TRANSNAV
International Journal
on Marine Navigation
and Safety of Sea Transportation

Volume 5
Number 1
March 2011

Safety Control of Maritime Traffic Near by Offshore in Time

D. Yoon
SUNY Maritime College and Mokpo National Maritime University

M Yi, J. S. Jeong & G. K. Park
Mokpo National Maritime University

N. S. Son
MOERI, Korea Ocean Research and Development Institute

ABSTRACT: This paper introduces and presents a strategy for ensuring safety during control of vessel interaction in real time. A measure of danger during the interaction is explicitly computed, based on factors affecting the impact force during a potential collision between an object and the vessel. A motion strategy to minimize the danger factors and risk level is developed for articulated degree of freedom for multi activities of vessel. Simulations and experiments demonstrate the efficacy of this approach. The aim of this research is to introduce and develop an assistant system by analyzing ships activities in real time from land aspect.

1 INTRODUCTION

As vessel move from the water point to water point and other water environments, safety of safety controls interacting with vessel becomes a key issue [1, 2]. The vessel system must provide a mechanism to ensure ship safety, given the uncertain environment and untrained sailors. To ensure the safety and intuitiveness of the interaction, the complete system must incorporate (i) safe mechanical design, (ii) safety control friendly interfaces such as natural language interaction and (iii) safe planning and control strategies. Our work focuses on this third item. In particular, the goal is to develop strategies to ensure that unsafe sailing does not occur between any point on an articulated vessel and a safety control in the vessel's workspace. This paper focuses specifically on the real time safety during safety control of vessel interaction. The concept of e-navigation can be drawn as below figure 1. The process of e-navigation will affect whole process of development. The process of practice and operation is affected by user requirement, operational function, and technical equipment and gear.

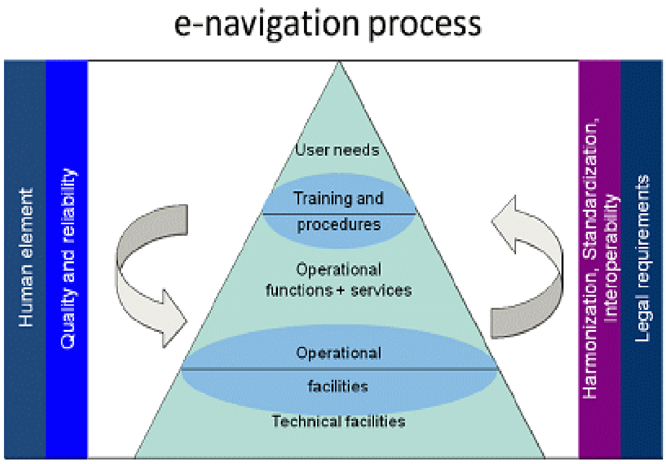

Figure 1. IMO Strategy for E-Navigation Process

2 DESIGN A MODEL FOR SAFETY CONTROL IN REAL TIME

In this research, there are several navigation equipment were used to analyze navigation data including from ARPA, AIS, NAVTEX and VHF. It is assumed that those data were received the data field from low data given by each navigation aids. In brief, the information from ARPA and AIS is as follows,

- Present bearing of the target
- Present range of the target
- Predicted target range at the closest point of approach (CPA)

– Predicted time to CPA (TCPA)
– Calculated true course of the target
– Calculated true speed of the target
– IMO number, Call Sign, Name, Length, Beam, Type of ship, Location of position-fixing antenna on the ship
– Ship's Position, Time in UTC, Course over ground, Speed over ground, Heading, Navigational status, Rate of turn, Ship's draught, Hazardous cargo, Destination and ETA

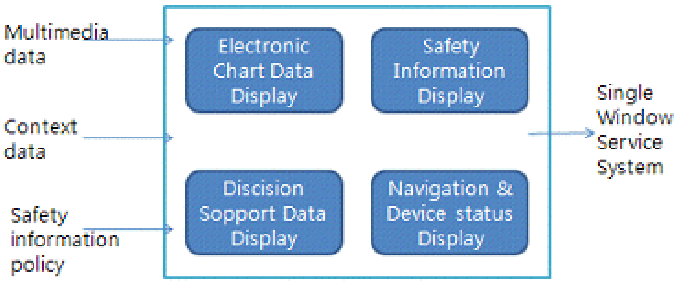

Figure 2. Integrated Service System Using AIS

Based on that information, this paper applied a model of meaning analysis which is made by each data field by navigation gear and target-related knowledge. The model can show just simple sentence. In next, by using the meaning analysis for designed navigational equipment, it is showed a model of meaning model for target.

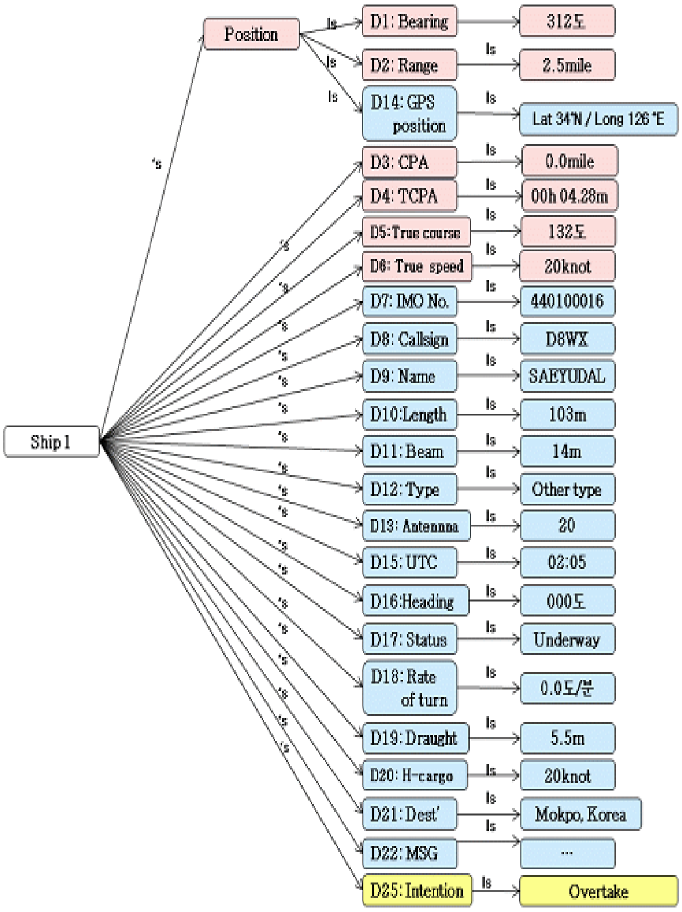

Figure 3. Model of Meaning Analysis: If target is Vessel

Case 1: If target is ship or vessel,

– Usually by performing ARPA, AIS, and VHF, the information can be obtained. Therefore, in this case, the model of meaning analysis is combined the information of ARPA, AIS, and VHF. Below figure can explain this case.

Case 2: If target is other than ship or vessel,

– Usually in this case, the model of meaning analysis is combined the information of ARPA and NAVTEX because it is impossible to get information from AIS and VHF. Below figure can explain this case.

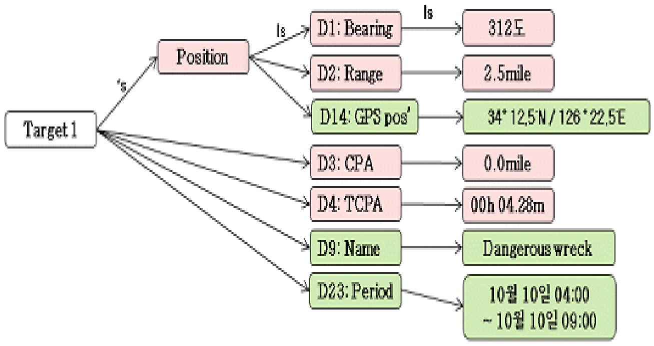

Figure 4. Model of Meaning Analysis: If target is Other Than Vessel

The view of intelligent safety information system and discrete event system

– Step of unit filtering and recognition: need to analyze data coming up in real time.
– Step of expecting situation: need to check out in terms of discrete event system.

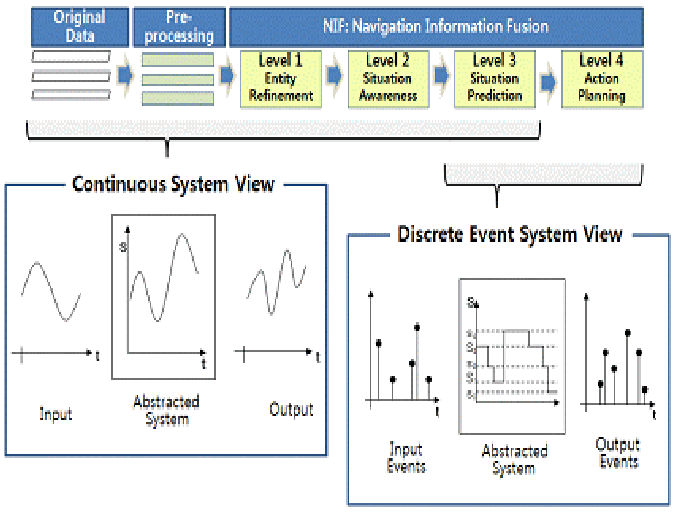

Figure 5. Navigation Information Mixing System by Discrete Event System View

– System Draft for Expecting Safety Situation

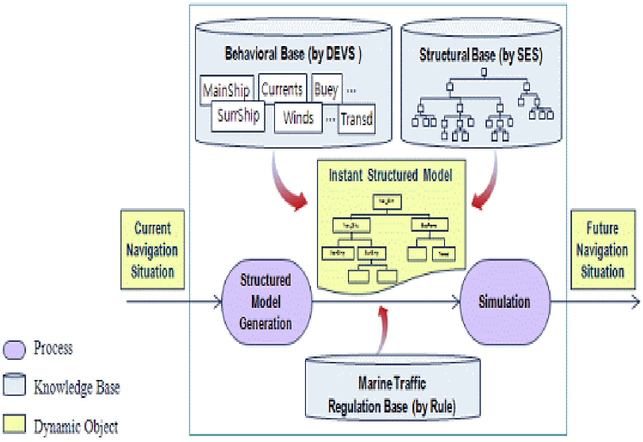

Figure 6. Draft of Simulation Module for Expecting Situation

1 Three Dynamic Units
- Input Factors: Current Navigation Situation
- Output Factors: Future Navigation Situation
- Inside Unit: Instant Structured Model for Dynamic Change of Situation

2 Three Knowledge Base including Behavioral Base, Structural Base (Behavioral Base SES(System Entity Structure)), Regulation Base

Two Inside Process for Structured Model Generation and Simulation Process

Blocking area theory is effective to avoid single traffic ship but it has difficulty in avoiding lots of traffics concurrently in the real sea. Through simulator experiments, it can be found that collision risk is estimated normally by using fuzzy algorithm, with the similar tendency of environmental stress in open sea and confined waterway. It can be drawn in figure 7.

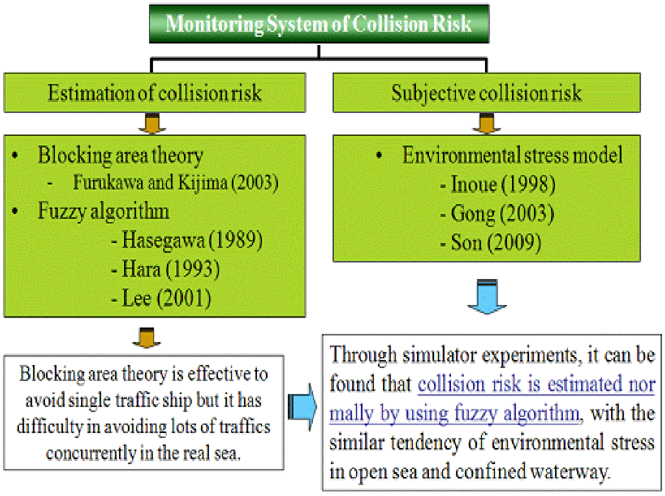

Figure7. Model Research for Risk Level of Ship Collision

Identification Model for Degree of Collision Risk

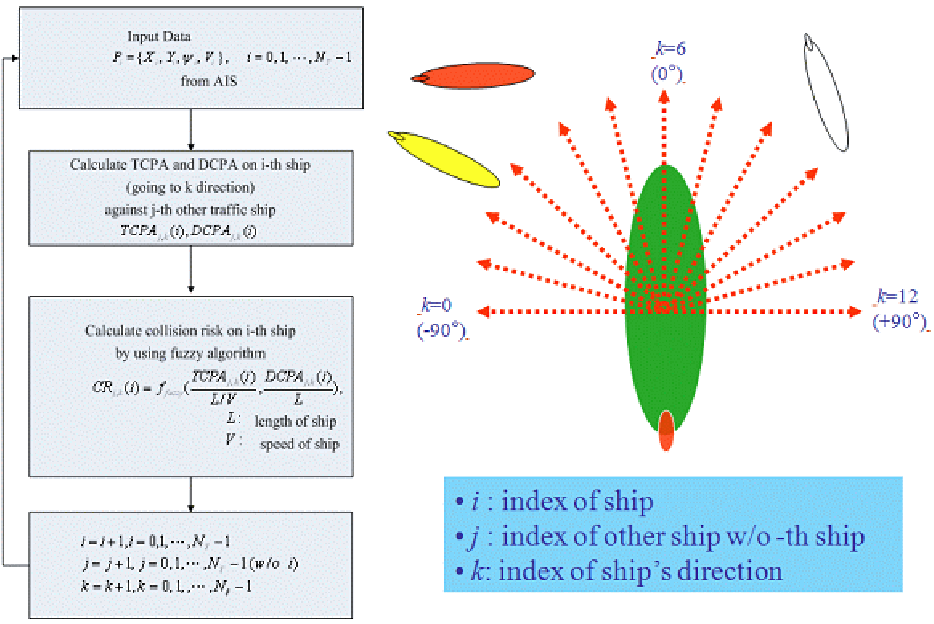

Figure 8. Flow Chart and Draft of Assessment Algorism of Degree of Collision Risk

Figure 8 showed a flow of an assessment algorism of degree of collision risk which is used for safe ship movement planning and control. Based on marine traffic data, interrelated model can be summarized and described in below Figure 9.

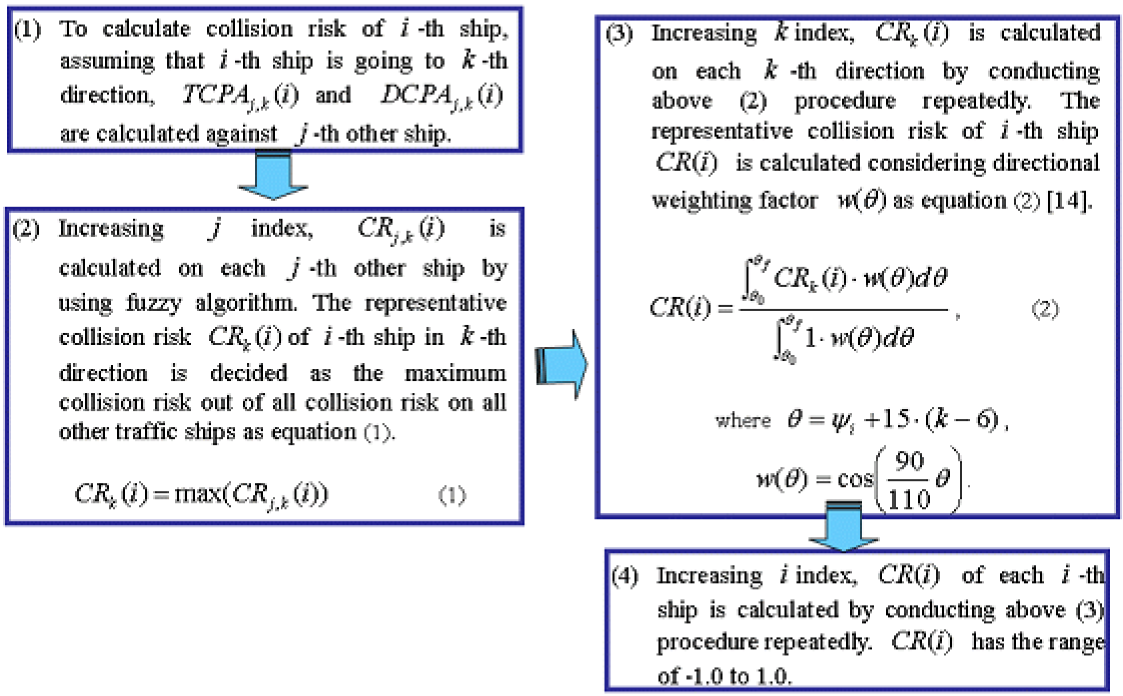

Figure 9. Chart of Assessment Algorism of Degree of Collision Risk

3 TEST RESULT FOR RISK ASSESSMENT

This research showed the test result of whole concept models in order to verify the assessment model of risk degree of environment near the vessel. The structure of test will be shown in the below figure. Dotted line is to be designed. Experimental frame's Generator provides random environmental data for verify outputting data. In the step of Pre-processing, data will be treated and processed in order to be understandable after receiving data. After then, input data will be used to calculate the assessment result of risk degree for each parameter after passing fuzzy professional system. Finally, Total_ERAN Process will guide and explain total degree of collision risk and unit risk degree to the user and/or sailor.

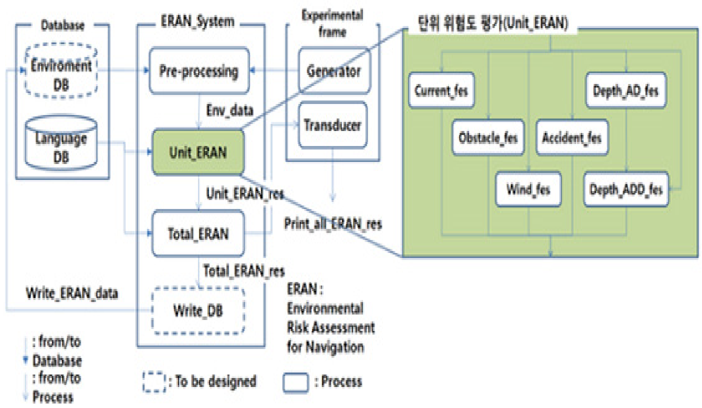

Figure 10. Chart of Test System

The experimental result is showed implementation for random situation and assumed scenario by generator. In the data base, environment DB are important parts in real time information and containing pre-decided environment risk list in its activating equipment. however in this research, real time environment information are created by generator which are investigating case for conception model , except in here Result from environment risk assessment by random cases from generator, Maritime safety information which is connected and unified to GICOMS (General Information Center on Maritime Safety & Security) makes it possible to revaluate its effectiveness and reproduce

- improve governmental, people require service .By provide suitable information which are necessary to government division and company
- improve safety for crew, cargo, vessel by providing pre-alarm in accident frequent site and danger site of pirate
- protect personal and national information by internet based on GICOMS operation security system

4 CONCLUSIONS

This study integrates various theories and methodologies implemented in vessel safety systems into a unique, original platform. Ultimate goal was the complete integration of a vessel safety, which in turn is able to promote the safety, security and comfort of vessel occupants from collision. Therefore, this paper introduced and presented a model for ensuring ship safety during a safety control of vessel interaction in real time. The level of danger in the interaction due to a potential collision is explicitly defined as the danger characteristic. A sequential onestep ahead trajectory planner (the safety system) is presented which generates vessel motion by minimizing the danger characteristic. The algorithm can be used for redundant or non-redundant manipulators, and operates correctly at all vessel configurations.

REFERENCES

[1] A. Bicchi, S. L. Rizzini, and G. Tonietti, "Compliant design for intrinsic safety: General Issues and Preliminary Design," presented at IEEE/RSJ Int. Conf. on Intelligent Vessel and Systems, pp. 1864- 1869, 2001

[2] A. J. Bearveldt, "Cooperation between Man and Vessel: Interface and Safety," presented at IEEE Int. Workshop on Vessel Human Communication, pp. 183-187, 1993.

[3] B. Martinez-Salvador, A. P. del Pobil, and M. Perez-Francisco, "A Hierarchy of Detail for Fast Collision Detection," presented at IEEE/RSJ Int. Conf. on Intelligent Vessel and Systems, pp. 745-750, 2000.

[4] N.S. Son, S.Y. Kim, J.Y. Oh, "STUDY ON AN ALGORITHM FOR THE ESTIMATION OF COLLISION RISK AMONG SHIPS BY USING AIS DATABASE", Proceedings of 9th Asian Conference on Marine Simulator and Simulation Research, pp.81-87, 2009

[5] J. Zurada, A. L. Wright, and J. H. Graham, "A Neuro-Fuzzy Approach for Vessel System Safety," IEEE Transactions on Systems, Man and Cybernetics - Part C: Applications and Reviews, vol. 31, pp. 49-64, 2001.

[6] J. Y. Lew, Y. T. Jou, and H. Pasic, "Interactive Control of Human/Vessel Sharing Same Workspace," presented at IEEE/RSJ Int. Conf. on Intelligent Vessel and Systems, pp. 535-539, 2000.

[7] N. S. Son, et. al., "Study on the Collision Avoidance Algorithm against Multiple Traffic Ships Using Changeable Action Space Searching Method,"Journal of Korean Society for Marine Environmental Engineering, Vol.12, No.1, pp.15-22, February 2009.

[8] Mira Yi, Gyei-Kark Park, and Jongmyeon Jeong, "DEVS Approach for Navigation Safety Information System", International Conference on Electronics, Information, and Communication, 2010

[9] O. Khatib, "Real-Time Obstacle Avoidance for Manipulators and Mobile Vessel," The Int. Journal of Vesselics Research, vol. 5, pp. 90-98, 1986.

[10] P. I. Corke, "Safety of advanced vessel in human environments,"Discussion Paper for IARP, 1999.

[11] "RIA/ANSI R15.06 - 1999 American National Standard for Industrial Vessel and Vessel Systems - Safety Requirements." New York: American National Standards Institute, 1999.

[12] S. P. Gaskill and S. R. G. Went, "Safety Issues in Modern Applications of Vessel," Reliability Engineering and System Safety, vol. 52, pp. 301-307, 1996.

[13] Y. Yamada, Y. Hirawawa, S. Huang, Y. Umetani, and K. Suita, "Human - Vessel Contact in the Safeguarding Space," IEEE/ASME Transactions on Mechatronics, vol. 2, pp. 230-236, 1997.

[14] Y. Yamada, T. Yamamoto, T. Morizono, and Y. Umetani, "FTABased Issues on Securing Human Safety in a Human/Vessel Coexistance System," presented at IEEE Systems, Man and Cybernetics SMC'99, pp. 1068-1063, 1999.

[15] Y. Yamada, Y. Hirawawa, S. Huang, Y. Umetani, and K. Suita, "Human - Vessel Contact in the Safeguarding Space," IEEE/ASME Transactions on Mechatronics, vol. 2, pp. 230-236, 1997.

[16] V. J. Traver, A. P. del Pobil, and M. Perez-Francisco, "Making Service Vessel Human-Safe," presented at IEEE/RSJ Int. Conf. on Intelligent Vessel and Systems (IROS 2000), pp. 696-701, 2000.