항만설계 시뮬레이터의 영상정보 신뢰성 분석에 관한 연구

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Visual Requirements of Port Design Simulators—A Comparative Study*

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Abstract

One of the main uses for ship simulators is in the field of port design, and an increasing number of simulators, of varying degrees of fidelity, are being used for this purpose. An essential feature of all such simulators is their visual scene, which must be of sufficent fidelity to convey the key visual cues

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briefing was given to enable the sujects to understand the objectives of the experiment and the scenario through which the ship was to be conned. The method of questioning, whereby questions were asked during the vessel's manoeuvres, was explained. Subjects were asked to answer each question as accurately as possible, leaving the answer blank if they were unable to provide an answer.

The questionnaire, designed to obtain quantitative data on the perceptions of distance, speed, bearing, rate of turn and distance from a leading line, is reproduced at Annex A.

2.4.3. Dynamic Test

Each of three experienced mariners, with sea experience of between 5 and 10 years, was asked to con the simulated ship along the artificial waterway so that the vessel passed along the two leading lines, and along the channel line between the two sets of breakwaters. The engine speed was kept constant and no additional information was available from instrumentation. Each subject was allowed two familiarisation runs before any experimental runs were attempted. A total of 9 runs was carried out by all subjects except two, who were able to complete only 6 runs.

2.4.4 Sea Test

Poor perception of distances and speeds in either simulator could be due either to the poor performance of the simulators or to the difficulty of mariners perceiving these quantities at sea. An important part of the experiment was therefore to test the ability of mariners at sea, carrying out similar tasks to those of the Individual Perception Test. The trainig vessel MARGHERITA was made available for this task, with the support of the on-board staff. Margherita is a converted minesweeper of 32m length and an eye height of only 6m, operating from Cardiff. While ideally a ship of similar size, operating in the same sea area would be more suitable, this ship nevertheless provided a sea environment in which to test the perception of mariners in similar circumstances.

A series of questions was asked which were as near as possible to those asked in the simulators, modified only by the necessarily changed environment.

3. ANALYSIS AND RESULTS

3.1 ANALYSIS METHODOLOGY

3.1.1 Individual Perception Tests.

To perform a statistical analysis for the perception of distance, bearing, speed and rate of turn, six null hypotheses are made. To test the hypotheses, the results of the experiments are analysed by a T-Test, since the variations of the populations are unknown and the size of the samples is 20 [8], [9]. The analysis was carried out using the SPSS-X package running on a VAX 11-780 computer at the University of Wales College of Cardiff. A two-tailed test was performed, and the significance level, which is the probability of rejecting a null hypothesis Ho when it is true, was chosen as 0.05. A null hypothesis Ho is rejected if a two-tailed probability for it is less than the significance level 0.05 [10], [11]. In addition to the T-Test, mean and standard deviation results are compared with real values to provide an indication of the accuracy of perception of the sample groups in each case. Similar analyses were made for both the simulator tests and the sea test. For the sea test, some minor corrections had to be made to the assessments in order to match them to the simulator results. In these cases, general statistics were compared rather indirectly, the T-Test not being performed.

3. 1. 2 Dynamic Test

The analysis of the dynamic test consisted of measuring the area of the swept path's divergence from the ideal track in each case and plotting the resulting Cost Function. To minimise the effects of mariner variability, the results of all three mariners on each case were averaged.

3. 2 RESULTS

3. 2. 1 Individual Perception Tests

3. 2. 1. 1 Distance Perception.

The difference between the distance perceptions for the two simulators was not regarded as significant at the 0.05 level. Overall distance perception was poor. The sea test confirmed that mariners' distance perception at sea is also poor, and it may be deduced that the distance perception obtained from the micro based simulator is not significantly different from that in the real world. It appears also that diffiulties experienced by mariners in assessing distance from a simulator's visual presentation is due not to the simulator's shortcomings, but to the human's low capability of distance perception.

3. 2. 1. 2 Speed Perception.

Three tests were made for the assessment of the mariners' perception of ship speed, two relating to the own ship and one relating to a crossing ship. Standard deviations of speed assessment in each simulator were large, but it is concluded that there is not a significant difference in the perception of speeds betwen the two simulators. In the sea test, estimates of a crossing ships going at 7 knots varied from 3 to 9 knots. The statistical analysis concluded that the accuracy of measurement at sea was greater than in either of the simulators. This is thought to be due in part to the lack of cues such as bow wave and wake in the simulator visual systems. In a port design scenario, there are few occasions when a crossing ship's speed is important, and the speed of one's own ship is directly obtainable from the log information.

3. 2. 1. 3 Bearing Perception

Bearing assessment was limited to objects close on the bow, and the accuracy of assessment was in all cases much higher than for either distance or speed assessment. There was no significant difference between the two simulators. Bearing assessment in the simulators was, however, more accurate than at sea. This is thought to be caused more by the difficulty of providing a suitable object at sea, where the object used tended to be too close, and changing in bearing rather rapidly.

3. 2. 1. 4 Rate of Turn Perception

Although the null hypothesis, of there being no significant difference between the two simulators, was again not rejected for rate of turn perception, the variance was large compared with the mean in each case. This suggests that mariners find assessment of rate of turn difficult, which was confirmed by the sea test.

3. 2. 1. 5 Relative Position from a Leading Line.

Again there was no significant difference between the two simulators in the ability of mariners to perceive the distance from a leading line. Again also, the variance was large, and the sea test confirmed that mariners, while able to tell with near certainty which side of a line they are on, are not able to assess the distance from the line with any accuracy.

3. 2. 2 Dynamic Test

The Cost Functions for successive averaged runs for each type of simulator are shown in Fig. 4. The effects of the learning process are clearly shown for the first four runs. Because of this learning phase, the analysis was carried out on runs 5－9 only. Both simulators exhibit the same tendency, of converging towards a Cost Function

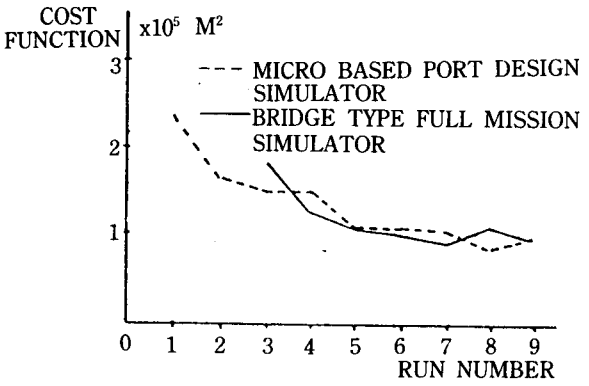

Fig. 4. Comparison of cost Function Values Between two Simulators

value of 1.0, with a difference between the two mean values of less than 0.1%.

It is concluded therefore that there is no significant difference between the quality and quantity of the information mariners receive from either simulator.

4. GENERAL CONCLUSIONS

The overall conclusions from the research are that :

* there is no significant difference between the two simulators tested regarding the ability of mariners to perceive visual cues relating to speeds and positions of ships in a visual scene.
* mariners in general perform poorly in assessing distances and speeds at sea, but can estimate a bearing close to the bow with reasonable accuracy, both in the simulator and at sea.
* simulator visual systems without bow wave and wake representation do not appear to give sufficient cues for mariners to assess a target vessel's speed accurately.
* rate of turn assessment is uniformly poor in both simulators and at sea.
* the microcomputer based simulator may be considered, as far as its visual scene representation is concerned, to be as valid as the full mission ship simulator for the port design task.

The overall results of the tests show sufficient correlation between the micro based simulator, the full mission simulator and reality for port design tasks to be undertaken using a simulator's visual imagery. It should be noted that for performing actual port design tasks, additional information will be available to the mariner.

As all mariners taking part in this experiment were experienced to at least Sceond Mate level, no conclusions can be drawn on the suitability of visual systems for training inexperienced mariners.

5. ACKNOWLEDGEMENTS

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ANNEX A

List of Individual Perception Questions.

1. What is our distance from the buoy on the starboard side ?
2. What is the speed of our ship ?
3. What is the bearing of the biggest island in front ? (Own ship's heading is given).
4. What is the speed of our ship now ? (Speed is changed without informing subjects).
5. What is the speed of the crossing vessel ? (Own ship's speed is known to the subject).
6. What is our distance from the crossing vessel ?
7. What is our distance from the bow of the ship on our starboard side ?
8. Is our ship turning to starboard or to port ?
9. The maximum rate of turn of this ship is … degrees per minute. What is our present rate of turn ?
10. Is our ship to port or to starboard of the leadig line ahead ?
11. By how many meters is our ship away from the leading line ?