WINMOS
WINTER NAVIGATION
MOTORWAYS OF THE SEA

Activity 5 – Human element and training

Sub activity 5.2 – Desktop study on defining criteria to simulator facilities and individual ship model quality

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Development proposals for ship handling simulator for maneuvering in ice

General

The development proposals in this report are based on the feedback obtained after test runs of the ship handling simulator for maneuvering in ice, from the "ice-simulator", in *Aboa Mare's* simulator center and the simulator in *Kalmar Maritime Academy*. The ice-simulator installed in *Aboa Mare* was developed in co-operation between *Image Soft*, *Aker Arctic* and *Simulco* and the simulator in Kalmar by *Kongsberg*. In *Aboa Mare's* simulator center there is also an ice-navigation simulator made by *Transas* to which comments in this document also refer.

Generally speaking the operations that must be possible to train in an ice-simulator require high quality vessel- and ice modelling. A reasonable assumption is that the ship model works exceptionally well in open water when performing maneuvers that require high precision and when a lot of engine power is used. The responses of the machinery must also be realistic. Realistic modelling of the forces in the ice and in the ice fields surrounding the ships are also of high importance for the operations that are to be trained. This also counts for the ice between vessels close to each other and the characters of the ice and its behavior to different weather conditions.

The ice conditions should be adapted to the conditions in the Bay of Bothnia, Sea of Bothnia and the Baltic Sea.

Important features

Ice characteristics and behavior of the ice to be added

The simulator should have the capacity to show different types of ice, such as "Floating Ice", "Sea ice" and "Drift ice". The ice should also be presented in different stages of development and forms e.g. "New ice", "Sluch", "Shuga", "Nilas", "Fast ice" etc.

The occurrence of floating ice should present in "Ice cover". This means that different "Concentration", different forms of ice such as "Pancake ice", "Floe" of different sizes "Floeberg", "Floebite" and "Brash ice" and different ice arrangements. The arrangements that should be presented are "Ice field" of different sizes, "Belts", "Strips", "Ice edge" e.g. "Compacted ice edge", "Jammed brash barrier", "Fast-ice edge" etc. All these should have their typical physical effect to ship, typical visual and radar image, and visual/radar location and physical effects to ship should have an exact match

The motion processes, due to different weather conditions, in the floating ice, diverging and compacting, and the deformation processes must be realistically presented. Same goes for the openings in the ice and the ice surface features.

Ship handling (merchant vessels)

The simulator should at least have three to five different types of merchant vessels in the data base and of different size.

The ship handling program should have the capacity of presenting the whole voyage, from open water, entering the ice, through the ice into the harbor.

- Navigating in open ice free and cold seas, the danger with ice loads on deck and ship stability.
- At open sea in darkness, the danger of hitting thick massive ice floes and difficultness of navigating in open sea in snow fall.
- Approaching the ice edge in downwind and windward side and the influence on the vessel at different ways to tackle the ice situation (e.g. wrong angles to the ice edge).
- The presentation of the ice, visual and in the radar should be so good that the planning and navigation of the vessel can be done in one or another way depending on simulated weather (fog, darkness etc.).
- Overtaking and meeting in fast ice and in leads.
- Icebreaker assistance
    - Towing (in notch, long cable and short cable)
    - Following the icebreaker
    - Convoy operations
    - Difficulties met when the distance are too long
    - The difficulties with short distance assistance
    - Stopping methods.
- Freeing beset vessels
- Berthing in ice

One other vital thing is to train communication between merchant vessels and icebreakers in different situations.

Ship handling (icebreakers)

The simulator should have different types of icebreakers (fixed propellers two or four and azimuthing thrusters).

The ship handling program should have the capacity of presenting a large variety of traffic and ice situations:

- Basis for operating the icebreaker
    - Healing
    - Turning in ice
- Starting assisting vessels
- Freeing a beset vessel (from the bow/from the stern);
- Towing
    - In notch
    - Long cable and short cable
- Assistance by two icebreakers
- Turning a merchant vessel into the wind
- Maneuvers in jammed brash barrier
- Maneuvers in big floes, ice edge and leads
- Arranging convoys

General Characteristics of the Simulator

1. Adding ice to the simulated radar image. Existing radar simulators are enhanced to support ice navigation. The radar image should at least show leads and ridges.
2. A towing function is implemented in the system. The function includes a tension-control feature for the winch. The assisted vessel's interaction with the icebreaker (forward- or turning- forces) should also be noted in the modelling (c.f. close-coupled towing).
3. The teachers' *Simulation Manager* tool is modified in accordance with the wishes of the buyer at least regarding the following properties:
   - The software is enhanced with a function setting the controls into the corresponding positions with the playback time. The software indicates into what position power and other controls should be adjusted.
   - The editor of the ice database is improved (see ice character above).
4. Remote controlled searchlights are added on the *own* ship. Two on merchant vessels. On icebreakers four are added forward, under the navigating bridge, and one in the stern.
5. The icebreaker is provided with a heeling function enabling heeling of 6° from side to side by pumping ballast water. When calculating the friction of the ice, the heeling is taken into account.
6. The crashing sound caused by the ice is added to the sound generator. A subwoofer produces vibrations.

Less important features

1. The system is enhanced with creating the visual views for, and the radar images of specific harbors in the Bay of Bothnia, Sea of Bothnia and the Baltic Sea.
2. Satellite images of the ice conditions, and ice conditions in accordance with the satellite image. The databases are created using the Meteorological Institute's information about the ice situation in a specific winter.
3. The IBPlott software will be lightly integrated with the simulator. This enables acquiring the ice situation as satellite images and can be used for training the planning of the journey. In addition the usage of the IBPlott software can also be trained.

Summary

Proposals for improvement of simulator functions

The present simulators have a very good presentation of the sea and vessels in open water conditions. Unfortunately they have some shortcomings when they should be adapted for ice navigation.

The most vital of these shortcomings are:

- Presentation of the ice, optical and in the radar;
- Presentation of the ice motion processes and deformation processes;
- The interaction on the ice by different weather conditions e.g. wind, current etc.;
- The interaction on the ice by icebreakers and vessels e.g. contact with the ice field and the performance of vessels and icebreakers in different ice conditions;
- Towing and the interaction between icebreaker and towed vessel;

- The possibility to recreate the previous situation (playback);
- The difficulty and the time required to create an ice filed;
- Responses of the machinery e.g. turbo sound; and
- Few icebreakers in the databases.

To get the simulator to work as well as a ship handling simulator in ice the following improvement has to be done:

- The presentation of the ice and also the behavior of the ice have to be improved;
- The interaction on the ice by icebreakers and vessels e.g. contact with the ice field and the performance of vessels and icebreakers in different ice conditions;
- Towing and the interaction between icebreaker and towed vessel;
- Present the sounds both from the ice and the machinery;
- Expand the number of icebreakers in the databases; and
- A possibility to recreate the previous situation.