

Rika Rosnelly

by LPPM Universitas Potensi Utama

Submission date: 05-Nov-2018 09:59AM (UTC+0700)

Submission ID: 1032878735

File name: 10.1109_CITSM.2017.8089310-CITSM_2017.pdf (242.31K)

Word count: 2110

Character count: 10578

A Comparison of Mamdani and Sugeno method for Optimization Prediction of Traffic Noise Levels

Alfa Saleh¹,Fujiati²,Rika Rosnelly³,Khairani Puspita⁴,Andi Sanjaya⁵

^{1,2,3,4,5}Faculty of Engineering and Computer Science

^{1,2,3,4,5}Universitas Potensi Utama

^{1,2,3,4,5}Medan, North Sumatera,Indonesia

Email : alfa@potensi-utama.ac.id¹,fuji@potensi-utama.ac.id²,rika@potensi-utama.ac.id³

khairani@potensi-utama.ac.id⁴,andi@potensi-utama.ac.id⁵

Abstract—The traffic noise is a disruption that leads to noise pollution if the noise is very loud. The traffic noise is caused by vehicle exhaust noise, engine and passenger of the transportation. The problem is the traffic noise has disturbed the comfort and health of living beings which are around the neighborhood. It is important that the strategy for controlling the noise of the traffic on the highway, so the noise pollution can be minimized. One of them is to control over the noise path. To predict the noise level of traffic on the highway, so in this study, researchers tested the approach using fuzzy inference systems that compare models mamdani and Sugeno in calculating the level of traffic noise based on the number of vehicles, the correction factor and the width of the road. From the data examined in this study, showed a percentage error of 1.77% for Fuzzy Mamdani models and 5.68% for the Model Sugeno, Fuzzy Mamdani models considered more accurate and effective than Sugeno models in predicting the traffic noise levels.

Keywords— Mamdani Models,Sugeno Models, Traffic Noise Levels

I. INTRODUCTION

The traffic density of a highway resulted in pollution, both air pollution generated by vehicle fumes and noise pollution resulting from the sound of the horn, the engine of the vehicle exhaust even the highway. At the level of the voices can be tolerated in the sense that the consequences thereof by the noise of the vehicle does not constitute a nuisance due to noise levels of vehicles has not reached the higher level of sound caused by such vehicles is already a nuisance or pollution called noise [1]. There are several variables are used as input to predict the traffic noise in this research, they are the width of the road, the correction factor and the number of vehicles. Fuzzy Inference System (FIS) has applied in various fields [2-5], There are two types of fuzzy inference system used in this study, Mamdani[6] and sugeno[7], In a previous study, mamdani is used to enhance the auto image zooming function, The performance of Mamdani is considered good, because it's able to distinguish zoom function based on distance[8] Furthermore, in addition to the other study, conducted comparison of Fuzzy Model Sugeno with Mamdani in System Air Conditioners, where in the study stated that fuzzy Sugeno Model allows the air conditioning system to work at full capacity. Fuzzy Model Sugeno also considered to be able for

being integrated with neural networks and genetic algorithms or techniques to optimize other [9] Recently, similar study was conducted to test Fuzzy Model Sugeno in terms of modeling emotional place for Model Design Emotional Adaptive with the aim of maximizing the quality improvement and the realization of emotion-based personal services, where the results of this study revealed that the process of inference Fuzzy Sugeno model is better and faster than the model Mamdani in terms of spatial expression of emotional Model VA [10]. In this study, the found problems was the traffic noise that cause noise pollution and of course threatens the health of living creatures around, therefore the solution offered is to control noise. To determine which areas are prone places noise then applied fuzzy inference system of mamdani and Sugeno models. The importance of knowing the level of traffic noise is to provide information to local governments to address the problem of noise or control the noise that does not cause pollution, noise pollution especially for road users and local communities.

II. MAMDANI AND SUGENO METHOD

A. Mamdani Fuzzy Models

Mamdani method is also known as the min-max method, introduced by Ebrahim Mamdani in 1975.

The method used in defuzzification mamdani models include:

1. Centroid
2. Bisector
3. Mean of Maximum (MOM)
4. Largest of Maximum (LOM)
5. Smallest of Maximum (SOM)

Fuzzy mamdani in this study using centroid method for discrete universe as follows :

$$z = \frac{\sum_{j=1}^n z_j \mu(z_j)}{\sum_{j=1}^n \mu(z_j)} \quad (1)$$

B. Sugeno Fuzzy Models

Fuzzy Inference System using Sugeno models, has a characteristic that is consequently not a fuzzy set, but it is a linear equation with variables according to the variables input. This method was introduced by Takagi Sugeno Kang in 1985. There are two models in the fuzzy inference system using Sugeno models, as follows :

1. Sugeno Fuzzy Models Zero-Order

General form of Sugeno fuzzy models zero-order is :

$$\text{IF } (x_1 \text{ is } A_1) \wedge (x_2 \text{ is } A_2) \wedge (x_3 \text{ is } A_3) \dots \wedge (x_n \text{ is } A_n) \text{ THEN } z = k \quad (2)$$

2. Sugeno Fuzzy Models First-Order

General form of Sugeno fuzzy models first-order is :

$$\text{IF } (x_1 \text{ is } A_1) \dots \wedge (x_n \text{ is } A_n) \text{ THEN } z = p_1 * x_1 + \dots + p_n * x_n + q \quad (3)$$

III. RESULT

In predicting the noise level of traffic on the highway. Where the concept of Fuzzy required variables and weighting value for each variable to perform calculations that would be obtained prediction results as expected. The steps are as follows :

A. Determination of Input and Output

The variables are used as inputs or outputs in this study can be seen in table 1 below [12]:

TABLE I. INPUT AND OUTPUT VARIABLES

Variables	Status
Number of vehicles	Input
Correction Factor	Input
Width of the road	Input
Noise level	Output

B. Establishment of Fuzzy Association

In the process of predicting the level of traffic noise, there are several variables that are used as shown in Table 1 above consists of variable number of vehicles, the correction factor, the width of the road and the noise level. Next will be fuzzy set of variables - variables. Fuzzy set formed can be seen in table 2 below :

TABLE II. FUZZY SET OF VARIABLES

Variables	Fuzzy sets	Range	Unit
Number of Vehicles	Few	[2, 20]	Unit
	Moderate	[20, 40]	
	Many	[40, 60]	
Correction Factor	Low	[0.4, 0.85]	%
	Normal	[0.4, 1.3]	
	High	[0.85, 1.3]	
Width of the road	Narrow	[3, 7.5]	Meter
	Medium	[3, 12]	
	Wide	[7.5, 12]	

C. Comparison of Mamdani and Sugeno Fuzzy Models

The settlement of Mamdani and Sugeno fuzzy models as follow :

1. Establishment of Membership Function

The membership function makes the range of values to get membership function value of each variable in determining the level of road traffic noise from a variable number of vehicles, the correction factor and the width of the road.

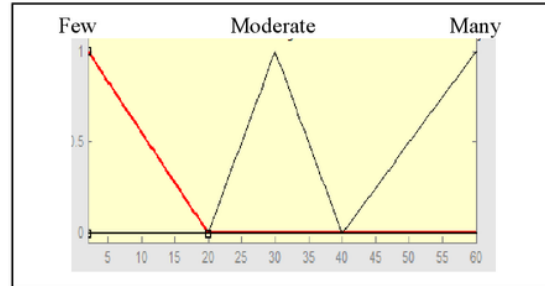


Fig. 1. Membership Function of Number of Vehicle

Membership function equation for a variable number of the vehicle as follows:

$$\mu_{Few}[x] = \begin{cases} 1; & x \leq 2 \\ \frac{20-x}{18}; & 2 < x < 20 \\ 0; & x \geq 20 \end{cases} \quad (4)$$

$$\mu_{Moderate}[x] = \begin{cases} 0; & x \leq 20 \\ \frac{x-20}{10}; & 20 < x < 30 \\ \frac{40-x}{10}; & 30 \leq x < 40 \end{cases} \quad (5)$$

$$\mu_{Many}[x] = \begin{cases} 0; & x \leq 40 \\ \frac{(x-40)}{20}; & 40 < x < 60 \\ 1; & x \geq 60 \end{cases} \quad (6)$$

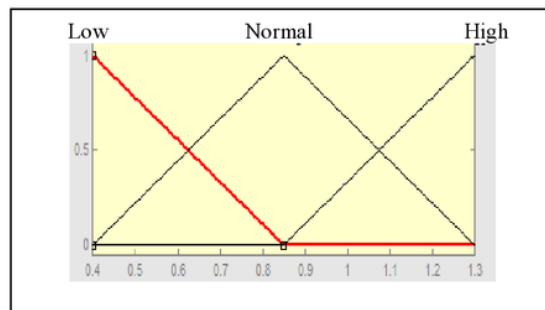


Fig. 2. Membership Function of Correction Factor

Membership function equation for a variable correction factor as follows:

$$\mu_{Low}[x] = \begin{cases} 1; & x \leq 0.4 \\ \frac{0.85 - x}{0.45}; & 0.4 < x < 0.85 \\ 0; & x \geq 0.85 \end{cases} \quad (7)$$

$$\mu_{Normal}[x] = \begin{cases} 0; & x \leq 0.4 \\ \frac{x - 0.4}{0.45}; & 0.4 < x < 0.85 \\ \frac{1.3 - x}{0.45}; & 0.85 \leq x < 1.3 \\ 0; & x \geq 1.3 \end{cases} \quad (8)$$

$$\mu_{High}[x] = \begin{cases} 0; & x \leq 0.85 \\ \frac{(x - 0.85)}{0.45}; & 0.85 < x < 1.3 \\ 1; & x \geq 1.3 \end{cases} \quad (9)$$

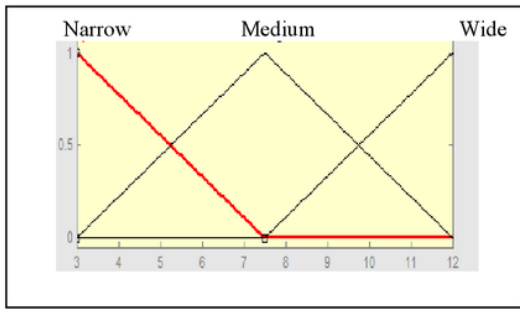


Fig. 3. Membership Function of Width of the road

Membership function equation for a variable width of the road as follows:

$$\mu_{Narrow}[x] = \begin{cases} 1; & x \leq 3 \\ \frac{(7.5 - x)}{4.5}; & 3 < x < 7.5 \\ 0; & x \geq 7.5 \end{cases} \quad (10)$$

$$\mu_{Medium}[x] = \begin{cases} 0; & x \leq 3 \\ \frac{x - 3}{4.5}; & 3 < x < 7.5 \\ \frac{12 - x}{4.5}; & 7.5 \leq x < 12 \\ 0; & x \geq 12 \end{cases} \quad (11)$$

$$\mu_{Wide}[x] = \begin{cases} 0; & x \leq 7.5 \\ \frac{x - 7.5}{5}; & 7.5 < x < 12 \\ 1; & x \geq 12 \end{cases} \quad (12)$$

Membership function for variable noise levels in accordance Sugeno fuzzy models can be seen in formula as follows:

$$\mu_{Low}[x] = 60 \quad (13)$$

$$\mu_{Medium}[x] = 80 \quad (14)$$

$$\mu_{High}[x] = 100 \quad (15)$$

Mamdani models as follows :

$$\mu_{Low}[x] = \begin{cases} 1; & x \leq 60 \\ \frac{80 - x}{20}; & 60 < x < 80 \\ 0; & x \geq 80 \end{cases} \quad (16)$$

$$\mu_{Medium}[x] = \begin{cases} 0; & x \leq 60 \\ \frac{x - 60}{20}; & 60 < x < 80 \\ \frac{100 - x}{17}; & 80 \leq x < 100 \\ 0; & x \geq 100 \end{cases} \quad (17)$$

$$\mu_{High}[x] = \begin{cases} 0; & x \leq 80 \\ \frac{(x - 80)}{20}; & 80 < x < 100 \\ 1; & x \geq 100 \end{cases} \quad (18)$$

D. Fuzzy Inference

Fuzzy Inference System is a computational framework that is based on fuzzy set theory, fuzzy rules IF-THEN and fuzzy reasoning in outline.

IF-THEN rules can be seen in table as follows :

TABLE III. IF-THEN RULES

Rules	IF-THEN			
	Number of vehicles	Correction Factor	Width of the road	Noise level
[R1]	Few	High	Narrow	Low
[R2]	Few	Normal	Narrow	Low
...
[R27]	Many	Low	Wide	High

E. Aggregation

At this stage all rule aggregated or combined in order to explain that the consequent obtained from any stage of inference rules will be modified with a solution set fuzzy respectively and combined with the results of other consequent modifications. The composition of the three fuzzy rules can be described in equation as follows:

$$\alpha - \text{pred} = \alpha - \text{pred1} * z1 + \alpha - \text{pred2} * z2 + \dots + \alpha - \text{predn} * zn \quad (19)$$

F. Defuzzification

Defuzzification stage is the stage of the calculation of the crisp output. The input of this stage is the fuzzy set obtained from the composition of fuzzy rules, and the output is a fuzzy set of numbers in the domain.

From 10 data tested with the provisions of the road width of 7.5 meters, a correction factor of 0958%, the number of

vehicles that are both varied and the value of the actual noise level derived by the Sound Level Meter[11].

TABLE IV. THE COMPARISON RESULT OF MAMDANI AND SUGENO

No	Number of vehicles	Traffic Noise Levels' Criterias			(Error) Mamdani	(Error) Sugeno
		Actual	Mamdani	Sugeno		
1	48	85.54	83.6	92.5	1.66%	5.95%
2	37	78.9	78.9	71.1	0.00%	6.15%
3	55	89.23	86.2	95.2	2.70%	5.33%
4	45	83.25	81.5	90.2	1.46%	5.79%
5	47	85.19	83	91.9	1.87%	5.72%
6	45	83.25	81.5	90.2	2.45%	4.90%
7	48	85.54	83.6	92.5	1.71%	5.91%
8	53	88.14	85.7	94.6	2.15%	5.69%
9	49	86.35	84.2	93	1.86%	5.74%
10	46	84.48	82.3	91.1	1.84%	5.59%
Avarage					1.77%	5.68%

Based on the testing of the 10 data over the known width of the road and a correction factor has the same value for the number of vehicles varies, because the road is used as a testing ground is the same path but with a number of different vehicles and getting the result value of the percentage of error in predicting the level of traffic noise.

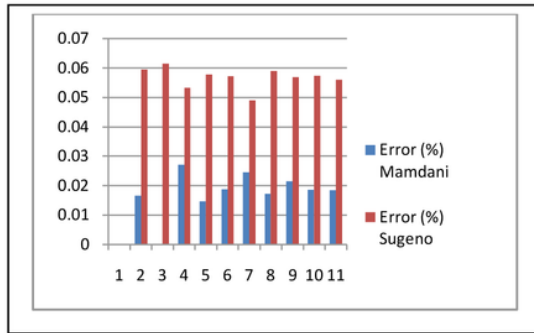


Fig. 4. Bar Diagram of The Comparison Result

IV. CONCLUSION

From this study, the prediction of traffic noise can be concluded as follows:

1. Fuzzy model of Mamdani and Sugeno models successfully applied in predicting the level of traffic noise with the criterias such as the number of vehicles, the correction factor and the width of the road.
2. From 10 datas were tested using Fuzzy Mamdani models generate an error of 1.77% while the value obtained Sugeno models percentage error of 5.68%. the result show that mamdani models is able to predict the traffic noise levels better than sugeno models. This error rate shows which method which has closer prediction with the real value, so the method can be applied for this case. The

error rate inform that that road has a risk makes a sound pollution which get effect to envirotnmen. So, The government can make decision to overcome this case such as the widening the road.

REFERENCES

- [1] Djalante Susanti, "Analisis Tingkat Kebisingan Di Jalan Raya Yang Menggunakan Alat Pemberi Isyarat Lalu Lintas (APIL) (Studi Kasus : Simpang Ade Swalayan)," *Jurnal SMARTek*, vol.8 , No. 4, pp. 280-300, Nopember 2010.
- [2] Islam, Tanvir, et al. "An exploratory investigation of an adaptive neuro fuzzy inference system (ANFIS) for estimating hydrometeors from TRMM/TMI in synergy with TRMM/PR." *Atmospheric Research* 145 (2014): 57-68.
- [3] Lohani, Anil Kumar, N. K. Goel, and K. K. S. Bhatia. "Improving real time flood forecasting using fuzzy inference system." *Journal of Hydrology* 509 (2014): 25-41.
- [4] Kaburlasos, Vassilis G., and Athanasios Kehagias. "Fuzzy inference system (FIS) extensions based on the lattice theory." *IEEE Transactions on Fuzzy Systems* 22.3 (2014): 531-546.
- [5] Balal, Esmaeil, Rucy Long Cheu, and Thompson Sarkodie-Gyan. "A binary decision model for discretionary lane changing move based on fuzzy inference system." *Transportation Research Part C: Emerging Technologies* 67 (2016): 47-61.
- [6] Mamdani, Ebrahim H., and Sedrak Assilian. "An experiment in linguistic synthesis with a fuzzy logic controller." *Intemational journal of man-machine studies* 7.1 (1975): 1-13.
- [7] Takagi, Tomohiro, and Michio Sugeno. "Fuzzy identification of systems and its applications to modeling and control." *IEEE transactions on systems, man, and cybernetics* 1 (1985): 116-132.
- [8] Elamvazuthi, I., Pandian Vasant, and Jeffrey Frank Webb. "The application of mamdani fuzzy model for auto zoom function of a digital camera." *arXiv preprint arXiv:1001.2279* (2010).
- [9] KaurArshdeep, Amrit Kaur. "Comparison of Mamdani Fuzzy Model and Neuro Fuzzy Model for Air Conditioning System," *International Journal of Soft Computing and Engineering (IJSC)*, Vol.2, Issue.2, pp. 323-325, 2012.
- [10] Kwon, Il-Kyoung, and Sang-Yong Lee. "An Emotional Space Modeling for the Adaptive Emotional Model Design Based on Sugeno Fuzzy Inference." *International Journal of Software Engineering and Its Applications* 8.6 (2014): 109-120.
- [11] Fahmy, Raafat, Hegazy Zaher, and Abd Elfattah Kandil. "A comparison between fuzzy inference systems for prediction (with application to prices of fund in Egypt)." *Intemational Journal of Computer Applications* 109.13 (2015).
- [12] Bahri,Samsul.,Rida,Samdara.,Fairuz.Zamani.,2007, Penggunaan Metode Logika Fuzzy Untuk Memprediksi Jumlah Kendaraan Bermotor Berdasarkan Tingkat Kebisingan Lalu Lintas,Lebar Jalan dan Faktor Koreksi, *Jurnal Gradien*, Vol.3 No. 2,hal 247-251.

Bu rika 1

ORIGINALITY REPORT

0%

SIMILARITY INDEX

0%

INTERNET SOURCES

0%

PUBLICATIONS

0%

STUDENT PAPERS

PRIMARY SOURCES

Exclude quotes On

Exclude bibliography On

Exclude matches < 25 words