Experimental study of ship navigator’s mental workload

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INTRODUCTION
- 82.1% of marine accidents were caused by operator’s negligence (Korean Maritime Safety Tribunal, 2013).
- Operator’s negligence was caused by excessive workload and cumulative fatigue.
- There are a variety of subjective assessment techniques (Hill et al., 1992): (1) Overall Workload (OW), (2) the Modified Cooper-Harper Scale (MCH), (3) the Subjective Workload Assessment Technique (SWAT), and (4) the National Aeronautic & Space Administration Task Load Index (NASA-TLX)
- NASA-TLX is one of the best-known methods to measure workload (Hart et al., 1988)
- There are a variety of physiological measurements techniques (Mulder, 1988): (1) electroencephalographic (EEG), (2) evoked brain potentials, (3) pupil diameter, and (4) heart-rate variability (HRV)
- HRV is one of the most well-known methods to measure workload.
- We measured the mental workload in a real ship as a basic study for comparison of mental workload between the simulator and the real ship.
- HRV, Psychomotor Vigilance Test (PVT), and NASA-TLX were used to analyze the change of mental workload.

METHOD
- A total of three participants took part in the experiments.
- The experiment was carried out using a real ship, the Training Ship HANBADA of the Korea Maritime and Ocean University (KMOU).
- HRV (Heart rate variability) --- Bodypro320
- RT (Response time) --- PVT 2.0 Laptop system
- Subjective evaluation --- NASA TLX questionnaire

Participants

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<tr>
<th></th>
<th>Age</th>
<th>On-board experience</th>
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<tr>
<td>Captain</td>
<td>44</td>
<td>8.7 years</td>
</tr>
<tr>
<td>Officer</td>
<td>28</td>
<td>2 years</td>
</tr>
<tr>
<td>Quarter master</td>
<td>48</td>
<td>26 years</td>
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Results
- Captain’s HR (Heart Rate) was that in Busan the level was higher than it was in Ulsan.
- In the cases of the officer and the quarter master, the HR was that in Ulsan the value was higher than it was in Busan.
- The captain’s R-R interval was that in Busan the value was lower than it was in Ulsan.
- In the cases of the officer and the quarter master, the R-R interval was that in Ulsan the value was higher than it was in Busan.
- The captain’s mean RT was that in Busan the value indicated a slower response than it did in Ulsan.
- In the cases of the officer and the quarter master, the mean RT was that in Ulsan the value indicated a slower response than it did in Busan.
- The captain’s total score was that in Busan the value was higher than it was in Ulsan.
- In the cases of the officer and the quarter master, the total score was that in Ulsan the value was higher than it was in Busan.

CONCLUSION
- The results of the analysis showed a similar tendency for all of the following: HR, R-R interval, mean RT, and total score.
- The results of this study showed greater differences according to port than according to arrival and departure.
- In the case of the captain, the mental workload was found to have increased in the Busan port compared to that in the Ulsan port because the captain’s responsibility is reduced by the pilot in Ulsan.
- In the cases of the officer and the quarter master, the mental workload was found to have increased in the Ulsan port compared to that in the Busan port because the officer and the quarter master were under increasing tension/stress in Ulsan. A pilot boards any training ship in Ulsan.
- Based on the results of this study, I would like to suggest that there is the possibility for various situational types of research and assessment using simulators.

Scenarios
- The first selected scenarios were departing from Busan port and arriving at Ulsan port.
- The second selected scenarios were departing from Ulsan port and arriving at Busan port.

Environment

HFES Europe Chapter conference