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Motorcycle-Security using Position Searching Algorithm Based on Hybrid Fuzzy-Dijkstra

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Abstract

Motorcycle safety system has been provided by the manufacturer in the form of a handlebar lock and electrical key equipped with alarms. Keys provided by the manufacturers sometimes fail in securing a motorcycle. In addition the safety system does not provide position information of the stolen motorcycle to the owner. With these problems, the paper presents safety locked motorcycle equipped with artificial intelligence algorithms. Artificial intelligence algorithm is used to find and detect the location of the motorcycle using the shortest path algorithm. This paper applies search algorithm using Dijkstra algorithm where the algorithm is used to make the decision to get the location of the motorcycle. By using the algorithm, the location of the motorcycle can be detected but it is not able to find the shortest path needed. Therefore, this paper describes the modification of Dijkstra algorithm by adding a Fuzzy algorithm that is used for the weight values in decision making, so that it can pursue to find the shortest path.

Keywords*: Dijkstra; Fuzzy; Motorcycle-Security; Position Searching Algorithm; shortest path*

1. Introduction

Rampant theft of motor vehicles in the capital in recent years has caused huge losses for the people, especially the owner of the vehicles. Thieves do not hesitate to steal vehicles parked in the front of the house, even they steal vehicles that placed in the garage of the house. This can happen because some important aspects neglected by the owners of motor vehicles, among them are a lack of awareness of unexpected things happened to their vehicles and the lack of security for vehicles that allow thieves to steal them.

Therefore, some previous researchers such as Nasir & Mansor [1] has developed a motorcycle safety system using GSM technology. This system uses a decision-making algorithm used for waking the alarm and sending a message. Other researchers, Padmapriya & KalaJames [2] used a camera as a security key. The camera captures facial images and detects the vehicle owner face with pattern recognition algorithms. Shieh et al [3] used RFID as motor vehicle safety. RFID serves as a safety lock for the vehicle.

From the previous research on safety of motor vehicles, the systems cannot detect the current position of the stolen vehicle. Hence, this paper describes the algorithm used in the decision making to detect motor vehicle position. One of the decision algorithms which has been investigated by several researchers is fuzzy algorithm. Fuzzy is an artificial intelligence algorithm first discovered by Zadeh [4]. This algorithm was used by previous researchers to control the altitude [5] and hover [6] on quadrotor.

Besides being used to control the system, this algorithm is used to make decisions for quadrotor path planning [7]. Fuzzy is also coupled with cell decomposition algorithm implemented by Iswanto et al, [8, 9] on mobile robot path planning. The algorithm was used to take a decision in finding the shortest path in mobile robot path planning algorithm.

Fuzzy logic is used to model the quantity of inputs. This logic is used for model situations where the decision making is complex and difficult to undertake the development of a mathematical model. All of the output values from the fuzzy logic can be used as the other algorithm inputs. Fuzzy logic is very close to human thought that is widely accepted and applied in a variety of real world problems, as well as to model the knowledge possessed by humans. Therefore, the author uses fuzzy logic to model the road characteristics. Fuzzy logic is often

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used to solve problems of systems automation controls, but it can also be used in the case of search optimization for the fastest path.

Dijkstra algorithm is an algorithm to solve problem in finding the shortest path with the value of each non-negative pathway. This algorithm is used by Li et al, [10] for decision making in solving the problem of police patrols. This algorithm solves the problem by generating a route, from the initial location to the destination location, to find the shortest, quickest or easiest route. Other researchers Joo Young Hwang et al, [11] examined the dijkstra algorithm used for planning the fastest path for the line graph. With the algorithm graph lines can be optimized to produce the quickest path toward its destination. Saab & Van Putte [12] apply dijkstra algorithm for finding the shortest path on the map. Ergun et al, [13] implemented dijkstra algorithm in transmission system multizonal. With dijkstra algorithm can find the shortest path pathway for the transmission system.

Previous research has explained that the algorithm is an algorithm dijksra fuzzy and decision makers to search the shortest path. However, the algorithms are not applicable to the actual conditions when our bad roads, crowded, and cramped.This paper presents dijkstra algorithm combined with fuzzy logic algorithm applied to the search algorithm for motorcycle to the actual condition. With the algorithm the closest path to the position of the motorcycle can be identified.

2. Research Method

The data collection was taken in several ways among others are surveys, distribution of questionnaires, data retrieval from the existing archives in the relevant agencies, interviews and observation.

Data needed include:

a) The length of the path data

b) road density data

Variables and attributes used in this study include:

a) μ = parameter variables (road-length, and density)

b) P = road-length (short, moderate, and long)

c) L = road-density (loose, normal, and dense)

d) O = output (smooth, moderate, little-dense, creepsolid, and jams).

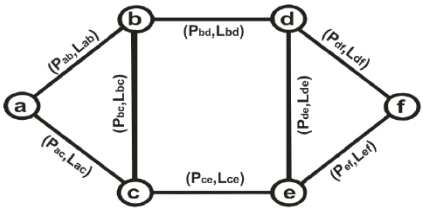

Figure 1. Representation of the Graf Road which has Two Parameters in each arc

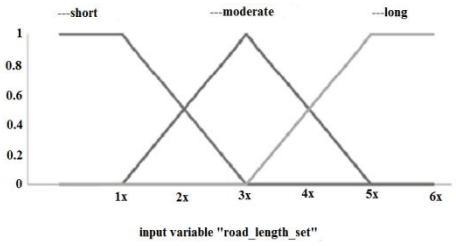

Figure 2. Membership Function of Road Length Set

A road has several parameters for a consideration on a decision on which path to take as shown in Figure 1. The length and density of the road are use in this case. Furthermore, from the graphical representation depicting a road network, its membership function is created. On the membership function of road length and density, the value of membership in each graph is represented by letters a and b. The letters a and b are the maximum value of the road length and density in the node graph a to f that is the initial node to the end node. So that each value will be the final frontier of the membership functions possessed by each parameter. The use of letters a and b, is that if there is a change in the parameter values, the shape of the membership function possessed will not be changed.

2.1. Road Length Membership Function

Road length membership function describes the degree of membership owned by the length of road, which has three degrees of membership namely short, medium and long terms.

Each membership function has a linear function. Linear function is used to provide information of value posessed by each degree of membership. Linear function posessed by a road length is as follows.

Linear function for short set:

$$\mu_{short} = \begin{cases} 1 & ; \quad P \leq \frac{1x}{6} \\ \frac{\left(\frac{1x}{6} - P\right)}{\left(\frac{3x}{6} - \frac{1x}{6}\right)} & ; \quad \frac{1x}{6} \leq P \leq \frac{3x}{6} \\ 0 & ; \quad P \geq \frac{3x}{6} \end{cases} \tag{1}$$

Linear function for moderate set:

$$\mu_{\text{moderate}} = \begin{cases} 0 & ; \quad P \leq \frac{1x}{6} \; or \; P \geq \frac{5x}{6} \\ \frac{\left(P - \frac{1x}{6}\right)}{\left(\frac{3x}{6} - \frac{1x}{6}\right)} & ; \quad \frac{1x}{6} \leq P \leq \frac{3x}{6} \\ \frac{\left(\frac{5x}{6} - P\right)}{\left(\frac{5x}{6} - \frac{3x}{6}\right)} & ; \quad \frac{3x}{6} \leq P \leq \frac{5x}{6} \end{cases} \tag{2}$$

Linear function for long set:

$$\mu_{\text{long}} = \begin{cases} 0 & ; \quad P \leq \frac{3x}{6} \\ \frac{\left(L - \frac{1x}{6}\right)}{\left(\frac{5x}{6} - \frac{3x}{6}\right)} & ; \quad \frac{3x}{6} \leq P \leq \frac{5x}{6} \\ 1 & ; \quad P \geq \frac{5x}{6} \end{cases} \tag{3}$$

2.2. The Function of Road Density Membership

Road density of membership functions describes the degree of membership posessed by the density of the road, which has three degrees of membership namely smooth, normal and solid.

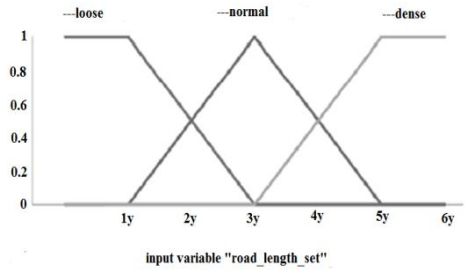

Figure 3. Membership Function of Density Roads Association

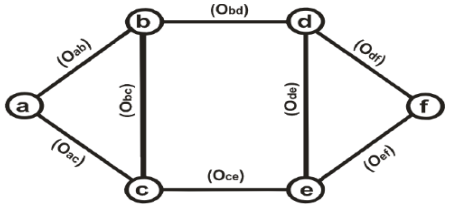

Figure 4. Graf Results of Fuzzy Logic Process

Road length to membership function is illustrated in Figure 3. Each membership function has a linear function as follows.

Linear function for loose set:

$$\mu_{\text{loose}} = \begin{cases} 1 & ; \quad L \leq \frac{1y}{6} \\ \frac{\left(\frac{1y}{6} - L\right)}{\left(\frac{3y}{6} - \frac{1y}{6}\right)} & ; \quad \frac{1y}{6} \leq L \leq \frac{3y}{6} \\ 0 & ; \quad L \geq \frac{3y}{6} \end{cases} \tag{4}$$

Linear function for normal set:

$$\mu_{\text{normal}} = \begin{cases} 0 & ; \quad L \leq \frac{1y}{6} \; or \; L \geq \frac{5y}{6} \\ \frac{\left(L - \frac{1y}{6}\right)}{\left(\frac{3y}{6} - \frac{1y}{6}\right)} & ; \quad \frac{1y}{6} \leq L \leq \frac{3y}{6} \\ \frac{\left(\frac{5y}{6} - L\right)}{\left(\frac{5y}{6} - \frac{3y}{6}\right)} & ; \quad \frac{3y}{6} \leq L \leq \frac{5y}{6} \end{cases} \tag{5}$$

Linear function for dense set:

$$\mu_{\text{dense}} = \begin{cases} 0 & ; \quad L \leq \frac{3y}{6} \\ \frac{\left(L - \frac{1y}{6}\right)}{\left(\frac{5y}{6} - \frac{3y}{6}\right)} & ; \quad \frac{3y}{6} \leq L \leq \frac{5y}{6} \\ 1 & ; \quad L \geq \frac{5y}{6} \end{cases} \tag{7}$$

2.3. Fuzzy Inference Process

If each membership function has three membership variables, the rule evaluation produced will be as shown in Table 1.

Table 1. The Performance of ...

Variable	Speed (rpm)	Power (kW)
Short	10	8.6
Moderate	15	12.4
Long	20	15.3

In Table of rule evaluation, it is written all possible combinations of the four parameters. After the process the author uses fuzzy Sugeno models to model the results of fuzzy logic. Notation 0.1 to 1 is the value or weight to indicate the level or grade of the road. The value is set to rule evaluation inputs posessed by fuzzy logic. The process of fuzzy output uses ordenol Sugeno models.

If (Xi is Pi) AND (Yi is Li) then z = O (9)

P is the road length parameter, L is a parameter. Fuzzy logic operator "AND" is used because in finding the fastest path the smallest value of every road is searched. So that the way to read the rule is "If the road length (P) and road density (L) then the road (O)". And i is the each posessed arc.

The results of fuzzy logic is further processed by using dijkstra algorithm. Each node weight is "O" in this algorithm as illustrated in Figure 4.

3. Results and Analysis

At this stage, the algorithm will be tested. The merger of fuzzy logic and dijkstra algorithms has a detailed and lengthy calculations. The first process of the search process is the provision of values of posessed parameter namely road length and density. Each node has two parameter values. The value as the input value of fuzzy algorithm. Values for each node can be

seen in Table III. The values are either based on a survey or random values for algorithm testing process. The values in Table III is illustrated in Figure 5.

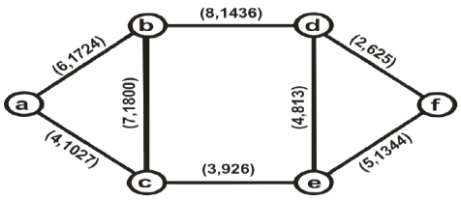

Figure 5. A graph that has Two Values for Each Parameter

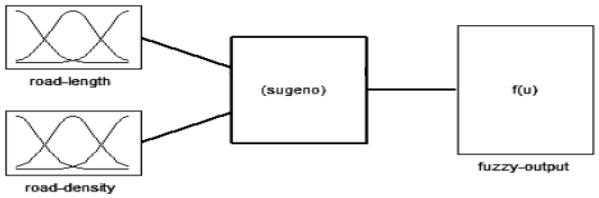

Figure 6. Fuzzy Logic Process

Each value of road length and density is added to the membership function posessed by fuzzy logic. Each node is inserted one by one.

The process of fuzzy logic, shown in Figure 6, is the road length parameter having its own membership functions and road density. Then both parameters will be processed by fuzzy Sugeno and it generates fuzzy output.

The membership function of the density of roads is also divided into three variable parameters. Figure 7 provides information on the model of the membership function of road density. Each variable parameter has different limits, according to the data of road length posessed by the path to be taken.

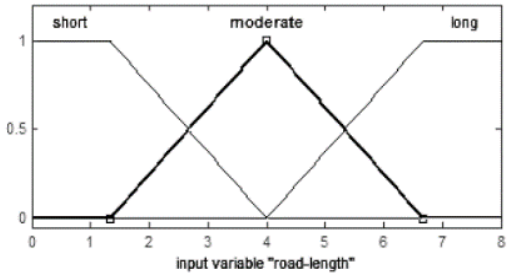

Figure 7. Membership Function of Road Length

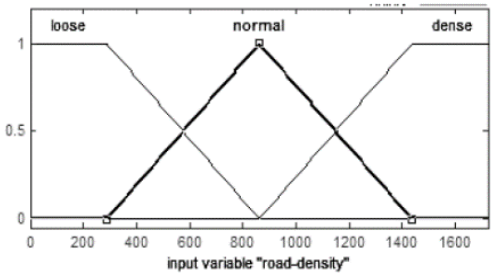

Figure 8. Membership function of Road density

The membership function of the density of roads is also divided into three variable parameters. Figure 7 provides information on the model of the membership function of road density. Each variable parameter has different limits, according to the data of road length posessed by the path to be taken.

Each parameter, the road length and road density, has three variable parameters. The rule evaluation that is owned by this process is nine rules. Detail rules is shown in Figure 9. The weight of the lightest is 0.1 is the way with most small weights to weight greatest.

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If (road-length is short) and (road-density is loose) then (fuzzy-output is smooth)
If (road-length is short) and (road-density is normal) then (fuzzy-output is moderate)
If (road-length is short) and (road-density is dense) then (fuzzy-output is little-dense)
If (road-length is moderate) and (road-density is loose) then (fuzzy-output is moderate)
If (road-length is moderate) and (road-density is normal) then (fuzzy-output is little-dense)
If (road-length is moderate) and (road-density is dense) then (fuzzy-output is creep-solid)
If (road-length is long) and (road-density is loose) then (fuzzy-output is little-dense)
If (road-length is long) and (road-density is normal) then (fuzzy-output is creep-solid)
If (road-length is long) and (road-density is dense) then (fuzzy-output is jams)
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Figure 9. Rule Evaluation

The fuzzy set output shown in Figure 10 has five variables that is smooth, moderate, little dense, creep-solid, and jam or very dense in which each has a limit value of 0-0.1 (smooth); 0.25 (moderate); 0.5 (little dense); 0.75 (creep-solid) and 1 (dense).

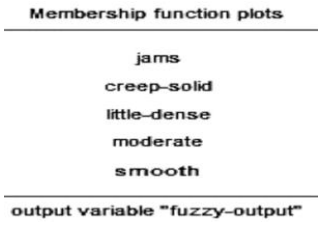

Figure 10. Fuzzy Output

The last process of the algorithm is fuzzy defuzzification process. If you take a sample for defuzzification process, node (a, b) has a road length of 6 and a density of 1724, the defuzzification process as shown in Figure 11 has a fuzzy output value of 0.95. length and density value are processed with the 9 rule evaluation process.

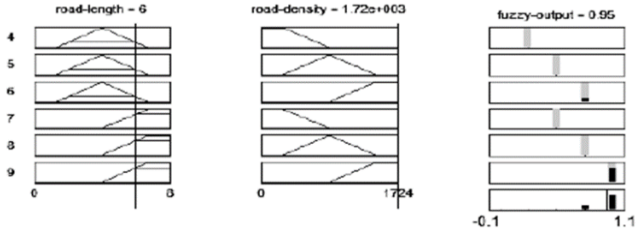

Figure 11. The Process of Defuzzification

After each node enters in the fuzzy logic process, the output will be as illustrated in Figure 12. In each road segment node, each node has a single value that is the result of the two parameters processed with fuzzy logic resulting in a fuzzy output posessed by each node street. These results are used in the selection of roads which are processed by using dijkstra algorithm.

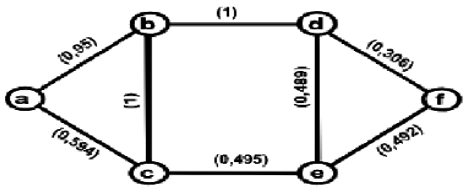

Figure 12. Graf of Fuzzy Logic Output

Each path has a different value according to the initial input, the graph now has one value that is fuzzy output. Fuzzy output is used as input of dijkstra algorithm. The process of dijkstra algorithm, such as the following steps. Algorithms to find the shortest route was developed by Dijkstra.

All process is conducted to the node f, so that from node A to node f solutions for the fastest path is obtained. The shortest path from point V1 to Vn is through points in L sequentially and the total of the smallest track weight is D (n). Once all three steps are finished,

the distance as the final results of the selected path is obtained. The results is shown in figure 14 that is the a-c-e-f as the route selected with the total of fuzzy output is 1.581.

4. Conclusion

Problems in path searching, using various criteria, can be resolved with a combination of fuzzy logic and algorithms dijkstra. The search process by a combination of these algorithms requires a detailed process of thinking. With this approach, some other parameters such as average speed of the vehicle, the road volume, and the degree of road damage or some other parameters that affect the rate speed of vehicle can be inputted. The value of the roads are always dynamic, so that the process and the selected route taken may change at any time.

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