Design of an Algorithm for Tracking Symmetrical Component Based on Adaptive Algorithm

Suradach Inpum and Krischonme Bhumkittipich
Department of Electrical Engineering, Faculty of Engineering
Rajamangala University of Technology Thanyaburi
Klong 6, Thanyaburi, Pathumthani, Thailand 12110
Tel: 0-2549-3571 Fax : 0-2549-3571 E-mail: krischonme.b@en.rmutt.ac.th

Abstract

Symmetrical components of current and voltage are great importance in many applications in power systems such as power quality and power system protection. This paper presents the new adaptive linear combiner (ADALINE) structure for symmetrical components traction and estimation. This structure is deal with multi-output systems for parameter traction/estimation rather than the existing ADALINE, which deals only with single output system. The new topology, it is called MO-ADALINE is also presented. Finally, the paper presents a new processing unit, which can estimate symmetrical components from the measured current signals. The advantage of this proposed unit is simple to implement. Simulation results are given to validate the proposed algorithms.

Key words: Symmetrical Component, Adaptive algorithm

1. Introduction

Symmetric component of current and voltage is important applied in many applications for the power system. In power system quality, the zero sequence and negative sequence currents are indicative unbalance of load in power system. In the power protection system, symmetrical component of current and voltage is as follows:

1) Zero sequence current (I_0)

2) Positive sequence current (I_1)

3) Negative sequence current (I_2)

4) Zero sequence voltage (V_0)

5) Positive sequence voltage (V_1) and

6) Negative sequence voltage (V_2) .

By using the computing function for measuring the distance relays or calculating fault location. Furthermore, various types relay necessary detect the size of component of miscellaneous sequence current. To bring decision-making and power protection systems, such as ground over current relay uses symmetrical component of zero sequent current for command the circuit breaker unload when faulted to ground in power system etc. Total mentioned this showed relays and power quality measuring instrument must be processed to track the value symmetrical component of current and /or symmetrical component of voltage on real-time

Generally used methods of fast fourier transform with the multiplier matrix (Matrix Transform), starting from signal analog of current and voltage has continued time been transformed into a digital signal by using a codec (A/D) process is also sent to microprocessor of current and voltage at any time based on fast fourier transform. When it results phase of current value and voltage at any time. The next step is to use multiplier matrix convert from phasor of current and voltage at any time is symmetrical component of current and voltage at any time. The entire process has to be the process done before the digital signal current and new voltage values are calculated in random order to the next round of calculations.

To simplify the process to follow up design symmetrical component. It is also a processing unit to track symmetrical components directly. In this research is designed adaptive Algorithm structured linear mixed to results three results at the same time is 1.)Symmetrical component zero sequent 2.)Symmetrical component negative sequent 3.)Symmetrical component positive sequent. This will help ease the adoption process to follow up design symmetrical component a real time

Future researchers believe new Adaptive Algorithm is another option to bring the application in power quality and protect power system.

2. Design an Algorithm

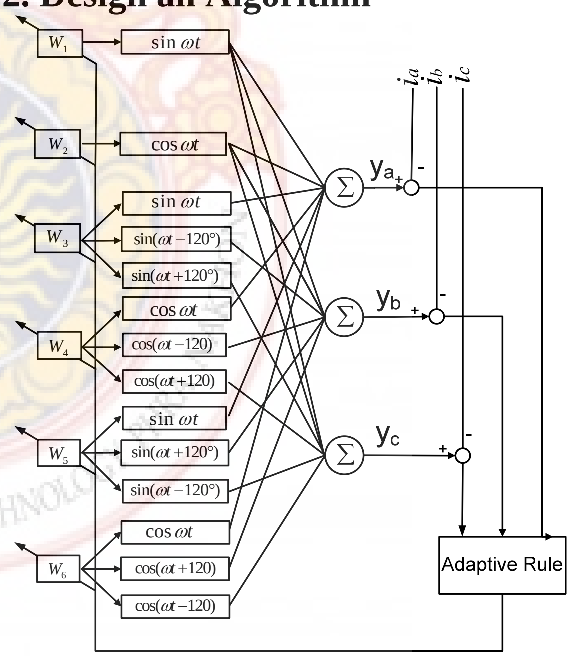


Fig.1. Structure of Algorithm

To create equations for symmet-rical component use relationship is based waveform of unsymmetrical and symmetrical components is important in this algorithm. Quantity of electrical (3 phase) symmetrical can show thus.

$$i_a = I_0 \sin(wt + f_0) + I_1 \sin(wt + f_1) + I_2 \sin(wt + f_2)$$
$$i_b = I_0 \sin(wt + f_0) + I_1 \sin(wt + f_1 - 120) + I_2 \sin(wt + f_2 + 120) \quad (1)$$
$$i_c = I_0 \sin(wt + f_0) + I_1 \sin(wt + f_1 + 120) + I_2 \sin(wt + f_2 + 120)$$

where I_0 and f_0 is size and phase angle of zero sequent components.

I_1 and f_1 size and phase angle of positive sequent components.

I_2 and f_2 is size and phase angle of negative sequent components

If use the equation

$\sin(a + b) = \sin(a)\cos(b) + \cos(a)\sin(b)$

Instead of equations (1) is given by

$$i_a = I_0 \cos(f_0)\sin(wt) + I_0 \sin(f_0)\cos(wt) + I_1 \cos(f_1)\sin(wt) + I_1 \sin(f_1)\cos(wt) + I_2 \cos(f_2)\sin(wt) + I_2 \sin(f_2)\cos(wt)$$
$$i_b = I_0 \cos(f_0)\sin(wt) + I_0 \sin(f_0)\cos(wt) + I_1 \cos(f_1)\sin(wt - 120) + I_1 \sin(f_1)\cos(wt - 120) + I_2 \cos(f_2)\sin(wt + 120) + I_2 \sin(f_2)\cos(wt + 120)$$
$$i_c = I_0 \cos(f_0)\sin(wt) + I_0 \sin(f_0)\cos(wt) + I_1 \cos(f_1)\sin(wt + 120) + I_1 \sin(f_1)\cos(wt + 120) + I_2 \cos(f_2)\sin(wt + 120) + I_2 \sin(f_2)\cos(wt + 120)$$

(2)

If prepare new equation (2) in the matrix

$$y(t) = F(t)q(t) \quad (3)$$

where $y(t)$ = measurement

$q(t)$ = estimates of future variables.

$F(t)$ = the relationship between time to change with the matrix. These variables shown in equation (4) - (6) listed below.

$$y(t) = \begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix} \quad (4)$$

$$q(t) = \begin{bmatrix} I_0 \cos(f_0) \\ I_0 \sin(f_0) \\ I_1 \cos(f_1) \\ I_1 \sin(f_1) \\ I_2 \cos(f_2) \\ I_2 \sin(f_2) \end{bmatrix} \quad (5)$$

$$F(t)^T = \begin{bmatrix} \sin wt & \cos wt & \sin wt & \cos wt & \sin wt & \cos wt \\ \sin wt & \cos wt & \sin(wt - 120) & \cos(wt - 120) & \sin(wt + 120) & \cos(wt + 120 \\ \sin wt & \cos wt & \sin(wt + 120) & \cos(wt + 120) & \sin(wt - 120) & \cos(wt - 120) \end{bmatrix} \quad (6)$$

This research hypothesis that the current signal or any voltage is function of cosine to velocity angular equal fundamental angular frequency of that power system. The components of the symmetrical component i to 10001 accordinly equation 7.

$$y(t) = A_i \cdot \cos(i \cdot w \cdot t + \theta_i) \quad (7)$$

where i is the locator of current signal measurement .

A_i is the peak value of current signal locator i.

ω_s is fundamental angular frequency of the power system.

t is at any time

θ_i is the phase angle of current signal locator i

$y(t)$ is signal outgoing from mathematical model.

Take equation 1, the new in the form of difference equation of the cosine equation follow 8 to 12 respectively.

$$y(t) = A_i \cdot \cos(\omega_s \cdot t) \cdot \cos(\theta_i) - A_i \cdot \sin(\omega \cdot t) \cdot \sin(\theta) \quad (8)$$

$$[X] = [\Phi] \quad (9)$$

$$[W] = [\theta] \quad (10)$$

$$y(t) = [W] \cdot [X]^t \quad (11)$$

$$e(t) = x(t) - [W] \cdot [X]^t \quad (12)$$

where $x(t)$ is the current signal or voltage to measure a component of symmetrical component.

$e(t)$ is the difference between the current signal or voltage require for measuring components of symmetrical compo-nent with signal out from the mathematical model.

$[W]$ is coefficient weight vector

From equation 6, when analog signal convert to discrete time signal. Coefficients $[W]$ can adaptive to have value $|e(t)|^2$ mini-mum following by Widrow-Hoff delta rule [1] obtain equation 7.

$$W(k+1) = W(k) + \frac{\alpha \cdot e(k) \cdot [X(k)]}{[X(k)] \cdot [X(k)]^t}$$

Where k is round of the adjustment coef-ficient weight vector.

$W(k)$ is coefficient weight vector round at k

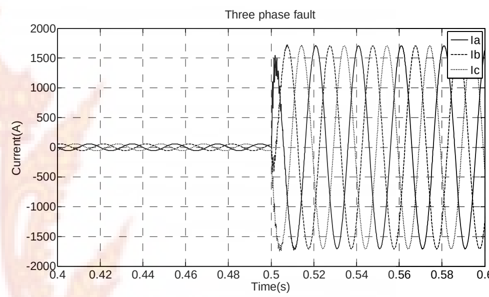
$W(k+1)$ is coefficient weight vector that is adjusted in the next round at $k+1$.

α is coefficient learning parameter

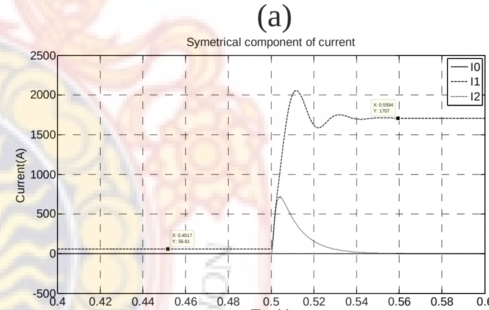
3. Results test of an algorithm

This case study will be determined initial system as follows supply voltage 3-phase 22kV at frequency 50Hz joined to transmission line long 10 km to distributed load size1796 +0.000032 i same as 3 phase.

First case study: simulation of fault occur in three-phase system. In system start at 0 seconds fault occur at 0.5 seconds shown in Figure 2.



(a)

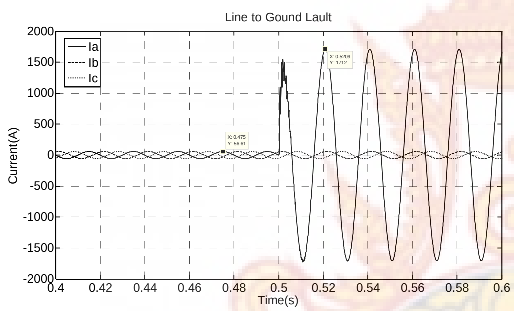


(b)

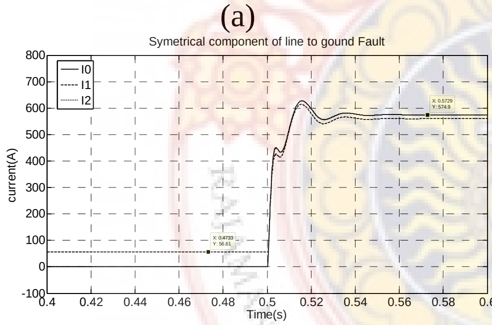
Fig. 2 (a) current signal when fault occur in the system three-phase, (b) symmetrical components of current signal.

From figure 3 describes the sepa-rate symmetrical components current signal in figure 2 (a) zero sequent (I_0), positive sequent (I_1), negative sequent (I_2) based on Adaptive Algorithm with Matlab program at 0 seconds to 0.49 sec-onds. System is normal measured only positive value approximately 56.6A equ-al to peak value of current in figure 2. At 0.5s of the three-phase fault occur in the first period 1-2 cycle. Algorithm tried adapt from ordinary state become fault state. Afterward algorithm reach steady state appear that only positive values mean 1708A equal to peak value of cur-rent in figure 2 and zero sequent, nega-tive sequent equal to zero. To the theory of fault occur in symmetrical component system.

Second case study: simulation of fault in line to ground system required to fault occur of phase A. In system the start at 0 seconds fault occur at 0.5 seconds shown in Figure 3 (a).



(a)

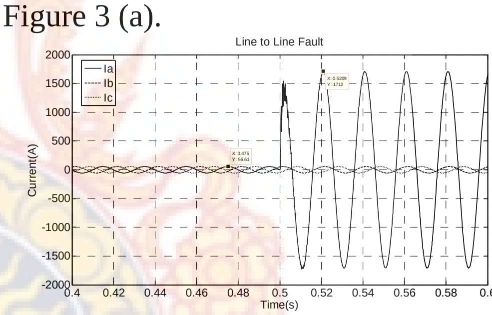


(b)

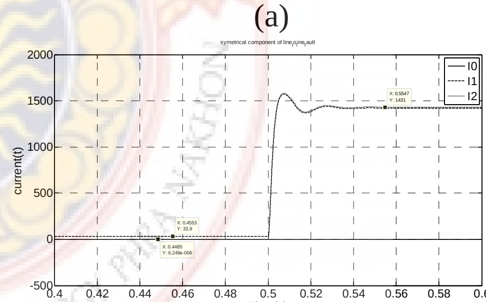
Figure 3 (a) current signal when fault occur in line to ground system.(b) symmetrical components of cu-rrent signal.

From Figure 3 describes the separate symmetrical component of current signal in figure 4 divide zero sequent (I_0), positive sequent (I_1), negative sequent (I_2) based on Adaptive Algorithm with Matlab program at 0 seconds to 0.49 seconds System is nor-mal measured only positive value approxi-mately 56.6 A equal to peak value of current in figure 4. At 0.5 seconds, three-phase fault occur in the first period 1-2 cycle Algorithm tried adapt from ordinary state become fault state. Afterward algorithm reach steady state appear that only positive values mean 1708-A equal to peak value of current in figure 4 and zero sequent, negative sequent equal to zero. To the theory of fault occur in sym-metrical component system. To the theo-ry of fault occur in line to ground sys-tem.

Third case study: simulation of fault occur in line to line system a dimi-nution in the line between the two. Make An Episode of the decrement phase a and phase c to the system in time from 0 seconds to pin the depletion at the time 0.5 seconds. Shown in Figure 3 (a).



(a)



(b)

Figure 4 (a) current signal when fault occur in line to line system, (b) Symmetrical component of current signal.

From Figure 4(b) describes the separate symmetrical component of cur-rent signal in figure 4 divide zero sequ-ent (I_0), positive sequent (I_1), negative sequent (I_2) based on Adaptive Algori-thm with Matlab program. By theory symmetrical component of the case stu-dy will be valuable three sequent the same as from experimental effective re-sults in Figure 4(b) with to that theory algo-rithm can tracking estimate.

4. Conclusions

New algorithm show that accurate estimates of symmetrical component and can tracking in transform system. Advantages of this algorithm compared with other algori-thm is easy algorithm. This algorithm pro-perly for applied as. The research will pre-sent next the occasion.

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