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THE USE OF AUTOMATIC COMMUNICATION SYSTEM ON EXAMPLE OF A CONVERSATION BETWEEN M/V CORCUS J AND M/V BALTIC ACE

ABSTRACT

Article presents the applications designed to perform automatic communication as a support for navigators steering their ships. Authors took into consideration the conversation between navigators in the collision situation that occurred at North Sea basin. The performed incorrect communication has been presented and alternative to it has been proposed. The results of simulation made with use of the prototype of automatic communication and negotiation system has been shown.

Keywords:
collision, automatic communication, reasoning mechanism, knowledge base electromagnetic

1. DESCRIPTION OF THE NAVIGATIONAL SITUATION

On 5.12.2012 at 1815 Universal Time Coordinated (UTC) in position 51° 51.9'N 002° 53.9'E, located within the Noordhinder Junction area of the southern North Sea (Fig 1), container ship CORVUS J, registered in Cyprus, collided with the Bahamas registered vehicle carrier Baltic Ace [3], [4]. As a result, the Baltic Ace sank in 15 minutes taking people lives and causing financial losses.

Figure 1. Position of the collision of m/v Corvus J and m/v Baltic Ace vessels [3]

According to the Bahamas Maritime Authority Investigation Report, both ships were on a collision course, and according to international regulations on preventing collisions at sea m/v Corvus J having m/v Baltic Ace on its starboard side should give way. Navigators controlling the ships started communication during which there was a misunderstanding. As a result of action taken by the navigators there was an accident in which one of the ships sank. According to the Bahamas Maritime Authority Investigation Report, navigators misunderstood their intentions and from the records of their conversations result is insufficient knowledge of the English language in which the communication was conducted.

A quick record of the dialogue carried out between the navigators and course of actions are shortly presented in the table 1.

Table 1. Selected actions and recorded messages of navigators on m/v Baltic Ace and m/v Corvus J (part 1)

Time (UTC)	Selected Actions	Communications
18:08:00	Baltic Ace and Corvus J were 3nm apart, with a CPA of 0.5nm. Corvus J was intending to cross ahead of the Baltic Ace.	
18:08:45	The first acknowledgement by the OOW onboard the Baltic Ace as to the CPA and the developing situation with the Corvus J	

Table 1. Selected actions and recorded messages of navigators on m/v Baltic Ace and m/v Corvus J (part 2)

18:09:40	Baltic Ace called the Corvus J on VHF.	Baltic Ace: So, I see that you pass my bow very close so keep your course and I alter my course a little to port, Ok, I alter to port. Corvus J: Yeah OK, because I am departing behind one vessel after you go behind me, OK thank you very much. Baltic Ace: Yeah I see, I alter to port, OK thank you.
18:09:40 - 18:11:28	Baltic Ace altered course to port and over the same period, the Corvus J commenced altering to a new course.	
18:11:28	Baltic Ace called the Corvus J having detected the alteration of heading by the Corvus J soon after the first VHF conversation.	Baltic Ace: Yeah I see you alter your course to starboard now yes? I alter to port, OK thank you. Corvus J: Yes just now, I will keep the course, because another vessel crossing my stern, she is going there behind me. If possible you change a little bit to port after we be fine. Baltic Ace: Ok, I go more to port, Ok.
18:11:28 - 18:12:27	Baltic Ace altered to port whilst the Corvus J maintained its course and speed.	
18:13:18	Corvus J establishes communication with the Baltic Ace	Corvus J: You keep your course like that? Baltic Ace: Yes I keep like that
18:14:18	The OOW on the Baltic Ace stated that the crossing distance between the two vessels was now 2 cables ahead. At this point both vessels were in their respective turns, the Baltic Ace was continuing to port and the Corvus J to starboard.	
18:15:17	Corvus J collided with the starboard side of the Baltic Ace.	

The report shows that the communication was carried out incorrectly. Navigators misunderstood their intentions and did not perform maneuvers agreed during communication.

The solution to such these types of problems may be solved in different way. There can be used a dedicated decision support system which can discover unsafe situations and inform navigators about them as well as propose a solution to pass

the other ships safely [8]. There may be also an additional system that would support the navigator's actions related to communication and reduce misunderstandings.

2. METHODS IN AUTOMATIC COMMUNICATION SYSTEM

The most important thing when reasoning in the automatic communication system is to determine the phase of the meeting based on the distance between the ships. This is due to the fact that, for example, during the first phases of the meeting, basic parameters are exchanged during communication and there is time to conduct negotiations and develop solutions that are convenient for both parties. In the final stages, however, there is no time to negotiate, the speed of decision-making/actions and the application of certain actions and designated maneuvers are important.

In order to manage communication processes, metarules are used, which indicate how the reasoning should be carried out using the rules stored in the knowledge base. Basic rules has a form:

If A then B

where A is a premise and B is a conclusion. And the rule is activated when the premise is satisfied and then the conclusion is applied.

There were prepared 6 sets of rules – one set for each phase of meeting and additional set of meta-rules which are used to determine the appropriate set of rule according to the meeting phase. There are different possible communication actions that can be made in different meeting phases: asking for different parameters and answering for this kind of questions, sending and receiving intentions as well as conducting the negotiations.

The inference engine is designed to interact with any set of rule for any number of surrounding ships. The communication to each other ship is carried out independently but the impact of arrangements with others is taken into account – the system stores in memory every fact or information as long as it can influence the reasoning process. The conception and mechanism of inference has been described in [5], [6] and [7].

3. AUTOMATIC COMMUNICATION PROCESS BETWEEN M/V CORVUS J AND M/V BALTIC ACE

Assumptions for the example:

- reasoning will be carried out automatically in order to initiate communication in the present situation,
- an automatic communication system operates on both ships,
- the example will be shown from the m/v Corvus J ship perspective, with highlighted moment of receiving the message from m/v Baltic Ace: Baltic Ace: "So, I see that you do pass my very little, Ok, I alter to port",
- the reasoning part of the system has the information contained in the message provided as the input data,
- the system is working all the time checking the distance between ships.

Automatic communication system on m/v Corvus J recognize based on the distance that m/v Baltic Ace entered the observation area so the message with basic parameters values is prepared and sent. If there is no message received with basic parameters values from Baltic Ace then there is prepared a question for those parameters. After this exchange the situation is identified with the use of COLREGS rules and Corvus J is the giving way ship so this information is provided to the navigator. The maneuvers values are prepared by the simulation module and also provided to navigator.

Let consider that similarly to real situation automatic communication system on m/v Corvus J received message from m/v Baltic Ace: *So, I see that you pass my bow very close so keep your course and I alter my course a little to port, Ok, I alter to port.*

Information from the message is an input data for the reasoning part (see tab. 4):

Table 2: Type, category and content of message from m/v Baltic Ace

type of the message: tell category of the message: information content: CV pass BA bow very close
type of the message: tell category of the message: request content: CV keep your course
type of the message: tell category of the message: intention content: BA alter course a little to port

Because the message include the intentions of m/v Baltic Ace the system on m/v Corvus J check whether all the data needed to simulate the solution proposed by the foreign ship is available. In the absence of such data, a message is sent to a foreign ship asking for the missing data. If all data are available, a simulation of the navigational situation for the given parameters is started.

The system uses the independent module to provide navigational decisions as well as simulations of different situations progress. In this automatic communication system such module is a kind of "black-box" – it is used to provide information but there is unknown its structure and algorithms of work. It may be human-expert or automatic decision support system (ex. NAVDEC [2]) to prepare the. When the results of simulation are ready, the system can make reasoning and generate proper message to m/v Baltic Ace. The message is given a tell type, warning category and contains information that the intentions of m/v Baltic Ace are not compliant with the COLREGS regulations[1]. In addition there is generated a question, which ask about intentions in connection with the warning. The warning message is also sent to navigator on the bridge of m/v Corvus J. Further reasoning and actions depends on the answer from m/v Baltic Ace.

The prototypes of automatic communication and negotiation system have been running as different processes and used to simulate the possible conversations between the ships. Simulation of possible responses from the m/v Baltic Ace and related actions were analyzed. This resulted in a collection of conversations that may arise in this example. Actions of navigators in accordance with system hints led to a collision-free solution to the presented navigational situation.

In a situation that occurred in the North Sea basin, the navigators, despite their intentions of actions began to change them. According to this, when performing verification of the correctness of the system, actions of navigators, among others changes of course, was introduced in near real-life situations. The system identifies such changes and as a result of reasoning signals to the navigator that such actions are inconsistent with the arrangements made in communication with a foreign ship. Also proper message is sent to the other ship.

CONCLUSIONS

There have been tested the set of possible navigational situations progresses with different kinds of communication strategies – starting from ships' parameters interchange finishing on negotiations of maneuvers. Even simple information exchange made possible to avoid the simulated collision, especially when proper warning was provided to navigators conducting the ships. The option of negotiation gave the possibility to prepare and act the maneuvers safe and efficiently for both ships.

The communication carried out using the described automation of reasoning processes leads in the presented example to a collision-free solution to presented situation.

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STRESZCZENIE

W artykule zaprezentowano aplikację utworzoną z zamiarem realizacji automatycznej konwersacji dla wspomagania nawigatorów kierujących statkami. Autorzy uwzględnili rozmowę między nawigatorami w sytuacji kolizji, która zdarzyła się na Morzu Północnym. Zaprezentowano niepoprawną komunikację pomiędzy statkami a także propozycję alternatywnej. Przedstawiono też wynik zasymulowanej komunikacji wykonanej z użyciem prototypu systemu automatycznej komunikacji i negocjacji.