ITEC 2018 Paper

Rheinmetall Simulation & Training

Joachim Hahn, Database Generation Simulation Expert

Next-Gen Workflows for the generation of sea areas for the use in nautical simulators

Abstract:

Developing visual databases for the use in nautical simulators is a time consuming and cost-intensive process. Multiple kinds of sources like vector and elevation data, imagery and land cover information need to be combined. Numerous geo-specific and geo-typical 3d models and textures have to be defined, created and composed within the scene. Large sets of rules for the generation of harbour areas and coastlines are to be considered and established.

A well-thought-out workflow can help to handle all such input data and export to any required output format such as visuals for OTW and binocular, night vision, infrared view, radar and sonar data including simulator specific meta-data. An additional tools pipeline leveraging state-of-the-art techniques like version control systems, generation in powerful build farms and fully integrated quality management can round-up the workflow. Last but not least, combining Electronic Nautical Charts (ENC) and available vector datasets like OpenStreetMap together with satellite imagery open up new and exciting opportunities to create highly realistic sceneries for nautical simulators.

Rheinmetall Simulation & Training has developed a next-generation cost-effective workflow to cover all those needs in a largely automated process. The workflow will be presented to the attendees and can be technically evaluated. The session will also demonstrate how the workflow can be easily adjusted to different quality demands, geographic regions or specific customer requests.

Next-Gen Workflows for the generation of sea areas for the use in nautical simulators

The product line

Rheinmetall's ship handling simulation ANS6000 product line represents one of the most modern and comprehensive Ship Handling Simulators in the market. With ANS6000 simulators, fundamental, basic and expert training can be conducted for maritime training and education from inexperienced junior officers to experienced officers of the watch. Moreover, the quality of simulation and the fidelity of mathematical models allow conducting research and development projects.

The systems high flexibility allows customised training solutions from desktop trainers to part task cubicles up to full mission bridges including bridge mock-up with real IBS (Integrated Bridge System) or emulated navigation equipment and vessel specific controls.

ANS6000 has been designed for training and research activities in accordance to the STCW regulations of IMO and have been certified by Det Norske Veritas Germanischer Lloyd (DNV GL).

Source Data

Electronic Navigational Charts

The main dataset for the ANS6000 system is the Electronic Navigational Charts (ENC) of the simulated sea area. It is used on the Electronic Chart Display and Information System (ECDIS) during the training and is also base for the generated datasets like visual terrain and correlating data like radar simulation.

Electronic Navigational Charts are official datasets created by national hydrographic offices. ENC is a modern vector representation of the printed nautical charts and must conform to standards of the International Hydrographic Organization (IHO).

The ENC contains all necessary information for the sea area like

- Coastlines and land areas
- Depth contours and soundings
- Shoreline constructions
- Harbour and production facilities
- Nautical lights, lighthouses, sea marks, buoyage, navigation lines
- Wind wheels
- Bridges
- Bearing points like towers, chimneys, high buildings, prominent trees

ENC Editing

Electronic Navigational Charts can be ordered in different quality or resolution levels (usages) from overview (usage 1) up to berthing (usage 6). The availability differs by the requested region of the world. All required map sheets and different usages are combined to one ENC base dataset.
To guarantee a homogeneous correlating dataset all required additions or changes on relevant nautical information is made within this dataset. Since retail charts are encrypted by default the result of the editing is saved to an xml-based vector format.

More sources

Beside the Electronic Navigational Charts many additional source datasets are required to create a high quality simulation sea area. These are geo-referenced datasets like elevation data, imagery, land cover data and vector datasets like OpenStreetMap.
The used 3d models and textures are not geo-referenced and will be placed or referenced by the terrain generation software according to the vector datasets.

While the ENC data describes the coastline and the underwater shape, the elevation data contains the height on land. Depending on the required quality the resolution of available datasets varies from 3 arc-seconds up to high definition grids with resolutions of several meters. Within the terrain generation software elevation data with different resolution can

be combined without a problem. Thereby expensive high res data can be limited to small areas while the main area is created with free available SRTM data.

The underground texture is a mixture of high quality imagery for the area around the eye-point and geo-typical textures assigned by land cover data for the background.

Land cover data describes the physical material at the earth surface. It is a raster dataset with a specific resolution per pixel. Depending on the used dataset the resolution is about hundred or several hundred meters per pixel

To increase the quality of the onshore side of the simulation, vector datasets like the world wide available OpenStreetMap are used to place cultivation and vegetation. With rulesets the visual representation can be controlled from high definition for the harbour and the passed by shores and a less detailed view for the background scenery.

3d models are used to populate the scenery. Some are specific land or sea marks, like lighthouses, towers, high buildings or monuments. Others are added to give a high quality visual impression like vegetation and buildings that are typical for the simulated area.

The Software

The package

Rheinmetall's VisualXtreme® workflow for image and database creation consists of several hand-in-hand working software packages:

- Editor for Electronic Nautical Charts
- Raster graphic editor
- 3d modelling software
- Terrain Generation Software
- The Rheinmetall image generator DISI-Xtreme®

By the help of the two editors and the 3d modelling software all source data is prepared for the generation of the sea area itself.

The Terrain Generation Software

The terrain generator is the main software to create sea areas. Here all source datasets are imported. The interaction of all information is controlled by rule sets.

Rule sets are mainly parameter lists to control the visual representation or the physical behaviour of imported elements. For the ENC data they link ENC attributes with a specific texture for the representation of a shoreline construction or defines the 3d models that are used to build up a harbour facility or a production area. Lights and other nautical features are taken from the ENC and the tool combines the parameters for light colour, blinking frequency, height, visibility range, etc. with a proper 3d model like a beacon or a lighthouse.

For the land cover data a rule set links to the geo-typical texture to take for every specific material or land use. These textures can be combined with correlated vector datasets that add single 3d models or complex elements like forests or road networks.

Additional the geo-typical textures assigned by the land cover can be varied or replaced considering the slope of the terrain (steep rocks without vegetation), the absolute height (e.g. trees only below 2000m), the climate zone or a combination of all.

OpenStreetMap and other vector data is filtered and imported rule based, too. This ensures that only training relevant elements are imported. The parameters for the visual representation set e.g. the width of roads, the used tree or house types, the look of railroads, etc.
The rules can be stacked, so a single road vector can place the asphalt road itself, can be equipped with buildings or street lamps in a fixed distance and/or with trees in a randomized distance.

The Image Generator

As image generator the Rheinmetall Simulation & Training development DISI-Xtreme is used. It is a high-performance system for 3d image generation of maritime scenarios based on newest game engine technology. Meanwhile DISI-Xtreme is the standard image generator for all recent Rheinmetall Simulation & Training simulator systems.

To ensure a high performance every multi-channel system is built in a client-server-architecture. The master is the interface between bridge simulation and image generator and is also software and database server for all clients. Each client is equipped with a high end graphics card and creates the image for one visual channel.

To synchronize all visual channels an additional hardware based technology is used. The graphic cards of the master and all clients are linked by fibre optics. This ensures a consistency and synchronisation over all visual channels even in scenarios with higher or inhomogeneous load on single channels.

The ocean representation of the DISI-Xtreme simulates a wave exposure synchronized with the complete simulation system. For each single point in time and on every place within the sea area the same wave height is calculated for the simulator and the visual representation. This guarantees a perfect fit between ocean representation and ship motion. The colour of water can also be changed like the intensity of foam caps at higher sea state.

Additional the ocean representation is influenced by the different local wave fields (primary and secondary wave) of each ship. Wave fields of different ships interfere with each other. A realistic bow and stern wave in combination with spray bring the visual impression to perfection. Underwater swirls caused by the propeller and the manoeuvring thruster are visualized by specific particle systems.

The infrastructure around

The interaction of the software tools listed above allows creating high quality sea area for maritime simulators. Additional hardware and software combines everything to a powerful system with an automated process.

A central data storage system saves all created datasets and together with a versioning tool every version can be restored.

While the composition of a sea area or other visual database is done at the employees work stations, the time consuming generation of the complete simulator dataset is moved to a build farm in a server room. These computers build the required area with the specified software version of the generation software for a specific target system and combine it to a delivery dataset with only one mouse click.

The quality management requires software for automated check-ups and manual tests. A graphical user interface gives full control to the generated terrain already during the development phase. The eye point can be moved freely or to pre-set camera positions, the weather environment can set as well as the sea state, the tide or the time of day.
A list of landmarks, harbour facilities or specific positions can be automatically compared between two versions by a comparison tool.

The workflow

Specification

The production process starts with the specification of the sea area including all required elements. Beside the training relevant aspects also the technical parameters including the system performance has to be taken into account.

The components of a database are

- Sea area with all required harbours and coast lines
- Static 3d models placed on the ground
- Dynamic objects placeable at the scene during simulation
- Effects, animation and particle systems like smoke of engines or chimney, turning wind wheels, traffic, weapon effects,…
- Textures for a photo-realistic impression
- Correlating data to support the bridge simulation like the visual and datasets like radar or sonar

For nautical simulation different kinds of sea areas can be created or combined depending on the training aim:

- Open Sea
- Way through drift ice and pack ice
- Passage of straits and canals
- Harbour approach
- Navigation within harbour areas
- Berthing
- Special training like weapon use, mine hunting, radar and sonar training

The required datasets are simulator depending and could be

- OTW view (out of the window)
- Binocular
- Night vision
- Infrared
- Radar
- Sonar
- Different kind of ice in water
- Different seasons like summer or winter

All data is created from one single data source. This guarantees a full correlation. Additional information like control files for locks or canals are also derived from the source.

Production process

When the specification is completed the source data has to be acquired. The ENC have to be reworked for the specific needs and elevation data and additional vector data have to be provided.

In parallel the creation of specific 3d models like land marks, sea marks or ships and vessels can be started if they are required.

The ENC as master dataset has to be checked and amended where necessary. It is to be taken into account that ENC is unfortunately not a native simulation dataset.

An existing default project assists in combining the different datasets. With a large suit of rule sets the data is imported and 3d models or the visual representation of the elements are assigned.

If the final outputs don’t meet the expectations completely not the output is modified but the responsible rule set. This ensures a fully repeatable data production.

All parts of the tool chain work hand-in-hand. The segregation between work stations, data storage and build farm together with the versioning allows a high level data production. Additional tools assist with statistic functions to optimize the workflow and with documentation to support the final acceptance with the customer

Conclusion

The new *Rheinmetall Simulation & Training* workflow is a powerful way for generating high quality sea areas for the company's ANS6000 product line

The largely automated process assists in creating simulation datasets for different quality demands, geographic regions or specific customer requests.

The use of pre-defined rule sets allows a rapid database creation and is very flexible to allow adjustments to increase the quality.

During the presentation the workflow, the data run and the high quality output is shown with diagrams, screen shots and photos.