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Management of autonomous and mixed waterborne traffic by cascading microscopic traffic simulation - The project “mikroVon”

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Abstract

Introduction

The development of autonomous vessels is progressing fast. While autonomous cars can react quickly on obstacles, encounters and other situations, ships have much longer response times.

Interactions with other vessels, especially in restricted waters, must be foreseen und planned carefully. A tool to simulate actual traffic faster than real time to predict encountering areas or passage times for defined routes can help to manage autonomous or mixed waterborne traffic.

In the reach of the research project “FernBin” a microscopic traffic simulation is under development.

The current project is based on a well evaluated model that is working with static data. mikroVon is the next step to a dynamic model that uses “live”-data on ship traffic.

Objective

The development of remote-controlled and autonomous ships demands for methods to manage the traffic and ensure safety on waterways. Especially mixed traffic with participation of humans and autonomous systems can cause critical situations.

A traffic simulation with forecast of encounters of ships can predict critical situations and produce automated warnings so the helmsman or automated system can adopt the ships course and speed.

Data flow

The actual state of a waterway and the ongoing traffic is mapped to the simulation by data from various sources:

- Waterway data
  - Water level depended flow velocities and water depth
  - Cross section properties
  - Traffic rules
  - Statistical traffic data
  - …
- Online data
  - Gauge data
  - Notices for skippers
  - …
- Vessel information
  - Course
  - Speed
  - Dimensions
  - …

Figure 1 shows a sketch of the possible data flow.

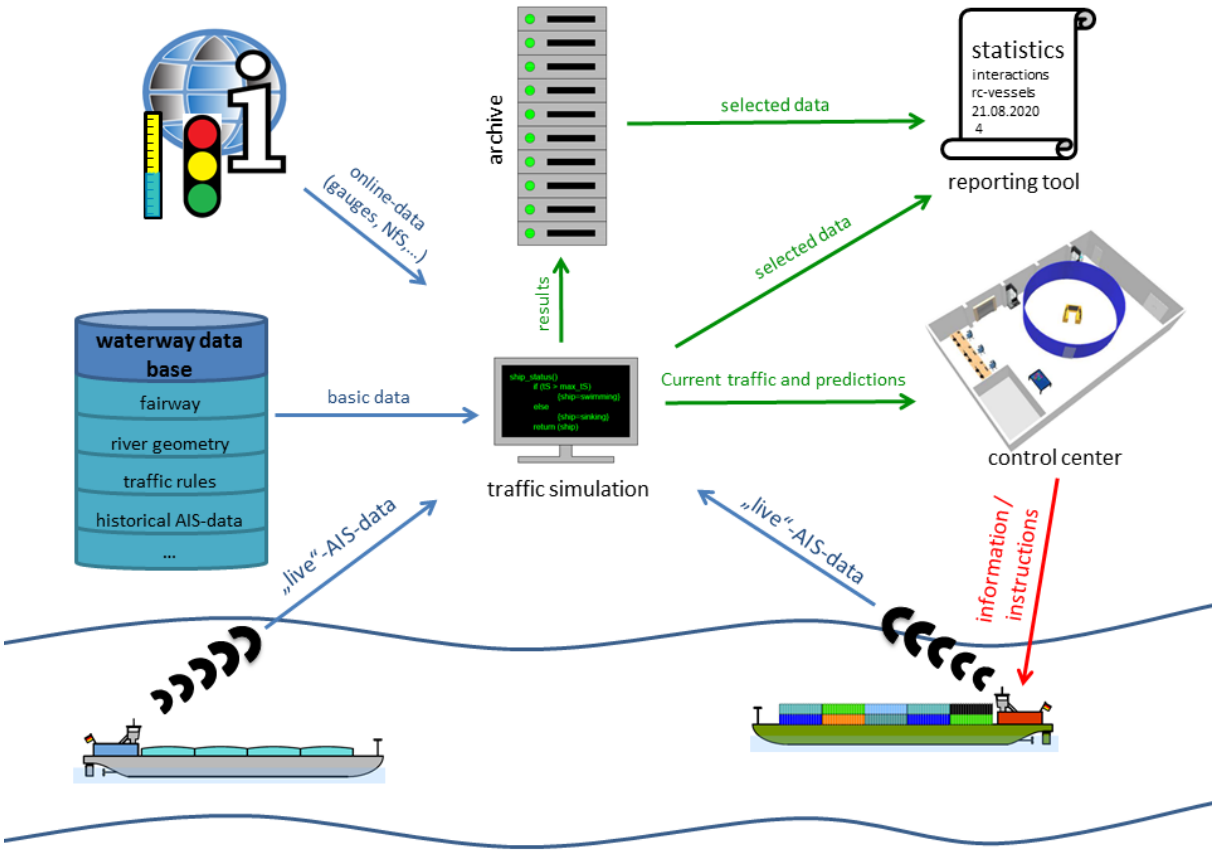

Figure 1: Data flow within mikroVon

Based on the available information, the simulation model predicts the ships trajectory for the nearest future (several minutes to hours) and derives encountering areas.

Cascaded runs

The accuracy of the prognosis decreases with longer prediction time. To always have the best possible forecast, the simulation runs are operated in cascades. A new simulation run starts in regular intervals including actualized "live"-data (AIS).

The principle of cascaded runs with updated traffic data is shown in Figure 2.

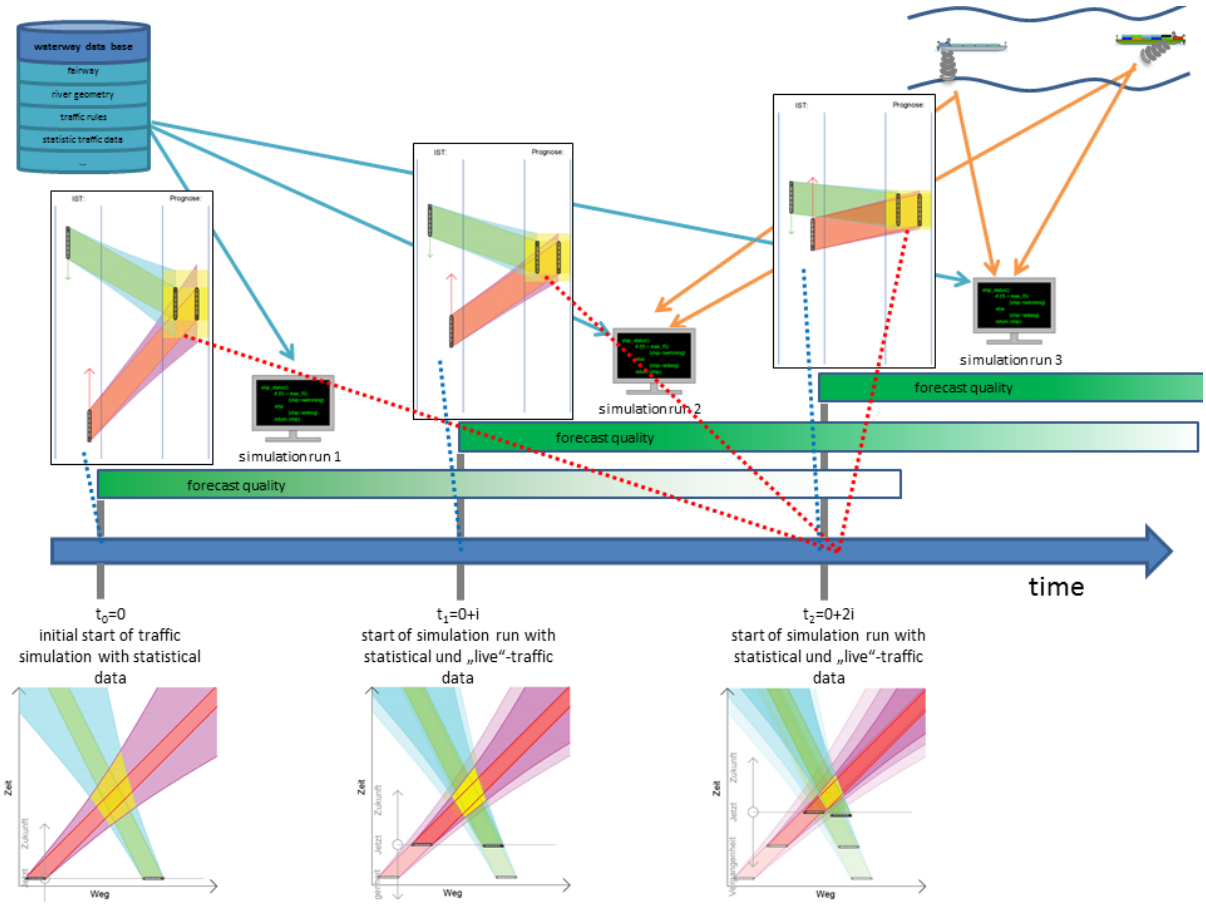

Figure 2: Cascaded runs of traffic simulation to obtain highest forecast quality

By running the simulation in cascades, the accuracy of prediction for future interactions steadily increases and adapts on the behavior of skippers.

Results

The main results are predicted encounters. These can be evaluated by ship sizes, fairway and river geometry, traffic rules and statistical data to classify the situation. If a critical situation is detected, automated warnings are broadcasted to skippers or a control center.

Besides, data and estimated time of arrival for various positions, passing time for restricted areas and much more information is produced in an unprecedented accuracy.