CONFIGURATION SELECTION METHOD WITH FUZZY DECISSION MAKING IN PREVENTION PORPOISING ON FLOATER N219

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ABSTRACT

Porpoising leads to hull damage an inconvenience for passengers and crew in ship operations, especially ships with high F_n. Porpoising is one type of ship and floatplane instability. The choice of ship and floater configuration can prevent the occurrence of porpoising instability. Configuration selection using fuzzy logic method with multiple attribute decision making for 8 variables with 6 configurations of deadrise angle β and LCG longitudinal centre of gravity of a ship. Determination of objective configuration scenario and objective function for optimum configuration selection. Region or domain clustering is performed for each variable in all six configurations. Membership value assessment is carried out by entering the input of the configurations. Membership value assessment is carried out by entering the input of the configuration variable into the membership function to obtain the membership value or degree of the six configurations. For each variable, plotting is also carried out to the region in the existing region division. Configuration selection gets 2 alternatives, namely by clustering the best configuration of deadrise angle of 20° and LCG value of 55% and the configuration of deadrise.

Keyword: clustering, configuration, floater, fuzzy logic, membership value

Introduction

Porpoising is a longitudinal instability of a ship heave and pitch movements that is common or often experienced by ship travelling at high speed in calm water condition [1]. It is necessary to be avoided because as the operation and use of ships that experience porpoising causes damage to the hull. In addition to the construction aspect, the comfort and safety aspects of the crew and passengers are important considerations why it is necessary to prevent ship operations in order to avoid this porpoising phenomenon [2].

Preventive or prevention of this instability condition can be done by selecting a ship configuration value that minimises the variables that indicate the ship is experiencing instability. In this configuration selection, a decision-making method with fuzzy logic is chosen. Fuzzy logic is able to define values between conventional states to provide definite conclusions even from vague, unclear, imprecise, and confusing information [3]. This method is a kind of counting or calculating variable words (linguistic variables) by providing a range of values as a definition of these words.

With the implementation of fuzzy logic, intended to be implemented as an approach for selecting the configuration of a floatplane' s floater to prevent and minimize porpoising during take-off. The data used from parameters results previously research study on porpoising instability during take-off in calm water conditions.

Literature Review

A significant challenge faced when ships or floatplanes accelerate is the instability known as porpoising [4] [5]. Porpoising refers to repetitive pitch motion of amphibious aircraft, floatplane, resulting from dynamic instability between aerodynamic and hydrodynamic forces on the floater of floatplane. This issue also arises when the aircraft's and the floatplane's longitudinal stance excessively high during take-off, potentially causing it to lose momentum and nosedive into the water [6]. From research porpoising [7], principal dimension of floater model of floatplane N219 that used measures are 9.6 m in length overall, 1.25 meter in width, and stands 1.1 meters tall. The demi hulls are spaced 3.95 meters apart, and the floater has displacement of 7,664 tons. From this research analysed 2 factors that affect to several parameter that affect to floatplane stability, namely deadrise angle and longitudinal centre of gravity of the floaters.

The selection of fuzzy logic [8] in the selection of this configuration was chosen because:

1. The mathematical concept underlying fuzzy logic reasoning is quite simple and easy to understand,
2. Fuzzy logic has some tolerance for imprecise data,
3. Fuzzy logic is very flexible,
4. Fuzzy logic is able to model very complex non-linear functions,
5. Fuzzy logic is able to build and apply the experiences of experts directly without having to go through a training process,
6. Fuzzy logic allows collaboration with conventional control techniques,
7. Fuzzy logic is based on natural language.

In fuzzy logic, there is a fuzzy set represents class of x value, characterized by a membership function or membership degree. The function itself associates each point or value within range [0,1], spanning from 0 (zero) to 1 (one] [9]. The framework design of fuzzy logic system begins with a process where a set of several *n* input enter the inference system is subsequently as a function. Fuzzy input is referred to fuzzification, which involves converting the input into linguistic variables using a membership function. Then, the inference system (function) transforms the fuzzy input within a region domain and evaluate it to outcome fuzzy output. The final stage of fuzzy logic is defuzzification, which converts fuzzy output from the inference system into a crisp form with a membership function that maintains as similarity within a specific value.

Methodology

An adjustment methodology with fuzzy logic decision making is needed according to the research context so as to obtain a methodology using the following stages:

1. Data Collection Process from initial data and transform into configuration form,
2. Determination of objective function,
3. Region division by clustering,
4. Determination of membership function,
5. Clustering of regions for each configuration,
6. Calculation of Membership value/degree of membership for each configuration,
7. Selection of objective regions for each Configuration,
8. Determination of membership value results for all variables in each configuration,

Process Transform Data

This process transforms the data according to the parameters and values given in the form of several configurations. In taking this configuration, the configuration is classified from 2 factors, namely β deadrise angle and LCG as a percentage of LOA. Table 1 provides initial data in the form of parameters and configuration of floater N219 that used for this study [7].

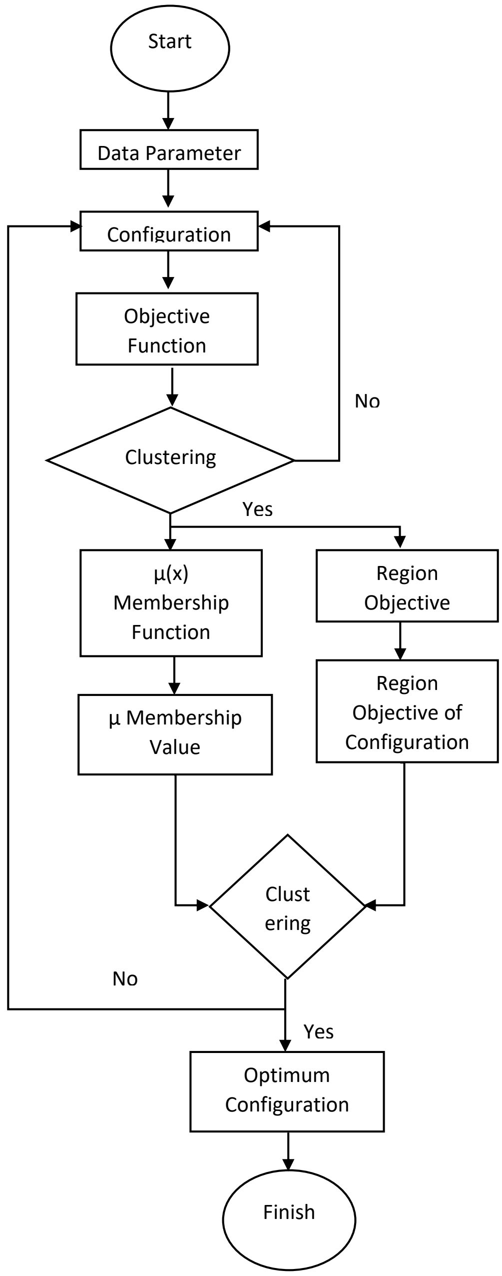

Figure 1. Flowchart Method

Table 1. Parameter and Configuration Floater [7]

Parameter	Unit	Configuration					
Deadrise Angle β	degree (°)	10			20		
LCG	%LOA	50	53.1	55	50	52.9	55
Drag Force	kN	23.513	23.537	24.568	23.214	23.505	24.4
Lift Force	kN	99.022	96.51	97.176	96.381	95.531	96.427
Heave Motion Amplitude	m	0.783	0.825	0.825	0.745	0.753	0.772
Heave Porpoising Amplitude	m	0.259	0.27	0.304	0.264	0.267	0.301
Heave Porpoising Period	s	0.962	1.033	1.077	0.98	1.032	1.076
Pitch Motion Amplitude	degree (°)	14.547	13.844	12.331	14.322	13.357	12.82
Pitch Porpoising Amplitude	degree (°)	4.205	4.356	4.651	4.001	3.968	4.352
Pitch Porpoising Period	s	0.955	1.023	1.064	0.971	1.023	1.068

Table 2. Configuration for Optimum Configuration Selection

Y β;LCG	FD	FL	hMa	hPa	hPp	pMa	pPa	pPp
Y10;50	23.513	99.022	0.783	0.259	0.962	14.547	4.205	0.955
Y10;53.1	23.537	96.51	0.825	0.27	1.033	13.844	4.356	1.023
Y10;55	24.568	97.176	0.825	0.304	1.077	12.331	4.651	1.064
Y20;50	23.214	96.381	0.745	0.264	0.98	14.322	4.001	0.971
Y20;52.9	23.505	95.531	0.753	0.267	1.032	13.357	3.968	1.023
Y20;55	24.4	96.427	0.772	0.301	1.076	12.82	4.352	1.068

The parameters drag force, lift force, heave motion amplitude, heave porpoising amplitude, heave porpoising period, pitch motion amplitude, pitch porpoising amplitude, pitch porpoising period were FD, FL hMa, hPa, pMa, pPa, pPp respectively. From data provided in transform to configuration deadrise and LCG as objective (Y axis in region graphics) and 8 parameters as (X axis in region graphics). The table 2 below shows data for result the configuration parameters of floater. Table 2 constructed from data in Table 1 that refer to research result concerning porpoising instability on floater of floatplane N219.

Table 3 shows that in these 8 variables in 6 configurations, there are 2 types of optimum values to be obtained, maximum which is the largest value that can be obtained and minimum which is the smallest value that can be obtained. Table 4 determines the configuration closest to the optimum with all variables fulfilled at the respective maximum and minimum values. However, in the 6 configurations, there is no configuration with the values of 8 variables in such a way, therefore it is necessary to select the optimum configuration that is close to the scenario configuration or objective above. Calculation of the membership degree value by inputting the configuration value of each variable from 8 existing variables to the membership function. By plotting these values on region graphs and calculation with tabulations and function will streamline the data processing.

Region Division

In the process of dividing the region, a clustering system is carried out, namely the activity of dividing regional groups (region) along with the upper and lower limit values. In each variable, clustering is carried out with 3 (three) regions. The selection of the trapezoidal curve in Figure 4 represents the mapping of inputs into a membership value that will be used for selecting the optimum configuration. In the region bounded or limited by the x-axis values for 1, 2, 4 and 5 were a, b, c and d respectively. Table 5 shows the division of regions for each of the variables. The division of this region by providing a range so that all point values of variables of each configuration can be included in the membership function. Clustering also requires linguistic variables that will be defuzzied as output results on configuration selection. In Table 6 shows the name for 3 regions of the division of the membership value curve for each variable which is the mention regarding the linguistic variables.

Table 3. Optimum Function and Parameter

Parameter		Optimum
Drag Force	FD	minimum
Lift Force	FL	minimum
Heave Motion Amplitude	hMa	minimum
Heave Porpoising Amplitude	hPa	minimum
Heave Porpoising Period	hPp	maksimum
Pitch Motion Amplitude	pMa	minimum
Pitch Porpoising Amplitude	pPa	minimum
Pitch Porpoising Period	pPp	maksimum

Table 4. Function Objective Configuration of Parameter

Parameter	FD	FL	hMa	hPa	hPp	pMa	pPa	pPp
Function Objective Configuration	23.214	95.531	0.745	0.259	1.077	12.331	3.968	1.068

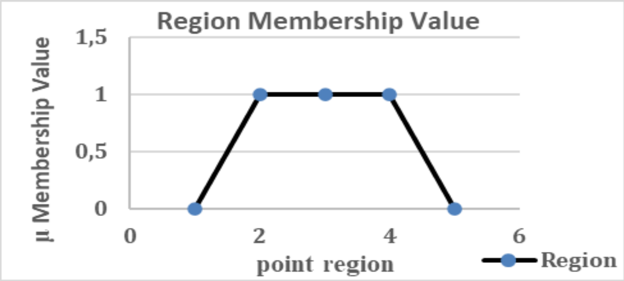

Figure 4. Trapezoidal Curve of Domain Membership Function

Table 5. Limit Value Boundary Region Domain

Boundary Region Domain of Variable	Upper Limit Value	Lower Limit Value	Range of Region
FD	23	25	2
FL	95	100	5
hMa	0.74	0.83	0.09
hPa	0.25	0.31	0.06
hPp	0.9	1.1	0.2
pMa	12	15	3
pPa	3.9	4.7	0.8
pPp	0.95	1.1	0.15

Determination of Membership Function

The membership function is curve function that shows the mapping input data points to the function to get the membership value or membership degree. Equation 1 is membership function that used to plot region and value of variable fuzzy. Variable fuzzy are value from 8 parameter of porpoising. Fuzzy set applied in each configuration are closely related to common and familiar editorial linguistics. Domain of fuzzy set used and set in Equation 3 so that all values allowed in the universe set. Objective function of configuration and optimum function used to get the highest similarity value for each variable of porpoising.

Table 6. Variable Linguistic of Parameter each Region Domain

Variable Linguistic of Parameter	Region I	Region II	Region III
FD	small	medium	large
FL	small	medium	large
hMa	low	middle	high
hPa	low	middle	high
hPp	brief	intermediate	long-term
pMa	low	middle	high
pPa	low	middle	high
pPp	brief	intermediate	long-term

Equation 1. Membership Function

$$\mu_{trapezoidal(x;a,b,c,d)} = \begin{cases} 0, & x \le a \\ \dfrac{x-a}{b-a}, & a < x < b \\ 1, & b \le x \le c \\ \dfrac{d-x}{d-c}, & c < x < d \\ 0, & d \le x \end{cases}$$

Result and Discussion

Figure 5 shows the results of the region of the domain and the plot of the FD values of the 6 configurations to produce the value or degree of membership/membership value of each FD value. Table 7 shows that the objective region cluster value is region I on the FD drag force variable for the minimise objective function. Therefore, for the FD drag force variable, there are 4 configurations that enter the objective region of the objective function.

Table.7 Membership Value and Clustering of Drag Force

Y\X Config β;LCG	FD	μ membership value FD	Clustering	Variable Linguistic
Y10;50	23.513	0.7695	Region I	small
Y10;53.1	23.537	0.8055	Region I	small
Y10;55	24.568	0.648	Region II	medium
Y20;50	23.214	0.321	Region I	small
Y20;52.9	23.505	0.7575	Region I	small
Y20;55	24.4	0.9	Region II	medium

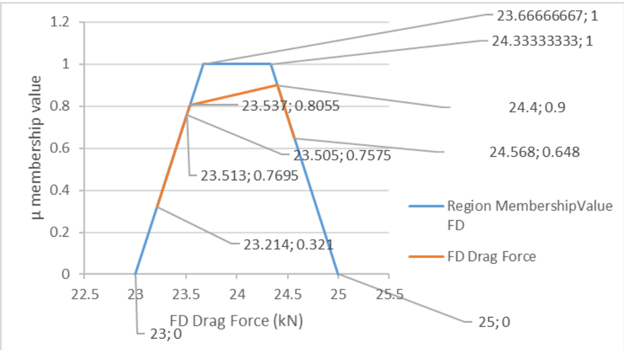

Figure 5. Graph of Region Drag Force Membership Value

Figure 6 shows the results of the region of the domain and the plot of the FL values of the 6 configurations to produce the value or degree of membership/membership value of each FL value. Table 8 shows that the objective region cluster value is region I on the FL lift force variable for the maximize objective function. Therefore, for the FL lift force variable, there are 4 configurations that enter the objective region of the objective function.

Table 8. Membership Value and Clustering of Lift Force

Y\X Config β;LCG	FL	μ membership value FL	Clustering	Variable Linguistic
Y10;50	99.022	0.5868	Region I	small
Y10;53.1	96.51	0.906	Region I	small
Y10;55	97.176	1	Region III	large
Y20;50	96.381	0.8286	Region I	small
Y20;52.9	95.531	0.3186	Region I	small
Y20;55	96.427	0.8562	Region III	large

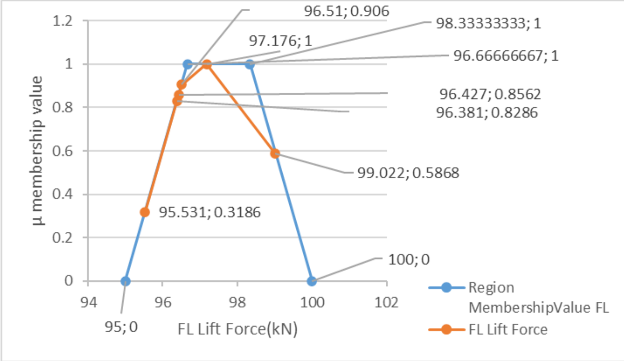

Figure. 6 Graph of Region Lift Force Membership Value

Figure 7 shows the results of the region of the domain and the plot of the hMa values of the 6 configurations to obtain the value or degree of membership/membership value of each hMa value. Table 8 shows the value for the objective region cluster value is region I on the hMa heave motion amplitude variable for the minimise objective function. Then for the variable hMa heave motion amplitude has 2 configurations that enter the objective region of the objective function.

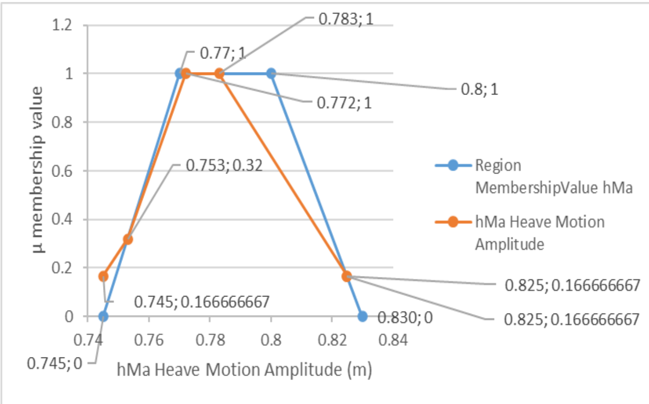

Figure 7. Graph of Region hMa Heave Motion Membership Value

Figure 8 shows the results of the region of the domain and the plot of the hPa heave porpoising amplitude values of the 6 configurations to obtain the value or degree of membership/membership value of each hPa value. Table 9 shows that the objective region cluster value is region I on the variable hPa heave porpoising amplitude for the minimize objective function. Then for the variable hPa heave porpoising amplitude has 3 configurations that enter the objective region of the objective function.

Table 9. Membership Value and Clustering of Heave Motion Amplitude

Y\X Config β,LCG	hMa	μ membership value hMa	Clustering	Variable Linguistic
Y10;50	0.783	1	Region II	middle
Y10,53.1	0.825	0.16667	Region III	high
Y10,55	0.825	0.16667	Region III	high
Y20,50	0.745	0.16667	Region I	low
Y20,52.9	0.753	0.32	Region I	low
Y20,55	0.772	1	Region II	middle

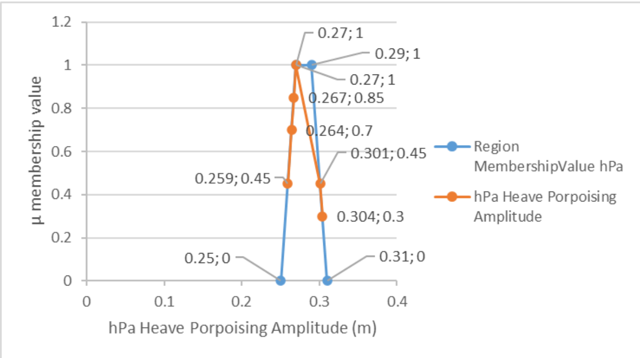

Figure 8. Graph of Region hPa Heave Porpoising Amplitude Membership Value

Figure 9 shows the results of the region of the domain and the plot of the hPp heave porpoising period value of the 6 configurations to obtain the value or degree of membership (membership value) of each hPp value.

Table 11 shows that the objective region cluster value is region III on the hPp Heave Porpoising Period variable for the maximize objective function. Therefore, the variable hPp heave porpoising period has 2 configurations that enter the objective region of the objective function.

Table 10. Membership Value and Clustering of Heave Purposing Amplitude

Y\X Config β,LCG	hPa	μ member-ship value hPa	Clustering	Variable Linguistic
Y10;50	0.259	0.45	Region I	low
Y10;53.1	0.27	1	Region II	middle
Y10;55	0.304	0.3	Region III	High
Y20;50	0.264	0.7	Region II	intermediate
Y20;52.9	0.267	0.85	Region II	intermediate
Y20;55	0.301	0.45	Region III	high

Table 11. Membership Value and Clustering of Heave Porpoising Period

Y\X Config β;LCG	hPp	μ membership value hPp	Clustering	Variable Linguistic
Y10;50	0.962	0.93	Region I	brief
Y10;53.1	1.033	1	Region II	intermediate
Y10;55	1.077	0.345	Region III	long-term
Y20;50	0.98	1	Region II	intermediate
Y20;52.9	1.032	1	Region II	intermediate
Y20;55	1.076	0.36	Region III	high

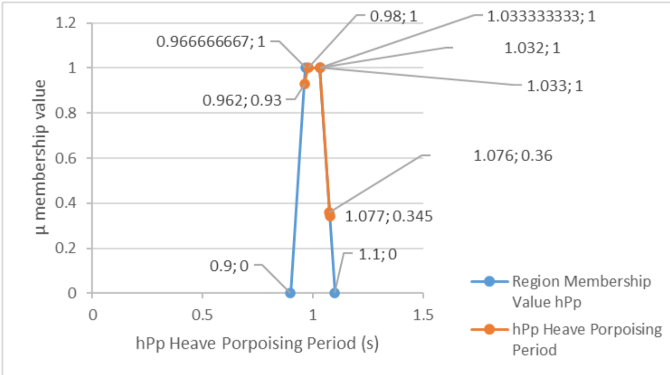

Figure 9. Graph of Region hPp Heave Porpoising Period Membership Value

Figure 10 shows the results of the region of the domain and the plot of the pitch motion amplitude pMa values of the 6 configurations to produce the value or degree of membership (membership value) of each pMa value. In Table 12 for the objective region cluster value is region I on the pMa Pitch Motion Amplitude variable for the minimize objective function. Therefore, the variable pMa pitch motion amplitude has 2 configurations that enter the objective region of the objective function.

Table 12. Membership Value and Clustering of Pitch Motion Amplitude

Y\X Config β;LCG	pMa	μ membership value pMa	Clustering	Variable Linguistic
Y10;50	14.547	0.453	Region III	high
Y10;53.1	13.844	1	Region II	middle
Y10;55	12.331	0.331	Region I	low
Y20;50	14.322	0.678	Region III	high
Y20;52.9	13.357	1	Region II	middle
Y20;55	12.82	0.82	Region I	low

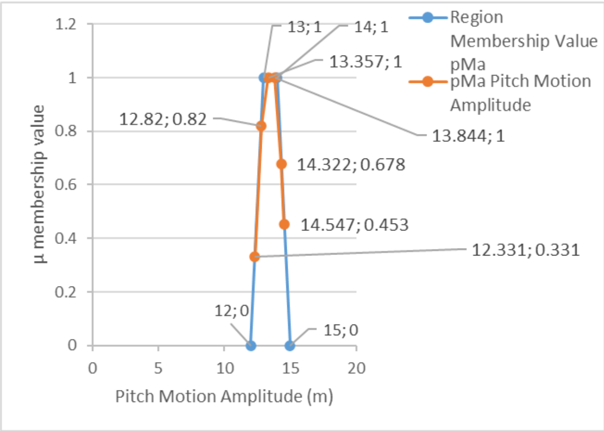

Figure 10. Graph of Region pMa Pitch Motion Amplitude

Figure 11 shows the results of the region of the domain and the plot of the pPa pitch porpoising amplitude values of the 6 configurations so as to obtain the membership degree or membership value of each pPa value. Table 13 shows that the objective region cluster value is region I on the pPa Pitch Porpoising Amplitude variable for the minimize objective function. Therefore, the variable pPa pitch porpoising amplitude has 2 configurations that enter the objective region.

Table 13. Membership Value and Clustering of Pitch Porpoising Amplitude

Y\X Config β;LCG	pPa	μ membership value pPa	Clustering	Variable Linguistic
Y10;50	4.205	1	Region II	middle
Y10;53.1	4.356	1	Region II	middle
Y10;55	4.651	0.18375	Region III	high
Y20;50	4.001	0.37875	Region I	low
Y20;52.9	3.968	0.255	Region I	low
Y20;55	4.352	1	Region II	middle

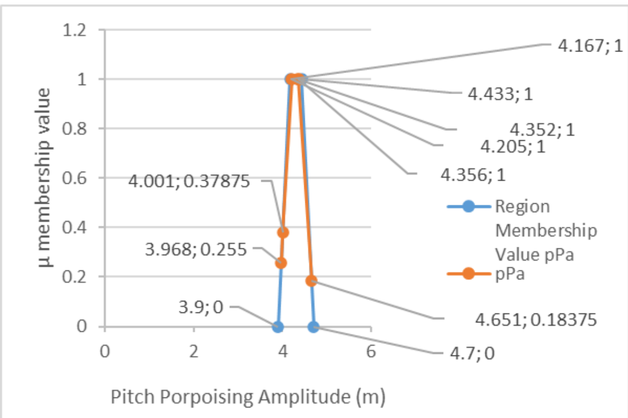

Figure 11. Graph of Region pPa Pitch Porpoising Amplitude

Figure 12 shows the results of the region of the domain and the plot of the pPp pitch porpoising period value of the 6 configurations to produce the membership degree or membership value of each pPp value. Table 14 shows that the objective region cluster value is region III on the pPp Pitch Porpoising Period variable for the maximize objective function. Therefore, the variable pPp pitch porpoising period has 2 configurations that enter the objective region.

Table 14. Membership Value and Clustering of Pitch Porpoising Period

Y\X Config β;LCG	pPp	μ membership value pPp	Clustering	Variable Linguistic
Y10;50	0.955	0.1	Region I	brief
Y10;53.1	1.023	1	Region II	intermediate
Y10;55	1.064	0.72	Region III	long-term
Y20;50	0.971	0.42	Region I	brief
Y20;52.9	1.023	1	Region II	intermediate
Y20;55	1.068	0.64	Region III	long-term

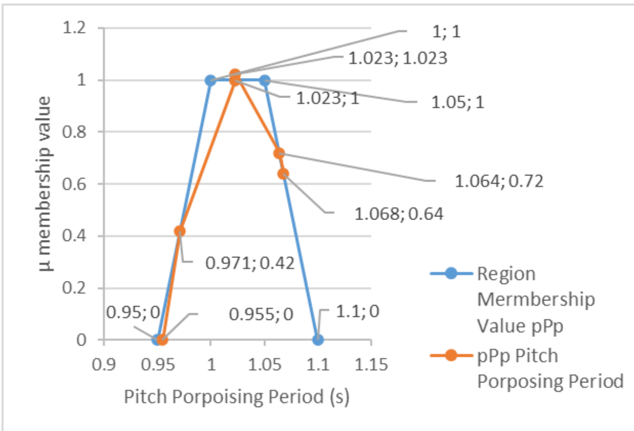

Figure 12. Graph of Region pPp Pitch Porpoising Period

Table 15 present of recapitulation of clustering region each variable that set with goal optimum value. The result of clustering region of each variable compared with the membership value of the configuration and the configuration of the goal scenario. Table 16 show optimum function of each variable with membership value as goal. As results of each of 8 variables none of 6 configurations β with LCG that precisely meet the pattern of Table 16. The value of each membership function for each variable is positive if it is maximum and negative if it is minimum. Based on Table 3, the positive membership function values are FD, FL, hMa, hPa, pMa, pPa while the negative ones are hPp and pPp.

Table 15. Recapitulation Configuration on Optimum Region of Clustering

FD region I	FL region I	hMa region I	hPa region I	hPp region III	pMa region I	pPa region I	pPp region III
Y10;50	Y10;53.1	Y20;50	Y10;50	Y10;53.1	Y10;55	Y20;50	Y10;55
Y10;53.1	Y20;50	Y20;52.9	Y10;53.1	Y10;55	Y20;55	Y20;52.9	Y20;55
Y20;50	Y20;52.9		Y20;50	Y20;52.9			
Y20;52.9	Y20;55		Y20;52.9	Y20;55			

Table 16. Resultant of Membership Value of Goal Optimum Value

Objective and μ	FD	FL	hMa	hPa	hPp	pMa	pPa	pPp
Value function objective configuration	23.214	95.531	0.745	0.259	1.077	12.331	3.968	1.068
Membership value objective μ	0.321	0.3186	0.16667	0.45	0.345	0.331	0.255	0.64
Σ μ								0.85727

Table 17. Region Objective of Variable to Region Membership Value

Y\X Config β,LCG	μ FD	μ FL	μ hMa	μ hPa	μ hPp	μ pMa	μ pPa	μ pPp	Σ μ Configuration
Y10;50	0.7695	0.5868	1	0.45	0.93	0,453	1	0,1	3,2293
Y10;53.1	0.8055	0.906	0.16667	1	1	1	1	1	2,878167
Y10;55	0.648	1	0.16667	0.3	0,345	0,331	0,18375	0,72	1,564417
Y20;50	0.321	0.8286	0.16667	0.7	1	0,678	0,37875	0,42	1,653017
Y20;52.9	0.7575	0.3186	0.32	0.85	1	1	0,255	1	1,5011
Y20;55	0.9	0.8562	1	0.45	0,36	0,82	1	0,64	4,0262

The resultant membership function value of each of the 6 configurations will be compared with the resultant membership function of the goal presented in Table 15. Table 17 comparation region with goal region of Table 16. Comparison results using the resultant membership value similarity of the 6 configurations in Table 17 with the optimum goal resultant value in Table 15. The resultant membership value of the optimum goal is 0.85727. The comparison results show that the closest value is the deadrise angle 20 LCG 52.9% configuration with a value of 1.564417.

Conclusion

Based on Table 15 the comparison shown in recapitulation clustering region with membership value resultant optimum of goal region. In order to avoid porpoising instability from 6 configurations of deadrise and LCG, it was found that 1 configuration is closest to the optimum condition for preventing and minimising porpoising on the floatplane floater. The configuration that meets the most criteria form the region and has similarity characterized by having similar values or degree of membership is the floater configuration with deadrise angle β of 20° and LCG value of 52.9% LOA. Membership value resultant of configuration 20° 52.91% of LOA and membership value resultant of goal are 1.564417 and 0.85727, respectively.

In this research using fuzzy logic compared to the method of selecting deadrise and LCG values in research, has a value of compliance, where the configuration selected in the research porpoising instability in take-off operation [7] also chooses a floater configuration with a deadrise angle value of 20° and length centre of gravity LCG of 52.91% of the overall length value. Thus, the results that have compatibility, configuration selection with fuzzy logic can be used as an alternative in selecting configurations in the prevention of porpoising on floatplanes and ships.

The fuzzy logic used in this research not included a weighting function. In further studies or other analyses, weighting can be used if there are differences in priorities or determination of different parameters from one another. The important thing to consider in using fuzzy logic is the determination of the region domain. In determining the region domain, it is important to adjust the area so that all variable values can enter the region and so that the boundaries of each are clear so that there is less ambiguity in determining the membership value or membership degree.

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References

[1] A. Sulisetyono, Computing Porpoising Instability and Motions of a High Speed Boat in Waves, Dalhousie University, 1999.

[2] O. M. Faltinsen, Hydrodynamics of High-Speed Marine Vehicles, Cambridge University Press, 2006. DOI: 10.1017/CBO9780511546068.

[3] I. Robandi, Artificial Intelligence Mengupas Rekayasa Kecerdasan Tiruan, ANDI, 2019.

[4] L. Wang, S. Qin, H. Fang, D. Wu, B. Huang, and R. Wu, Inhibition on porpoising instability of high-speed planing vessel by ventilated cavity, *Applied Ocean Research*, **111 (2021).** DOI: https://doi.org/10.1016/j.apor.2021.102688.

[5] D. Savitsky, Hydrodynamic design of planing hulls, *Marine Technology and SNAME News*, 1, 4 (1964) 71–95. DOI: https://doi.org/10.5957/mt1.1964.1.4.71.

[6] S. Gudmundsson, General Aviation Aircraft Design Applied Methods and Procedures, Butterworth-Heinemann, 2022.

[7] M. H. N. Aliffrananda, A. Sulisetyono, Y. A. Hermawan, and A. Zubaydi, Numerical analysis of floatplane porpoising instability in calm water during takeoff, *International Journal of Technology*. **13 (2022)** 190–201. DOI: https://doi.org/10.14716/ijtech.v13i1.4903.

[8] M. Sfakiotakis, D. M. Lane, and J. B. C. Davies, Review of fish swimming modes for aquatic locomotion, *IEEE Journal of Oceanic Engineering*. **24 (1999)** 237–252. DOI: https://doi.org/10.1109/48.757275.

[9] L. A. Zadeh. Similarity relations and fuzzy orderings, *Information Sciences*. 3 **(1965)** 177–200. DOI: https://doi.org/10.2307/2272014