ISSN No. 0976-5697

Volume 8, No. 3, March – April 2017

International Journal of Advanced Research in Computer Science

RESEARCH PAPER

Available Online at www.ijarcs.info

Road Damage Classification using Back Propagation Algorithm

Pradityo Utomo
Lecturer, Merdeka Madiun University
Madiun, Indonesia

Tomi Tristono
Lecturer, Merdeka Madiun University
Madiun, Indonesia

Arief Budiman
Lecturer, Merdeka Madiun University
Madiun, Indonesia

Rosyid Kholilur Rohman
Lecturer, Merdeka Madiun University
Madiun, Indonesia

Abstract : Industrial development in Indonesia impact to the road damage at several districts. Because the industrial transport which owned by some industry to distribute the product were heavy transport, so the road damage could not be avoided. So that, the government was expected to be able to detect the road damage earlier before many traffic accident in various districts happened. To support the government performance handling the road damage, the government has to be able to have classifications the road damage so the government does not wrong in handle the damage. As the technology development, the government could apply information technology to have the road damage classifications using computer. Backpropagation method was one of the neural networks method that able to do road damage classifications. With the digital image processing support, system would have good accuracy. Some of digital image processing method used for cropping, edge detection, and thresholding. The data used in this research was a photograph from the highway, where the data consisting of road damage image and a photograph of the road that there was no the damage. Then the data will have the image processing first prior to classifications by system that used backpropagation method. So that, in this research produced a system that could do road damage classifications with the accuracy about 84 %.

***Keywords*:** Road Damage, Goverment, Computerized, Digital Image Processing, Backpropagation.

I. INTRODUCTION

Indonesia was a developing countries that having the number of people who were dense enough. The population density in Indonesia was in ranked fourth in the world, according to the central bureau of statistics, country`s population in 2015 was 254,9 million people [1]. As the citizen increase number, many industrial factories has also built to provide a job vacancy to the citizen. Industrial development not only happened to large industries, but the home industries were also developed. According to Indonesian minister of industry, on 2016 the industry must be able to reach up to 5.7 %. Where the non-oil industry increasing about 5,21 % [2]. To overcome the problem of Indonesian economic problem, the industry development should have higher than economic growth.

Industrial development in the major cities were getting increase. From non-agriculture, like cement industry, iron, steel, motor vehicle, electronics, ship, train, and airplane also be developed. Some type of industry in the non-agriculture field who widely established in several big cities among other herbs industry, the clothing industry, and cement industry. cement factories have been established in Gresik, Cibinong, and Ujung Pandang. To distribute the cement production need heavy transport vehicles. Heavy transport vehicles often used a truck container, the average weight of heavy container about 18,000 kg [3]. Because the industry's trucks passing through the highway with average weighs about 18,000 kg, so the highway damage occurring in many places. It happened because the highway were not capable of being curbed with the weight of industry's vehicle.

The road damage happened in various places, especially big cities. According to bina marga the ministry of public works it is 4,000 holes along roads in central java and east java [4]. Holes damage could cause the traffic accident, based on the data from Police Traffic Corps headquarters in 2015 total of accident case reached at 23,000 cases [5]. Mostly caused by the rider or driver spur their vehicle in high speed. The damaged road, often become the main cause of traffic accident on the highway. For this, needed early detection to known the damaged in the highway. So that, safety for rider or driver could guaranteed when driving on the good condition highway. The government was expected to be more consider of the highway condition. Sometimes the government handled it a little late, because the goverment believed that road conditions still all right. One types of the road damage was a rift way. From the small rift way condition, could possible to be large road damaged. So it may become one of the factors of traffic accident. The government should detect earlier for the damages occurring in the highway.

With the development of information technologies to solve problem in various fields, which is increased rapidly made several field were dependent very much on information technology. So many researches made to overcome several problems. Based on the above explanation, we'll have research to built a computerized system to help solving the problems in the transportation field, especially the highway. A system based on computerized could do the damage detection in the highway. So that the government, especially the ministry of public works can helped in doing the detection of the highway damage earlier.

II. LITERATURE REVIEW

The road damage happened in various places, especially in large cities. One destruction on the road was a rift,

according to manual road maintenance number : 03 / mn / b / 1983 the directorate of street. This research would discussed on a system to detect damage on the highway, where to be detected was the type of rifted road. The types of a rifted road were crack block, alligator crack, irregular crack, and transverse crack [6].

Cracked block was a crack that form a series of checkered shaped quadrangle and interconnected. Extensive cracks block about 200mm until 3000mm. The hexagonal form occurred as a result of damage from pavement concrete connection asphalt layer. This was caused by shrinkage on the cement material. As for the image of a cracked block damage could be seen from figure 1.

Figure 1. Block Crack

In figure 1 had shown form of block crack. Besides block crack, an other kind of a rift were alligator crack. Where a rift shaped in a small polygon connection and integrated similar like alligator skin, generally, rift size ranged from 150mm until 300mm. This was cause by less thick pavement, the form of a alligator rift could be seen in figure 2.

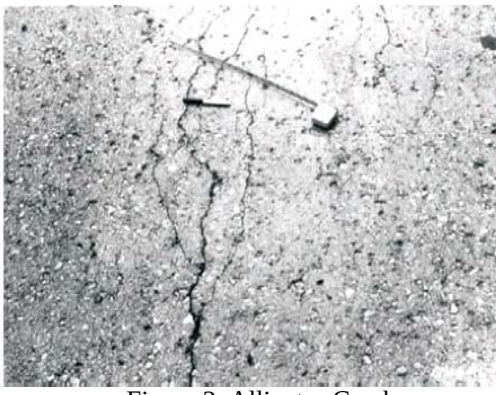

Figure 2. Alligator Crack

According to figure 2, a kind of a rift shaped into a small connected polygon called with alligator crack. The road damage not only alligator crack, but also there was a types of a rift in being irregular crack. Irregular crack due to the weak bond between the top surface layer with the lower layer. As it would cause the land slide, the cause of another irregular crack were low basic land modulus and thin surface coating. An irregular rift not only happened from the result asphalt or land conditions, but also from the vehicles passing, some of them because the asphalt dragged down by a vehicle. A kind of an irregular rift was presented in figure 3.

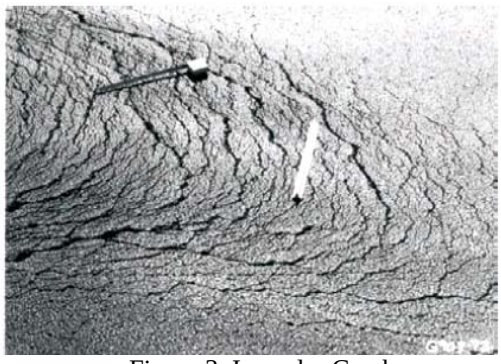

Figure 3. Irregular Crack

Irregular crack has been served in figure 3, where the road was shifted. Because Of this shifted, cause the road damage. Besides block crack, alligator crack, and irregular crack there were also types of transvere rift. Transverse crack happened as a result of shrinkage connection to the concrete or cement layers. As for the picture of transverse crack transverse presented at figure 4.

Figure 4. Transverse Crack

In figure 4 has been shown a picture of transverse crack, where the rift looked perpendicular to the axis the road. Based on the rift types on the road we would like to built a system that have knowledge to do damage classifications on the highway, especially rift way. Some associated research that has been done was by Cahyono [4]. On that research has been made a system to detect road surface damage using template matching methods. The system was made to detect the road damage. The data used in the research using picture of the normal and broken highway. Before the pattern recognition of damaged and normal roads, would do the digital image processing and extraction first. System would using 10 template and 20 template, where the system accuracy for 10 template was 60 % and 75 % for 20 template. There was also research on evaluation on the damage level by suswandi et al in 2008 using the pavement condition index (pci) to supporting the decision-making. Pci could help in choosing or prioritise which road that need to handle first. Where the road with the smallest value need to handle quickly. Besides research about road damage, in the transportation field there were also research on detection and vehicle clasification done by adistya, and muslim [7]. In detecting and classifying, researchers used backpropagation neural network method, and using a method of digital image processing in doing the edge detection using sobel. Where the system could detect the form of car with highest accuracy about 94 %. But on that research, the system has not been able to recognize the type of vehicle more specific.

In transportation field, the using of backpropagation artificial neural network could be used for classifying the type of soil. Former research has been done by nafiah et al [8]. As for the variables used in the research including the depth, qc, the number of obstacles, friction resistance, obstacles attachment, the number of obstacles attachment, local obstacles, friction ratio, and soil descriptions. The best result obtained in the research was 88 %, system could do the classification of soil type, by 5000 iteration, hidden layer 10, and learning rate 0.05. The research also done by risaldi et al [9], they used the backpropagation method. In the research, backpropagation used for classifying the quality of the kelapa wood. Where the classification systems with backpropagation would be compared with the result of LibSVM. For the result LibSVM having accuration of 77,06 %, while the system with backpropagation having accuracy of 81,76 %.

Based on those research, in this research would be build a system that able to do road damage classifications using the backpropagation method. So that the government would be able to detect the road damage earlier.

III. RESEARCH METHODOLOGY

In this research would be build a system to help the government in detecting the road damage earlier. Where the system could do classifications to the road damage especially in rift highway. The data used in this research was primary and secondary data. Primary data was data that used to support the secondary data, the primary data obtained from interviews with an transportation expert. While the secondary data was road damages photographs. The data was a picture of the highway that in the condition like block crack, alligator crack, irregular crack, and transverse crack. So that the output to be delivered by the system was the type of cracks in the highway. As the research stage was presented in figure 5.

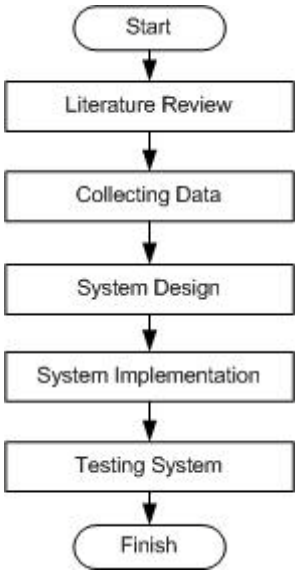

Figure 5. Research Phase

In figure 5 has been shown every stage which will done in this research. The first phase was doing the literature study on the types of the damage and the methods used in this research. After literature study phase continued whith the data collection. Where the data applied to the system were the photographs of the rift highway. Next stage was the design system. The system design could be seen in figure 6.

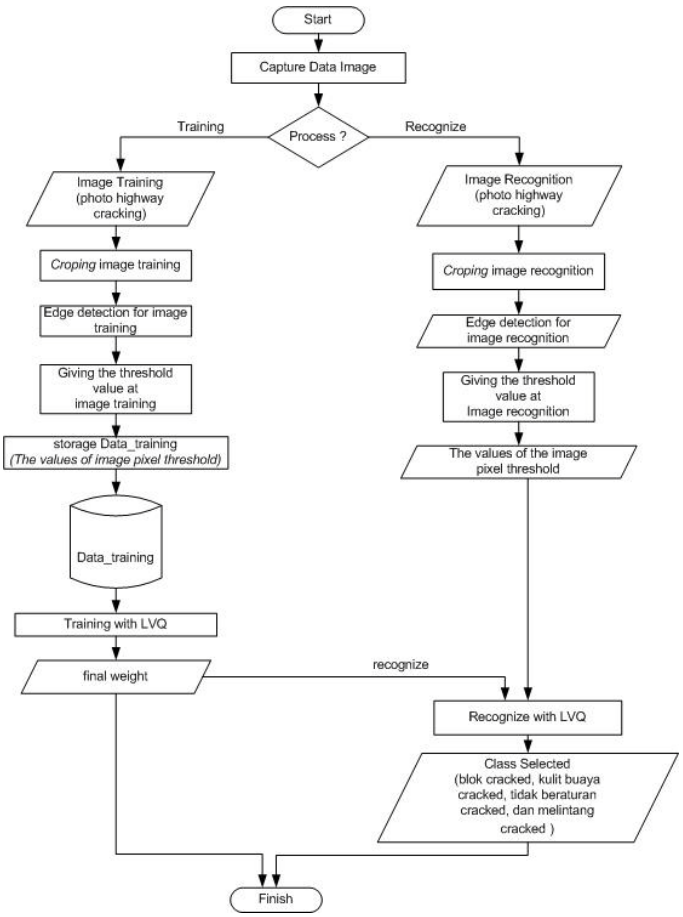

Figure 6. System Design

In the figure 6, the system would do two processes, it was the training process and the recognition. For the training stage starts from digital image processing from the damage road photograph that used for the training proccess later. Digital image processing done among croping, edge detection, and thresholding. The method used in edge detection was using laplacian 1 operator. Where the edge detection using laplacian method would produce thinner edge than other methods. The reference of matrix for reckoning the edge detection could be seen in the formula 1 [10].

$$f(x,y) = \begin{bmatrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{bmatrix} \quad (1)$$

As for the calculation formula of laplacian 1 operator could be see in the formula 2 [11].

$$r(y,x) = 4f(y,x) - [f(y-1,x) + f(y,x-1) + f(y,x+1) + f(y+1,x)] \quad (2)$$

Edge Detection using formulas 2 , then the image done with threshold value. After finished the process of image processing, pixels values would be saved into a database. A

collection of pixels values of every data would have training to get final weight value using backpropagation.

For the recognition process would have also through image processing just like the training process. Where the data would also have croping, edge detection, and thresholding. Pixels value that already had been threshold, would be have recognition for the weight value from the training proccess. Where system would do classifications on each data at the time of recognition proccess. The Classes were block crack, alligator crack, irregular crack, and transverse crack. Where classes indicates the types of damage which occurs on the surface of highway.

Based on the developed system design, would be continue with the system implementation. The developed system would have testing to measure the performance of the application built. Tests carried out to with accuration calculation. Accuration result obtained from the amount of recognizable compared with the whole number and then multiplied with 100 %. From the accuracy calculation would be used to conclude the success of system in doing classifications.

IV. RESULT AND DISCUSSION

From the application system that has been created, and then it would have the implementation of the developed system. Where the application built using borland delphi 7 with MySQL database. As for the result of the implementation of classification systems of road damage can be seen from figure 7.

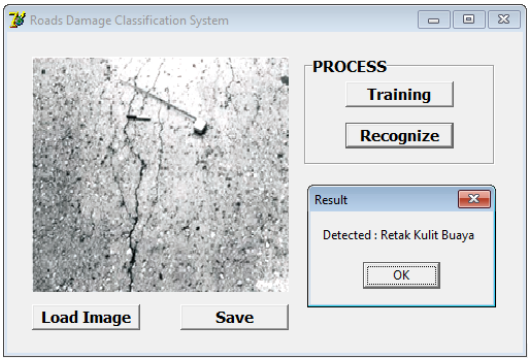

Figure 7. Implementation of Road Damage Classification System

In figure 7 shown the recognition process, and from the recognition process have results of the classifications. But before doing the recoginition process like explanation before, it must completed training data first. The training data was undertaken from the data that have been stored in the database. For the data used in the training process was 200 data image. From the total of 200 image data that consist of 50 block crack image, 50 alligator crack image, 50 irregular crack image, and 50 transverse crack image. While for the number of image used for the recognition process was 100 image, consisting of 25 crack block image, 25 alligator crack image, 25 irregular crack image, and 25 transverse crack image. The training process done with backpropagation algorithm with 1000 iteration. While for learning rate used were 0.05, 0.005, and 0.0005. The number of properly known classifications data of the damage based on a rift road could be seen in table 1.

Table 1. Recognized Road Damage

Road Damage Class	**Recognized Road Damage**		
	***Learning Rate* 0,0005**	***Learning Rate* 0,005**	***Learning Rate* 0,05**
Block Crack	18	20	22
Alligator Crack	17	19	21
Irregular Crack	15	18	21
Transverse Crack	17	19	20

Based on table 1 has been shown the amount of recognizable data by right met for the classification target desired. In the recognition process using final training weight value with learning rate 0,0005, from 25 block crack image, could be recognized block crack image about 18 image. The rest of 25 alligator crack image could be recognized as alligator crack image was 17 image. In addition to 25 irregular crack image, only 15 image that could be recognized. To transverse crack image data could be recognized properly 17 image of 25 transverse crack image. So the total image that could be recognized properly according to classes was 67 image.

While the recognition process using final training weight value with learning rate 0.005, from 25 block crack image, could be recognized as block crack image was 20 image. The rest of 25 alligator crack image, could be recognized as alligator crack image was 19 image. In addition to 25 irregular crack image, only 18 image that could be recognized. To transverse crack image could be recognized properly about 19 image of 25 transverse crack image. So the total image that could be recognized properly according to classes was 76 image.

For the recognition process result that using final training weight value with learning rate 0.05, from 25 block crack image, could be recognized as block crack image about 22 image. The rest of 25 image alligator crack image, could be recognized for 21 image. In addition to 25 irregular crack image, there were 21 image that could be recognized properly. For the transverse crack image could be recognized right as many as 20 image of transverse crack image. So the total image that could be recognized properly according to classes was 84 image.

V. CONCLUSION

Conclusions from the development of road damage classification systems using backpropagation was as follows :

1. Classification systems for road damage using backpropagation method had successfully built and be

able to do the road damage classifications especially rift highway.

2. Classification systems with the backpropagation methods could do classifications with accuracy about 67 % with learning rate 0,0005. While for accuracy with learning rate 0,005 having accuracy as much as 76 % , and 84 % using learning rate 0.05 .

VI. AKCNOWLEDGEMENT

- Merdeka Madiun University Research and Community Service Department.

VII. REFERENCES

[1] Akbar, C. Jumlah Penduduk Indonesia Sudah 254,9 juta, Laki-laki Lebih Banyak Dari Perempuan. http://www.hidayatullah.com/berita/nasional/read/2015/11/20/83632/jumlah-pendududari-perempuan.html (accessed June 20 2016), 2015.

[2] Menteri Perindustrian. Tahun 2016, Target Pertumbuhan Industri 5,7 Persen. http://www.kemenperin.go.id/artikel/13740/Tahun 2016,-Target-Pertumbuhan-Industri-5,7-Persen (accessed June 20 2016), 2015.

[3] Jacky. Truk, Kontainer, Spesifikasi, Kubikasi Dan Tonasenya. http://persaudaraansejati.blogspot.co.id/2014/02/truk-kontainer-spesifikasi-kubikasi-dan.html (accessed 20 June 2016), 2014.

[4] Cahyono, S. D. Sistem Deteksi Kerusakan Permukaan Jalan Raya Dengan Metode Template Matching. Universitas Merdeka Madiun, 2014.

[5] Mustofa, D. Z. Hingga September 2015, Ada 23 ribu Kasus Kecelakaan di Indonesia. http://www.merdeka.com/otomotif/hingga-september-2015-ada-23-ribu-kasus-kecelakaan-di-indonesia.html (accessed June 20 2016), 2015.

[6] Cahyono, S. D. Analisa Kerusakan dan Desain Perbaikan Outer Ring Road Kota Madiun. Tesis. Surakarta: Magister Teknik Sipil, Universitas Sebelas Maret, 2011.

[7] Adistya R., Muslim M. A. Deteksi dan Klasifikasi Kendaraan Menggunakan Algoritma Backpropagatin dan Sobel. Journal of Mechanical Engineering and Mechatronics. ISSN: 2527-6212. Vol.1 No.2, 2016.

[8] Nafiah, S., Puspitodjati, S., Wulandari, S. Pengklasifikasian Jenis Tanah Menggunakan Jaringan Syaraf Tiruan dengan Algoritma Backpropagation. Proceeding Seminar Ilmiah Nasional Komputer dan Intelijen. Depok. 2008.

[9] Risaldi, M., Purwanto., Himawan, H. Klasifikasi Kualitas Kayu Kelapa Menggunakan Algoritma Neural Network Backpropagation. Jurnal Teknologi Informasi Vol.10 No.1, 2014.

[10] Gonzales, R., Woods, R. *Digital Image Processing*. Penerbit: Pearson. 2010..

[11] Kadir, A., Susanto, A. Teori dan Aplikasi Pengolahan Citra. 1st ed. Penerbit ANDI. Yogyakarta. 2013.