GIS technology for maritime traffic systems

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Objectives of combined research in the fields of Geographical Information Systems (GIS) and maritime transportation are to develop data models and computing architectures that favour the development of traffic monitoring and analysis for decision-aid systems. This article illustrates benefits of an integration of GIS and Intelligent Transportation Systems (ITS) for maritime navigation.

Safety and security are constant concerns of maritime navigation, especially when considering the constant growth of maritime traffic and decrease of crews on decks. This has favoured to the development of automated monitoring systems such as the Automatic Identification System (AIS) and Electronic Chart Display and Information System (ECDIS). However, officers on the watch and monitoring authorities still require the development of additional and advanced decision-aid solutions that will take advantage of these communication and cartographical systems.

The combined development of geolocalisation, information and telecommunication technologies offer higher traffic data availability, but bring new challenges for the integration, analysis and delivery of maritime traffic data. This increases the need for integrated traffic systems able to cope with all these technological domains. The development of real-time integrated maritime platform implies a reconsideration of the storage, modelling, manipulation, analysis and visualization functions whereas current models and architectures have not been preliminarily designed to handle such dynamic phenomena.

Amongst several technological solutions that might contribute to the emergence of maritime-based decision-aid systems, integration of Geographical Information Systems (GIS) with maritime navigation systems appears as one of the promising directions to explore. Our approach relies on a monitoring-based project whose purpose is the integration of heterogeneous positional data coming from (1) Automatic Identification System (AIS), (2) public traffic data available from the Internet and (3) real-time monitoring system developed for sailing races. These systems generate geolocalisation frames from different types (e.g. AIS frames) and from different ad-hoc networks (e.g. VHF for AIS, WiMAX for sailing races). Coupled with external databases, this constitutes the entry of an internal spatio-temporal database that manages historic and real-time data. These data includes maritime trajectories, vessel characteristics and environmental data.

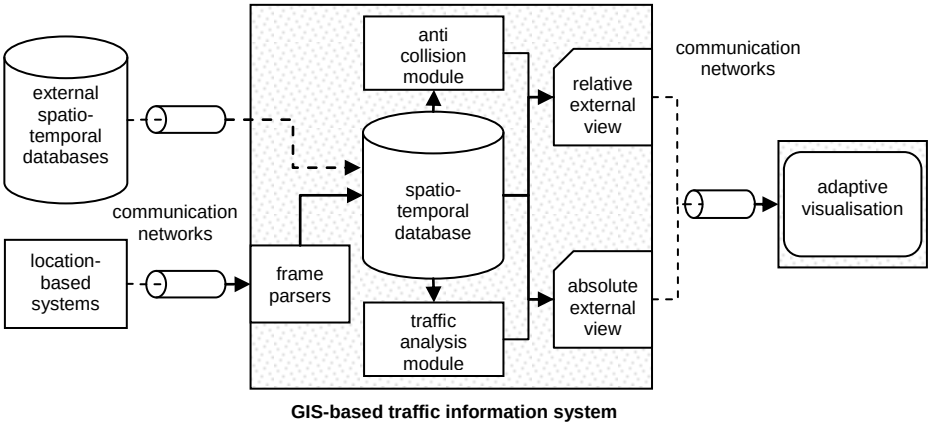

Figure 1. integrated GIS

The framework developed so far integrates several modules such as an anti-collision function that monitors running aground risks and evasive ship behaviours. This module also integrates simulation capabilities in order to control and predict the evolution of ship behaviours and trajectories. These simulations are based a multi-agent system and micro-simulation capabilities, where ships are modelled as autonomous agents acting in their environment according to maritime rules. The module is designed for maritime authorities and educational and training purpose. Moreover, the traffic analysis module integrates intelligent inference mechanisms that can derive traffic patterns through data mining process. The objective is to observe and understand maritime traffic at different levels of granularity.

Two complementary external views are of interest for maritime traffic monitoring. The usual one is given by the conventional absolute view of spatial trajectories. The second one combines the relative position and relative velocity of

mobile ships with respect to an observer. This relative external view helps users to perceive the traffic evolution according to their point of view and their perception of the underlying processes that emerge from the ships behaviours.

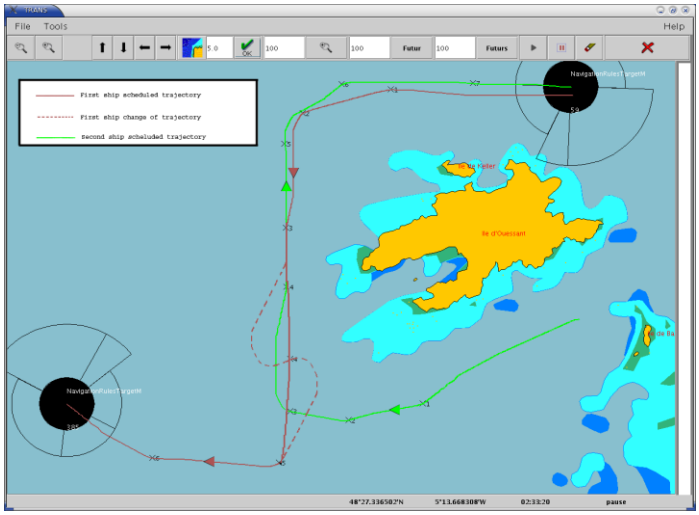

Figure 2. illustration of anti-collision module

On-going research in terms of user interaction focus on adaptive GIS concept which can be defined as a generic and context-aware GIS that is automatically adapted according to several contexts defined by (1) the properties and location of the geographical data manipulated (e.g. maritime traffic data), (2) the underlying categories that reflect different user profiles (e.g. port authorities) and (3) the characteristics of the computing systems that include web and wireless techniques. The use of adaptive GIS as a decision-aid system for end-users and decision-makers appears as a useful approach for maritime transportation systems.

The framework developed so far provides a preliminary step towards the development of integrated GIS and maritime information systems. Remaining research challenges include the development of cross-domain protocols and exchange standards for the transmission and interoperability of traffic data, integration of different geographical information sources combined, adapted and shared in real-time between different levels of users acting in the maritime environment. Conventional statistical, geographical data analysis and visualization methods should also be adapted to the specific nature of maritime traffic information. At the implementation level, there is also a need for the development of GIS-based distributed computing environment, computational and processing capabilities as traffic data and applications are usually physically allocated in different geographical locations and computationally expensive in terms of the data volumes generated. Overall the development of GIS for maritime information systems should improve the management and planning of maritime navigation, thus favouring the search for a safer sea.

Links:

GIS research group of Naval academy: http://www.ecole-navale.fr/fr/irenav/groupes/sig/sig-en/

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