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Measurement of Wave Amount on Brass Plated Tire Steel Cord Using Local Minima and Maxima

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Abstract:

The method of measuring the diameter in the picture of the Brass Steel Tire Cord with Pixel Distance and Sliding Window, produces an average value of 0.241 obtained by measuring Pixel Distance, when using a sliding window, the average measurement result is 0.238, the accuracy of both methods of measuring the diameter of Cord Steel Tire Brass is considered quite good, the average results obtained from 29 Steel Tire Brass Cord data set samples (April Lia Hananto et al., 2020). The problem obtained in the conventional measurement phase of Wave Amount, on the Brass Cord Tire Cord is that the resulting accuracy still requires an observation process from an officer who is considered an expert, there is a possibility of error in his observation (Bouchet et al., 2003). In this study will change the measurement process using computer vision techniques using image processing (Tateno et al., 2020). The method used in the measurement of the Number of Waves uses Local Minima and Maxima with three approaches to the Wave Amount method. The results obtained by the average measurement can be recognized as its level of accuracy and close to the standard value of the measurement company.

***Keywords:** Brass plated tire steel cord, Wave Amount, Image Local minima, Local maxima.*

1. Introduction

Two methods of measuring diameter in the Brass Steel Tire Cord picture with Pixel Distance and Sliding Window, produce an average value of 0.241 obtained by measuring Pixel Distance, when using a sliding window, the average measurement result is 0.238, the accuracy of both methods of measuring the diameter of the Cord Steel Tire Brass is considered quite good, the average results obtained from 29 Steel Tire Brass Cord data set samples (April Lia Hananto et al., 2020). The next step is to measure the number of waves in the Cord Cord Brass Cord, conventional measurements are carried out using microscopic devices, the problem obtained at this stage is the resulting accuracy still requires the observation process of an officer who is considered an expert, carried out by an officer there is a possibility of error in his observations (Bouchet et al., 2003). In this study will change the measurement process using computer vision techniques using image processing (Tateno et al., 2020). The method used in the measurement of the number of waves using local Minima and Maxima with a variety of approaches.

2. Literature Review

a. Brass Plated Tire Steel Cord

The brass-coated steel cord is a composite of several individual cables. At the factory, each wire has been coated with brass and pulled to the specified diameter. The fence has been brought to a diameter of 1.22 mm and plated brass to coverage of 6.8 g brass wire/kg. After platting, this wire has not been pulled further. The thickness of the cable from the brass layer made on the diameter is the ideal specimen for engineering development c. Steel cords are twisted a few to dozens of φ0.15～φ0.4mm wires, and these are applied brass plating for adhering rubber. Our steel cords use high cleanliness high carbon steel wire rod only for steel cords. They have enabled high strength, high flexibility, and high fatigue resistance products. Steel cords are the necessary reinforcement used for the belt section that responsible for steering stability and durability in steel radial tires and also used for the carcass section in large tires for trucks and busses. They are used for reinforcement for belt-shaped rubber products (Ruth G, 1982).

a.  b. 

Fig. 1 a. Roll tire wire and braided wire, b. braided wire [1].

Fig. 2 Brass plated tire steel cord

b. Digital image

An image that can be processed with a digital computer device must be represented numerically with discrete values first. The process of representing images from a continuous function into discrete values, both of these two dimensions, is called the process of digitizing images (Sundani et al., 2019).

c. Application areas that use digital image processing

Application areas that use digital image processing applications are so extensive that it is difficult to provide a comprehensive cover in this book. While categorized according to the electromagnetism energy spectrum, the area of application of digital image processing here is summarized about service objectives. This is motivated by the fact that one particular application (eg supervision) can be obtained by various censors involved and hence presents confusing information in categorization. In general, fields that use digital image processing techniques can be divided into photography, remote sensing, medical imaging, forensics, transportation, and military applications but not limited (Wu et al., 2010).

d. Measurement of wave amount

Waves are vibrations that travel. The ideal form of a wave will follow the sinusoid movement. In addition to electromagnetic radiation, and possibly gravitational radiation, which can travel through a vacuum, waves are also present in a medium (which due to changes in shape can produce a spring force) where they can travel and can move energy from one place to another without causing particles the medium moves permanently, i.e. there is no mass transfer.

3. Research Methodology

This study conducted trials on 29 samples of Brass-coated Steel Tire Cord with Wave Amount measurement techniques using Local Minima And Maxima (Patil & Van Ooij, 2004). To find out the results obtained from the results of the measurement technique, the average results of each sample are calculated by the block diagram representation as shown in Figure. 1 is the model of this research (Ashar et al., 2020). This model is designed based on the company's core business processes (Fernando et al , 2020)(Hananto & Priyatna, 2020):

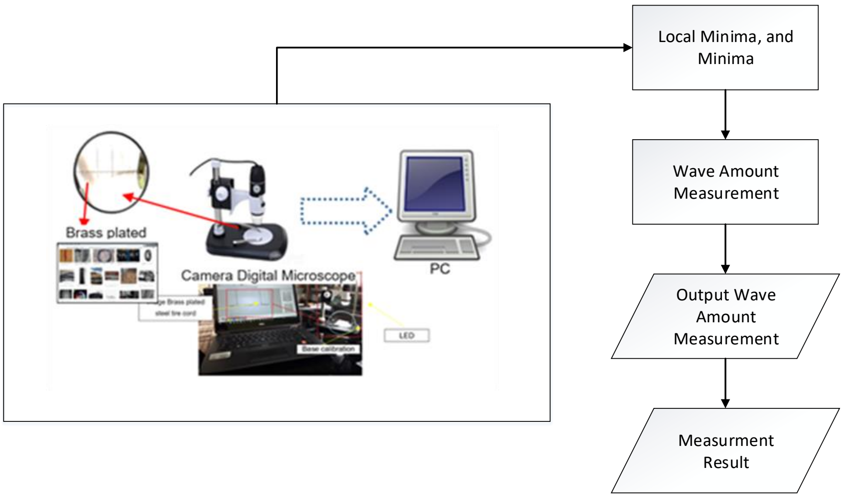

Figure 1: Overview of research proposed method

3.1. Local Minima and Maxima

Brass Tire-Plated Steel Cord Objects have waveforms, Brass-Plated Steel Tire Cord must have wave consistency by company standards. The formation of the top and bottom sides of the Brass Steel Tire Cord object will continue according to the shaft size (Gkioulekas, 2014). This measurement requires a method for calculating wave consistency where local minima and local maxima are used for the measurement method (Muntner et al., 2019). Figure 2 shows the shape of the Brass-coated Steel Tire Cord in the simulation image by showing local minima and local maxima:

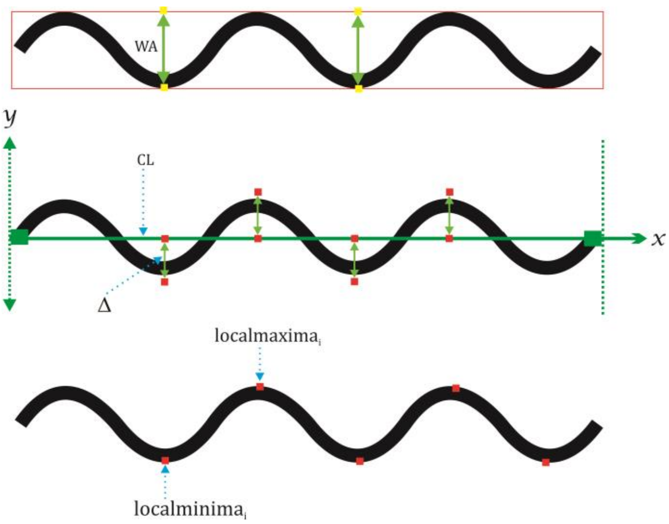

Figure 2. Local minima and local maxima on brass plated tire steel ropes in the simulation

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3.2. Wave Amount

The main problem in image recognition in computer vision is to determine the number of waves in a Brass Tire-Plated Steel Cord image so that it intuitively makes sense (Balu, 2015). Estimating the measurement of the number of waves in a Brass Tire-Plated Steel Cord image is useful in various forms of representation and forms an introduction task (Lorenzo-ginori, 2011).

1. Wave Amount Measurement: Method 1st

Measurement of Brass Plated Tire Steel Cord is simulated with the formula shown in Figure 4 below:

Figure 4: Measurement wave amount simulation with method 1

Algorithm finding Wave Amount by maximum and minimum of *y-axis* **is**
input : image *I*, calibration *C* **output** : W_{am} as Wave Amount (Note that *follow the surface of I to get the top (C1(x1, y1)) and bottom (C2(x2, y2)) surface)* **find** the Wave Amount (Wa) by maximum coordinate of y_1 and minimum coordinate of y_2 $W_{a_m} \leftarrow \lvert Max\ (y_1) - Min\ (y_2) \rvert$ **find** the **Wave Amount in millimetre** by multiplying Wa with calibration *C* value $W_{a_m} \leftarrow \lvert Ma \text{ X } C$ **return** W_{a_m}

2. Wave Amount Measurement: Method 2nd

Measurement of Brass Plated Tire Steel Cord is simulated with the formula shown in Figure 5 below:

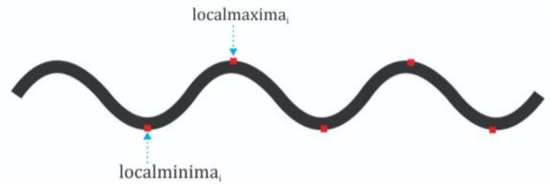

Figure 5: Measurement wave amount simulation with method 2

Algorithm finding Wave Amount by each local maxima and minima **is**

input : image *I*, calibration *C*
output : W_{a_m} as Wave Amount
(Note that *follow the surface of I to get the top (C1(x1, y1)) and bottom (C2(x2, y2)) surface)*
find the local maxima and local minima from curve edge of C1 and C2
for each y_1 in *C1* **do**
$Localmaxima \leftarrow GradientDescent\ (x_1\ y_1)$
for each y_2 in *C2* **do**
$Localmaxima \leftarrow Inverse\ of\ GradientDescent\ (x_2\ y_2)$
find the Wave Amount (*Wa*) by local maxima and local minima of curve Edge
$W_a \leftarrow \mu(Localmaxima) - \mu(Localminima)$
find the **Wave Amount in millimetre** by multiplying *Wa* with calibration *C*

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value

$W_{a_m} \leftarrow W_a$ X C

return W_{a_m}

3. Wave Amount Measurement: Method 3rd

Measurement of Brass Plated Tire Steel Cord is simulated with the formula shown in Figure 6 below:

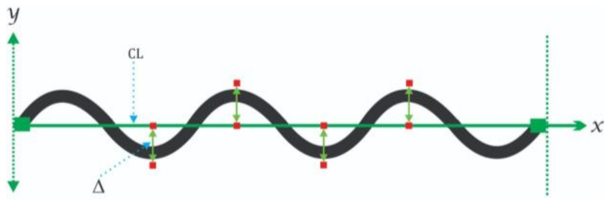

Figure 6: Measurement wave amount simulation with method 3

Algorithm finding Wave Amount by each local maxima and minima **is**

input : image I, calibration C

output : W_{a_m} as Wave Amount

(Note that *follow the surface of I to get the top (C1(x1, y1)) and bottom (C2(x2, y2)) surface)*

find the local maxima and local minima from curve edge of $C1$ and $C2$

for each y_1 in $C1$ **do**

$Localmaxima \leftarrow GradientDescent\ (x_1\ y_1)$

for each y_2 in $C2$ **do**

$Localmaxima \leftarrow Inverse\ of\ GradientDescent\ (x_2\ y_2)$

find the Center Line (C_l) based on local maxima and minima

$$C_1 \leftarrow \frac{\frac{\sum_{i=1}^{n} localmaxima_i}{T2} + \frac{\sum_{i=1}^{n} localmaxima_i}{T2}}{2}$$

find the Wave Amount (Wa) based on local maxima-minima of curve Edge and Center Line

$$W_a \leftarrow \mu|\ localmaxima_i - C_1\ | + \mu|\ localminima_i - C_1\ |$$

find the **Wave Amount in millimetre** by multiplying Wa with calibration C value

$W_{a_m} \leftarrow W_a$ x c

return W_{a_m}

4. Findings

We explain the process of measuring the number of Wave Amount of Brass Tire Ropes using industry standards with Image Processing Techniques and MATLAB. For each result obtained from measurements using the two proposed methods, the Brass Cord Tire Steel dataset is tested by comparing standard production tables from Bekaert Indonesia companies. Table 1 is a sample with the results of the Number of Waves that have been measured using conventional techniques and measurements with digital image techniques. In Table 2 are samples with wave amount results that have been measured using conventional techniques and measurements with digital image techniques:

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Table 2. Wave amount measurement brass steel tire cord with image processing

No	Dataset	Conventional Measurement	Method 1st	Method 2nd	Method 3rd
1	Image Brass Plated Tire Steel Cord 1	0.404	0.485	0.411	0.411
2	Image Brass Plated Tire Steel Cord 2	0.413	0.684	0.474	0.474
3	Image Brass Plated Tire Steel Cord 3	0.424	0.437	0.400	0.400
4	Image Brass Plated Tire Steel Cord 4	0.417	0.453	0.376	0.376
5	Image Brass Plated Tire Steel Cord 5	0.380	0.453	0.372	0.372
6	Image Brass Plated Tire Steel Cord 6	0.416	0.636	0.411	0.411
7	Image Brass Plated Tire Steel Cord 7	0.418	0.501	0.437	0.437
8	Image Brass Plated Tire Steel Cord 8	0.423	0.437	0.406	0.406
9	Image Brass Plated Tire Steel Cord 9	0.426	0.477	0.411	0.411
10	Image Brass Plated Tire Steel Cord 10	0.422	0.429	0.379	0.379
11	Image Brass Plated Tire Steel Cord 11	0.378	0.477	0.387	0.387
12	Image Brass Plated Tire Steel Cord 12	0.442	0.398	0.384	0.384
13	Image Brass Plated Tire Steel Cord 13	0.456	0.382	0.360	0.360
14	Image Brass Plated Tire Steel Cord 14	0.400	0.453	0.403	0.403
15	Image Brass Plated Tire Steel Cord 15	0.444	0.453	0.382	0.382
16	Image Brass Plated Tire Steel Cord 16	0.428	0.525	0.419	0.419
17	Image Brass Plated Tire Steel Cord 17	0.406	0.469	0.411	0.411
18	Image Brass Plated Tire Steel Cord 18	0.382	0.429	0.411	0.411
19	Image Brass Plated Tire Steel Cord 19	0.428	0.406	0.379	0.379
20	Image Brass Plated Tire Steel Cord 20	0.445	0.477	0.403	0.403
21	Image Brass Plated Tire Steel Cord 21	0.431	0.668	0.400	0.400
22	Image Brass Plated Tire Steel Cord 22	0.362	0.421	0.339	0.339
23	Image Brass Plated Tire Steel Cord 23	0.362	0.469	0.355	0.355
24	Image Brass Plated Tire Steel	0.354	0.413	0.339	0.339

No	Dataset	Conventional Measurement	Method 1st	Method 2nd	Method 3rd
	Cord 24				
25	Image Brass Plated Tire Steel Cord 25	0.381	0.572	0.356	0.356
26	Image Brass Plated Tire Steel Cord 26	0.386	0.374	0.360	0.360
27	Image Brass Plated Tire Steel Cord 27	0.429	0.525	0.386	0.386
28	Image Brass Plated Tire Steel Cord 28	0.413	0.485	0.259	0.330
29	Image Brass Plated Tire Steel Cord 29	0.429	0.477	0.392	0.392
	Average	**0.410**	**0.478**	**0.386**	**0.389**

Brass Plated Tire Steel Cord wave amount measurements, can be presented in graphical form which can be seen in Figure 9:

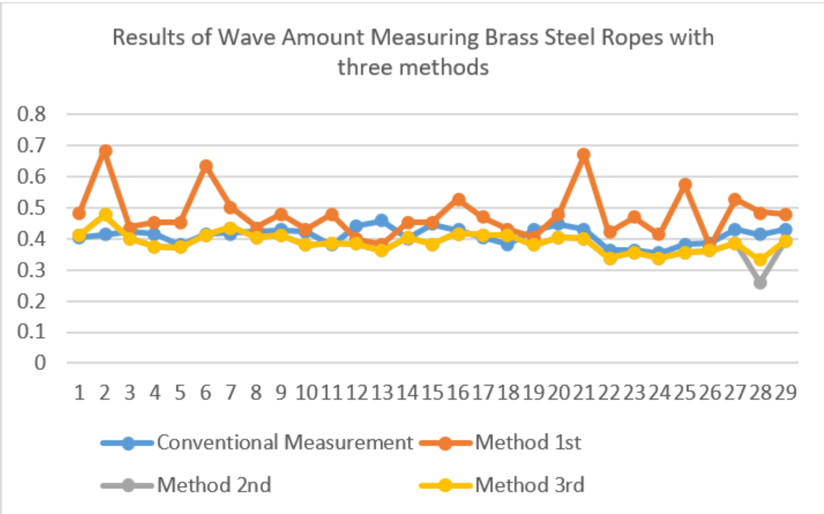

Figure 9: The results of comparison of wave amount measurements of Brass Plated Tire Steel Cord

5. Discussion and Conclusion

In the measurement of Wave Amount Brass-coated Steel Tire Cord using local maxima and local minima using the approach of various methods, a quantitative test can be produced with the results. Wave Amount measurement of Brass Plated Steel Tire Cord using method 1 obtained an average value of 0.478, the results of measurements using method 2 obtained an average value of 0.386, and the average measurement results using method 3 obtained a value of 0.389. The accuracy of the three methods in measuring Wave Amount Brass Steel Tire Cord is considered quite good, but the method that approaches the standard value is using method 3, and it can be concluded that from us the measurement method of Wave Amount Brass Steel Tire Cord which has high accuracy is method 3, it can be concluded that this method approaches the company's standard measurement values.

References

[1]. April Lia Hananto, Sarina Sulaiman, and S. W. (2020). *COMPARISON OF PIXEL DISTANCE AND SLIDING WINDOWS METHOD IN BRASS PLATED TIRE STEEL CORD DIAMETER MEASUREMENT* (Vol. 4).

[2]. Ashar, N. D. B. K., Yusoff, Z. M., Ismail, N., & Hairuddin, M. A. (2020). ARX model identification for the real-time temperature process with Matlab-arduino implementation.

ICIC Express Letters, *14*(2), 103–111. https://doi.org/10.24507/icicel.14.02.103

[3]. Balu, R. (2015). Design and development of automatic appendicitis detection system using sonographic image mining. *Shodhganga : A Reservoir of Indian Theses @ INFLIBNET*, 167. Retrievedfrom http://shodhganga.inflibnet.ac.in/bitstream/10603/33597/12/12_chapter4.pdf%0Ahttp://shodhganga.inflibnet.ac.in/handle/10603/33597

[4]. Bouchet, M. H., Clark, E., & Groslambert, B. (2003). *Country Risk Assessment A Guide to Global Investment Strategy Library of Congress Cataloging-in-Publication Data*.

[5]. Fernando, E., Meyliana, Warnars, H. L. H. S., & Abdurachman, E. (2020). Blockchain technology for pharmaceutical drug distribution in Indonesia: A proposed model. *ICIC Express Letters*, *14*(2), 113–120. https://doi.org/10.24507/icicel.14.02.113

[6]. Gkioulekas, E. (2014). Generalized local test for local extrema in single-variable functions. *International Journal of Mathematical Education in Science and Technology*, *45*(1), 118–131. https://doi.org/10.1080/0020739X.2013.790515

[7]. Hananto, A. L., & Priyatna, B. (2020). *ANDROID DATA SECURITY USING CRYPTOGRAPHIC ALGORITHM COMBINATIONS*.

[8]. Lorenzo-ginori, J. V. (2011). *Evaluation of Distance Transform-based alternatives for image segmentation of overlapping objects*. (February).

[9]. Muntner, P., Shimbo, D., Carey, R. M., Charleston, J. B., Gaillard, T., Misra, S., … Wright, J. T. (2019). Measurement of blood pressure in humans: A scientific statement from the american heartassociation. In *Hypertension* (Vol. 73).

[10]. Patil, P. Y., & Van Ooij, W. J. (2004). Mechanism of adhesion degradation of rubber to brass-plated steel cords. *Journal of Adhesion Science and Technology*, *18*(12), 1367–1394. https://doi.org/10.1163/1568561042323266

[11]. Priyatna, B., & Hananto, A. L. (n.d.). *ZFONE SECURITY ANALYSIS OF VIDEO CALL SERVICE USING GENERAL NEWORK DESIGN PROCESS METHOD (GNDP)*.

[12]. Ruth G, and A. M. (1982). *Canfiguration of The Brass on Brass-Plated Steel Wires in Tire Cords* (p. giuffria). p. giuffria.

[13]. Sundani, D., Widiyanto, S., Karyanti, Y., & Wardani, D. T. (2019). Identification of image edge using quantum canny edge detection algorithm. *Journal of ICT Research and Applications*, *13*(2), 133–144. https://doi.org/10.5614/itbj.ict.res.appl.2019.13.2.4

[14]. Tateno, K., Shiku, O., & Ohtubo, Y. (2020). Counting algorithm for sequential optical images of immunoreactive mouse taste bud cells. *ICIC Express Letters*, *14*(1), 1–8. https://doi.org/10.24507/icicel.14.01.1

[15]. Wu, L., Zhou, H., Zhang, Q., Zhang, J., Ni, F., Liu, C., & Qi, Y. (2010). DNA Methylation Mediated by a MicroRNA Pathway. *Molecular Cell*, *38*(3), 465–475. https://doi.org/10.1016/j.molcel.2010.03.008