Kristine Haase¹,²

In cooperation with
Prof. Dr.-Ing. Uwe von Lukas²

¹Christian-Albrechts-Universität zu Kiel
²Fraunhofer IGD, Rostock

supported by SevenCs GmbH, Hamburg, and by I-SH Innovationsstiftung Schleswig-Holstein, Germany
Definition of Augmented Reality (AR)

AR: Mixing of virtual content into the real environment

Source: Milgram, 1994
Augmented and Mixed Reality

AR mixing of virtual and real objects for film post production: include lighting, shadows, occlusion and physical interaction
AR Devices

- AR glasses: see-through projectors, projected overlay
- Tracking of head-position and view direction
- Optical mixing of real scene and virtual content
- Virtual content enhances (augments) reality

AR Design glasses, Project Artesas.
Images: Zeiss
Example: Maintenance support
Example: Maintenance support
Overview

- Use and examples of AR Applications
- Use-AR: AR in maritime environment (IGD Rostock)
- Case study: AR-Binocular in maritime Navigation
- Potential of AR in maritime Navigation
Time to market of AR-Technologie (2008)

Years to mainstream adoption:
- ○ less than 2 years
- ○ 2 to 5 years
- ○ 5 to 10 years
- ▲ more than 10 years
- ⊳ obsolete

Source: Gartner (July 2008)
Potential of AR for business areas

- Automotive
- Aerospace
- Construction
- Maintenance
- Medicine
- Marketing
- Tourism/Entertainment
- Defence/Security
- Maritime Industry
Ergonomic design and safety issues

Automotive
• Head-up Displays
• Driver safety warnings
• „Looking through car body“

Aerospace
• Ergonomic Cockpit design
• Radar target overlay
Tourism/Marketing/Entertainment

• Mobile AR for guidance and intuitive navigation
• AR Games on mobile phones and I-Pad
• Superposition of AR content (historical sites, TV and Film production)
Construction and Maintenance

- Information overlay
- Electronic online manual
- „x-Ray Vision“
- Tutoring and support
Example: Functional overlay

AR Maintenance on I-Pad
Visual overlay of functionality and measured flow data
Example: X-ray vision of pipes in ship cabin

UseAR study: Position of pipes behind walls, extracted with AR

Source: Lürssen
Planning, adapting of industrial processes

Industrial plants and productions sites

- Testing production processes with virtual prototypes
- Retrofit of new parts to existing sites
Example: Fitting new parts on-site

Use-AR Study: Visual superpositioning of novel diesel engine into existing structures. Visual markers register the virtual prototypes to the real world.

Source: MAN Diesel SE, Metaio
Fraunhofer AR-Study for the maritime Industry

Use-AR (2009):

• Study to apply AR in maritime Industry, Fraunhofer IGD in Rostock

• Content (in German)
  - Technology
  - Case studies
  - Evaluation & Recommendations
  - Literature

• Download: www.use-ar.de
Case Study: AR-Binocular

Augmented Reality System for maritime navigation
Navigation problem: Map adjustment

Source: [Porathe, Shepard]: 2D/3D Repräsentation of navigation maps
Navigation problem: Map adjustment

Study (Porathe, Shepard) reveals:
Comparison of map adjustment between navigation officer and Layman:
1. Transformation (Rotation) needs time proportional to rotation angle, can not be trained, navigation officers and Layman indistinguishable
2. Navigation officers value the intuitive use of 3D egocentric maps

Concept AR-Binocular: Direct 3D overlay of map in view with AR (3D Egocentric view)
Setup of AR Binocular: transform to 3D Perspective

Traditional: 2D Top-View

Nautic chart top view

View from Bridge

New: 3D Egocentric view

Augment 3D view with nautical chart data
Data flow of AR-Binocular

Prepare Chart data

Readout Sensor data
- Kamera
- GPS
- AIS
- INS
- MarkerTracking
- ObjectTracking

Augment video

Point AR-Binocular

Adjust egocentric view, superimpose chart data to video
Chart data base: ECDIS maps

- Electronic Navigation: ENC
- International Hydrographic Organization (IHO), Special Publication,
- Transfer Standard S-57
- ENC/PS Product Specification for ECDIS (Electronic Chart Display and
- Information System
- directEnc/SENC (System Electronical Navigational Chart) ECDIS software
- SevenCs GmbH
Prepare chart data: extract layers and objects

ENC charts
Knowledge base/Object extraction
3D Scene/Visualization

S-57 Ed. 3.1/ENC Product Specification
Chart Data

Vector-Topology
[inside, outside, touch, intersects, contain]

OpenSG 3D Symbology Library

CityGML International Standard

Customization: 3 classes, 7 function types (manages all ENC-features)

OpenSG Scene graph System for rendering purpose

Parser for Xlinks and referenced VRML-Symbols for scene graph hierarchy

+ Topology
+ Semantic
+ 3D Symbols
Further extensible:
+ surface textures
+ appearance models
+ exchangable format
+ wide extensibility

Prepare chart data: extract layers and objects
Sensor data for 3D view estimation

Mobile system:
6 DoF ~ Ø 6m, pitch ±~45 °, roll ±~ 45 °, heading 360 °

1. View camera: 7-fold magnification, 640x480 Pixel
   Angle of view: 7x10° (1/60 ° Resolution per Pixel)
2. Binocular display for viewing, 2 x 640x480 Pixel
3. Position (3 DoF) GPS ship navigation system
4. Artificial Horizon (Gravitometer, Gyroscope)
5. Visual heading sensor relative to ship Compass
Visual Heading-Sensor

Heading-Sensor: Heading camera (Fish-eye camera)
1. InfraRed-Marker on ceiling (rotation estimation)
2. Object tracking in view camera (image processing)
Example-Scene using AR-Binocular
Example-Scene using AR-Binocular
AR on Tablet PCs
Potential of AR for maritime Navigation

+ AR holds potential for use in maritime navigation
+ Map superposition in camera view feasible, head-up projection displays on bridge is an option
- Systematic content production (authoring) still missing
- Sensors for mobile AR expensive and still in progress
+ Integration of AR on Smartphones/I-Pads in the future
Thank you very much

In cooperation with
Prof. Dr.-Ing. Uwe Freiherr von Lukas
Maritime Graphics
Fraunhofer IGD, Rostock

Kontact: www.mip.informatik.uni-kiel.de