FUZZY LOGIC IMPLEMENTATION AS SPEED CONTROL DOOR OPENER ON THE ROLE PLAYING GAME BATTERY-MAN

Yaya Abdul Somad[1]

[1] Teknik Informatika – Universitas Komputer Indonesia
Jl. Dipatiukur 112-114 Bandung
E-mail : yayasomad@yahoo.co.id

ABSTRACT

Battery-Man game is a game simulation type games. Battery-man game has a concept game speed control door opener to take a decision very slow, slow, medium, fast and very very slow. Speed door opener will largely determine the success of the players in this game. Battery-making will take time, if the players simply take the batteries in small amounts, then the time it takes too little. Conversely, if a player takes a lot of battery, it will take quite a long time. But on the other hand, if the battery is not appropriate to open the door, the door will be very slow speed, if the numberof batteries as required by the driver door, then the speed will be fast.

But the game simulation Battery-Man requires an algorithm that can determine the value for 2 variables, voltage and current. The explanation is based on the fuzzy logic algorithm takes into Battery-Man game as a regulator of the speed opening the door to take a decision very slow, slow, medium, fast, and very slow.

Of the results of tests performed, it can be concluded that the implementation of fuzzy logic in the game's Battery-Man hs fulfilled the purpose, which can generate output actions in accordance with conditions such as very slow, slow, medium, fast, very slow once based variable voltage fuzzy and flow..

Keywords: Fuzzy Logic, Voltage, Current.

1. INTRODUCTION

1.1 Background

Fuzzy logic is a logic that has a value of vagueness or ambiguity (fuzzyness) between right or wrong. But how much truth and error a value depending on the weight of its membership. Fuzzy logic has a degree of membership in a range of 0 to 1. Fuzzy logic is an appropriate way to map an input space into an output space, has a continuous value. Fuzzy expressed in degrees of a membership and degree of truth. Therefore, something can be said to be partly right and partly wrong at the same time.[1]

AI (Artificial Intelligence) or artificial intelligence is part of computer science that studies how to make a machine (computer) can do the job and as good as done by human beings could even be better than do humans [3]. One branch of artificial intelligence is fuzzy logic. Fuzzy logic is used to overcome the problems that have more than one answer. Fuzzy logic therefore more similar to the human way of thinking in the form of an algorithm which is then executed by the machine. Application of Fuzzy logic in Battery-Man game is to control the speed of the door opener. Based on the characteristics of fuzzy logic can be used for problems such as determining the speed control door opener using variables - variables that have been specified. The variables input on Battery-Man games are voltage and current..

Battery-Man game is a game simulation type games. Battery-man game has a concept game speed control door opener to take a decision very slow, slow, medium, fast, and very slow. Speed door opener will largely determine the success of the players in this game. Making the battery will require time, if the players simply take the batteries in small amounts, then the time it takes too little. Conversely, if a player takes a lot of battery, it will take quite a long time. But on the other hand, if the battery is not appropriate to open the door, the door will be very slow speed, if the number of batteries as required by the driver door, then the speed will be fast. But the simulation game Battery - Man requires an algorithm that can determine the value for two variables: voltage and current. Based on the above, the fuzzy logic algorithm takes into Battery-Man game as a regulator of the speed opening the door to take a decision very slow, slow, medium, fast, and very slow.

1.2 Purpose of the Research

Based on the problems studied, the purpose of writing this final task is to implement Fuzzy Logic as manager Speed Door Opener on Role Playing Game Battery-Man.

While the objectives to be achieved in this research is the suitability of fuzzy logic to control

the speed of opening the door to take a decision very slow, slow, medium, fast, and very slow in accordance with the input of players in the game Battery-Man.

2. CONTENTS OF RESEARCH

2.1 Theory

2.1.1 *Fuzzy Logic*

Fuzzy language is interpreted as fuzzy or vague. A value can be of great value or wrong simultaneously. In the known fuzzy degrees of membership that has a range of values 0 (zero) to 1 (one). In contrast to firmly set that has a value of 1 or 0 (yes or no).

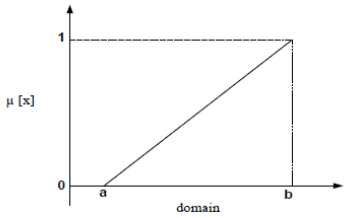
Fuzzy logic is a logic something that has a value of vagueness or ambiguity (fuzzyness) between right or wrong. In the theory of fuzzy logic a bias value is true or false together. But how large a presence and error depending on the weight of its membership. Fuzzy logic has a degree of membership in a range of 0 to 1. In contrast to the digital logic which only has two values 1 or 0. Fuzzy logic is used to translate a quantity that is expressed using language (linguistic), for example the amount of speed that the vehicle speed is expressed by the slow, somewhat quick, fast, and very fast. And fuzzy logic indicates the extent to which a value was correct and the extent to which a value was incorrect. Unlike classical logic (scrisp) / firm, a value has only 2 possible that a member of the set or not. Degree of membership 0 (zero) means that the value is not a member of the set and 1 (one) means the value is set members.

Fuzzy logic is an appropriate way to map an input space into an output space, having continuous values. Fuzzy expressed in degrees of a membership and degree of truth. Therefore, something can be said to be partly right and partly wrong at the same time (Kusumadewi. 2004) Fuzzy Logic allows the membership value between 0 and 1, gray level and also black and white, and in linguistic form, the concept would not have been like "a little" , "passable" and "very" (Zadeh 1965). The advantages of the theory of fuzzy logic is in the process of reasoning ability in the language (linguistic reasoning). So that in its design does not require mathematical equations of the object to be controlled.

1. Membership function

Membership function is a curve that shows the mapping of points of input data into membership values (often called the degrees of membership) which has the interval between 0 and 1. One way that can be used to get the value of membership is through the approach function. There are some functions that are used, including the:

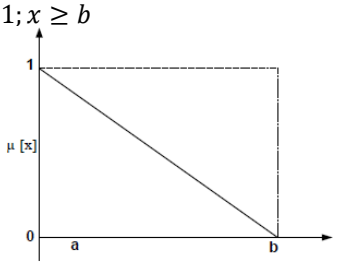
a. Linear representation



Gambar 2.1 Kurva Linear Naik [3]

Fungsi keanggotaan Linear Naik:

$$\mu[x] = \begin{cases} 0; x \le a \\ \frac{x-a}{b-a}; \quad a \le x \le b \\ 1; x \ge b \end{cases}$$

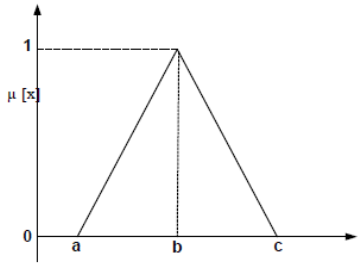


Gambar 2.2 Kurva Linear Turun [3]

Fungsi Keanggotaan Linear Turun:

$$\mu[x] = \begin{cases} \frac{b-x}{b-a}; a \le x \le b \\ 0; x \ge b \end{cases}$$

b. Representasi Segitiga

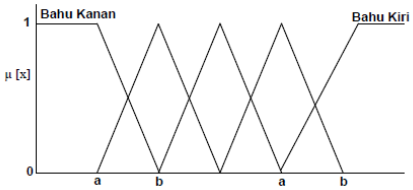


Gambar 2.3 Kurva Segitiga[3]

Fungsi keanggotaan kurva segitiga:

$$\mu[x] = \begin{cases} 0; x \le a \; atau \; x \ge c \\ \frac{x-a}{b-a}; a \le x \le b \\ \frac{b-x}{c-b}; \; b \le x \le c \end{cases}$$

c. Representasi Bahu



Gambar 2.4 Kurva bahu [3]

Membership functions right shoulder:

$$\mu[x] = \begin{cases} 1; x \leq a \\ \frac{(b-x)}{(b-a)}; \quad a \leq x \leq b` \\ 0; x \geq b \end{cases}$$

Membership functions left shoulder:

$$\mu[x] = \begin{cases} 0; x \leq a \\ \frac{(x-a)}{(b-a)}; \quad a \leq x \leq b \\ 1; x \geq b \end{cases}$$

2. Fuzzy Inference System Tsukamoto method

Pada Metode Tsukamoto, setiap konsekuen the rules in the form of IF-Then shall be represented by a fuzzy set with membership function monotonous. As a result, the output inference result of each rule is given explicitly (crisp) by α-predicate (fire strength). The end result is obtained by using a weighted average.

Aggregation to determine the output of all rules and combined into a single fuzzy set. Defuzzification to produce health value using a weighted average.

$z = \frac{\alpha 1 z 1 + \alpha 2 z 2 \ldots + \alpha n z n}{\alpha 1 + \alpha 2 \ldots + \alpha n}$

1z = nilai crisp

α1 = the degree of membership of each variable

z1 = domain value on linguistic variable z.

2.2 Algorithm Analysis and Design

2.2.1 analysis Input

By definition, fuzzy logic is an appropriate way to map an input space into an output space. Generating the first fuzzy input by input crisp, crisp input is analog input value is given to search and calculate the degree of membership or the degree of membership in a way fuzzification process.

Input limits given in designing the fuzzy system on Battery-Man game is different to produce output behavior, the following are variables used Input and Output.

Tabel 3.2 Variabel *Output* dan *Input*

Output	Output/Input	Input
speed doors	Voltage	Very small
		small
		medium
		Large
		Very large
	Current	Very small
		small
		medium
		Large
		Very large

2.2.2.1 Analysis of Fuzzy Voltage

1. Variable Voltage, there are five fuzzy set, namely: Very small, small, medium, large, very large. Universe speaker for the variable voltage is 0 - 100. Domain hipunan fuzzy set on variable voltage, namely :
   1) Very small : 0 – 40
   2) Small : 20 – 60
   3) medium: 40 – 80
   4) Large : 60 – 100
   5) Very large : 80 – 100

2.2.2.2 Analysis of Fuzzy Current

1. Variable Current, there are five fuzzy set, namely: Very small, small, medium, large, very large. Universe speaker for the variable voltage is 0 - 50. Domain hipunan fuzzy set on variable voltage, namely:
   1) Very small : 0 – 20
   2) Small : 10 – 30
   3) Medium : 20 – 40
   4) Large : 30 – 50
   5) Very large : 40 – 50

2.2.2.3 Analysis of Fuzzy speed doors

1. Variable speed doors, there are five fuzzy set, namely: Very small, small, medium, large, very large. Universe speaker for the variable voltage is 0 - 50. Domain hipunan fuzzy set on variable voltage, namely :
   1) Very Slow : 0 – 20
   2) SLow : 10 – 30
   3) Medium : 20 – 40
   4) Fast : 30 – 50
   5) Very Slow Once : 40 – 50

2.2.3 Implementation of Fuzzy Logic

2.2.3.1 Voltage and Current Case

Suppose obtained voltage value is 27.77, the 27.77 value will be converted into fuzzy values, where the voltage value of 27.77 is at a very low linguistic value. Based on the stages or aggregation process that determines the output in accordance with the rules of fuzzy.

1. Stages fuzzification

Calculation fuzzification for each linguistic variable voltage (very small, small, medium, large, very large) when the voltage value [27.77] is as follows :

μVery small [27,77]= $20 \leq 40 = 0$

μSmall [27,77]= $\frac{60-20}{40} = 1$

μMedium [27,77]= $\frac{80-40}{60} = 0{,}6$

μLarge [27,77]= $\frac{100-60}{80} = 0{,}5$

μVery large [27,7]= $100 \geq 80 = 0$

2. Establishment of Rule Stages

Here's a design stage the establishment of the rule.

Tabel 2.2 *Fuzzy Rule*

IF	Tegangan	AND	Arus	THEN	Kecepatan Pintu
IF	Sangat Kecil	AND	Sangat Kecil	THEN	Sangat Lambat
IF	Sangat Kecil	AND	Kecil	THEN	Sangat Lambat
IF	Sangat Kecil	AND	Sedang	THEN	Sangat Lambat
IF	Sangat Kecil	AND	Besar	THEN	Sangat Lambat
IF	Sangat Kecil	AND	Sangat Besar	THEN	Sangat Lambat
IF	Kecil	AND	Sangat Kecil	THEN	Lambat
IF	Kecil	AND	Kecil	THEN	Lambat
IF	Kecil	AND	Sedang	THEN	Lambat
IF	Kecil	AND	Besar	THEN	Sedang
IF	Kecil	AND	Sangat Besar	THEN	Sedang
IF	Sedang	AND	Sangat Kecil	THEN	Sedang
IF	Sedang	AND	Kecil	THEN	Sedang
IF	Sedang	AND	Sedang	THEN	Cepat
IF	Sedang	AND	Besar	THEN	Lambat
IF	Sedang	AND	Sangat Besar	THEN	Lambat
IF	Besar	AND	Sangat Kecil	THEN	Sangat Lambat
IF	Besar	AND	Kecil	THEN	Lambat
IF	Besar	AND	Sedang	THEN	Lambat
IF	Besar	AND	Besar	THEN	Lambat
IF	Besar	AND	Sangat Besar	THEN	Lambat
IF	Sangat Besar	AND	Sangat Kecil	THEN	Lambat
IF	Sangat Besar	AND	Kecil	THEN	Lambat
IF	Sangat Besar	AND	Sedang	THEN	Sangat Lambat Sekali
IF	Sangat Besar	AND	Besar	THEN	Sangat Lambat Sekali
IF	Sangat Besar	AND	Sangat Besar	THEN	Sangat Lambat Sekali

3. Stages Inference Engine

Once the value of the degree of membership in the get, then the values of the degree must be compared in accordance with the existing rule base, in order to seek Minimum value calculated for each rule.

1. [R1] *IF* Voltage *is* Very small *AND* Current *is* µVery small *THEN* Speed Doors *is* Very Slow
   α-pred$_1$ = µVerySmall[10]∩µVerySmall [8]
   = MIN (0 ; 0)
   = 0
2. [R2] *IF* Voltage *is* Very small *AND* Current *is* small *THEN* Speed Doors *is* Very Slow
   α-pred$_2$ = µVery Small [10] ∩ µSmall [8]
   = MIN (0 ; 1)
   = 0
3. [R3] *IF* Voltage *is* VerySmall *AND* Current *is* Medium *THEN* Speed Doors *is* Very Slow
   α-pred$_3$ = µ Very small [10] ∩µMedium [8]
   = MIN (0 ; 0,6)
   = 0
4. [R4] *IF* Voltage *is* VerySmall *AND* Current *is* Large *THEN* Speed Doors *is* Very Slow
   α-pred$_4$ = µ Very small [10] ∩ µ Large [8]
   = MIN (0 ; 0,5)
   = 0
5. [R5] *IF* Voltage *is* VerySmall *AND* Current *is* Very large *THEN* Speed Doors *is* Very Slow
   α-pred$_5$ =VerySmall[10] ∩ µ Very large [8]
   = MIN (0 ; 0)
   = 0
6. [R6] *IF* Voltage *is* Small *AND* Current *is* Verry Small *THEN* Speed Doors *is* Slow
   α-pred$_6$ = µSmall[10] ∩ µVerrySmal[8]
   = MIN (1 ; 0)
   = 1
7. [R7] *IF* Voltage *is* Small *AND* Current *is* Small *THEN* Speed Doors *is* Slow
   α-pred$_7$ = µKecil[10] ∩ µKecil[8]
   = MIN (1 ; 1)
   = 1
8. [R8] *IF* Voltage *is* Smal *AND* Current *is* Medium *THEN* Speed Doors *is* Slow
   α-pred$_8$ = µSmall[10] ∩ µMedium[8]
   = MIN (1 ; 0,6)
   = 1
9. [R9] *IF* Voltage *is* Small *AND* Current *is* Large *THEN* Speed Doors *is* Medium
   α-pred$_9$ = µSmall[10] ∩ µLarge[8]
   = MIN (1 ; 0,5)
   = 1
10. [R10] *IF* Voltage *is* Smal *AND* Currrent *is* Verry Large *THEN* Speed Doors *is* Medium
    α-pred$_{10}$= µSmall[10] ∩ µVerryLarge[8]
    = MIN (1 ; 0)
    = 1
11. [R11] *IF* Voltage *is* Medium *AND* Current *is* Verry Small *THEN* Speed Doors *is* Medium
    α-pred$_{11}$ = µMedium[10] ∩ µVerrySmall[8]
    = MIN (0,6 ; 0)
    = 0,6
12. [R12] *IF* Voltage *is* Medium *AND* Current *is* Small *THEN* Speed Doors *is* Medium
    α-pred$_{12}$ = µMedium[10] ∩ µSmall[8]
    = MIN (0,6 ; 1)
    = 0,6
13. [R13] *IF* Voltage *is* Medium *AND* Current *is* Medium *THEN* Speed Doors *is* Fast
    α-pred$_{13}$ = µMedium[10] ∩ µMedium[8]
    = MIN (0,6 ; 0,6)
    = 0,6
14. [R14] *IF* Voltage *is* Medium *AND* Current *is* Large *THEN* Speed Doors *is* Slow
    α-pred$_{14}$ = µMedium[10] ∩ µLarge[8]
    = MIN (0,6 ; 0,5)
    = 0,6
15. [R15] *IF* Voltage *is* Medium *AND* Current *is* Verry Large *THEN* Speed Doors *is* Slow
    α-pred$_{15}$ = µMedium[10] ∩ µVerryLarge[8]
    = MIN (0,6 ; 0)
    = 0,6
16. [R16] *IF* Voltage *is* Large *AND* Current *is* Verry Smalll *THEN* Speed Doors *is* Verry Slow
    α-pred$_{16}$ = µLarge[10] ∩ µVerrySmall[8]
    = MIN (0,5 ; 0)
    = 0,5

17. [R17] *IF* Voltage *is* Large *AND* Current *is* Small *THEN* Speed Doors *is* Slow
α-pred$_{17}$ = µBesar[10] ∩ µKecil[8]
= MIN (0,5 ; 1)
= 0,5
18. [R18] *IF* Voltage *is* Large *AND* Current *is* Medium *THEN* Speed Doors *is* Slow
α-pred$_{18}$ = µLarge[10] ∩ µMedium [8]
= MIN (0,5 ; 0,6)
= 0,5
19. [R19] *IF* Voltage *is* Large *AND* Current *is* Large *THEN* Speed Doors *is* Slow
α-pred$_{19}$ = µLarge[10] ∩ µLarge[8]
= MIN (0,5 ; 0,5)
= 0,5
20. [R20]*IF* Voltage *is* Large *AND* Current *is* Verry Large *THEN* Speed Doors *is* Slow
α-pred$_{20}$ = µLarge[10] ∩ µVerryLarge[8]
= MIN (0,5 ; 0)
= 0,5
21. [R21] *IF* Voltage *is* Verry Large *AND* Current *is* Verry Small *THEN* Speed Doors *is* Slow
α-pred$_{21}$ = µVerryLarge[10] ∩ µVerrySmall[8]
= MIN (0 ; 0)
= 0
22. [R22] *IF* Voltage *is* Verry Large *AND* Current *is* Small *THEN* Speed Doors *is* Slow
α-pred$_{22}$= µVerryLarge[10] ∩ µSmall[8]
= MIN (0 ; 1)
= 0
23. [R23] *IF* Voltage *is* Verry Large *AND* Current *is* Medium *THEN* Speed Doors *is* Very Slow Once
α-pred$_{23}$ = µVerryLarge[10] ∩ µMedium[8]
= MIN (0 ; 0,6)
= 0
24. [R24] *IF* Voltage *is* Very Large *AND* Current *is* Large *THEN* Speed Doors *is* Very Slow Once
α-pred$_{24}$ = µVerryLarge[10] ∩ µLarge[8]
= MIN (0 ; 0,5)
= 0
25. [R25] *IF* Voltage *is* Verry Large *AND* Current *is* Verry Large *THEN* Speed Doors *is* Very Slow Once
α-pred$_{25}$ = µVerryLarge[10] ∩ µVerryLarge[8]
= MIN (0 ; 0)
= 0

4. Stages defuzzification

1. Rule 1 = Verry Slow $\frac{10-z}{10} = 0$
Z1 = 10 – 0 = 10
2. Rule 2 = Verry Slow $\frac{10-z}{10} = 0$
Z1 = 10 – 0 = 10
3. Rule 3 = Verry Slow $\frac{10-z}{10} = 0$
Z1 = 10 - 0 = 10
4. Rule 4 = Verry Slow $\frac{10-z}{10} = 0$
Z1 = 10 – 0 = 10
5. Rule 5 = Verry Slow $\frac{10-z}{10} = 0$
Z1 = 10 – 0 = 10
6. Rule 6 = Slow $\frac{z-10}{10} = 1$
Z1 = 10 – 10 = 0
7. Rule 7 = Slow $\frac{z-10}{10} = 1$
Z1 = 10 – 10 = 0
8. Rule 8 = Slow $\frac{z-10}{10} = 1$
Z1 = 10 – 10 = 0
9. Rule 9 = Medium $\frac{z-20}{10} = 1$
Z1 = 20 – 20 = 0
10. Rule 10 = Medium $\frac{z-20}{10} = 1$
Z1 = 20 – 20 = 30
11. Rule 11 = Medium $\frac{z-20}{10} = 0{,}6$
Z1 = 12 + 20 = 32
12. Rule 12 = Medium $\frac{z-20}{10} = 0{,}6$
Z1 = 12 + 20 = 32
13. Rule 13 = Fast $\frac{z-30}{10} = 0{,}6$
Z1 = 18 + 20 = 38
14. Rule 14 = Slow$\frac{z-20}{10} = 0{,}6$
Z1 = 12 + 20 = 32
15. Rule 15 = Slow$\frac{z-20}{10} = 0{,}6$
Z1 = 12 + 20 = 32
16. Rule 16 = Verry Slow $\frac{z-40}{10} = 0{,}5$
Z1 = 20 + 40 = 60
17. Rule 17 = Slow $\frac{z-10}{10} = 0{,}5$
Z1 = 5 + 10 = 15
18. Rule 18 = Slow $\frac{z-10}{10} = 0{,}5$
Z1 = 5 – 10 = 15
19. Rule 19 = Slow $\frac{z-10}{20} = 0{,}5$
Z1 = 5 – 10 = 15
20. Rule 20 = Slow $\frac{z-10}{10} = 0{,}5$
Z1 = 1 + 80 = 15
21. Rule 21 = Slow $\frac{z-40}{10} = 0$
Z1 = 0 + 40 = 40
22. Rule 22 = Slow $\frac{z-40}{10} = 0$
Z1 = 0 + 40 = 40
23. Rule 23 = Very Slow Once $\frac{z-40}{10} = 0$
Z1 = 0 + 40 = 40
24. Rule 24 = S Very Slow Once $\frac{z-40}{10} = 0$
Z1 =0 + 40 = 40
25. Rule 25 = Very Slow Once $\frac{z-40}{10} = 0$
Z1 = 0 + 40 = 40

$$Z = \frac{\begin{array}{c}0 \times 10 + 0 \times 10 + 0 \times 10 + 0 \times 10 + 0 \times 10 + 1 \times 10 + 1 \times 10 + 1 \times 10 + 1 \times 10 + 1 \times 10 + 0{,}6 \times 32 + 0{,}6 \times 32 + 0{,}6 \times 38 + 0{,}6 \times 32 + 0{,}6 \times 32 + 0{,}5 \times 60 + 0{,}5 \times 15 + 0{,}5 \times 15 + 0{,}5 \times 15 + 0{,}5 \times 15 + 0 \times 40 + 0 \times 40 + 0 \times 40 + 0 \times 40 + 0 \times 40\end{array}}{\begin{array}{c}0 + 0 + 0 + 0 + 0 + 1 + 1 + 1 + 1 + 1 + 0{,}6 + 0{,}6 + 0{,}6 + 0{,}6 + 0{,}6 + 0{,}5 + 0{,}5 + 0{,}5 + 0{,}5 + 0{,}5 + 0 + 0 + 0 + 0 + 0\end{array}}$$

$$= \frac{\begin{array}{c}0 + 0 + 0 + 0 + 0 + 10 + 10 + 10 + 10 + 10 + 19{,}2 + 19{,}2 + 22{,}8 + 19{,}2 + 19{,}2 + 30 + 7{,}5 + 7{,}5 + 7{,}5 + 7{,}5 + 0 + 0 + 0 + 0 + 0\end{array}}{10{,}5}$$

$$= \frac{202{,}1}{10{,}5} = 19{,}72$$

Conclusion :

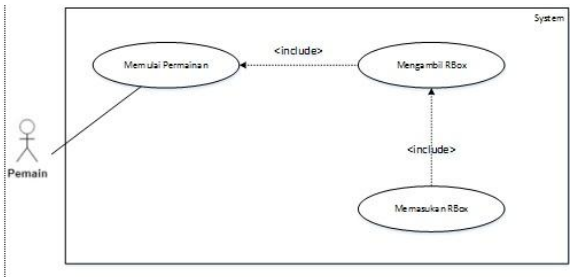
The values obtained from the defuzzyfication process is then used to determine the decision with the following rules :

1. Very Slow : 0 – 20
2. Slow : 10 – 30
3. Medium : 20 – 40
4. Fast : 30 – 50
5. Very Slow Once : 40 – 50

Then the result is the value of 19.72 Slow.

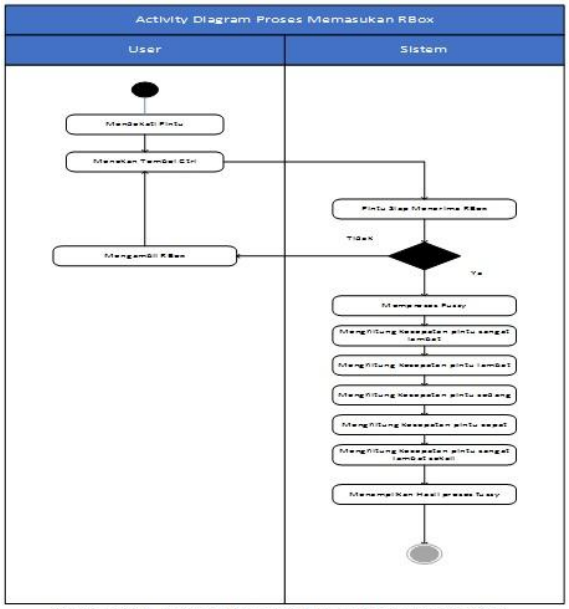
2.2.4 Functional Needs Analysis

2.2.4.1 Use Case



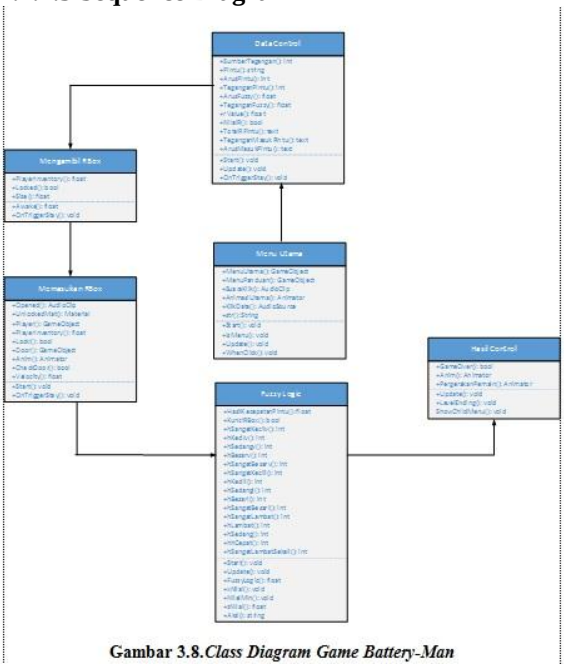
Gambar 3.4.*Use Case Diagram Game Battery-Man*

2.2.4.2 Activity Diagram



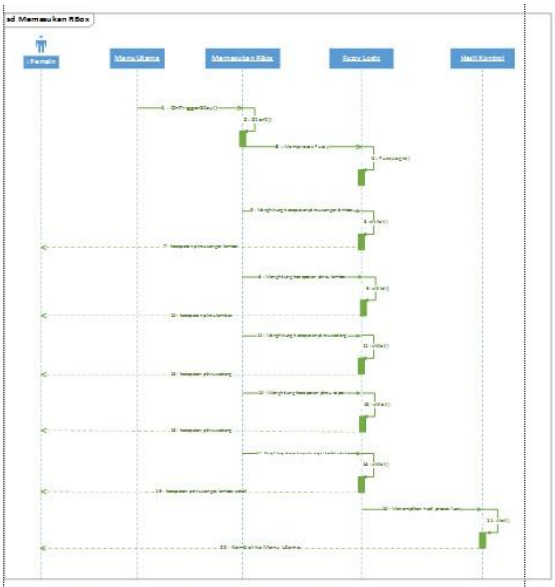
Gambar 3.7. *Activity Diagram* Proses Memasukan RBox

2.2.4.3 Sequence Diagram



Gambar 3.8.*Class Diagram Game Battery-Man*

2.2.4.4 Class Diagram



Gambar 3.11. *Diagram Sequence* Memasukan RBox

2.3 Implementation and Testing

2.3.1 Testing Systems

Testing is something that needs to be done to determine deficiencies or errors in the software being tested. Testing intended to determine the software that is made already meet the criteria in accordance with the purpose of designing such software.

2.3.2 Testing plan

In the test plan, test plan to use functionality that is by using black box testing focuses on functional requirements and testing software simulsi aimed at conformance level defuzzification value with a predefined behavior. Here is the plan of tests performed in Table 4.3:

Tabel 4.3 Black Box Testing

Tabel 4.3 Pengujian *Black Box*

No	Komponen yang di uji	Jenis Pengujian
1.	Menu Utama	Black Box
2.	Mulai Permainan	Black Box
3.	Panduan Game	Black Box
4.	Hasil Permainan	Black Box

2.3.3 Testing Results

The test results obtained from testing the fuzzy logic algorithm and the black box. The suitability of any item that will use fuzzy logic algorithms testing and black box testing is done according to plan

.

2.3.3.1 Black Box Testing Results

Here are the results of the testing of software that has been constructed using black box method is based on observations that have been carried out and resulted in the conclusion of the test

.

1. Testing Main Menu

Testing main menu with cases and test results, then observed and produce conclusions can be seen in table 4.4 :

Table 4.4 Testing Main Menu

Kasus yang akan di uji	Hasil Uji	
	Hasil yang diharapkan	Kesimpulan
Menu Utama	Sistem menampilkan menu permainan	[√] Berhasil [ ] Tidak Behasil

2. Testing Start Game

Testing began the game with cases and test results, then observed and produce conclusions can be seen in table 4.5:

Tabel 4.5 Testing Start Game

Kasus yang akan di uji	Hasil Uji	
	Hasil yang diharapkan	Kesimpulan
Memulai Permainan	Sistem menampilkan layar permainan	[√] Berhasil [ ] Tidak Behasil

3. Testing Free Game

Manual testing game with cases and test results, then observed and produce conclusions can be seen in table 4.6:

Tabel 4.6 Testing Free Game

Kasus yang akan di uji	Hasil Uji	
	Hasil yang diharapkan	Kesimpulan
Panduan Game	Sistem menampilkan panduan game	[√] Berhasil [ ] Tidak Behasil

4. Testing Results Games

Testing results of the game with cases and test results, then observed and produce conclusions can be seen in table 4.7:

Tabel 4.7 Testing Results Games

Kasus yang akan di uji	Hasil Uji	
	Hasil yang diharapkan	Kesimpulan
Hasil Permainan	Sistem menampilkan hasil permainan	[√] Berhasil [ ] Tidak Behasil

2.3.3.2 Simulation Testing Results

Simulation testing to ensure that some rules are made to run correctly. This experiment is testing the voltage and current input variable, the output variable speed door because on this part there are some rules that have been made under the rules of Fuzzy Logic. Every part of the rule-rule fuzzy logic will be verifiable, whether the application program that has been created to run well or not. Rule to be tested are 25 types of rule, and 5 kinds of speed

door. Tests carried out by the main character to implement fuzzy logic algorithm.

1. Testing Rule 1

Here are the results of testing that has been done on rule 1 for the speed of the door, can be seen in Table 4.8 and Figure 4.5 below.

Tabel 4.8 Testing Results Rule 1

		Tegangan		Arus		Kecepatan Pintu
Rule 1	IF	Sangat Kecil	AND	Sangat Kecil	THEN	Sangat Lambat
Hasil Pengujian						
No	Parameter		Nilai	Nilai z	Kecepatan Pintu	
1	Tegangan		21.73913	14.18679	Sangat Lambat	
2	Arus		10.86957			



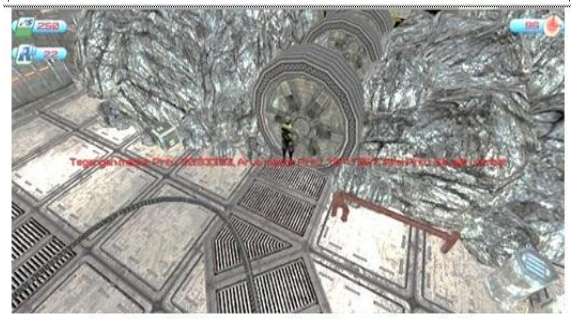
Gambar 4.5 Representasi hasil pengujian *rule* 1

2. Testing Rule 2

Here are the results of testing that has been done on rule 2 for the speed of the door, can be seen in Table 4.9 and Figure 4.6 below.

Tabel 4.9 Testing Results *Rule* 2

		Tegangan		Arus		Kecepatan Pintu
Rule 2	IF	Sangat Kecil	AND	Kecil	THEN	Sangat Lambat
Hasil Pengujian						
No	Parameter		Nilai	Nilai z	Kecepatan Pintu	
1	Tegangan		20.83333	12.24359	Sangat Lambat	
2	Arus		10.41667			



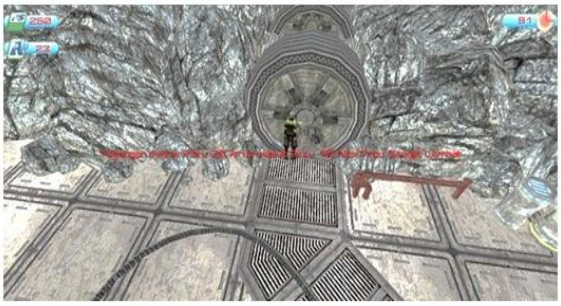
Gambar 4.6 Representasi hasil pengujian *rule* 2

3. Testing Rule 3

Here are the results of testing that has been done on rule 3 for the speed of the door, can be seen in Table 4.10 and Figure 4.7 below.

Tabel 4.10 Testing Results *Rule* 3

		Tegangan		Arus		Kecepatan Pintu
Rule 3	IF	Sangat Kecil	AND	Sedang	THEN	Sangat Lambat
Hasil Pengujian						
No	Parameter		Nilai	Nilai z	Kecepatan Pintu	
1	Tegangan		20	10	Sangat Lambat	
2	Arus		10			



Gambar 4.7 Representasi hasil pengujian *rule* 3

2.3.4 Conclusion Testing

After testing it on get the conclusion that the rule - the rule that has been tested in accordance with the design and fuzzy logic that can produce good decisions and right.

3. CLOSING

3.1 Conclusion

Based on the results obtained in the research and preparation of this paper as well adapted to the purpose, it could be concluded that the implementation of fuzzy logic in Battery-Man game has met the goal, that can generate output actions in accordance with conditions such as very slow, slow, medium , fast, very slow once based on fuzzy variable voltages and currents.

3.2 Suggestions

Based on the results of the overall implementation and testing, it can be given suggestions that additional parameters and behaviors in Tsukamoto Fuzzy Logic algorithm to determine the appropriate behavior in the speed of the door and are expected to do the rounding value of linguistic order accuracy defuzzification value between processes in the application in accordance with the calculation manuals.

REFERENCES

[1] Kusumadewi, S. 2003. *Artificial Interlligence (Teknik dan Aplikasinya)*. Yogyakarta: Graha Ilmu.

[2] Nasution. H. 2012. *Jurnal Implementasi Logika Fuzzy Pada Sistem Kecerdasan Buatan.* Universitas Tanjungpura.

[3] Widhiastiwi, Y. 2007. *Model Fuzzy Dengan Metode Tsukamoto.* Bina Widia, Vol. 18 No. 02.

[4] Rollings, Andrew; Morris, Dave. 2004. *Game Architecture and Design: A New Edition*. New Riders.

[5] Marsic. I. 2012. *Software Engineering*. Rutgers University.