

Cdr Odd Sveinung Hareide
Technical Manager Electronic Navigation
Royal Norwegian Navy Navigation Competence Centre



The use of Eye Tracking Technology in Maritime High-Speed Craft Navigation

HFC Forum – Trondheim 22nd October



Paradigm shift – Digitalization



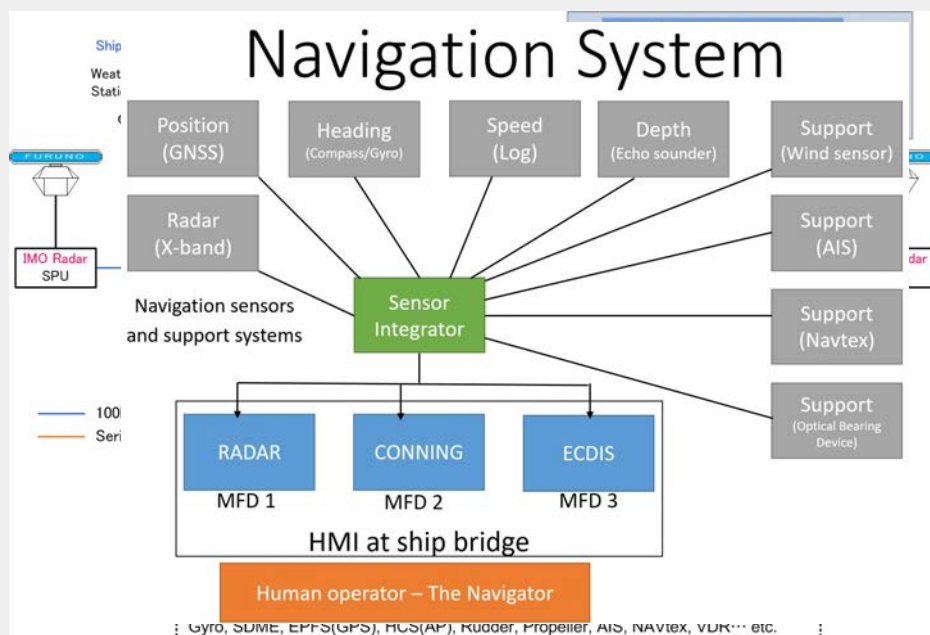
Human-in-the-loop?

2



FORSVARET

Digitalization

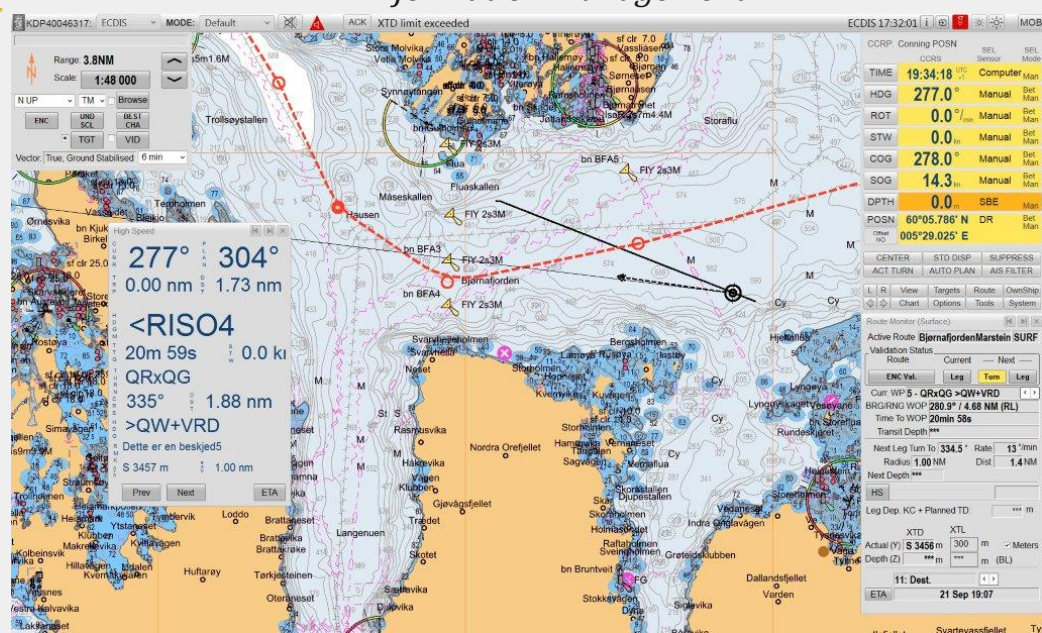


3



FORSVARET

Information Management



4



Navigator's SA

Level 1: Perception (Notice)

Level 2: Comprehension

Level 3: Projection

Navigator's Situation Awareness

Spatial
awareness

Task
awareness

System
awareness

Environment

Weather

Mission

SNCS

INS

MCS

5



Eye Tracking Technology

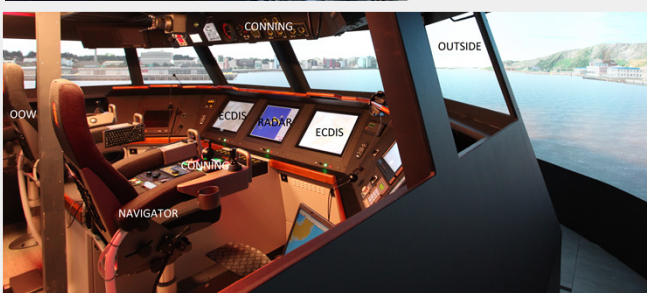


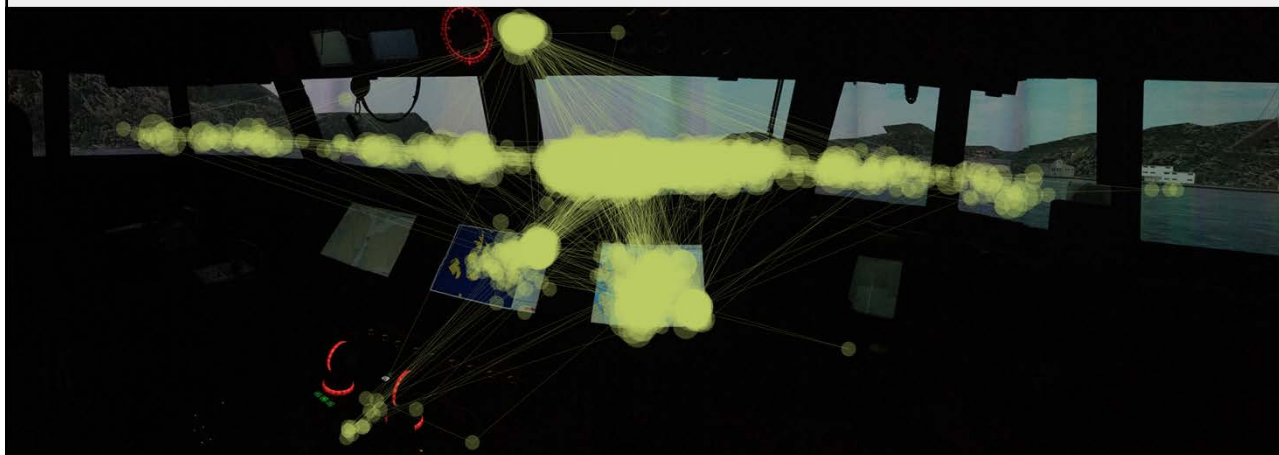
Photo courtesy of Tobii, SMI and The Royal Norwegian Navy

6



Eye Tracking Data

Scan Pattern

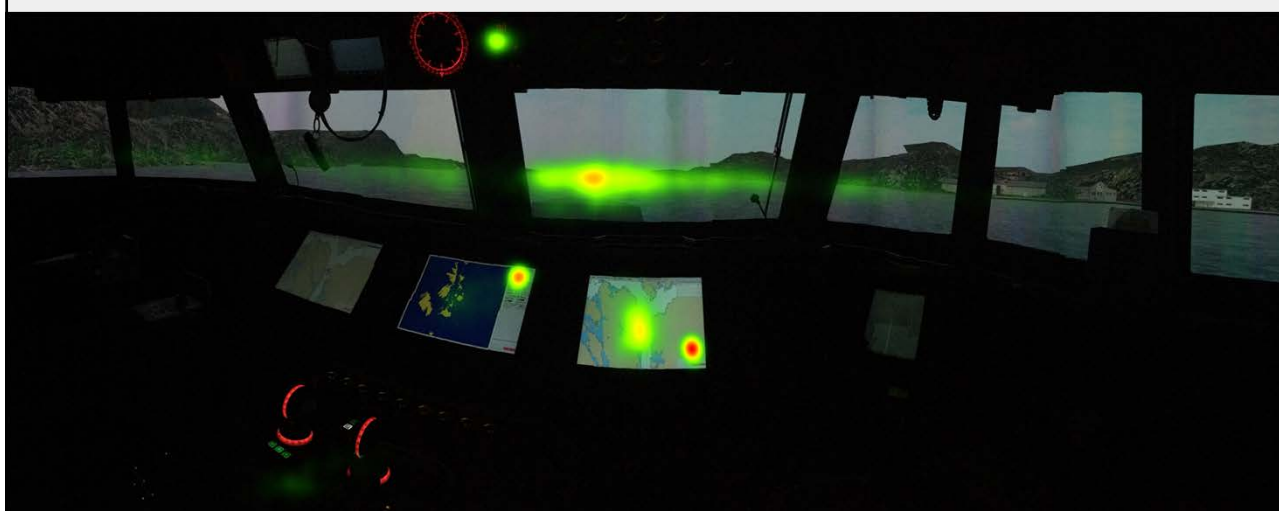


7



Eye Tracking Data

Heat Map

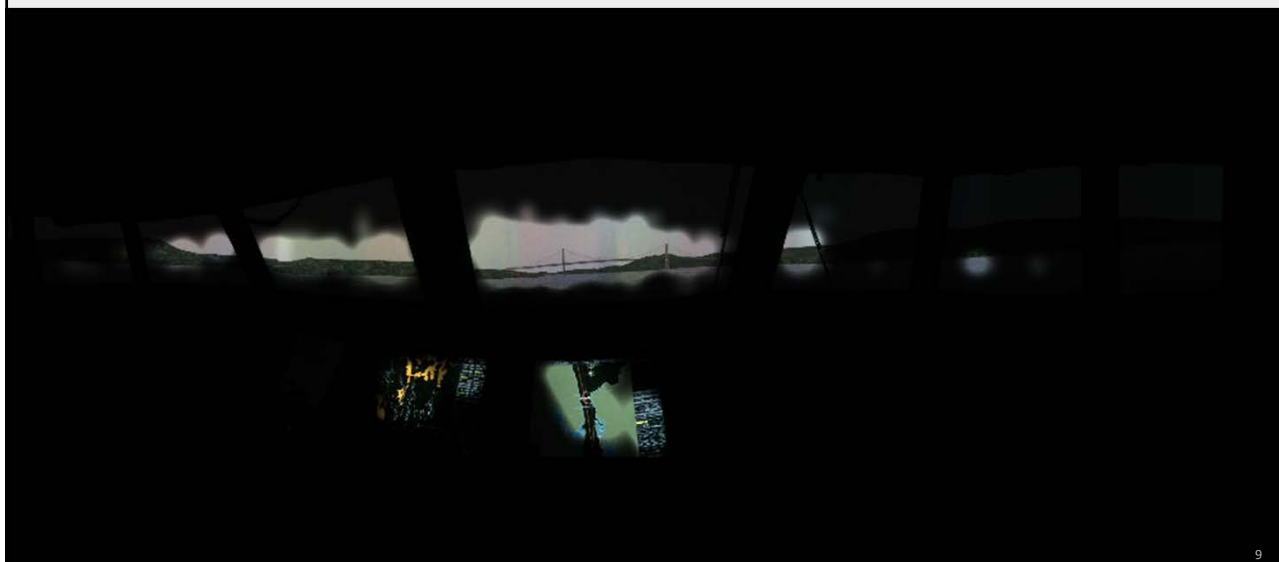


8



Eye Tracking Data

Focus Map

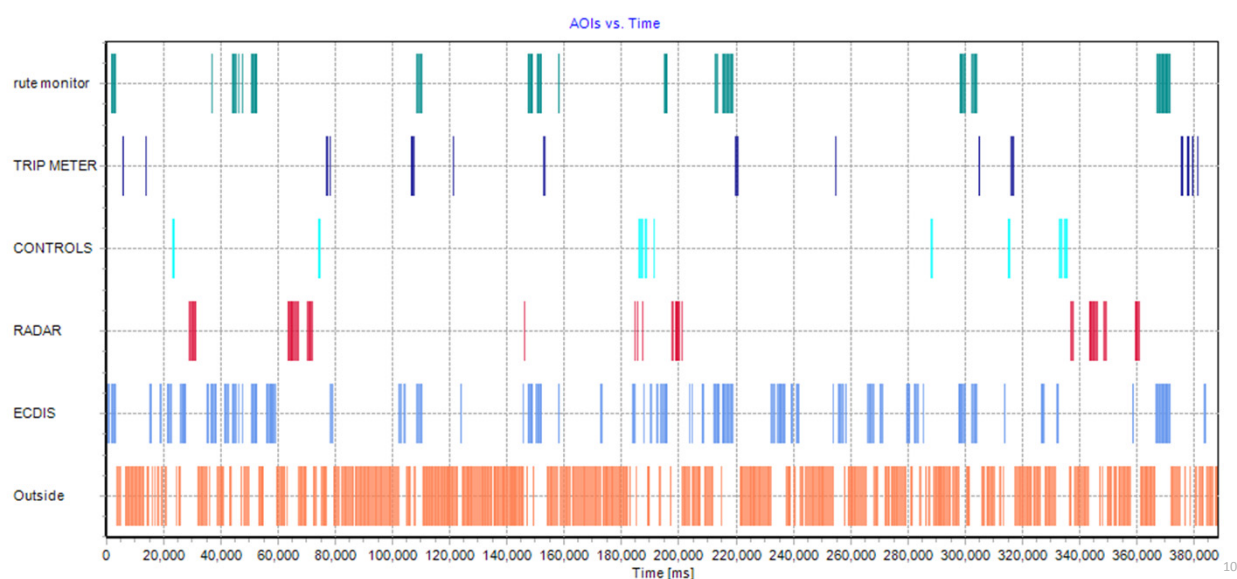


9



Eye Tracking Data

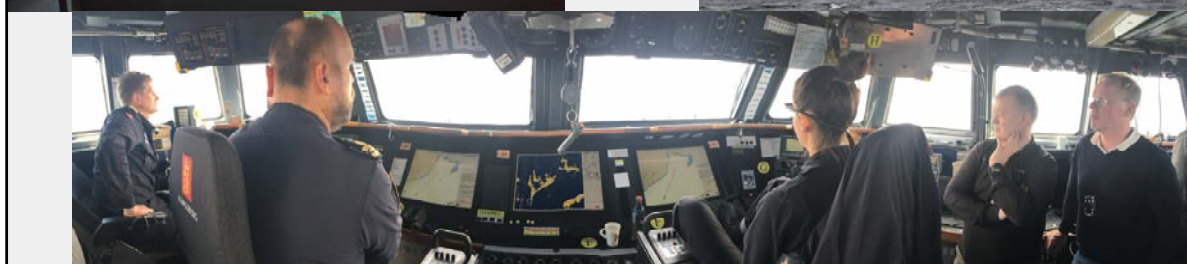
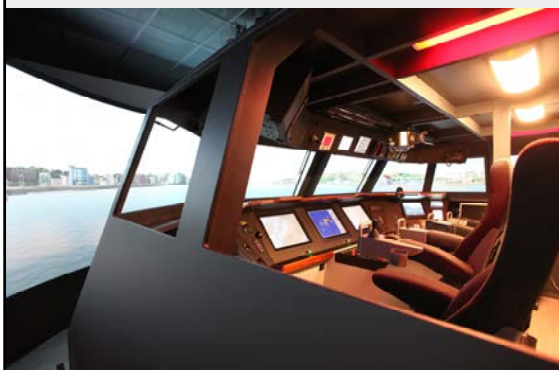
Sequence Charts



10



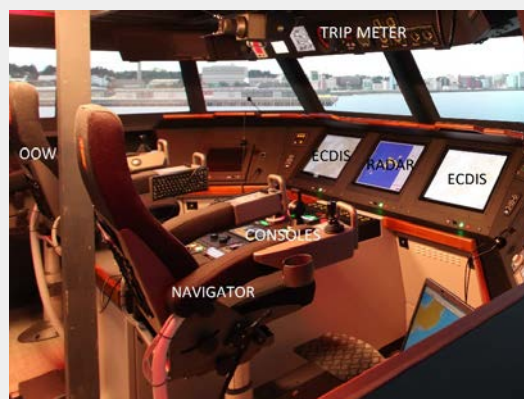
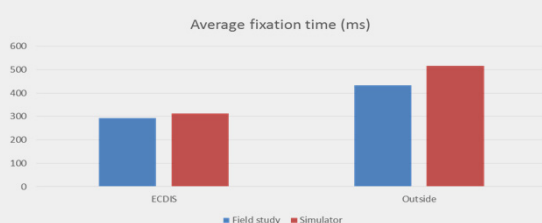
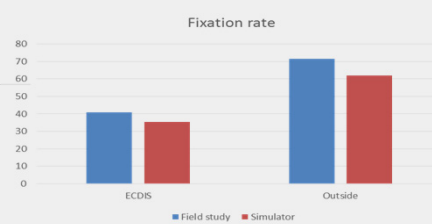
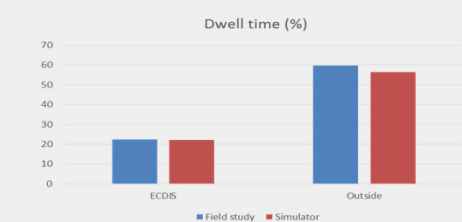
The big questions!



11



Live vs Simulator Bridge Navigation Training



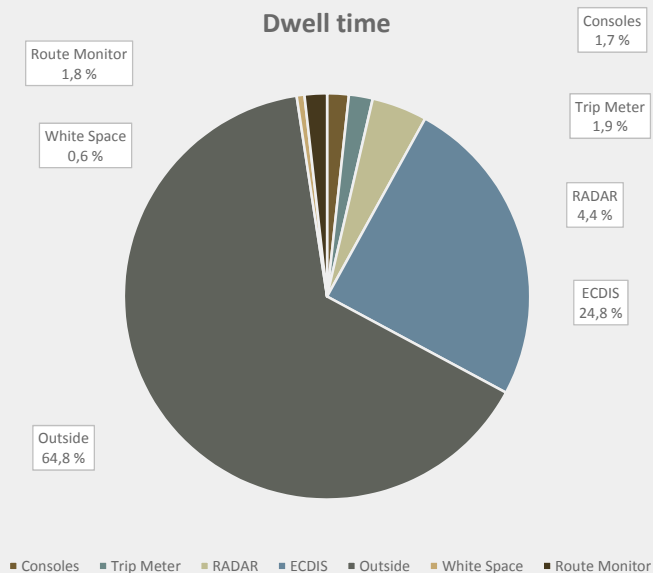
12



FORSVARET

Maritime Usability Study by Analysing Eye Tracking Data

Dwell time



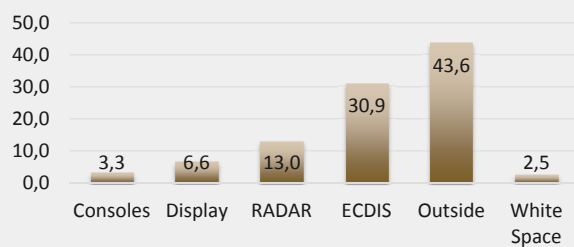
13



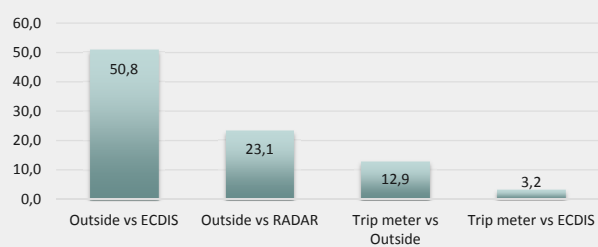
FORSVARET

Maritime Usability Study by Analysing Eye Tracking Data

Look-backs (%)



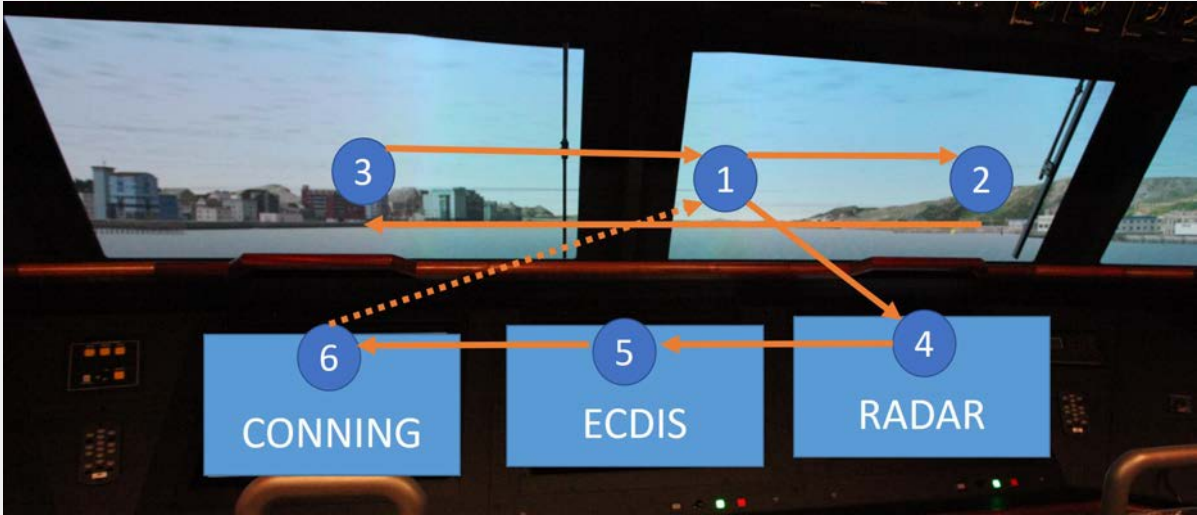
Backtrack (%)



14



Scan Pattern for the Maritime Navigator



The Maritime Scan

Revised

15



Developing a High-Speed Craft Route Monitor Window

High Speed

CURR
TRP
HDGM

000°
0.00
>(0,1)FM2sb

PLAN
DST

226°
2.01

TG
TURN
CRS
HDG
RMK
XT

38m 16s
45B
330°
<RISO4
Dette er en beskjed4
P 145 m

STW
DST
RA

0.0
3.43
1.00 nm

P

N

Leg

Turn

Leg

ETA

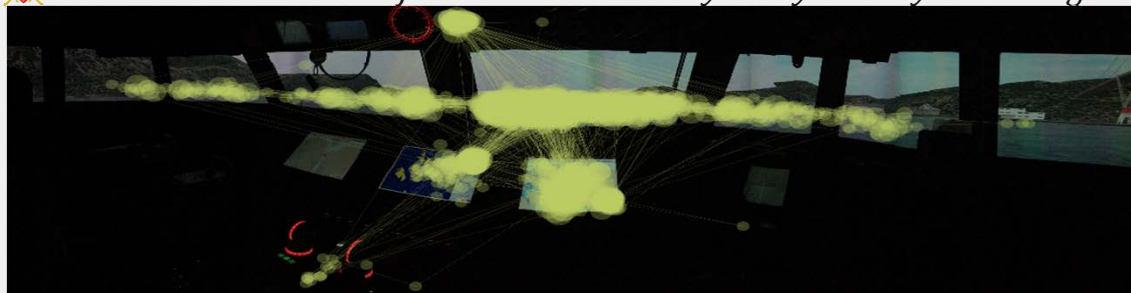
Current Heading	Planned Course
Sailed distance	Planned Leg Distance
Current heading mark	
Time to Wheel Over Point	
Turning information	
Next Course	Next leg distance
Next heading mark	
Remarks	
XTD	Turn radius

16

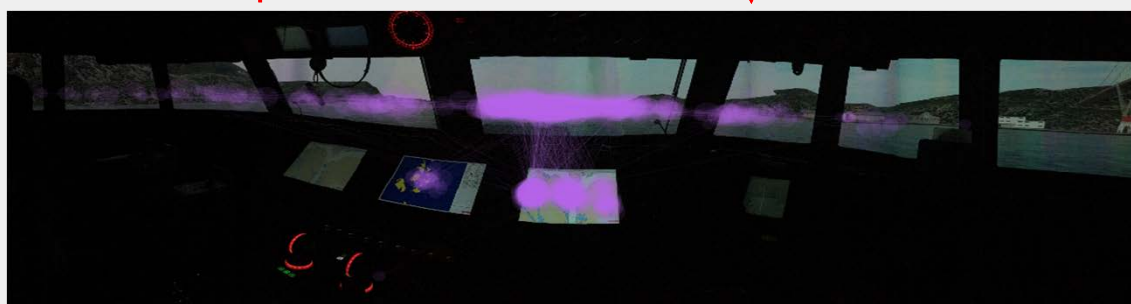


FORSVARET

Validation of a Maritime Usability Study with Eye Tracking Data



PRE MLU ↑



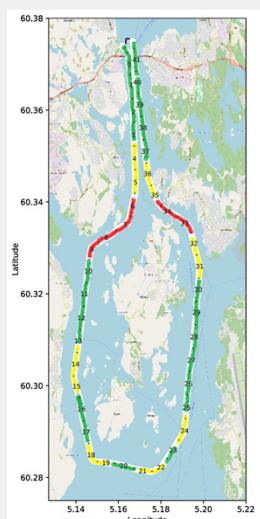
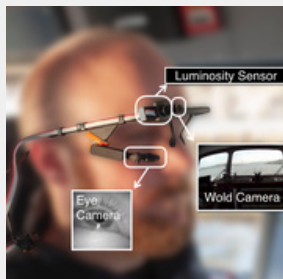
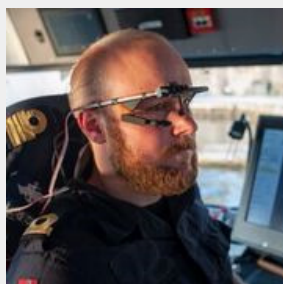
POST MLU ↓

17

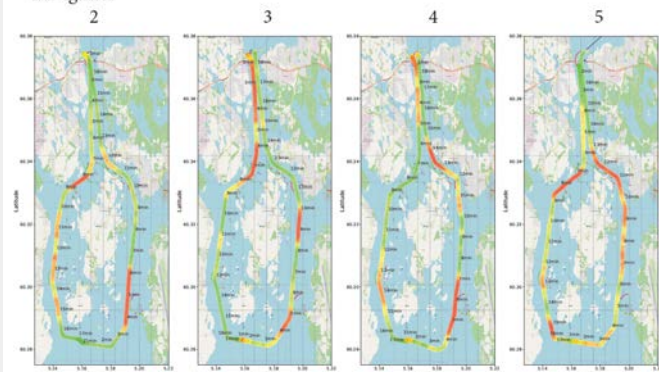


FORSVARET

Eye Tracking Technology to measure Cognitive Workload



Navigators



18

FORSVARET

Future work

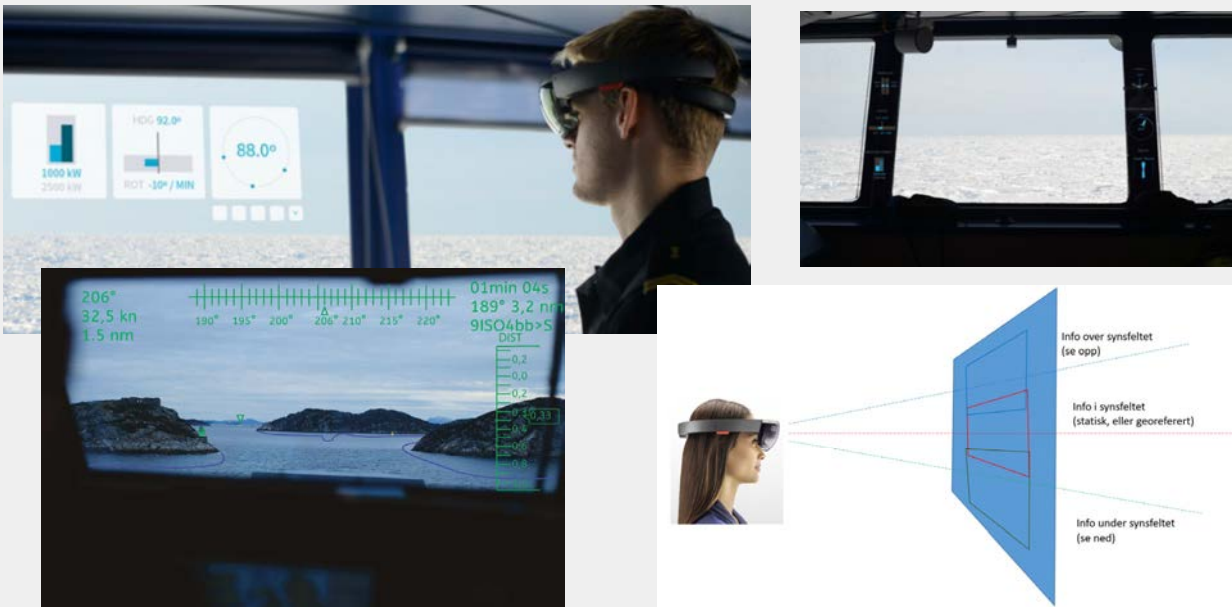


Figure: Prof Thomas Porathe, NTNU.

FORSVARET

References

NECESSE

ROYAL NORWEGIAN NAVAL ACADEMY
MONOGRAPHIC SERIES

VOLUME 1 ISSUE 1 2016

Militær navigasjon
- effektiv og troverdig

NECESSE

Militær navigasjon -
teknologi og operative team

NECESSE

ROYAL NORWEGIAN NAVAL ACADEMY
MONOGRAPHIC SERIES

VOLUME 2 ISSUE 1 2017

Militær navigasjon – dagens teknologi
for morgendagens krigføring

Odd Sveinung Hareide

The use of Eye Tracking Technology in Maritime High-Speed Craft Navigation

Thesis for the Degree of Philosophiae Doctor

Trondheim, April 2019

Norwegian University of Science and Technology
Faculty of Engineering
Department of Ocean Operations and Civil Engineering

UiT The Arctic University of Norway
Faculty of Science and Technology
Department of Technology and Safety

University of South-Eastern Norway
Faculty of Technology, Natural Sciences
and Maritime Sciences
Department of Maritime Operations

Western Norway University of Applied Sciences
Faculty of Business Administration
and Social Sciences
Department of Maritime Studies

NTNU Norwegian University of Science and Technology

UiT The Arctic University of Norway

USV University of South-Eastern Norway

Western Norway University of Applied Sciences



FORSVARET

Eye Tracking Technology in Maritime High Speed-Craft Navigation

1. The importance of simulator navigation training
2. Visual distribution of the HSC navigator
Scan Pattern for the Modern Navigator
3. Use of ETGs in maritime usability studies
HCD process
Developing HSCRMW →
Importance of familiarisation
4. Deeper understanding of HSC navigation
Phases of Navigation (control strategy)
Maritime Navigator's SA model
5. Implementation in curriculum and courses

High Speed			
CURR	000°	PLAN	226°
TRP	0.00	DST	2.01
H D G M	>(0,1)FM2sb		
T T G	38m 16s	S T W	0.0
T U R N	45B		
N C R S	330°	D S T	3.43
H D G R M K X T	<RISO4		
Dette er en beskjed4			
P	145 m	R A	1.00 nm
P	N	Leg	Turn Leg ETA

22