Plagiarism Checker X Originality Report

Plagiarism Quantity: 28% Duplicate

Date	Wednesday, March 28, 2018
Words	1629 Plagiarized Words / Total 5888 Words
Sources	More than 115 Sources Identified.
Remarks	Medium Plagiarism Detected - Your Document needs Selective Improvement.

International Journal of Electrical and Computer Engineering (IJECE) Vol. 8, No. 2, April 2018, pp. 699~710 ISSN: 2088-8708, DOI: 10.11591/ijece.v8i2.699-710 ? 699 Journal homepage: http://iaescore.com/journals/index.php/IJECE Algorithm for Fault Location and Classification on Parallel Transmission Line using Wavelet based o n Clar Transformation Makmur Saini1, A. A. Mohd Zin2, M. W. Mustafa3, A. R.

Sultan4, Rusdi Nur5 1,5Department of Mechanical Engineering, Politeknik Negeri Ujung Pandang, Indonesia 2,3Department of Electrical Engineering, Universiti Teknologi Malaysia, Malaysia 4Department of Electrical Engineering, Politeknik Negeri Ujung Pandang, Indonesia Article Info ABSTRACT Article history: Received Nov 2, 2017 Revised Mar 10, 2018 Accepted Mar 16 , 201 8 This paper proposed a new algorithm for fault location and classification ug elet asedo tranrmatinto btainthfau rren This novel method of fault current approach is studied by comparing the use of the glide path of the fault voltage.

The current alpha and beta (Current Mode) were used to transform the signal using discrete wavelet transform (DWT).Thfau catinwadmin y sinthClarke□ transformation, and then turned into a wavelet, which was very precise and thorough. The most accurate was the mother wavelet Db4 which had the fastest time and smallest error detection when compared with the other wamoers. is d e s srmatinis mp wit e ber□s, ich as ro ced results with similar error percentage.

The simulation results using PSCAD / EMTDC software showed that the proposed algorithm could distinguish internal and external faults to get the current signal in the transformation of a signal fault. Keyword: Clar□s

Sources found:

Click on the highlighted sentence to see sources.

Internet Pages

- 0% Empty
- 0% http://www.scirp.org/(S(351jmbntvnsjt1aa
- 0% https://79073900.r.bat.bing.com/?ld=d3rD
- 1% http://iaescore.com/journals/index.php/I
- 0% https://79073900.r.bat.bing.com/?ld=d3L7
- 0% https://79073900.r.bat.bing.com/?ld=d3QM
- 0% https://79073900.r.bat.bing.com/?ld=d39_
- 0% https://34003470.r.bat.bing.com/?ld=d3sH
- 0% https://www.energy.siemens.com/ru/pool/h
- 0% http://home.ubalt.edu/ntsbarsh/stat-data
- 6% https://www.sciencedirect.com/science/ar
- 0% https://79073900.r.bat.bing.com/?ld=d3vK
- 0% https://79073900.r.bat.bing.com/?ld=d3KK
- 0% https://www.researchgate.net/publication
- 0% https://www.researchgate.net/publication
- 0% https://www.researchgate.net/publication
- 0% https://79073900.r.bat.bing.com/?ld=d30a
- 0% https://79073900.r.bat.bing.com/?ld=d3TT
- 0% https://dl.acm.org/citation.cfm?id=30956
- 0% https://79073900.r.bat.bing.com/?ld=d3dn

afomatio Wavelet transformation Corresponding Author: Makmur Saini, Departement of Mechanical Engineering, Politeknik Negeri Ujung Pandang, Jalan Perintis Kemerdekaan Km. 10, Makassar 90245, Indonesia. Email: makmur.saini@poliupg.ac.id 1.

INTRODUCTION Currently, the parallel transmission networks are widely used in the electrical power systems. Therefore, a fast and reliable protection is very much needed in such aspects as rapid fault detection and accurate estimation of the location fault will reduce errors, and assist in the maintenance and restoration services to improve the continuity and reliability of electric supply. Therefore, parallel transmission lines require more special consideration in comparison with a single transmission line, due to the effect of mutual coupling on the parallel transmission line. It also must conform to the standard IEEE.STD.114 2004 [1].

One main advantage of parallel transmission is the availability of the transmission lines during and after the fault. Fault location problems in the parallel transmission lines have been widely researched. Many diagnostic approaches have been proposed in the literature, including fault location based on the amount of electricity, which includes one-terminal method [2], [3], two-terminal method [4], [5], traveling wave analysis method [6], [7], resistance measurement method [8], and the determination of fault location estimation using wavelet transform [9]. Tperpopseddete velet anfomatiousig Clars anrn eterne the fault location estimation and classification on the parallel transmission lines.

This study presents a deaprac ib n Clars anrn noas ha -beta transformation, which ? ISSN: 2088-8708 Int J Elec & Comp Eng, Vol. 8, No. 2, April 2018 : 699 710 700 is a transformation of a three-phase system into a two-phase system [10], [11], where after the result, the Wavelet transform is an effective tool in analyzing the transient current and signal associated with faults, both in frequency and in the time-domain [12], [13] and is ideal for dealing with non-stationary signal.

This can improve the accuracy, reliability of the detection and classification of power quality disturbance [14], and features can be applied to determine the fault location estimation [15]. The proposed approach combines the decomposition of electromagnetic wave propagation modes, usig Clars anfomatn f igpossig,gin y he iscrwatrnsrn asedo the maximum signal amplitude (WTC) 2 to determine the intrusion time.

This work made extensive use of the simulation software PSCAD/EMTDC [16] which resulted in the fault of the simulation of the transient signal transmission line parallel to the number of data points . For one kind of fault, these data were then tr ansr LABwitthe f ketrfomatiotocot thr -phase signal into alpha and beta signals. The signals were then transformed into several mother wavelets [17] such as Db4, Sym4, Coil4 and Db8 which were manipulated for comparison in terms of time and the distance estimation fault in the parallel

0%	https://79073900.r.bat.bing.com/?ld=d3E6
0%	https://79073900.r.bat.bing.com/?ld=d33b
0%	https://en.wikipedia.org/wiki/Vector_spa
0%	https://79073900.r.bat.bing.com/?ld=d3RB
0%	https://79073900.r.bat.bing.com/?ld=d35S
0%	http://www.math.psu.edu/tseng/class/Math
0%	https://79073900.r.bat.bing.com/?ld=d3TJ
0%	https://www.ysi.com/File%20Library/Docum
0%	https://79073900.r.bat.bing.com/?ld=d3zr
0%	http://www.math.tamu.edu/~yvorobet/Math4
0%	https://79073900.r.bat.bing.com/?ld=d3DS
0%	https://79073900.r.bat.bing.com/?ld=d3yS
0%	https://www.sciencedirect.com/science/ar
0%	https://www.mathworks.com/help/wavelet/g
0%	https://79073900.r.bat.bing.com/?ld=d3R4
0%	https://79073900.r.bat.bing.com/?ld=d3R5
0%	http://iopscience.iop.org/article/10.108
0%	http://www.utdallas.edu/~kjp/EE4250/lab3
0%	https://79073900.r.bat.bing.com/?ld=d3BC
0%	https://79073900.r.bat.bing.com/?ld=d3J1
0%	http://www.eng.monash.edu/non-cms/ecse/i
0%	https://www.researchgate.net/profile/Vik
0%	https://www.scribd.com/document/80207800
0%	http://ewh.ieee.org/cmte/substations/scd
0%	https://www.cavs.msstate.edu/publication
0%	https://79073900.r.bat.bing.com/?ld=d3aH
0%	https://www.scribd.com/document/35119966
0%	https://en.wikipedia.org/wiki/Low-pass_f
0%	http://dl.acm.org/citation.cfm?id=157919
1%	http://pe.org.pl/articles/2014/11/42.pdf

transmission line. 2. BPIPE FCLE□D AVEET OATIO 2.1.

Clas ransformation Clar's rrio(□0 a faytical poh mpmes ymmetry components (,1) ke□strsrnca vermeso ymy mpnentdaacsucat can fthecir an heme lar'sTfomatio(□0 ttrfomatiometd that contains the elements of a 3 x 3 matrix, containing matrix element in the form of real, whereas the symmetry component contains matrix components in the form of real and complex numbers. A three-phase current which has a digital representation is assumed to have the form [18], [19]. Therefore, the above components can be formed into a matrix [20] = a□ =C [ ] [ ] (1) where C is the well-known transformation introduced by Edith Clarke [21]. 2.2.

Fault Chactizaiorke□Traomaio 2.2.1. Single Line of Ground Fault Phase A to G A suppose for a line to ground fault (AG), assuming the grounding resistance is zero, then the instantaneous boundary conditions will be: 0 and 0 (2) Then, the boundary condition instantaneous will be: [ ] [ ] (3) 2.2.2. Line to Line Fault in Phase A-B A suppose for the line to line fault (AB), assuming the grounding resistance is zero, then the instantaneous boundary conditions will be: 0 , - and (4) Then, the boundary condition instantaneous will be: Int J Elec & Comp Eng ISSN: 2088-8708 ? Aom r alt Lotion ssificano ransio e Makmur Saini) 701 (5) 2.2.3.

Line to Line to ground Fault in Phase AB to G A suppose line to line to ground fault (ABG), assuming the grounding resistance is zero, then the instantaneous boundary conditions will be: 0 , and 0 (6) Then, the boundary condition instantaneous will be: [ ] [ ] (7) 2.2.4. Three Phase Fault in Phase ABC A suppose for three phase fault (ABC), assuming the grounding resistance is zero, then the instantaneous boundary conditions will be: + + 0 and + + 0 (8) Then, the boundary condition instantaneous will be: [ ] [ ] (9) Based on the above analysis, the characteristics of various faults ba sedoClars ansrn - Modal, - Moal d?cabposed . 2.3.

Wavelet Transformation Wavelet transformation is the decomposition of a signal by a function which is deleted and translated by the so-called mother wavelet. The function of the mother wavelet can be written as follows [22], [23]: ( ) (10) Where a is the dilation parameter (a Real) and b is a translation parameter (b Real), parameter a indicates the width of the wavelet curve, when the value of a wider magnified wavelet curve is diminished as the curve gets smaller, while the wavelet parameter curve b shows the localization of wavelet centered at t b.

The detection of the discrete wavelet transformed (DWT) fault is required so that the equation becomes [24], [25] / (11) Variables j and k are integers that scale the shifts of the mother wavelet function, to produce types of mother wavelet such as Syms and Haar wavelets. The width of a wavelet is shown by the scale , and the position is indicated by the wavelet scale . ? ISSN: 2088-8708 Int J Elec & Comp Eng, Vol. 8, No. 2, April 2018 : 699 □ 710 702 Discrete Wavelet Transformations (DWT) are methods used to decompose the input signal, and the signal is analyzed by giving treatment to the wavelet coefficients. The decomposition process

0% https://www.researchgate.net/profile/Mak
0% http://www.tandfonline.com/doi/pdf/10.10
0% http://www.academia.edu/8083626/A_Novel_
0% https://79073900.r.bat.bing.com/?ld=d30O
0% https://www.scribd.com/document/68444773
0% https://79073900.r.bat.bing.com/?ld=d3ir
0% https://79073900.r.bat.bing.com/?ld=d3BX
0% https://www.scribd.com/document/23398078
0% https://79073900.r.bat.bing.com/?ld=d3lJ
0% https://79073900.r.bat.bing.com/?ld=d3af
0% https://79073900.r.bat.bing.com/?ld=d36R
1% https://www.slideshare.net/MakmurSaini1/
0% https://778802.r.bat.bing.com/?ld=d3szqZ
0% https://79073900.r.bat.bing.com/?ld=d3Y7
0% http://www.ematlab.com/paper/power%20qua
0% https://www.scribd.com/document/24525128
0% https://www.researchgate.net/profile/Vah
0% https://documents.mx/documents/ge-d60-re
0% https://778802.r.bat.bing.com/?ld=d3Aaa6
0% https://79073900.r.bat.bing.com/?ld=d3dK
0% https://79073900.r.bat.bing.com/?ld=d3nV
0% https://79073900.r.bat.bing.com/?ld=d3_E
0% https://79073900.r.bat.bing.com/?ld=d3Ko
0% https://140162609.r.bat.bing.com/?ld=d3x
0% https://79073900.r.bat.bing.com/?ld=d35E
0% https://79073900.r.bat.bing.com/?ld=d30O
0% http://www.scijournal.org/html/INT-J-ELE
0% http://www.academia.edu/9395309/AN_ACURA
0% http://www.science.gov/topicpages/q/quan
0% https://www.sciencedirect.com/science/ar

involves two filters, which are low-pass filter and a high-pass filter [26].

This is achieved by successive high pass and low pass filtering of the time domain signal and is defined by the following equation: [ ] ? [ ] [ ] (12) [ ] ? [ ] [ ] (13) where [ ] output high-pass filter and [ ] output low-pass filter. The signal is first passed through the high-pass filter and low pass filter, and then half of each output is taken as sampling, down through the sampling operation, the signal of desired frequency component can be obtained from the recurring decompositions as shown by Figure 1 [27]. Figure 1.

The process decomposition of discrete wavelet transform This is called a decomposition first level process in the frequency range of 250-500 kHz. The output from the low-pass filter is used as the input of the next decomposition second level, with a frequency range of 125-250 kHz. This process is repeated again until it reaches the third level of decomposition with a frequency of 62.5-125 kHz, and so forth, according to the level desired. In this study, it is chosen to reach level 4, with a frequency range of 31.25-62.5 kHz and a level 8 with frequency range of 7.8125-15.625 kHz [28].

The combination of the output from the high-pass filter and low-pass filter output is called Coefficient Wavelet transformed (CWT), which contains information on the results that have been compressed and transformed. In this study, the high pass filter and low-pass filter are coupled and becoming a Quadrature Mirror Filter (QMF), in which the couples meet the following [29] equation: [ ] [ ] (14) where [ ] high-pass filter, [ ] low-pass filter, L length of each filter.

Successful to the down sampling operation that removes redundant information signal, wavelet transform has become one of the most reliable and accurate composition methods [30]. 3. THE PROPOSED ALGORITHM In this study, the simulations were performed using PSCAD, and the simulation results were obtained from the fault current signal. The steps performed in this study were: a. Findng he ut Clare□s anfomatioandwat ansr he nal w f SC was then converted into m. files (*.

M) and then converted into mat. Files (*mat) with a sampling rate of and frequency dependent of 0.5 Hz-1 MHz. Level 3 Coefficient Level 2 Coefficient h[n] 2 g[n] 2 h[n] 2 g[n] 2 Level 1 Coefficient h[n] 2 g[n] 2 Int J Elec & Comp Eng ISSN: 2088-8708 ? Aom r alt Lotion ssificano ransio e Makmur Saini) 703 b. Deter ming he ata eaifernce e he gnal s ansr y ntheClar□ transformation to convert the transient signals into the basic current mode signal in using Equation (1).

c.

Transforming the mode current signals again by using DWT and WTC, which were the generated coefficients,

0% https://documents.mx/engineering/power-s
0% https://www.tandfonline.com/doi/full/10.
0% https://www.sciencedirect.com/science/ar
0% https://79073900.r.bat.bing.com/?ld=d3pp
0% https://79073900.r.bat.bing.com/?ld=d3pJ
0% https://79073900.r.bat.bing.com/?ld=d3rz
0% https://34003470.r.bat.bing.com/?ld=d3Z1
0% https://www.springerprofessional.de/en/f
0% http://www.tms.org/Communities/FTAttachm
0% https://79073900.r.bat.bing.com/?ld=d3ee
0% https://ntrs.nasa.gov/archive/nasa/casi.
0% https://79073900.r.bat.bing.com/?ld=d31i
0% http://iaesjournal.com/online/index.php/
0% https://79073900.r.bat.bing.com/?ld=d3t0
0% http://shodhganga.inflibnet.ac.in/bitstr
0% https://79073900.r.bat.bing.com/?ld=d3q3
0% https://79073900.r.bat.bing.com/?ld=d3vB
0% https://link.springer.com/chapter/10.100
0% https://mafiadoc.com/publication-chair_5
0% https://www.grantforward.com/AliAbur
0% https://www.researchgate.net/publication
0% https://www.pdx.edu/power-lab/faculty
0% https://143001890.r.bat.bing.com/?ld=d3n
0% https://79073900.r.bat.bing.com/?ld=d3D3
0% http://nasrul.fke.utm.my/
1% https://www.researchgate.net/publication
0% http://web4.uwindsor.ca/users/n/nkar/88-
0% https://uk.linkedin.com/in/nick-kelly-7b
0% http://ieomsociety.org/ieom2018/global-e
0% https://79073900.r.bat.bing.com/?ld=d3jf

and then squared to be in order to obtain the maximum signal amplitude to determine the time of the interruption [31], [32]. d. Processing the ground mode and aerial mode and (WTC)2 using the Bewley Lattice diagram [32], [33] of the initial wave to determine the fault location and detection. e. Adding the magnitude of the current gamma to make the fault classification algorithm which then became modal that can be proposed.

While the magnitude of the current gamma of each different types of fault can be seen in Table 1. (15) f. Determining whether the internal fault in both Circuit 1 or Circuit 2 and external fault using the following equation: If | | or | | Fault Internal Circuit 1 (16) If | | | | Fault Internal Circuit 2 (17) If | | | | Fault External (18) g. The protection technique should be able to classify the faulted phase for single-phase-to-ground faults.

In the case of single-phase-to-ground faults, two of the modal components that include the faulted phase should have almost the same amplitude and the other modal component should be zero, as follows: | | | | | | ? AG fault (19) | | | | | | | | ? BG fault (20) | | | | | | | | ? CG fault (21) The algorithm will continue to determine the faulted phases involved in a multiple-phase fault. In the case of line to line faults, the criteria are as given in (22)-(24): | | | | | | | | ? AB fault (22) | | | | | | | | ? AC fault (23) | | | | | | ? BC fault (24) In the case of double line to ground faults, the criteria are as given in (25)-(27): | | | | | | | | ? ABG fault (25) | | | | | | | | | | ? ACG fault (26) | (| | | |) | | | | | ? BCG fault (27) h.

Determining the fault Classification where the fault classification was divided into 2 categories ? ISSN: 2088-8708 Int J Elec & Comp Eng, Vol. 8, No. 2, April 2018 : 699 710 704 ground and unground. The current approach had zero given threshold or less equal to zero than the disruption of unground fault, otherwise if the current is greater than the specified threshold limit, it would be the ground fault.

The unground fault was the line to line fault, while the threshold limit was given for termination 0:02, while the ground was divided into 2, which were line to ground fault with the given 0:05 for the termination criteria [34], as shown in Figure 2 that illustrates the proposed fault-type classification algorithm that uses the modal components of the current signals. 4. SIMULATION RESULTS AND DISCUSSIONS The system was connected with the sources at each end, as shown in Figure 2. This system was simulated using PSCAD/EMTD. For the case study, the simulation was modelled on a 230 kV double circuit transmission line, which was 200 km in length.

Figure 2. One line diagram of the simulated transmission system Transmission data: Sequence Impedance ohm/km. Transmission LineZ1 = Z2 = 0.03574 + j 0.5776 Z0 = 0.36315 + j 1.32.647 Fault Starting = 0.22 second Duration in fault 0.15 Second Fault resistance ( ) = 0.001, 25, 50, 75 and 100 ohm Fault Inception Angle = 0, 15, 30, 45, 60, 90, 120 and 150 degree Source A and B Z1 = Z2 = Z0 = 9.1859 + j 52.093 Ohm Type Conductor = Chukar, diameter 1.602 inch, 0.0524 ft 0.0162763 m The results of the calculations took

0% https://www.slideshare.net/iaeme/4022014

0% https://www.scribd.com/document/20488800

0% https://vdocuments.site/annual-reportant

0% https://wikivisually.com/wiki/Universiti

0% http://www.iste.co.uk/book.php?id=259 into account the position of the tower and distance between the conductors.

The conductor types used for this simulation were obtained using the propagation velocity = = 299863.4379 km/second. 4.1. Internal Fault Table 1 shows the results of various internal fault variations with fault resistance 0.001 Ohm and the fault inception angle of 0 degrees at various distances of errors. The biggest fault currentoccurred on the line to ground fault (AG) at a distance of 25 km with a current of 2.8953 kA.

The selected threshold line to grundfo ult = 0.03 from the simulation results showed that the fault threshold line to ground (AG) was = 007which s mallertan tesld(Also shown in Table 2 / and / on all types of faults that are greater than 1, which indicate that the fault was an internal fault in circuit 1, WTC of the aerial mode and ground mode are shown in Figure 3 TClar□trsfomatioa he t veDb b bggep rcentage error in fault location, about 0.4649 %, at the three phase disorder (AB) which had a distance of 75 km and the WTC of the aerial mode and ground mode are shown in Figure 4 while the smallest percentage error in fault location was about 0.0750 %, in line to line (AC) at a distance of 100 km.

This indicates that the proposed algorithm for fault classification is accurate and precise. G A G 1 A 1 A 2 2 Int J Elec & Comp Eng ISSN: 2088-8708 ? Aom r alt Lotion ssificano ransio e Makmur Saini) 705 Table 1. Fault AG BG AB AC ABG ACG ABC Distance (km) 25 50 75 100 125 150 175 (Ohm) 0.001 0.001 0.001 0.001 0.001 0.001 0.001 Fault Inception Angle 0 0 0 0 0 0 0 (kA) 2.8953 0.5330 -2.3266 2.3941 -1.6213 1.5088 1.3156 (kA) 0.5543 3.3782 2.6240 -0.4809 2.3185 -0.5580 1.7432 (kA) 0.5590 -0.5358 0.4682 2.1064 -0.5121 -1.9317 -1.8289 (kA) 1.9146 -0.8914 -2.3264 2.3938 -1.6364 1.6941 1.3141 (kA) 0.4722 2.0446 1.6739 1.0421 1.4762 0.9851 1.8197 (kA) 1.9612 2.9020 4.0132 -1.3441 3.0248 1.2014 2.3410 (kA) 1.0492 1.1841 0.00178 0.00198 0.5472 -0.4538 0.0321 (kA) -0.5674 0.4403 0.6615 -0.5065 -0.6707 0.7786 -0.8424 (kA) -0.3011 -0.4040 0.4453 0.5377 0.6624 0.4012 0.9667 / -3.3743 -2.0245 -3.5168 -4.7267 -2.4391 2.1758 -1.5599 / -1.5682 -5.0609 -3.5212 1.9381 -1.9417 2.1708 1.8823 Calculate point of Fault (km) 25.765 49.103 75.930 99.850 123.995 150.98 174.235 % Error 0.3825 -0.4994 0.4649 -0.0750 -0.5024 0.4994 0.3825 (a) (b) Fig ure 3.

Line to line fault (AG) circuit 1 from 25 from bus A, (a) Aerial mode for wavelet mother Db8, (b) For ground mode for wavelet mother Db8. (a) (b) Fig ure 4. Line to ground fault (AB) circuit 1 from 75 from bus A, (a) Aerial mode for wavelet Mother Db8 , (b) For ground mode for wavelet mother Db8 4.2. Influence of Fault Resistance Table 2 shows the effects of variations in the resistance of 25 ohms and 50 ohms with fault inception angle at 15 and 45 degrees with varying distances.

The simulation showed that when the resistance was increased, the fault current would drop, where the biggest fault current occurred in line to ground (BG) at a distance of 50 km with a fault resistance of 25 ohms. ? ISSN: 2088-8708 Int J Elec & Comp Eng, Vol. 8, No. 2, April 2018 : 699 □ 710 706 Table 2 shows the effects of variations in the resistance of 25 ohms and 50 ohms with fault inception angle at 15 and 45 degrees with varying distances.

The simulation showed that when the resistance was increased, the fault current would drop, where the biggest fault current occurred in line to ground (BG) at a distance of 50 km with a fault resistance of 25 ohms. The fault inception at the angle of 15 degrees was 0.03. When using the mother wavelet Db8, the percentage error in the fault location was ranged between 0.4-0.5%, as shown in Table 3. / and / varied from 2.5-8, indicating that the fault was internal to circuit 1. Table 2.

Result for different resistance faults based on mother wavelet Db8 Fault BG AB ACG ABC Distance (km) 50 75 125 150 Fault Inception Angle 15 15 45 45 Fault Resistance (Ohm) 25 50 25 50 25 50 25 50 (kA) -0.2241 -0.2277 -.2.0771 -1.6669 1.4632 -1.1601 1.5970 1.4178 (kA) -2.2829 1.7328 2.1951 1.7831 0.2377 0.2190 1.8558 -1.576 (kA) 0.2450 -0.2375 0.1574 0.1574 -1.4154 -1.1325 -1.7960 1.5244 (kA) -0.9056 -0.7183 -2.0771 -1.6669 1.2068 -1.0092 -1.5970 1.4178 (kA) 1.2291 0.9303 1.3429 1.0968 0.9234 0.7546 1.8761 1.5944 (kA) 2.1335 -1.6427 3.4108 2.7635 -0.7128 0.6131 2.5946 2.2336 (kA) 0.7745 0.5730 0 0 0.4156 -0.2974 0 0 (kA) 0.2046 -0.2253 0.4731 0.4566 0.4330 0.3544 0.6073 0.5599 (kA) 0.2581 -0.2329 0.3001 0.2724 0.4203 0.3759 0.5707 0.5207 / -4.4262 3.1882 4.3904 3.6507 2.7871 2.8476 2.6296 2.5322 / 8.2661 3.9944 11.3655 4.0264 2.1970 2.0074 3.2874 2.1773 Calculate point of Fault (km) 49.760 49.010 75.93 76.048 124.100 123.99 150.83 150.98 % Error -0.1199 -0.4994 0.4649 0.5024 -0.4499 -0.5024 0.4199 0.4949 4.3. Influence of Fault Inception.

As shown in Table 3, the simulations showed the effect on the variation of fault inception angle, ranging from 30 degrees to 150 degrees, with variations in fault resistance of 75 ohm and 100 ohm in the various types of fault and fault distance. Meanwhile, the threshold obtained in line to line ground disturbance (BCG) at a fault distance of 75 km, fault resistance 75 ohm and fault inception angle 75 degrees was d 001grterthattesho n fa tothe ondo 0.05, as it was faulted to the ground.

The fault line to line (AC) at a fault distance of 125 km, fault resistance of 100 ohms and fault incetioano3 egrs b thrldo? 0007sma the hrl o? 0.02. Table 3 also shows that if the fault inception angle was enlarged, then the fault current would increase, except for fault three-phase (ABC), which resulted with / and / , between 1.2-3, indicating that the fault was internal fault circuit 1. Meanwhile, the percentage error in fault location was obtained around 0.2-0.5% when using the mother wavelet Db4. The fault classification algorithms show that the proposed algorithm is correct and responsive. Table 3.

The obtained result for different Fault Inception Angle based on mother wavelet Fault AG AC BCG ABC Distance (km) 150 125 75 50 Fault Resistance (Ohm) 75 100 75 100 Fault Inception Angle 60 75 30 45 75 90 120 150 (kA) 0.8616 0.9626 -0.8963 -0.9292 0.5147 -0.6369 -2.2589 -2.0813 (kA) 0.3496 0.4948 0.0639 0.1791 1.4682 1.5235 2.1835 -1.9497 (kA) 0.4069 0.5048 0.9368 1.0783 1.4639 1.5305 2.1482 2.0210 (kA) 0.6723 0.8005 0.8963 0.9292 0.7293 -0.8503 2.2589 2.0813 (kA) 0.3219 0.4762 0.5763 0.7183 1.4764

1.5586 -2.1178 -1.9726 (kA) 0.7216 0,7418 -0.3217 -0.2940 1.7983 1.9133 3.2379 2.8001 (kA) 0.1957 0.1829 0 0 0.3223 0.3496 0 0 (kA) 0.4196 0.5677 0.2908 0.3547 0.4812 0.6391 0.9405 1.0646 (kA) 0.2260 0.3706 0.2374 0.3752 0.5994 0.7006 1.0632 1.1361` / 1.6002 1.4100 3.0822 2.6197 1.5165 -1.3305 2.4018 1.9555 / 1.4187 1.2849 2.4276 1.9144 2.4631 2.2247 2.2517 1.7363 (kA) 0.1957 0.1829 0 0 0.3223 0.3496 0 0 Calculate point of Fault (km) 150..39 150.54 124.59 124.29 75.63 75.71

49.46 49.01 % Error 0..1949 0.2699 -0.2204 -0.3525 0.3150 0.3525 -0.2699 -0.4946 Int J Elec & Comp Eng ISSN: 2088-8708 ? Aom r alt Lotion ssificano ransio e Makmur Saini) 707 4.4. Percentage Error in Fault Location for different Types of Mother Wavelet Table 4 shows the simulation error in determining the fault location when using various types of mother wavelet on the interference resistance of 100 ohms, fault inception angle of 0 degrees and a distance of interference, varied from 25 km-190 km.

The fault location estimation error was formulated as follows: Error % (24) From Table 4 it can be seen that the smallest average error was shown by the mother wavelet DB4, while mother wavelets Sym 4, Coil 4 and Db8 have a variation around 0.2-05% Table 4. Percentage error in fault location for different types of Mother Wavelet from Circuit 1, = 0 a t IpoAn(0 Type Of Fault Actual Point Fault (km) Db4 Coif4 Syms4 DB8 Calculate point of Fault (km) Error = (x-d)/L *100% Calculate point of Fault (km) Error = (x-d)/L *100% Calculate point of Fault (km) Error = (x-d)/L *100% Calculate point of Fault (km) Error = (x-d)/L *100% LG (AG) 25 25.0151 0.0076 25.7650 0.3852 25.3150 0.1575 25.7650 0.3825 50 49.7601 -0.1949 49.6110 -0.4949 49.0103 -0.4949 49.0103 -0.4949 75 75.2550 0.1275 75.8549 0.4274 76.0080 0.5024 76.0048 0.5024 125 124.745 -0.1275 124.142 -0.4274 123.995 -0.5024 123.995 -.0.5024 150 150.239 0.1949 150.389 0.4949 150.989 0.4949 150.988 0.4949 175 174.985 -0.0076 174.350 -0.3852 174.695 -0.1575 174.235 -0.3825 190 189.981 0.0091 189.082 -0.4590 189.750 -0.1216 189.232 -0.3840 LL (AB) 25 24.5650 -0.2174 24.1153 -0.4423 25.4651 0.2325 25.9150 0.4575 50 49.7601 -0.1199 49.1603 -0.4199 48.8603 -0.5695 48.9350 -0.5323 75 75.4050 0.2204 75.8549 0.4274 76.0080 0.5024 76.0048 0.5024 125 124.590 -0.2204 124.142 -0.4274 123.995 -0.5024 123.995 -.0.5024 150 150.239 0.1199 150.841 0.4199 151.139 0.5698 151.065 0.5323 175 175.435 0.2174 175.885 0.4423 174.535 -0.2325 174.085 -0.4575 190 190.432 0.2159 190.232 -0.3840 189.680 -0.1591 189.150 -0.4215 LLG (BCG) 25 25.0151 0.0076 25.0151 0.0076 25.0151 0.0076 25.6150 0.3075 50 49.7520 -0.1237 49.3120 -0.3449 49.1610 -0.4199 50.8849 -0.4425 75 75.6290 0.3150 75.8849 0.4424 75.8540 0.4274 76.0048 0.5024 125 124.371 -0.3150 124.161 -0.4224 124.145 -0.4274 123.995 -.0.5024 150 150.241 0.1237 150.691 0.3449 150.839 0.4199 149.115 0.4425 175 174.985 -0.0076 174.985 0.0076 174.985 -0.0076 174.385 -0.3075 190 190.282 0.1409 189.682 -0.1591 189.982 -0.0091 189.240 -0.3765 LLL (ABC) 25 25.0151 0.0076 25.3150 0.1575 25.6150 0.3075 25.9890 0.4950 50 49.4600 -0.2699 49.0103 -0.4949 48.8310 -0.5848 49.0103 -0.4949 75 75.4050 0.2025 76.0048 0.5024 76.0080 0.5024 76.1090 0.5549 125 124.595 -0.2025 123.995 -0.5024 123.995 -0.5024 123.901 -.0.5549 150 150.540 0.2699 150.989 0.4949 151.169 0.5848 150.988 0.4949 175 174.985 -0.0076 174.685 0.1575 174.395 -0.3075 174.020 -0.4950 190 190.582 0.2909 189.532 -0.2340 189.530 -0.2340 189.090 -0.4515 4.5.

External Fault Table 5 shows that / and / 1 in various types of fault, with a fault resistance of 100 and 0.001 Ohms, and fault inception angle of 0 and 60 degrees, which shows that the disturbance was an external fault. The largest fault current was found in the type of fault Bus B Line to line (AB) with fault resistance 0.0001 Ohm, fault inception angle at 60 degrees, and at 1.4344 kA. 4.6.

Detmi aLotn usingKreuer□Traomaio Table 6 shows the percentage error in the calculation of fault location by using another method, whh s eaurs rfrio rcoarn si Clar□s ansrn (Table 1). It turned out that the results obtained by both methods in determining the fault location percentage error were similar. The only difference between / and / in, Table 1 was that the transformations achieved / -3,3743 and / = -1.5682 respectively, in the type of line to ground disturbance (AG) at fault distance 25 km, fault inception angle 0 degrees and fault resistance 0.001 ohm, whereas Table 6 shows type of fault at / 3.6515 and / 2.4853. ? ISSN: 2088-8708 Int J Elec & Comp Eng, Vol. 8, No. 2, April 2018 : 699 □ 710 708 Table 5.

The obtained result for different external fault Fault Location Bus A Bus B Fault AG AB BCG ABC AG AB BCG ABC Fault Inception Angle 0 60 0 60 0 60 0 60 (Ohm) 0.001 100 0.001 100 (kA) -1.1360 1.2477 -0.3563 - 0.6316 -0.7879 -1.4344 0.3333 -0.8333 (kA) 0.3369 -1.5471 0.5576 -0.5190 0.3972 1.1107 0.3329 0.8671 (kA) 0.4560 0.3269 0.5570 0.6439 -0.3662 0.3271 0.3319 -0.8220 (kA) -0.9213 1.2477 -0.4162 0.6316 - 0.6139 -1.4344 0.3228 -0.8333 (kA) 0.3047 -1.0665 0.5654 -0.5342 0.3045 0.4572 0.3412 0.8856 (kA) - 0.9213 1.2478 0.4166 0.6316 -0.6138 -1.4342 0.3231 0.8332 (kA) 0.3051 -1.0661 0.5658 0.5343 0.3048 0.4573 0.3415 0.8854 / 1 1 1 1 1 1 1 1 / 1 1 1 1 1 1 1 1 (kA) -0.2151 0 0.0624 0 0.2136 0 0.0631 0 (kA) - 1.1360 1.2477 -0.3563 -0.6316 -0.7879 -1.4344 0.3333 -0.8333 Table 6.

The obtained result for different faults based on Karenbauer transformation and mother wavelet Db8 Fault AG BG AB AC ABG ACG ABC Distance (km) 25 50 75 100 125 150 175 (Ohm) 0.001 0.001 0.001 0.001 0.001 0.001 0.001 Fault Inception Angle 0 0 0 0 0 0 0 Ia (kA) 2.8953 0.5330 -2.3266 2.3941 -1.6213 1.5088 1.3156 Ib (kA) 0.5543 3.3782 2.6240 -0.4809 2.3185 -0.5580 1.7432 Ic (kA) 0.5590 -0.5358 0.4682 2.1064 -0.5121 - 1.9317 -1.8289 (kA) -1.0604 -1.0156 -1.6500 0.8938 -1.2098 0.6492 -0.9158 (kA) 0.8711 -0.2779 -0.6763 1.5000 -0.4432 1.1054 0.9397 (kA) -0.2904 0.2989 -0.3918 -0.2586 0.2967 0.3248 0.5674 (kA) 0.3505 0.1752 -0.2992 -0.3757 0.3797 0.4649 0.5864 / 3.6515 -3.3978 4.2133 -3.4563 -4.0776 1.9988 -1.6140 / 2.4853 1.5862 2.2603 -3.9925 -1.1673 2.3778 1.6025 Io (kA) 1.0422 1.1841 0.0179 0.0198 0.5472 -0.4538 0.0321 Calculate point of Fault (km) 25.765 49.103 75.930 99.850 123.995 150.98 174.235 % Error 0.3825 -0.4994 0.4649 -0.0750 -0.5024 0.4994 0.3825 5.

CONCLUSION The application of parallel transmission lines requires a more special consideration in comparison with the single transmission line, due to the effect of mutual coupling method. To overcome this problem, a new method was proposed, by using the Current alp handb(rmoe)frm Clar□ transformation to convert the signal. Then, discrete wavelet transform (DWT) is used to obtain wavelet transform coefficients (WTC) 2, to determine the current time when the fault amplitude values (WTC 2 would reach a maximum point, to determine the fault location distance. This paper also proposed algorithm fault classin y nClar□s anrn.Tsiiors wedthat he esults e cur, which were also compared against the res ults bnedbug he enb□s afomatio .

ACKNOWLEDGEMENTS The authors would like to express their gratitude to Universiti Teknologi Malaysia, The State Polytechnic of Ujung Pandang, PT. PLN (Persero) of South Sulawesi and the Government of South Sulawesi Indonesia for providing the financial and technical support for this research. REFERENCES [1] IEEE Guide for Determining Fault Location on AC Transmission and Distribution Lines, IEEE Std C37.114, (2004). [2] J. Song and Y.G. Suonan ,□Anarate fault location algorithm for parallel transmission lines using one terminal data, □ Elect Power Energy Syst, 31, pp.124 □ 129, 2009. [3] J. Izykoki,al.

catig ltin wer smissio nudavailily f mpmeasumenat one end, □ Proc Inst Elect Eng Gen Transm Distrib, 151, pp. 268 □ 273, 2004. [4] SH. g,al. , fau catinalgom asedo alysis r ntransedpel smissio lines, □ IEEE Trans Power Del, 24, pp. 1850 □ 1856, 2009. [5] J. uoan,al.et. dmainfau catin r aralltrannlinug nchnizedcuts, Elect Int J Elec & Comp Eng ISSN: 2088-8708 ? Aom r alt Lotion ssificano ransio e Makmur Saini) 709 Power Energy Syst, 28, pp. 253 260, 2006.

[6] Traveling-Wave-Based Fault Location in Electrical Distribution Systems with Digital Simulations TELKOMNIKA (Telecommunication Computing Electronics and Control). 12(2),pp 297-309, 2014 [7] A. Sara ,et. No mmuicatinproonopel smisnlies sinbo pen switching travellg s,□ IET Gener Transm. Distrib, 6, pp.88-98, 2012. [8] Y.J. n ,et. Anaratfau catinalgohfodub -circuit transmission systems □ , In Power engineering society summer meeting ,eatt□ inn,USA,IEE p. 1344 □ 1349, 2000. [9] H. Jung, al., et., □Notechiqfofau catinestimatinopel anmissio nug elet, Int J Electr Power Energy Syst, 29, pp.76 □ 82, 2007. [10] B. Polajzer, al.

Detection of voltage sources based on instantaneous voltage and current vectors and o rthonclarke□s transformation, □ IET Gener Transm Distrib, 2, pp.219-226, 2008. [11] B. Noshad, al.,et. A nalgritm asedo Tranfom dDiscrete velet nrm r e differential protection of three-phase power transformers considering the ultra-saturation phoo, Electric Power Systems Research, 110, pp.9-24, 2014. [12] B. SouhaS.R.,

□ Adaptive Speech Compression based on Discrete Wave Atoms Transform , International Journal of Electrical and Computer Engineering (IJECE), 6 (5), pp. 2150-2157. [13] S. Patthi, al.,et. Neutral current wave shape analysis using wavelet for diagnosis of winding insulationn of a tranr□ Turk J Elec Eng & Comp Sci, 20, pp. 835-841, 2012. [14] P. Chrasekar dV aj,□ Detection and classification of power quality disturbance waveform Using MRA b d velet sm dnral etwo Journal of Electrical Engineering, 61(4), pp.235-240, 2010. [15] Y.Menchafou1, al.,et. Extension of the Accurate Voltage-Sag Fault Locati o etho ectriPwer, J. Electrical Systems,12(1), pp.33-34, 2016.

[16] Maknimg P, al., et., □ Fa ianointrasmissionlinug velet nrm a□ IEEE/PES Transmission and Distribution Conference and Exhibition, IEEE. pp.2246-2250, 2002 [17] PCAD/EMer□s Mu . Manitoba HVDC Research Center. Winnipeg MB. Canada, 2001. [18] Mario, M. C. al. ,□ Three-phase adaptive frucy sut asedo Tranfoo, IEEE Trans. on Power Delivery, 21 (3), pp. 1101-1105 (2006). [19] O.F. Alfredo, al. ,□ Three-phase adaptive freqeny ret asedo Trsfoo, IEEE Trans. on Power Delivery, 21(3), pp. 1101-1105, 2006. [20] G. Hosemann and H.M.

Swald oal rati etectofod igital different ial roo□ IEEE Trans on Power Deliv, 8(3), pp.933 □ 940, 1993. [21] M. Saini, al. ,□ Anaccufau etecti dloo ntrannlie sinwavbedo transformation, □ Przeg ektrotechiczn 90(11), pp. 156-161, 2014. [22] P. Bunnon ,□ Electricity Peak Load Demand using De-noising Wavelet Transform integrated with Neural Network Methods , International Journal of Electrical and Computer Engineering (IJECE), 6 (1), pp. 12~20, 2016 [23] J. Sajad, al., et.,

□Classificatinopwer uality disturbances using S-transform and TT-transform based on the artinral etwo Turk J Elec Eng & Comp Sci, 21, pp.1528 □ 1538, 2013. [24] F. Ravas, al. ,□ Application of wavelet transformation in defectos copy of power steam generator Journal of Electrical Engineering, 55 (10), PP. 101-104, 2004. [25] B. Alb,al. ,□ Continuous wavelet transform for fault location in distribution power networks, definition of mother wavelet inferred from fault originated transient, □ IEEE Trans on Power Delivery, 23, PP. 380-389 , 2008 [26] A.

Sigh fico f ant hmenInDistribti ysteUsin velet srm , Journal of Electrical Engineering, 65(3), 144 □ 150, 2014 [27] D. Zhang and J. Li . An Image Registration Method Based on Wavelet Transform and Ant Colony Optimization , TELKOMNIKA (Telecommunication Computing Electronics and Control). 13(2),pp 304-313, 2015 [28] F. Janicek, al. ,□ A New Protection Relay Based on Fault Transient Analysis Using wavelet Transform , Journal of Electrical Engineering, 58 (5), PP. 271 □ 278, 2007. [29] K.

Saravanababu, al. ,□ Transmission Line Faults Detection, Classification, and Location Using Discrete WaTranfom, International Conference on Power, Energy and Control (ICPEC), Rangalatchum Dindigul. IEEE, PP. 233-238, 2013. [30] D. Chandra, al.et. A Wavelet multiresolution analysis for location ofau ntrannlin□ Electrical Power and Energy System, 25, PP. 59-69, 2003. [31] H. Eristi and Y.

mint asedfe ture extraction for fault detecti o tinfopo transmission lines, □ IET Gener Transm Distrib, 6, pp.968-976, 2012 [32] C. Pothisarn and A. Ngaopitakkul, □watrasfoadbappati eul etwoaom for fault location on single-circuit transmission line , In: Proceedings of the 2008 IEEE International Conference on Robotics and Biomimetics, Bangkok, Thailand, IEEE,PP. 1613-1618, 2009. [33] F.H. Magnago, A. Abur, □ Fault location using wavelets, □ IEEE Transactions on Power Delivery, 13(4), pp.1475-1480, 1998. [34] S. Lin, al.

Travellg e me freqeny aracteristic asedfau cati ofotransio es,□ IET Gener Transm Distrib, 6, 764 □ 772,

2012. ? ISSN: 2088-8708 Int J Elec & Comp Eng, Vol. 8, No. 2, April 2018 : 699 710 710 BIOGRAPHIES OF AUTHORS Makmur Saini received his B. Eng. in Electrical Engineering in 1987 from Hasanuddin University and M.Eng Electrical Power in 1993 from Insitut Teknology Bandung Indonesia. Currently, he is an Associate Professor Engineering Department of Mechanical Engineering, Politeknik Negeri Ujung Pandang, Makassar.

His research interests include Power System Protection, power system stability, Transmission and Distribution, High Voltage and renewable energy application. Abdullah Asuhaimi Mohd Zin received the B.Sc. degree from Gadjah Mada University, Indonesia, in 1976, the M.Sc. degree from University of Strathclyde, Strathclyde, U.K. in 1981, and the Ph.D. degree from the University of Manchester Institute of Science and Technology, Manchester, U.K., in 1988.

Currently, he is a Professor Engineering Department, Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru. His research interests include power system protection, application of neural network in power system, arcing fault in underground cables, power quality and dynamic equivalent of power systems. Dr. Mohd Zin is a corporate member of The Institution of Engineers, Malaysia (IEM) and a member of the Institute of Electrical Engineers (U.K.).

He is a registered Professional Engineer (P. Eng.) in Malaysia and Chartered Engineer (C.Eng.) in the United Kingdom. Mohd Wazir Mustafa received his B. Eng Degree (1988), M. Sc. (1993) and PhD (1997) from university of Strathclyde. He is currently an Associate Professor and Deputy Dean Graduate Studies and Research at Faculty of Electrical Engineering, Universiti Teknologi Malaysia (UTM), Johor Bahru, Malaysia. He research interest includes power system stability, FACTS and power system distribution automation. He is a member of IEEE.

Ahmad Rizal Sultan received the B.Sc. degree in 1999, the M.Eng Electrical 2006 from Hasanuddin University; Indonesia. Currently, he is an Associate Professor Engineering Department of Electrical Engineering, Politeknik Negeri Ujung Pandang, Makassar. His areas of interests are Power System Grounding Analysis, Power System Protection and Electric installation. Rusdi Nur received his B.Eng. in Mechanical Engineering in 1999 from Hasanuddin University, Dipl.Eng of Manufacturing Engineering in 2001, and M.Eng of Mechanical Engineering in 2008 from Hasanuddin University Indonesia. Ph.D. degree from Universiti Teknologi Malaysia, Johor, Malaysia, in 2016.

Currently, he is an Associate Professor Engineering Department of Mechanical Engineering, Politeknik Negeri Ujung Pandang, Makassar. His research interests include machining process and sustainable manufacturing.