

10TH INTERNATIONAL COMMAND AND CONTROL
RESEARCH AND TECHNOLOGY SYMPOSIUM

>> THE FUTURE OF C2 <<

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Realization and Evaluation of a User Support System for the Optical Classification of Naval Vessels

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Overview

- Introduction
- Algorithms for investigation of silhouette and visible marks
- Overall design of the user support system
- Realization
- Evaluation and testing
- Conclusion
- Outlook

Introduction

- Optical reconnaissance is important, especially on deployments like Operation Active Endeavor
- Task is not trivial
 - Many different classes / frequently modified
 - Image material varies concerning its quality
- Manning ships optimally means less staff operating more (complex) systems
- Easy-to-use and easy-to-learn user support system for optical classification desirable
- Two highly tested algorithms for investigation of silhouette and visible marks exist

Algorithms

- Contour classifier

- Input

- Silhouette of OTBC
- Spatial orientation

- Processing

- Standardized OTBC is compared with reference silhouettes of all known ship classes in the database

- Output

- Result list, sorted by the correlation coefficients

- Marks classifier

- Input

- Visible marks with position
- Position independent marks
- Spatial orientation

- Processing

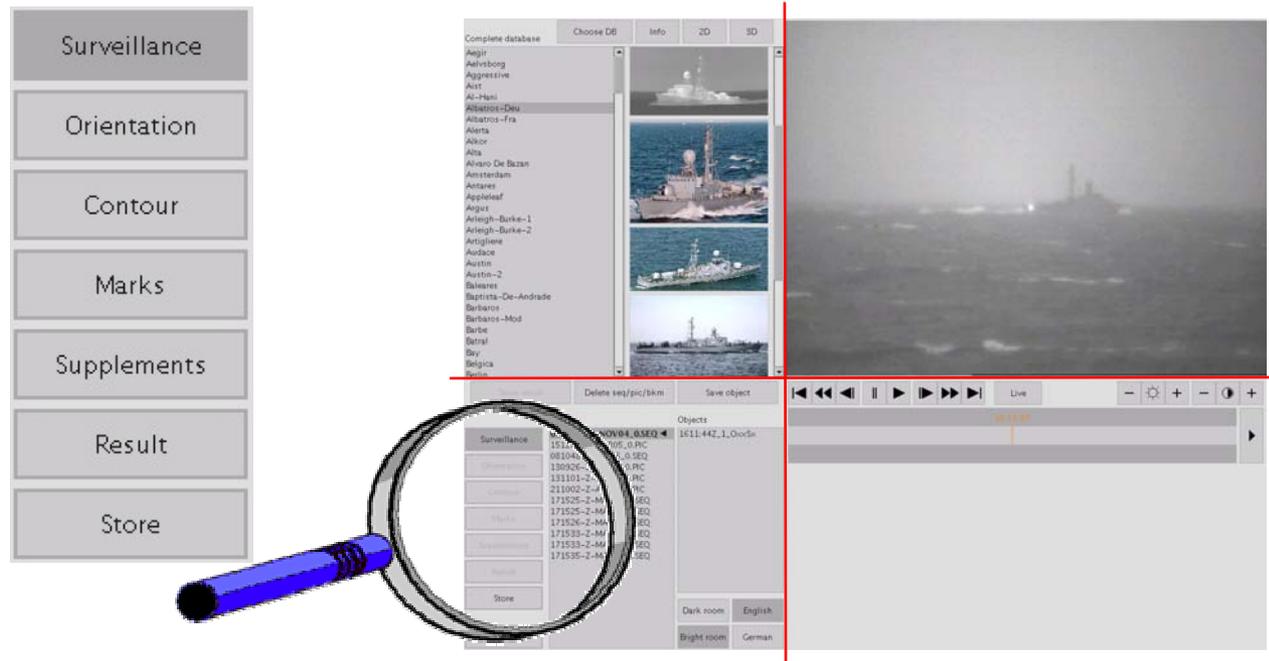
- Distances between OTBC and DB mark positions are calculated

- Output

- Result list, sorted by accumulated distance

Overall design

- Clear process states
 - Surveillance
 - Orientation
 - Contour
 - Marks
 - Supplements
 - Result
 - Store
- Concise screen layout
 - Sensor
 - Database
 - Overall controls
 - Specific controls



Screen layout (Surveillance)

The screenshot displays a surveillance software interface with the following components:

- Top Navigation:** Buttons for "Complete database", "Choose DB", "Info", "2D", and "3D".
- Database List:** A scrollable list of ship names including Aegir, Aelvsborg, Aggressive, Aist, Al-Hani, Albatros-Deu, Albatros-Fra, Alerta, Alkor, Alta, Alvaro De Bazan, Amsterdam, Antares, Appleleaf, Argus, Arleigh-Burke-1, Arleigh-Burke-2, Artigliere, Audace, Austin, Austin-2, Balears, Baptista-De-Andrade, Barbaros, Barbaros-Mod, Barbe, Batral, Bay, Belgica, and Berlin.
- Image Preview:** Three small thumbnail images of ships are shown in a vertical column.
- Main Video Feed:** A large, dark, and somewhat blurry video window showing a ship at sea.
- Control Panel:** A row of buttons including "Store result", "Delete seq/pic/bkm", "Save object", playback controls (stop, play, fast forward, fast reverse), a "Live" button, and brightness/contrast adjustment icons.
- Object Tracking:** A horizontal timeline or sequence viewer showing a vertical marker at "18:11:47".
- Object Lists:**
 - Imagery:** A list of image sequences starting with "091611-Z-NOV04_0.SEQ" and ending with "171535-Z-MAY05_1.SEQ".
 - Objects:** A list containing the object ID "1611:44Z_1_0xxxSx".
- Settings:** Buttons for "Dark room", "Bright room", "English", and "German".
- Navigation:** A vertical sidebar on the left with buttons for "Surveillance", "Orientation", "Contour", "Marks", "Supplements", "Result", "Store", and "Exit".

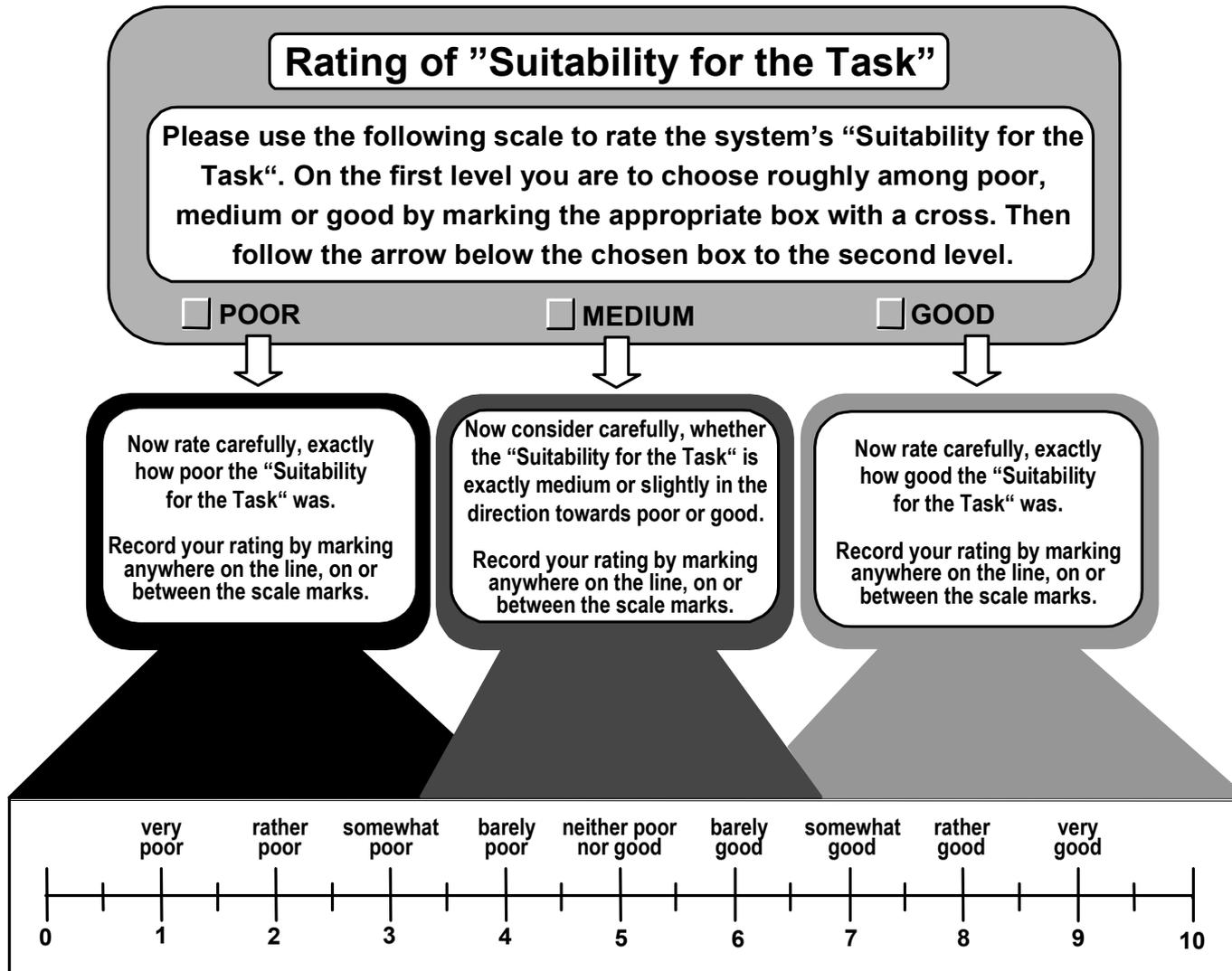
Realization

- Modern programming language JAVA
- Rapid prototyping with graphical development environment
- Subject matter experts were frequently asked to examine the system and give feedback
 - Expert talks with officers and sailors took place at the Naval C2 Systems Command (KdoMFüSys) in Wilhelmshaven
 - Nearly finished system tested on naval vessels
- System optimized and enhanced based on advice
- Fine tuning
 - Discussed details with representatives of the Federal Office of Defense Technology and Procurement (BWB) and KdoMFüSys

Evaluation and testing

- Usability
 - Nearly finished system tested on naval vessels
 - Standardized personal introduction with exemplary classification
 - Operators worked on realistic scenarios on their own
 - ISO 9241-10 qualities rated with ZEIS scale
 - Questionnaire on what displeases and what appeals to operators
- Accuracy
 - Team members and colleagues
 - Students
 - Bundeswehr Technical Centre for Ships and Naval Weapons (WTD 71), Eckernförde
 - University of the Federal Armed Forces, Hamburg
 - Naval C2 Systems Command (KdoMFüSys), Wilhelmshaven
 - Sailors

Two level rating scale (ZEIS)



ZEIS results

Quality \ Rating	Low	Adequate	High
Suitability for the task	0	11	11
Self-descriptiveness	0	10	12
Controllability	0	8	14
Conformity with user expectations	1	7	14
Error tolerance	3	12	7

Frequent comments

- It is easy and uncomplicated to operate the System
- The structure is clear without ambiguity
- Because of the process states, no more information than needed is shown
- The availability of two color models, daylight and dark-room mode, helps reduce distraction
- The ability to switch between different languages supports learning international terms
- It should be possible to have the contour of the OTBC automatically generated
- The ship information should be reachable from process state Results

Conclusion

- A user support system for classification based on optical sensor imagery is necessary
- Two algorithms capable of supporting operators exist
- The newly developed GUI provides functionality to feed the algorithms with the necessary input
- The GUI also provides functionality to analyze and interpret algorithms' results
- Experimentation under realistic service conditions has proved that the user support system is efficient and highly accepted and appreciated
- The optimized system is ready for deployment

Outlook

- More tests onboard several different seagoing vessels
- Final preparation for deployment
 - Find and remove bugs
 - Write necessary documents for accreditation
- Potential enhancements for future versions
 - Include classification applications broader than naval vessels
 - Include automatic / semi-automatic mechanism to deduce object's contour
- Further optimization of the user support system based on experience on deployment

Questions

