ALGORITHMS FOR ANTI-COLLISION SYSTEM FOR MARITIME SAFETY TASKS USING UAV

Andrejs Zvaigzne, Aleksandrs Gasparjans, Dmitrijs Gorelikovs, Anatoly Levchenkov, Mikhail Gorobetz (Riga, Latvia)

The paper proposes the solutions for applying the embedded devices, unmanned aerial vehicles (UAV) and evolutionary algorithms to minimize simultaneous existence of maritime transport units at the same location and time, i.e. avoiding a possibility of collision.

Nowadays maritime transport flow is intensive and increasing. Maritime transport accidents become an everyday reality. It is hard to evaluate losses from the accidents and all these consequences for the state in general and a separate citizen, but the negative effect is definitely proved. The collisions of the maritime transport units have the most serious consequences.

Thus, the main goal of the research is to investigate and develop the algorithms for maritime transport traffic speed, course and scheduling control minimizing the probability of collision. The research includes the analysis of existing maritime transport safety and navigation systems, the development of the new maritime anti-collision system (MACS), including mathematical models, multiple criteria risk assessment function of evolutionary algorithms, self-training neural networks models, simulation models and prototypes for anti-collision task.

The proposed maritime anti-collision system obtains the data from Automatic Identification System (AIS) about all available units in the defined area. The main disadvantage of AIS is the lack of information about static objects and small maritime units, which are not equipped with AIS.

The main function of the proposed anti-collision system detects the locations of the higher probability of collisions on the all over route of the unit from the origin to destination. The system is able to propose the possible solution of multiple criteria task to minimize the probability of collision with the minimal changes of the route, speed or the schedule to reduce the negative effect by increasing the safety. The proposed anti-collision system is targeted to be integrated in the Electronic Chart Display and Information System (ECDIS) providing the information in a new additional specific overlay, designed for anti-collision system.

As well, UAV may option the proposed system as an auxiliary safety feature. The equipment of UAV includes the object recognition devices and the software to detect static objects, obstacles or other units in the area, which do not provide the AIS data. It significantly extends the safety functionality of the proposed anti-collision system by trajectory calculating of the all units and objects in the area additionally to AIS.

The main advantage of the proposed system is that system extends the ECDIS by providing real-time recommendations for safe control of the vessel and warns in case of the probable risk of collision. It is able to forecast dangerous situations and avoid them with the minimal consequences.

The computer model of the maritime transport with stochastic parameters, such as traffic, technical condition, weather conditions is created. In addition, functional prototypes of embedded intelligent devices are manufactured to test the system in real conditions.

Set of previously performed simulations have been performed. The developed models and algorithms may improve the safety level of transport system control. The results of the evolutionary algorithms provide better results than the original schedule in 100% cases by all target function criteria. Essential reduction of collision probability is possible from the original value 0.94 to result value 0.01.