

Analysing the probability of risks by using AIS Data

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요 약 : The ships always have had the risk of collision. There are also a number of near-miss situations especially in the congested area such as port entrance, restricted waters and crossing point of the ship's route. In those areas, the navigator might have more stress than other areas. If the collision risk of decided area is calculated, it might be possible to analyse the human factors by using this data. It is also helpful for deciding a position of aids to navigation or any other system for the safety navigation. For this purpose, the model of collision risk with AIS data has been explained in this paper. The calculated result from the proposed model has been examined by using the simulation.

핵심용어 : AIS; Risk analysis; Marine Traffic Safety; Collision Probability

Analysing the probability of risks by using AIS Data

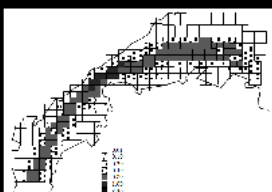
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Objective

- Estimating the workload related with human factors on board by using the geometrical collision diameter for the safety navigation.

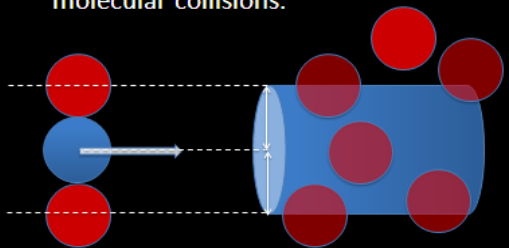
Analysing the human factors in the area

- When knowing or analysing the human factors in the area, the common measure is demanded for explaining the situation in the area.



Gas Model

- The gas model is one of the models that calculate the expected frequency of gas molecular collisions.



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Collision Rate Calculation by the gas model

- N ships are operating in an area S.
- One group of ships i, navigating same direction with V_i in the area A. And the other group j, is navigating same direction with V_j in the area A.
- If a ship is represented as a disk with diameter D, the probability of a collision between i and j during time t is calculated.
- If $E[V_r]$ is the expected relative velocity, the expected number of collisions is calculated.

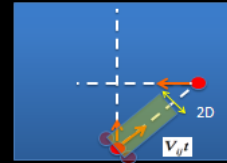
$$V_{r_{ij}} = (V_i^2 + V_j^2 - 2V_i V_j \cos\theta)^{1/2}$$

$$P_{ofCollision} = \frac{2DV_{r_{ij}}t}{A}$$

$$Expected = \frac{N^2}{2} \times \frac{2DE[V_r]t}{A}$$

Using the Gas Model Idea

- The collision frequency is depend on the relative speed and geometrical collision dimension.
- The yellow area is explaining the danger.
- The area might be small
- The sampling time might be long.



Calculation for analysing the frequency of meeting factor

$$FM = DijE[V_r]t$$

$$E[V_r] = \int_{V_i} \int_{V_j} \int_0^{2\pi} (V_i^2 + V_j^2 - 2V_i V_j \cos\theta)^{1/2} P_\theta(\theta) P_{V_i}(V_i) P_{V_j}(V_j) d\theta dV_i dV_j$$

$P(\theta)$: probability density function of θ

$P(V)$: probability density function of V

Calculation for analysing the human factor

Then the total expected frequency of meeting factor is:

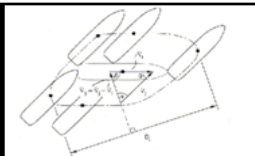
$$E[FM] = \rho_{cell} \sum FM$$

- ρ_{cell} : the density of the ship in the cell

Geometrical Collision Diameter by Pedersen's Model

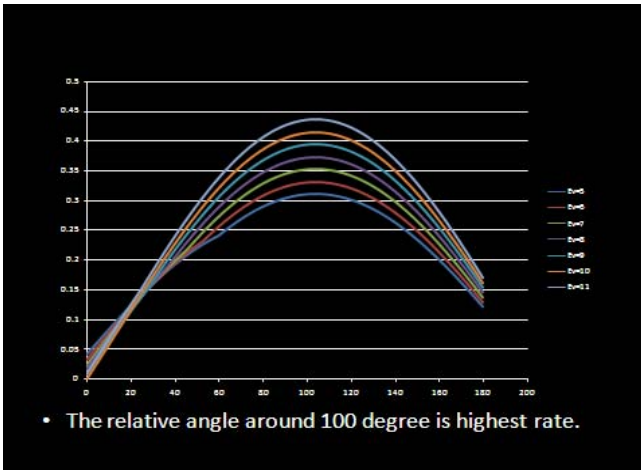
- For the calculation of geometrical collision diameter, the Pedersen model is used.

$$D_{ij} = \frac{L_i V_j + L_j V_i}{V_{ij}} \sin\theta + B_j \left\{ 1 - \left(\sin\theta \frac{V_i}{V_{ij}} \right)^2 \right\}^{1/2} + B_i \left\{ 1 - \left(\sin\theta \frac{V_j}{V_{ij}} \right)^2 \right\}^{1/2}$$

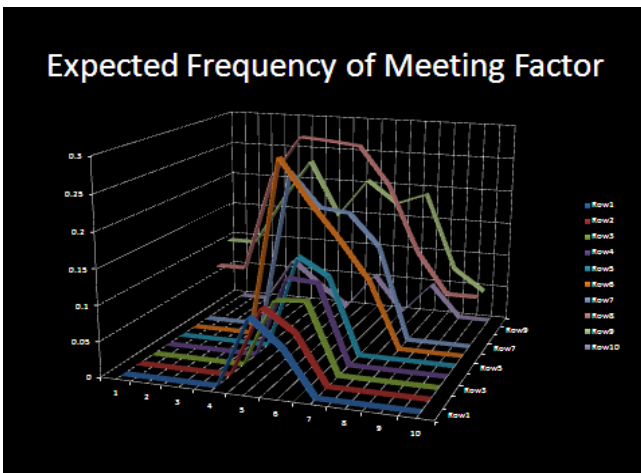
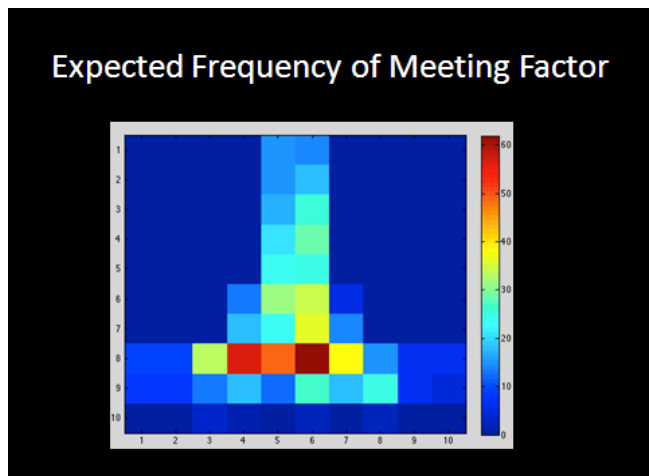
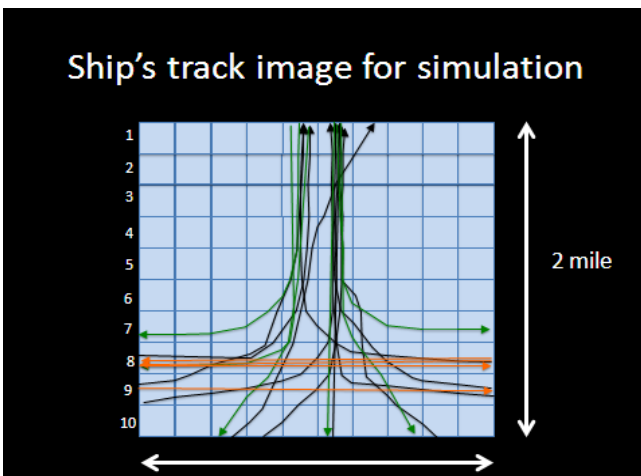


Two Ships Simulation

- Ship i and Ship j
- $V_i=10$ Knot
- $V_j=5$ to 11 Knot
- Relative angle 0 to 180 degree
- B_i and B_j are 30 m
- L_i and L_j are 120
- Cell size 1 mile \times 1 mile



- ### Simulation by simulated AIS data
- 20 ships
 - Time=0.5 h
 - Ship's type
 - Container (366x48)
 - Cargo (160x25)
 - Tanker (100x17)
 - Area (2 miles square, 0.2miles square cell)



- ### Conclusion & Future Analysis
- It is possible to know the situation in the area by using this method
 - Because calculation process is simple, the real time analysis is possible by using AIS.
 - It might be used for the human factor analysis in the future.
 - For analysing human factors by using this measure, more sample data is necessary.
 - Real time calculation is undergoing by using AIS data.