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JURNAL INFOKUM, Volume 10, No.1, Desember 2021 **ISSN : 2302-9706**

Application of Fuzzy Logic in Motorcycle Security Systems Based on Internet of Things (IoT)

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Abstract

Article Info

Received : 29 November 2021
Revised : 23 December 2021
Accepted : 29 December 2021

The development of motorcycle use in Indonesia is increasing every year. This increasing trend is also accompanied by the increasing number of theft crimes of motorcycles. This is due to the physical nature of the motorcycle which is relatively small and easy to steal. In this study the author will discuss the motorcycle theft prevention system by installing various sensors built using fuzzy logic and utilizing the concept of the Internet of Things (IOT). This fuzzy logic consists of values and domains that are classified into several variables to conclude the degree and status of the motorcycle as an alarm trigger. Then by utilizing IOT the alarm is converted into a notification that will be sent via the motorcycle user's Telegram application if the motorcycle is stationary, Bergerak or moved. This system has 2 (two) components, namely hardware in the form of several sensors including infrared sensors along with a microcontroller and software connected to the Telegram application which functions as a motorcycle status notification receiver.

Keywords : Motorcycle safety, Fuzzy Logic, Internet of Things.

1. Introduction

Transportation has an important role in everyday life. This is because the majority of our activities are outdoors and require us to be able to get from one place to another quickly and easily. Motorcycles are the most dominant choice of transportation mode for the community in terms of effectiveness, efficiency and economic value. Based on data from the Central Statistics Agency of North Sumatra Province, the number of motorcycle exist in North Sumatra is 463,305 units until 2020.

But behind the advantages and convenience it has, motorcycles are a mode of transportation that is easy to steal, disassemble, and easily shipped in the form of parts (McDono, C, 2011). There were 2,634 units of crime or violations reported in the type of motor vehicle theft in 2019 (Central Statistics Agency of North Sumatra Province, 2021). Motorcycle safety is the most vital thing in preventing these crimes. According to Pachica, et al. (2017), the easiest and most economical choice falls on the installation of an alarm that will make a sound when attempting to steal a motorcycle. However, if the owner is out of reach of the motorbike they will not hear the alarm going off. Therefore, it is also necessary to notify the owner if the alarm is triggered by certain activities.

In this journal, the author proposes the application of Fuzzy Logic to an Internet of Things (IOT) based security system. By integrating Fuzzy Logic into information systems and process engineering, it produces applications such as control systems and decision-making systems that are more flexible, stable, and sophisticated (Nasution, 2012). This fuzzy logic consists of values and domains that are classified into several variables to conclude the degree and status of the motorcycle as an alarm trigger. The conclusion is sent as an alarm notification to vehicle owners via the Telegram application as an application of the IoT concept which is a combination in a network connected to a machine or device that sends and receives data via a network connection (Novelan, 2020).

2. Methods

2.1 Research Stages

The stages of research that the author did in this journal are as follows:

1. Problem Analysis
2. System Design
3. System Build
4. System Test

2.2 Research Design

In this study, the authors built a design for a sensory network system on a motorcycle. The design of this study consisted of several stages. The first stage begins with compiling a table of sensor values that will be used as test parameters using fuzzy logic.
The sensor table is as follows :

Table 1. Sensor Value

No	Function	Variabel	Fuzzy Set	Domain
1	Input	Getaran	Normal	[0 20]
			Waspada	[20 40]
			Gawat	[40 60]
		Putaran Roda	Tidak Bergerak	[0 20]
			Bergerak	[20 30]
2	Output	Output	Aman	[0 20]
			Hati-Hati	[20 30]
			Ada Maling	[30 50]

Followed by the second stage, namely designing the general architecture of the sensory network system with tools and devices that can be illustrated as follows:

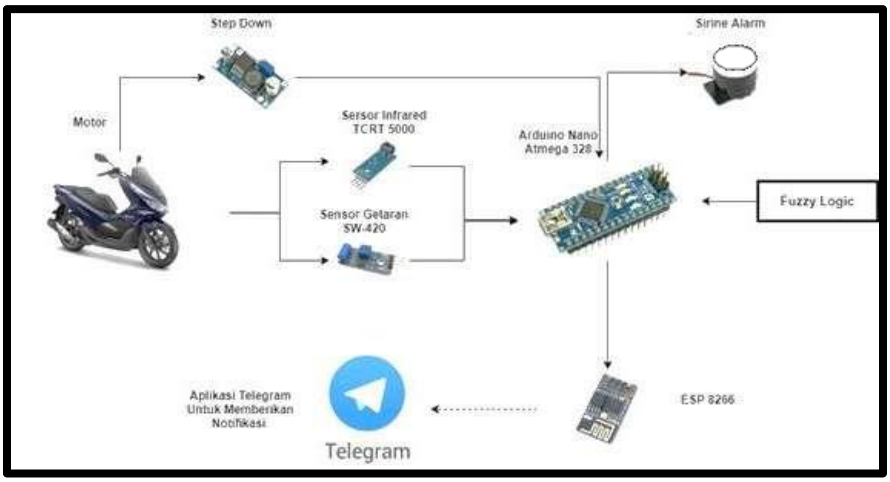

Figure 1. Sensory Network General Architecture

The next stage is the installation of sensor components/devices on the motorcycle body which can be seen in the following description:

Figure 2. Installation of the vibration sensor on the motorcycle handlebar.

Figure 3. Installation of infrared sensors on motorcycle wheels

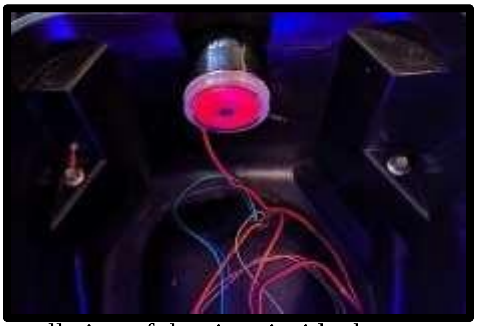

Figure 4. Installation of the siren inside the motorcycle seat

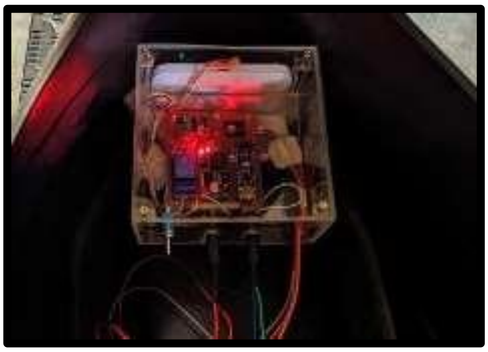

Figure 5. Installation of the microcontroller inside the motorcycle seat

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Figure 6. Installation of current with a motorcycle battery

3. Results and Analysis

3.1 Fuzzification

The fuzzification of this motorcycle safety device uses two inputs from a vibration sensor (SW420) and an infrared sensor (TCRT 5000) while the output is a value which is then converted into the sound of alarms and notifications sent via the Telegram application. There are two input variables, namely Vibration and Wheel Rotation. In the table below there is a fuzzy set of each variable.

Table 2. Sensor Value

No	Function	Variabel	Fuzzy Set	Domain
1	Input	Getaran	Normal	[0 20]
			Waspada	[20 40]
			Gawat	[40 60]
		Putaran Roda	Tidak Bergerak	[0 20]
			Bergerak	[20 30]
2	Output	Output	Aman	[0 20]
			Hati-Hati	[20 30]
			Ada Maling	[30 50]

In the membership function, input the sensor using the triangular and trapezoidal curve shapes. The figure below is a membership function of the input vibration and infrared sensors.

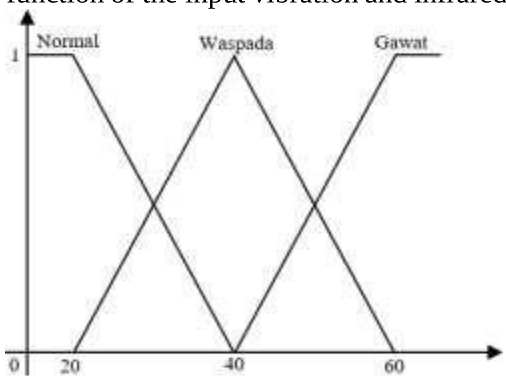

Figure 7. Vibration Sensor Input Membership Function

For the input membership function of the Vibration sensor above, two membership functions are used, namely the representation of a triangular curve and a representation of a trapezoidal curve as follows.

$$\mu Normal \quad \begin{cases} 1; & x \leq 20 \\ \dfrac{40-x}{40-20}; & 20 \leq x \leq 40 \\ 0; & x \geq 40 \end{cases}$$

$$\mu Waspada \quad \begin{cases} 0; & x \leq 20 \\ \dfrac{x-20}{40-20}; & 20 \leq x \leq 40 \\ \dfrac{60-x}{60-40}; & 40 \leq x \leq 60 \end{cases}$$

$$\mu Gawat \quad \begin{cases} 0; & x \leq 40 \\ \dfrac{x-40}{60-40}; & 40 \leq x \leq 60 \\ 1; & x \geq 60 \end{cases}$$

Figure 8. Triangular Curve Representation and Trapezoidal Curve Representation

For the input membership function of the infrared sensor above, the membership function of the trapezoidal curve representation is as follows.

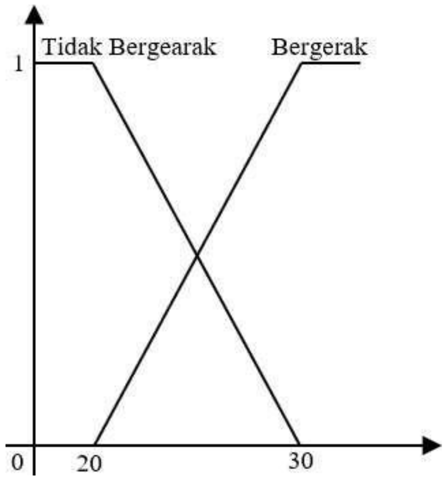

Figure 9. Infrared Sensor Input Membership Function

µTidak Bergerak $\begin{cases} \dfrac{30-x^{1;x\leq 20}}{30-20_{0;\ x\geq 30}}; 20 \leq x \leq 30 \end{cases}$

µBergerak $\begin{cases} \dfrac{x-20^{0;\ x\leq 20}}{30-20_{1;\ x\geq 30}}; 20 \leq x \leq 30 \end{cases}$

3.2 Example case 1 on fuzzy input calculation

In this case, a vibration value of 28 is given and a wheel rotation value of 30 is given. By using the above function, the fuzzification value is obtained by:

a. Vibration membership function

1. Normal fuzzy set, µNormal [28] = $\frac{40-x}{40-20} = \frac{40-28}{40-20} = \frac{12}{20} = 0{,}6$

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2. Waspada fuzzy set, µWaspada[28] = $\frac{x-20}{40-20} = \frac{28-20}{40-20} = \frac{8}{20} = 0{,}4$

3. Gawat fuzzy set, µGawat[28] = 0

b. Wheelspin membership function
1) Tidak Bergerak fuzzy set, µTidak Bergerak[30] = 0
2) Bergerak fuzzy set, µBergerak[30] = 1

3.3 Forming of Fuzzy Rules

There are six fuzzy rules in this motorcycle safety device, namely:

[Aturan 1] If (Getaran is Normal) and (Putaran Roda is Tidak Bergerak) then (20)
[Aturan 2] If (Getaran is Normal) and (Putaran Roda is Bergerak) then (30)
[Aturan 3] If (Getaran is Waspada) and (Putaran Roda is Tidak Bergerak) then (20)
[Aturan 4] If (Getaran is Waspada) and (Putaran Roda is Bergerak) then (50)
[Aturan 5] If (Getaran is Gawat) and (Putaran Roda is Tidak Bergerak) then (30)
[Aturan 6] If (Getaran is Gawat) and (Putaran Roda is Bergerak) then (50)

3.4 Rules Composition

The composition of the rules for this motorcycle safety tool uses the MIN implication function to get the α=predicate value of each rule. Then each value of α=predicate is used to calculate the output of the inference results explicitly (crips) on each rule (z1, z2, z3, …, zn). In example 1 above, the composition of the rules is as follows:

[Aturan 1] If (Getaran is Normal) and (Putaran Roda is Tidak Bergerak)then (20)

$$\alpha - predikat1 = \mu Normal \cap \mu TidakBergerak$$
$$= min(\mu Normal[28], \mu TidakBergerak[30])$$
$$= min(0{,}6; 0) = 0$$

[Aturan 2] If (Getaran is Normal) and (Putaran Roda is Tidak Bergerak)then (30)

$$\alpha - predikat1 = \mu Normal \cap \mu Bergerak$$
$$= min(\mu Normal[28], \mu Bergerak[30])$$
$$= min(0{,}6; 1)$$
$$= 0{,}6$$

[Aturan 3] If (Getaran is Waspada) and (Putaran Roda is Tidak Bergerak)then (20)

$$\alpha - predikat1 = \mu Waspada \cap \mu TidakBergerak$$
$$= min(\mu Normal[28], \mu TidakBergerak[30])$$
$$= min(0{,}4; 0)$$
$$= 0$$

[Aturan 4] If (Getaran is Waspada) and (Putaran Roda is Bergerak)then (50)

$$\alpha - predikat1 = \mu Waspada \cap \mu Bergerak$$
$$= min(\mu Normal[28], \mu Bergerak[30])$$
$$= min(0{,}4; 1)$$
$$= 0{,}4$$

[Aturan 5] If (Getaran is Gawat) and (Putaran Roda is Tidak Bergerak)then (30)

$$\alpha - predikat1 = \mu Gawat \cap \mu TidakBergerak$$
$$= min(\mu Normal[28], \mu TidakBergerak[30])$$
$$= min(0; 0)$$
$$= 0$$

[Aturan 6] If (Getaran is Gawat) and (Putaran Roda is Bergerak)then (50)

$$\alpha - predikat1 = \mu Gawat \cap \mu Bergerak$$

$= min(\mu Normal[28], \mu Bergerak[30])$
$= min(0; 1)$
$= 0$

3.5 Defuzzification

The picture below shows the membership function of the fuzzy output

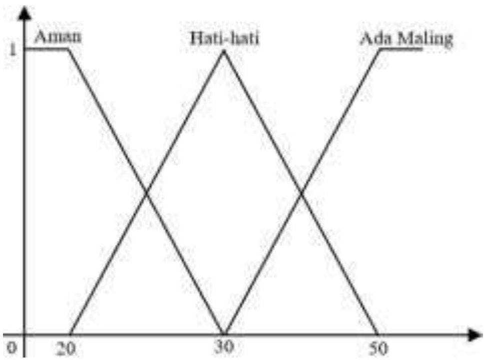

Figure 12. Membership Function Of The Fuzzy Output

In this Sugeno fuzzy defuzzification process, the average method is used. From the example case 1, the results of the defuzzification are as follows:

$$z = \frac{\propto pred1 * z1 + \propto pred2 * z2 + \propto pred3 * z3 + \propto pred4 * z4 + \propto pred5 * z5 + \propto pred6 * z6}{\propto pred1 + \propto pred2 + \propto pred3 + \propto pred4 + \propto pred5 + \propto pred6}$$

$$= \frac{0 * 20 + 0,6 * 30 + 0 * 20 + 0,4 * 50 + 0 * 30 + 0 * 50}{0 + 0,6 + 0 + 0,4 + 0 + 0}$$

$$= \frac{38}{1}$$

$= 38$

Figure 13. Notification Output Results from Sensors installed in the Telegram Application

4. Conclusion

Based on the research that has been done, the authors conducted a case study test using input and output functions, each of which has a variable, a fuzzy set, and a domain for the measurement range. As for the input function, it consists of Getaran. (Vibration), which has a Normal set with a 0-20 domain, Waspada (Alert) with a 20-40 domain, and Gawat (Danger) with a 40-60 domain. The vibration sensor is placed on the motorcycle handlebar so that it can detect the amount of vibration generated. The next variable is Putaran Roda (Wheel Spin), which has a set of Tidak Bergerak (Idle) with a domain of 0-20 and Bergerak (Moving) with a domain of 20-30. Infrared as a wheel rotation detection device is placed on the motorcycle wheel.

In addition to the input function, there is an output function to give conclusions on all forms of events that occur on motorcycles. The output variables consist of the Safe set with the 0-20 domain, Caution with the 20-30 domain, and There are Thieves with the 30-50 domain. The output will send a notification via the telegram application. So, if based on a research case study that has a vibration with a value of 28 and a wheel rotation with a value of 30, the notification sent via telegram contains a Caution message because the vibration value and wheel rotation are members of the Caution set in the output function. Thus, the motorcycle will send a signal to the user if the motorcycle moves without the user's knowledge through the user's telegram application and the user can act quickly and anticipate theft actions that will occur on his motorcycle.

References

[1] McDono, C. The Changing Face of Vehicle Theft.

[2] Novelan, Muhammad Syahputra (dkk). 2020. *Sistem Kendali Lampu Menggunakan NodeMCU dan Mysql Berbasis IOT (Internet of Things).* InfoTekJar: Jurnal Nasional Informatika dan Teknologi Jaringan Vol. 5 No. 1 (2020) Edisi September.
[3] Badan Pusat Statistik Provinsi Sumatera Utara. 2021. *Jumlah Kendaraan Bermotor Menurut Unit Pelaksana Teknis (UPT) dan Jenis Kendaraan (ubnit), 2018-2020.*
[4] Badan Pusat Statistik Provinsi Sumatera Utara. 2021. *Banyaknya Peristiwa Kejahatan/Pelanggaran yang Dilaporkan menurut Jenis Kejahatan/Pelanggaran, 2015-2019.* [5] Budiyono (dkk). 2019. *Rancang Bangun Sistem Alarm Pada Sepeda Motor Honda Beat FI 2014.*
[6] Pachica, Archie O. 2017. *Motorcycle Theft Prevention and Recovery Security System.*
[7] International Journal of Apllied Engineering Research ISSN 0982-4562 Volume 12 Number 11 pp. 2680-2687.
[8] Harys, Hafidzilhaj (dkk). 2014. *Aplikasi Logika Fuzzy Untuk Prediksi Kejadian Hujan (StudiKasus: Sub DAS Siak Hulu).* Jurnal Online Mahasiswa Fakultas Teknik Universitas Riau Vol. 1 No. 1 (2014).
[9] Sari, Syah Dia Putri Mustika. 2017. *Penentuan Harga Dengan Menggunakan Sistem Inferensi Fuzzy Tsukamoto Pada Rancang Bangun Aplikasi "Finding-Tutor".* Departemen Tenik Informatika Fakultas Teknologi Informasi Institut Teknologi Sepuluh Nopember Surabaya.
[10] Salazar, Jordi (dkk). 2017. *Internet of Things.* Czech Technical University of Prague Faculty of Electrica Engineering 1st Edition. ISBN 978-80-01-06232-6.
[11] Patel, Keyur K. (dkk). 2016. *Internet of Things-IOT: Definition, Characteristics, Architecture, Enabling Technologies, Aplication & Future Challenges.* Department of Electrical Engineering Faculty of Technology dan Engineering MSU. DOI 10.4010/2016.1482. ISSN 2321 3361.
[12] J. Sihotang, "Analysis Of Shortest Path Determination By Utilizing Breadth First Search Algorithm," *J. Info Sains Inform. dan Sains*, vol. 10, no. 2, pp. 1–5, 2020.
[13] C. Baturu, "Brute Force Algorithm Implementation Of Dictionary Search," *J. Info Sains Inform. dan Sains*, vol. 10, no. 1, pp. 24–30, 2020.
[14] H. Sunandar and B. Nadeak, "Analysis and Implementation of PlayFair Chipper Algorithm in Text Data Encoding Process," vol. 10, no. 02, pp. 19–23, 2020.