The design of fuzzy collision avoidance expert system implemented by Matlab fuzzy logic toolbox

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Abstract : *In recent years, shipping at the sea has been rapidly grown in marine nations and vessel's collisions are increasing as well. The collision avoidance is one of issues maritime safety. To reduce vessels' collisions, the fuzzy inference system is one of popular algorithms for collision avoidance. In this paper we aim to implement Matlab. Fuzzy logic toolbox software for collision avoidance algorithm.. For this we used an original Matlab fuzzy logic toolbox and customized the toolbox for the collision avoidance algorithm. .*

Keywords : Collision risk, Fuzzy logic toolbox, automatic identification system(AIS), fuzzy expert system
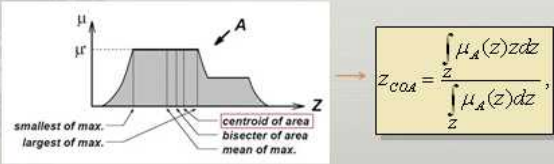
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Mamdani fuzzy model

- Defuzzyfier-> Converts the fuzzy output of the inference engine to crisp using membership functions
- We used Mean Of Maximum (MOM) method to illustrate CR.

$$z_{COA} = \frac{\int_z \mu_A(z)z\,dz}{\int_z \mu_A(z)\,dz},$$
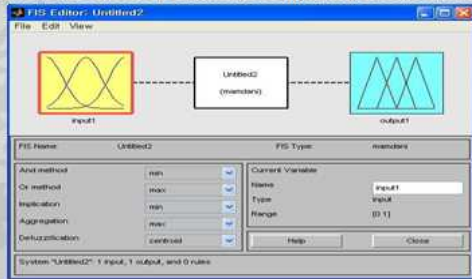

Fuzzy collision risk

$$CR_{j,k}(i) = f_{fuzzy}\left(\frac{TCPA_{j,k}(i)}{L/V}, \frac{DCPA_{j,k}(i)}{L}\right)$$

$$CR(i) = \frac{\int_{\theta_0}^{\theta_f} CR_k(i) * \omega(\theta_k)\,d\theta_k}{\int_{\theta_0}^{\theta_f} 1 * \omega(\theta_k)\,d\theta_k}$$

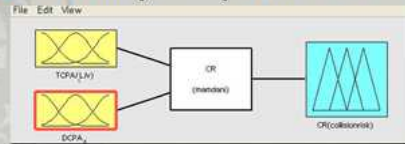## Matlab fuzzy logic toolbox

- Fuzzy Logic Toolbox software is a collection of functions built on the MATLAB technical computing environment
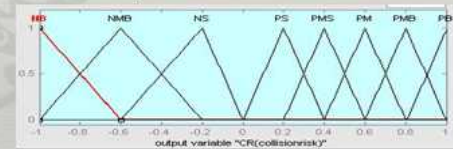

Implementation of Collision Risk in Matlab Fuzzy Logic Toolbox

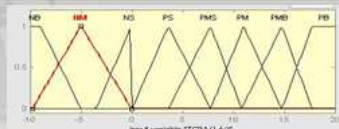- Mamdani style fuzzy model in Matlab
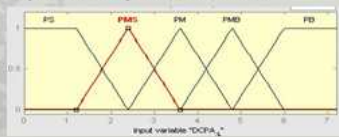

- Membership function of Collision risk

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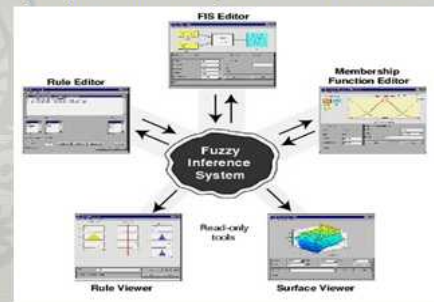
- Fuzzy membership function of TCPA

- Fuzzy membership function of DCPA

S: Small   M: Medium
P: Positive   N: Negative
B: Big

Matlab fuzzy logic toolbox

- Fuzzy Logic Toolbox Graphical User Interface Tools

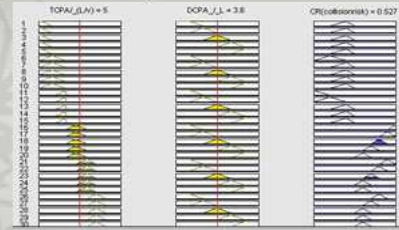## Implementation of Collision Risk in Matlab Fuzzy Logic Toolbox

Inference laws of Collision risk

		TCPA							
		NB	NM	NS	PS	PMS	PM	PMB	PB
D	PS	NS	NMB	NB	PB	PMB	PM	PMS	PS
C	PMS	NS	NS	NMB	PMB	PM	PMS	PS	PS
P	PM	NS	NS	NS	PM	PMS	PS	PS	PS
A	PMB	NS	NS	NS	PMS	PS	PS	PS	PS
	PB	NS	NS	NS	PS	PS	PS	PS	PS

Implementation of Collision Risk in Matlab Fuzzy Logic Toolbox
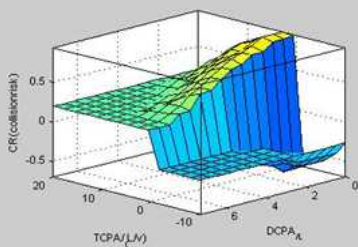
■ Implementation of fuzzy rules in Matlab

Implementation of Collision Risk in Matlab Fuzzy Logic Toolbox

■ Surface view of Collision Risk

Conclusions and Future study

■ Fuzzy collision avoidance system will advise a proper avoidance action to resolve the risk

■ Matlab fuzzy logic toolbox is very efficient to create fuzzy expert system and plots.

■ We will compare fuzzy inference system with other collision avoidance algorithm