Measurement Wavelength 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 wavelengths 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 wavelengths uses Local Minima and Maxima with approaches to the Wavelengths 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, Wavelengths, Image Local minima, Local maxima.

1. Introduction

Two methods of measuring the 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 Cord diameter Steel Tire Brass is considered quite good, the average results obtained from 29 sample data set Brass Tire Steel Cord (April Lia Hananto et al., 2020). The next step is to measure the wavelengths on the Brass Cord Tire Cord, conventional measurements are carried out using microscopic devices, the problem obtained at this stage is the accuracy produced still requires the observation process of an officer who is considered an expert, carried out by an officer there is a possible error in his observation (Bouchet et al., 2003). In this research will change the measurement process using computer vision techniques using image processing (Tateno et al., 2020). The method used in the measurement of Wavelength using Local Minima and Maxima with a variety of method approaches.

2. Literature Review

a. Brass Plated Tire Steel Cord

The brass-plated steel tire cord is composites of several individual wires. In manufactures, each wire has been plated with brass and drawn to a specified diameter. The wire had been drawn to a diameter of 1.22 mm and brass plated to a coverage of 6.8 g brass/kg wire. After platting, this wire had not been drawn further. The wire diameter ad brass coating thickness made it an ideal specimen for technique development (Ruth G, 1982).

a. b.

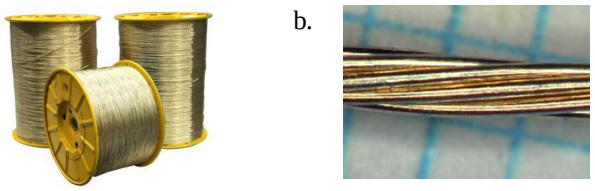

Figure 1 a. Roll tire wire and braided wire, b. braided wire [1].

Figure 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 wavelength

Wavelength is the distance between one peak of the frequency of the wave with another peak. In other words, Frequency Wavelength is the distance a wave must travel in one period. The wavelength of a frequency is usually denoted by the symbol λ (read as LAMDA) with the unit being meter (m). 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 Wavelength 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. 3 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):

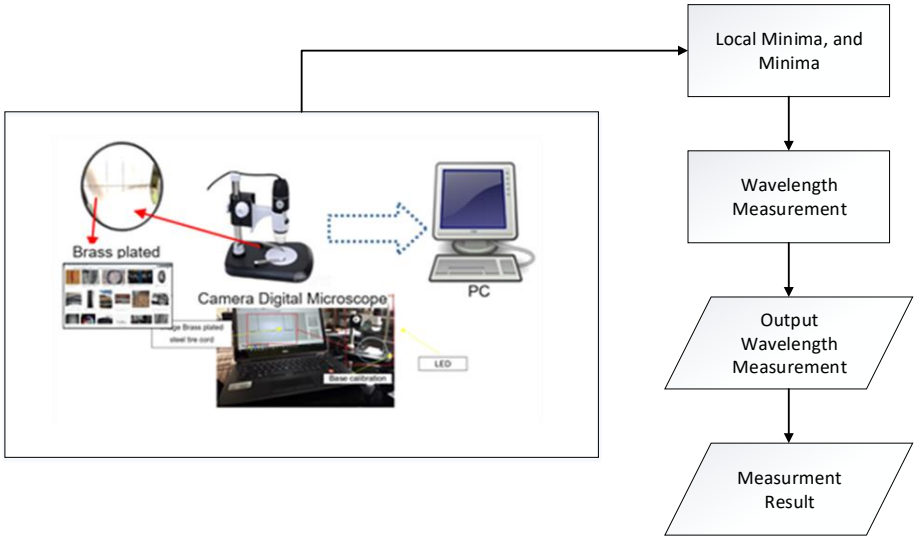

Figure 3. Overview of research proposed method

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 4 shows the shape of the Brass-coated Steel Tire Cord in the simulation image by showing local minima and local maxima:

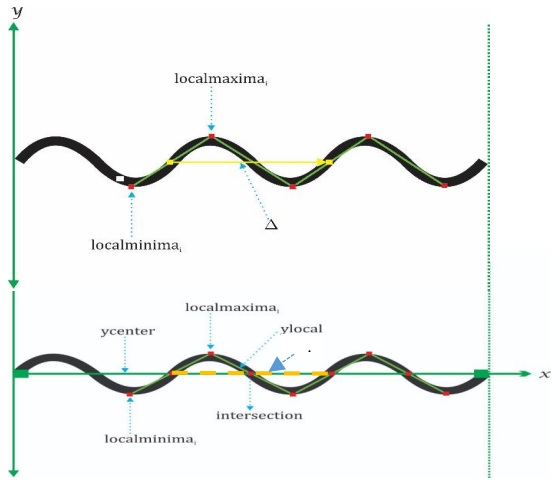

Figure 4. Local minima and local maxima on brass plated tire steel ropes in the simulation

3.2. Wavelength

The main problem in image recognition in computer vision is to determine the wavelength in the image of the Armored Tire Cord so that it intuitively makes sense(Balu, 2015). Estimating wavelength measurements in the Brass Steel Tire Cord drawings is useful in various forms of representation and forming introductory tasks (Lorenzo-ginori, 2011).

1. Wavelength Measurement: Method 1st

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

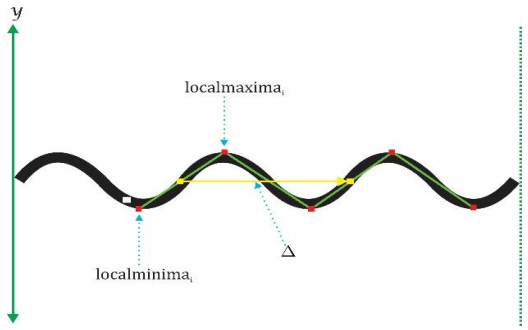

Figure 5. Measurement wavelength simulation with method 1

Algorithm finding Wavelength by each local maxima and minima **is**

input : image *I*, calibration *C*
output : λ_m as Wavelength
(Note that *follow the surface of I to get the top (C1(x_1, y_1)) and bottom (C2(x_2, y_2)) 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**
localminima $\leftarrow$ inverse of GradientDescent($x_2 y_2$)
find the midpoint of distance line between local maxima and local minima
for m = 1 to length of localmaxima **do**
for n = 1 to length of localminima **do**
if n-m $\leq 1 \cap$ n-m ≥ 0 **do**
$\mu_i \leftarrow \left[\frac{\text{localmaxima}(x)_m+\text{localminima}(x)_n}{2}, \frac{\text{localmaxima}(y)_m+\text{localminima}(y)_n}{2}\right]$
find the distance Δ between two midpoints that generate one wavelength
for i = 1 to length of μ **do**
$\Delta_i \leftarrow \sqrt{(\mu_i(1)-\mu_{i+2}(1))^2 + (\mu_i(2)-\mu_{i+2}(2))^2}$
find the Wavelength (λ) based on local maxima-minima of curve Edge and Center Line
$\lambda \leftarrow \max(\Delta)$
find the **Wavelength in millimeter** by multiplying λ with calibration *C* value
$\lambda_m \leftarrow \lambda \times C$
return λ_m

2. Wavelength Measurement: Method 2nd

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

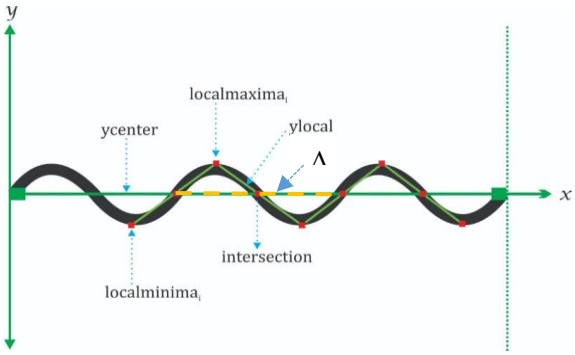

Figure 6. Measurement wavelength simulation with method 2

Algorithm finding Wavelength by each local maxima and minima **is**

input : image *I*, calibration *C*
output : λ_m as Wavelength
(Note that *follow the surface of I to get the top (C1(x_1, y_1)) and bottom (C2(x_2, y_2)) 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**
localminima $\leftarrow$ inverse of GradientDescent($x_2 y_2$)
find the center line coordinate from local maxima and local minima

$$y_{center} \leftarrow \min(localmaxima) + \frac{\max(localminima) - \min(localmaxima)}{2}$$

$$x_{center} \leftarrow (0, \text{length}(I, 2))$$

find the intersection between center line and curve
for m = 1 to length of localmaxima **do**
for n = 1 to length of localminima **do**
if $n - m \leq 1 \cap n - m \geq 0$ **do**
$x_1 \leftarrow [localmaxima(x)_m, localminima(x)_n]$
$y_1 \leftarrow [localmaxima(y)_m, localminima(y)_n]$
$[x_{int}, y_{int}] \leftarrow \boldsymbol{intersect}(x_1, y_1, x_{center}, y_{center})$
$\mu_i \leftarrow [x_{int}, y_{int}]$

find the distance Δ between two intersections that generate one wavelength
for i = 1 to length of μ **do**
$\Delta_i \leftarrow \sqrt{(\mu_i(1)\text{-}\mu_{i+2}(1))^2 + (\mu_i(2)\text{-}\mu_{i+2}(2))^2}$
find the Wavelength (λ) based on local maxima-minima of curve Edge and Center Line
$\lambda \leftarrow \max(\Delta)$
find the **Wavelength in millimetre** by multiplying λ with calibration *C* value
$\lambda_m \leftarrow \lambda \times C$
return λ_m

1. Findings

We explain the process of measuring the wavelengths 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 wavelength results that have been measured using conventional techniques and measurements with digital image techniques:

Table 1. Wavelength measurement brass steel tire cord with image processing

No	Dataset	Conventional Measurement	Method 1st	Method 2nd
1	Image Brass Plated Tire Steel Cord 1	3.533	3.463	3.629
2	Image Brass Plated Tire Steel Cord 2	3.530	3.579	3.947
3	Image Brass Plated Tire Steel Cord 3	3.515	3.582	3.709
4	Image Brass Plated Tire Steel Cord 4	3.548	3.371	3.493
5	Image Brass Plated Tire Steel Cord 5	3.521	3.411	3.533
6	Image Brass Plated Tire Steel Cord 6	3.501	2.817	3.105
7	Image Brass Plated Tire Steel Cord 7	3.520	3.419	3.237
8	Image Brass Plated Tire Steel Cord 8	3.609	3.542	3.562
9	Image Brass Plated Tire Steel Cord 9	3.531	3.411	4.085
10	Image Brass Plated Tire Steel Cord 10	3.549	3.407	3.416
11	Image Brass Plated Tire Steel Cord 11	3.532	3.538	3.293
12	Image Brass Plated Tire Steel Cord 12	3.606	3.307	3.309
13	Image Brass Plated Tire Steel Cord 13	3.592	2.823	2.899

No	Dataset	Conventional Measurement	Method 1st	Method 2nd
14	Image Brass Plated Tire Steel Cord 14	3.443	3.490	3.443
15	Image Brass Plated Tire Steel Cord 15	3.607	3.391	3.584
16	Image Brass Plated Tire Steel Cord 16	3.598	3.443	3.679
17	Image Brass Plated Tire Steel Cord 17	3.517	3.367	3.245
18	Image Brass Plated Tire Steel Cord 18	3.514	3.399	3.465
19	Image Brass Plated Tire Steel Cord 19	3.528	3.542	3.609
20	Image Brass Plated Tire Steel Cord 20	3.500	3.379	3.853
21	Image Brass Plated Tire Steel Cord 21	3.612	3.436	3.866
22	Image Brass Plated Tire Steel Cord 22	3.583	3.415	3.533
23	Image Brass Plated Tire Steel Cord 23	3.580	3.554	3.776
24	Image Brass Plated Tire Steel Cord 24	3.594	3.443	3.671
25	Image Brass Plated Tire Steel Cord 25	3.603	3.491	3.837
26	Image Brass Plated Tire Steel Cord 26	3.602	3.486	3.520
27	Image Brass Plated Tire Steel Cord 27	3.419	4.210	4.404
28	Image Brass Plated Tire Steel Cord 28	3.713	3.348	5.143
29	Image Brass Plated Tire Steel Cord 29	3.719	3.626	3.897
	Average	**3.559**	**3.437**	**3.646**

Brass Plated Tire Steel Cord wavelength measurements, can be presented in graphical form which can be seen in Figure 7:

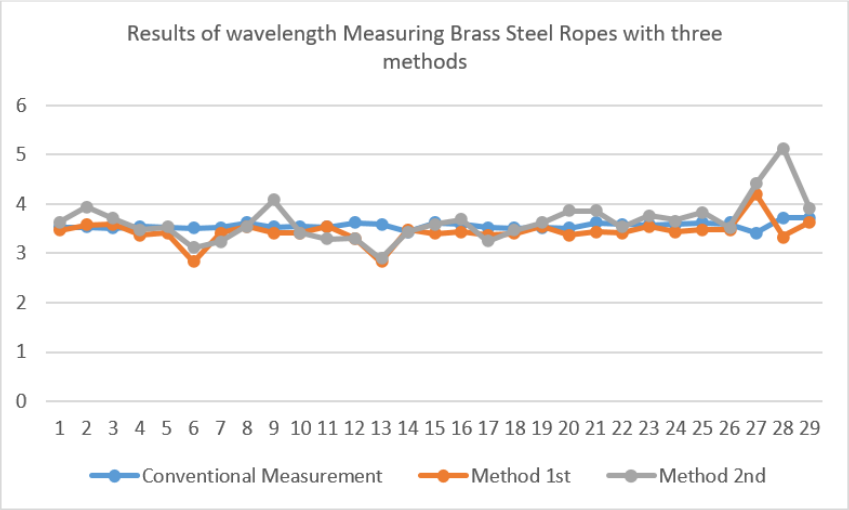

Figure 7. The results of comparison of wavelength measurements of Brass Plated Tire Steel Cord

2. Discussion and Conclusion

In measuring the wavelength of Brass-coated Steel Tire Ropes using local maxima and local minima approaches various quantitative testing methods with measurement results. Method 1 gets an average value of 3,437 measurements, and method 2 produces an average value of 3,464 measurements. Both methods have good accuracy values, but when compared to method 2 it 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