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Expert System in Clustering the Damage of a Motorcycle Matic with the K-Means Algorithm

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Abstract. Research on Expert Systems to Diagnose Matic Motorcycle Engine Damage by applying Algoritma K-means. Research to detect damage to an automatic motorcycle by observing the symptoms of an automatic motorcycle. This study aims to help Matic Motorcycle users to find out about damage to the automatic motorcycle based on the results of the application of the K-Means algorithm without having to meet with experts directly. Research by applying Algoritma k-Means by forming groupings based on electrical damage, compression and engine performance, continuous variable transmission timing and automatic sensors so that the damage can be grouped. The results of the expert system research with the K-Means Algorithm can help matic motorcycle users to find out the type of damage based on the grouping that has been determined by the K-Means algorithm.

1. Introduction

The high level of demand for matic motor vehicle users with powerful engines triggers the emergence of an ideal new technology called the Continuously Variable Transmission (CVT) wheel drive system[1]. This system generates movement automatically according to engine speed, so the driver is free from having to shift gears. As a result, riders are more comfortable and relaxed when riding Matic Motorcycle [2].

Continuously Variable Transmission (CVT) also avoids the beat of a machine that usually arises when moving manual transmissions to conventional engines[3]. Substitution of the transmission on the CVT system was very soft, along with the addition of engine power and speed[4]. There are three main components that play an important role in the CVT, the first is the front pulley or Drive Pulley (primary), then the rear pulley or Driven Pulley (secondary), and the last is the V-belt which acts to connect the two[5]. In short, the performance of the front pulley is connected to the engine crankshaft, and is tasked with accommodating power from the engine and transferring it to the rear pulley which is connected to the axle[6]. The function of the V-belt is like a chain in a manual motor whose job is to continue the engine rotation to the wheels[7]. The V-belt is made in such a way that it is free from dirt, dust and water[8],

The motorcycle factory deliberately designed the cooling air intake hole higher than the axle to avoid the entry of water when the motorcycle was running in a flooded area[9]. Research on CVT Transmission of automatic matic motorcycles continues the development of the Expert System article to diagnose Matic Motorcycle Engine Damage with Forward Chaining Method[10].



Although in general, symptoms of motor automatic CVT damage can be felt when driving. For example, the motor feels vibrate, causing noise from the transmission and damage because the motor is affected by flooding, so that the motor is submerged in water and other damage[11].

Expert system is one branch of artificial intelligence that learns how to adopt the way an expert thinks and reason in solving a problem and making a decision or drawing conclusions from a number of facts[12]. In previous studies, namely expert systems diagnose automatic motorcycle engine damage using the Forward Chaining method[10]. Damage to the automatic motorcycle is related to many interrelated components. In previous studies using the forward chaining method with the results of the decision tree-based rules (Decision Tree). Future studies using the K-Means algorithm method that has more accurate segmentation results, because the classification process by dividing the damage area which is divided into 4 clusters, consisting of: Electricity, Compression and Engine Performance, Continuous Variable Timing transmission and automatic sensors.

2. Methods

The method of research is the experimental research, it has some stages

2.1. Data Collecting

Descriptive method called empirical research means research based on experience, both own experience and the experience of others. Empirical research always tries to prove hypotheses by trial and error[13]. In research using descriptive methods as research methods. The use of this method is done, to solve problems in an effort to collect data, compile, clarify and analyze the facts of a problem. Referring to previous research, this writer uses Forward Chaining Method [10].

In the initial stage, research to obtain data on the types of damage and ways to repair an automatic motorcycle, conducted a direct interview with 3 mechanical experts who are experts in the automatic motorcycle field with 7 years experience. The raw data collection process includes direct interviews with experts to get data on the types of damage to parts and symptoms of damage to the automatic motorcycle. Furthermore, mechanical experts are asked to fill out a questionnaire containing questions about damage to parts and symptoms of damage and answer the choice of questions with answers [Yes / No].

2.2. Initial Data Processing

Next preliminary data processing is the result of questionnaire data that answers the dominant score of Yes from 3 mechanical experts in the form of a dominant answer score from 3 experts that [Yes / No], is processed using the Knowledge base concept. Knowledge base is the core program of the expert system where the knowledge base is a knowledge representation of an expert[14]. Facts are represented by establishing conformity between internal representations of facts and natural language representations. This rule contains how to use knowledge to solve specific problems on each domain. In the data processing of the questionnaire, it is represented as a paired order or as an IF condition THEN action. In the IF Section is the Type of Parts Damage and the THEN condition is to describe the symptoms of definite situation damage in the form of a collection of these statements[10].

From existing data regarding the diagnosis of damage to automatic motorcycles that have rules, so that in explaining the problem of getting a good solution from several causes of damage, knowledge is created. With the application of the Knowledge Base, an expert tree is formed using the Forward Chaining method.

2.3. Analysis using the K-means algorithm

Data Clustering is one of the Data Mining methods that is unsupervised. There are two types of data clustering that are often used in the process of grouping data, namely hierarchical (hierarchical) data clustering and non-hierarchical (non-hierarchical) data clustering.

K-Means is a non-hierarchical data clustering method that attempts to partition existing data into one or more clusters / groups that have the same characteristics grouped into one and the same cluster and data which have different characteristics are grouped into groups other[15]. The goal is to minimize the objective function set in the clustering process, which generally seeks to minimize variations within a cluster and maximize variation between clusters[16].

1. Classification based on the type of damage the spare parts consist of: Electrical Engineering Compression and Performance, Continuous Variable Timing transmission and Matic sensor.

Table 1. Data Sample

Class	Damage Type	Spart Part
Class 1	Electricity	Battery, spool, magnetic rotor, pulse ignite, pick up coil, Bvoltage converter, CDI unit, ignition key, fuse, ignition coi, spark plugs
Class 2	Engine Compression and Performance	Valves, pistons, bearings, Cylinder,Liners, Double Bowls, Rollers, Couplings, V-Belts
Class 3	Continuous Variable Timing transmission	Double Bowl, Roller, Clutch, V-Belt
Class 4	Matic sensor	EOT(Engine Oil Temperature),Injectors, MAP (Manifold, Absolute Pressure)

3. Result and Discussion

So that the system can calculate the likelihood of a symptom in an expert system where answers often do not have full certainty. This uncertainty can be the result of an event. Uncertain results are caused by several factors, that is, uncertain rules and uncertain user answers to a choice of symptoms given by the system. This is very easily seen in disorders diagnosis systems, where experts cannot define the relationship between symptoms and their causes with certainty and the user cannot feel a symptom with certainty as well. In the end there will be many possible diagnoses. With calculations using the K-Means algorithm the density value given can be used as a reference to show the amount of confidence.

In order for the data system to calculate and diagnose the motorcycle matic damage group in Table 2, the user must choose a list of symptoms displayed in accordance with the symptoms experienced by the motorcycle matic, each symptom displayed has a presentation value, to be able to calculate the probability. Following is the application of the formula from the k-means algorithm theory.

We will apply K-Means Clustering for the above data into 4 clusters. First we will count Centroid. And generated a new cluster in Table 3

Table 2. Data Sample

Data Samples	G01	G02	G03	G04	G05	G06	G07	G08	G09	G10
Rusdi	0,4	0,4	0,3	0,3	0	0,4	0	0,4	0	0,4
Badrun	0,5	0,5	0,6	0,8	0,7	0	0	0,9	0,9	0,6
Tuslela	0,3	0,3	0,5	0,5	0,7	0,7	0,5	0,8	0,8	0
Irfan	0,5	0,4	0,3	0,3	0,7	0,7	0	0,8	0,7	0,5
Nining	0,8	0,8	0,7	0,7	0	0,6	0	0,5	0,5	0,5
Tyas	0,4	0,7	0,3	0,5	0,7	0,3	0,3	0,8	0,3	0,6

Table 3. Formation of a New Cluster

Cluster	C1	C2	C3	C4	C5	C6	C7	C8	C9	C0
1	0,4	0,4	0,3	0,3	0	0,4	0	0,4	0	0,4
2	0,5	0,5	0,6	0,8	0,7	0	0	0,9	0,9	0,6
3	0,3	0,3	0,5	0,5	0,7	0,7	0,5	0,8	0,8	0
4	0,5	0,4	0,3	0,3	0,7	0,7	0	0,8	0,7	0,5

The calculation uses the Euclidean Distance equation, to determine the distance between clusters to 1,2,3,4.

- (i) The rst calculation is Distance from Cluster 1 to cluster 2, Distance from Cluster 1 to cluster 3, Distance from Cluster 1 to cluster 4, Distance from Cluster 2 to cluster 1, Distance from Cluster 2 to cluster 3, Distance from Cluster 2 to cluster 4 Distance from Cluster 4 3 to cluster 1, Distance from Cluster 3 to cluster 2, Distance from Cluster 3 to cluster 4, Distance from Cluster 4 to cluster 1, Distance from Cluster 4 to cluster 2, Distance from Cluster 4 to cluster 3, so that it is obtained in Table 4:

Table 4. Cluster Calculation Results 1,2,3,4

Data Set	C1	C2	C3	C4	Cluster
Rusdi	0	1,5	1,4	1,1	1
Badrul	1,5	0	1,1	0,9	2
Tuslela	1,4	1,1	0	0,8	1
Irfan	1,3	0,9	0,8	0	4

- (ii) The Second Calculation is The next step we move to data 5, namely:Distance from Cluster 1 to cluster 5, Distance from Cluster 2 to cluster 5, Distance from Cluster 3 to cluster 5, Distance from Cluster 4 to cluster 5, so that it is obtained in Table 5:

The 5th dataset is included in cluster 1, because the minimum / closest distance to the dataset is cluster 1, which is 1.0 and is entered into electricity. Then we update Centroid with the results in Table 6 :

Table 5. Cluster Calculation Results 5

Data Set	C1	C2	C3	C4	Cluster
Dataset K-5 Nining	0	1,5	1,4	1,1	1

Table 6. The 5th Centroid Update dataset

Data Samples	G01	G02	G03	G04	G05	G06	G07	G08	G09	G10
1	0,6	0,6	0,5	0,5	0	0,5	0	0,45	0,25	0,45
2	0,5	0,5	0,6	0,8	0,7	0	0	0,9	0,9	0,6
3	0,3	0,3	0,5	0,5	0,7	0,7	0,5	0,8	0,8	0
4	0,5	0,4	0,3	0,3	0,7	0,7	0	0,8	0,7	0,5

Calculation of Five The next step we move on to data 6, i.e. The 6th dataset belongs to cluster 4, because the minimum / closest distance to the dataset is cluster 4, which is 0.7 and belongs to the lightweight Matic Sensor group. Then we update Centroid in Table 7 :

Table 7. The 6th Centroid Update dataset

Data Samples	G01	G02	G03	G04	G05	G06	G07	G08	G09	G10
1	0,6	0,6	0,5	0,5	0	0,5	0	0,45	0,25	0,45
2	0,45	0,45	0,6	0,75	0,7	0,2	0	0,85	0,85	0,6
3	0,3	0,3	0,5	0,5	0,7	0,7	0,5	0,8	0,8	0
4	0,5	0,4	0,35	0,5	0,5	0,6	0,35	0,55	0,5	0,65

All data has been obtained, and each data has been grouped by cluster 1, cluster 2, cluster 3 and cluster 4. Then we input the results of the grouping in the rst table. So the results are as in Table 8:

Table 8. Dataset of Final Grouping Results

Data Samples	Centroid 1	Centroid 2	Centroid 3	Centroid 4	Cluster
Rusdi	0,0	1,5	1,4	1,1	Electricity
Badrul	1,5	0,0	1,1	0,9	Engine Compression and Performance
Tuslelai	1,4	1,1	0,0	0,8	Continuous Variable Timing transmission
Irfan	1,3	0,9	0,8	0,0	Matic sensor
Niningi	1,0	1,2	1,3	1,1	Electricity
Tyas	0,9	0,9	1,0	0,7	Matic sensor

4. Conclusion

From the results of this study it can be concluded the grouping of the types of damage from spare parts using the K-Means algorithm, namely: K-means algorithm can better diagnose the level of damage based on the symptoms given by the user, By calculating using the K-Means algorithm the damage value of a motorcycle matic, can show the accuracy of the calculation based on the division of cluster 1, cluster 2, cluster 3 and cluster 4.

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