A REVIEW ON OPTIMAL PARAMETER SETTING FOR DIRECTIONAL RELAY IN MULTIMACHINE SYSTEM

Huma Anwar, Imran Khan, Anwar Ahmed, Apoorva Srivastava

[1,2,3] *Azad Institute of Engineering & Technology,*
Babu Banarasi Das National Institute of Technology & Management, Lucknow.

ABSTRACT: *This paper presents a new algorithm for optimal parameter setting for directional over current relay in multi machine system. Security index has been evaluated using optimization technique in simulation with multi machine system. Directional over current relays instead of recloses of the transmission line, assisted by tripping and blocking function. The fundamental characteristic of shielding tool in the energy system is to come across and eliminate the chosen faulty components as speedy as possible. These proses further purpose an algorithm to break – down the large size problem.*

Keywords: *Directional over current relay, Interconnected network, Over current protection, Optimal coordination, Linear programming.*

1. INTRODUCTION

The most nation in the global [1] .RES are those resources which may be used to provide electricity time and again. E.G-solar strength, wind strength, biomass electricity, geothermal power and many others. And some other names of the assets are known as opportunity source of power [2]. Renewable electricity in India comes beneath the purview of ministry of recent and renewable electricity [MNRE]. India's amongst the world leaders in the renewable strength use and region India on the center of its global solar alliance challenge sell Renewable Strength assets are play essential role of source of strength for destiny power requirement in nag the increase and improvement of solar strength the world over to over one hundred twenty countries. India's over all set up ability reached 329.4GW with renewable accounting for 57.472GW as of 14 June, 2017. 61% of the renewable power came from the wind while sun contributed nearly 19%. Large hydro established potential turned into 44.41GW as of 28 February, 2017. [3] These assets are relying on site and their sizes vary from few kilowatts to megawatts depending upon the provision and location. Usually electricity generated from them isn't bulk, as evaluate to thermal and nuclear strength plant. Therefore they do not require lengthy energy transmission line for energy transmission traces for strength generating devices to load center. RES are emerging as capability source of deliver of electric electricity for rural electrification where at least 25-30 million human beings but un-electrification inside the rural areas, like use India.

2. RELAY

The fundamental characteristic of shielding tool in the energy system is to come across and eliminate the chosen faulty components as speedy as possible. Over modern-day relays are widely used for safety of radial sub- transmission device and distribution device and it has low price [7].However their sluggish operating pace is not perfect feature for their software as number one safety scheme for sub transmission system. The protection scheme that's designed for unidirectional waft of fault modern-day fails to provide the good enough safety coordination while DERs electricity is injected within the distribution machine. For the machine having more than one source connected this is meshed or looped community, directional over current relay [DOCR] grows to be suitable preference for better selectivity. Since DOCR operate simplest whilst the fault modern waft in the precise tripping path desired. DOCR are supplied in electric system to isolate simplest the defective strains inside the occasion of faults within the system. These relay are located at both cease of traces. To hold the continuity of supply to healthful segment and to isolate the healthy section best, relays are coordinated. Their coordination is a crucial issue of the protection gadget layout .Relay coordination trouble is to decide the collection of the relay operation for every feasible fault area in order that faulted phase remote with enough coordination margins and without immoderate time delays.
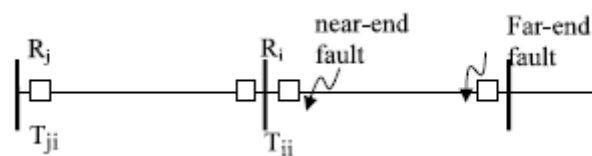

Fig. (1) An illustrative diagram of basic definition

3. Protection Coordination Studies

A. Optimization Technique

The use of optimization technique in relay coordination was first suggested by Uradenetaet al [1988]. In this paper two techniques were proposed for solving the time inverse over current relay coordination problem. First technique was applicable for fixed network configuration and second one was for variable network configuration. The time dial settings [TDS] determination in interconnected power system has been described as an optimization problem [19].In general DOCR relay allow for continuous TDS but discrete pick up current settings [I]. In referred study, however both TDS and [I] were assumed continuous variable, in order to avoid the use of mixed nonlinear programming technique. Linear programming methods were simple and easily converge to optimal solution. The linear programming   methods were simple and easily converge to optimal solution. The linear programming technique like –simplex, two phase simplex and dual simplex and big-M (penalty) methods have been tried in performing the coordination of over current relays

Rosen rock-hill climb method of nonlinear programming has been used for optimal setting of pick up current [20] and Birla et .al [2005] also made an attempt to use "Mat Lab Toolbox And Numeric Algorithm Group ''sequential quadratic programming routines. Application of random search technique [RST] for solving relay coordination problems are also discussed in [21].evolutionary programming is multi point searching optimization algorithm. Optimization technique based on evolutionary programming also has been reported in this paper [22].

B. Protection Coordination for Distribution System with Der

The various method and technique which are used in development of relay coordination with DER-

*   General protection scheme
*   Multi- agent based protection scheme
*   Expert system based protection scheme
*   Dual setting protection scheme

Above mention method which is describe in detail in the paper [23]. This is helpful in relay

4. Control Methodology

 A Retina, 2010 defined the main feature of the protective gadgets inside the strength device is to detect and dispose of the selected faulty components as speedy as possible. Directional over modern-day relays are normally used for the protection of interconnected sub transmission structures, distribution structures, or as a secondary safety of transmission structures. For the structures having a couple of source linked, this is meshed or looped networks, directional over modern relays turn out to be the suitable choice for higher selectivity, when you consider that directional relays perform only whilst the faulty contemporary flows in the particular tripping direction favored. This paper calculates the TDS by means of deciding on one of the available choose up current settings as the predetermined fee. The simplex two segment method is used to determine the non-obligatory TDS of the relays.

Improvement in the solution is brought via the usage of the particle swarm optimization method to the co-ordination problem for attaining the worldwide most reliable price with less computational time. Sample three bus and 8 bus systems are utilized for evaluating the effects obtained by means of PSO with that of the simple method. The optimization approach used within the recent times minimizes the operating time of the relays an awful lot, while compared to the opposite techniques. This technique electric powered electricity grid. [DER] is quicker, less expensive choice to creation of big, valuable energy vegetation and excessive voltage transmission line. They offer customers the capacity for lower price, higher energy satisfactory, accelerated energy efficiency and energy independence [5].

Also complements faster solution of coordination system. In this paper, an optimization methodology is provided to clear up the hassle of coordinating directional over current relays in a day reel interconnected energy gadget. The optimization of the coordination of Directional over present as can be similarly progressed by way of considering or formulating new coordination constraints. [29]. The RES are disbursed within the nature and generally included within the distribution in the distribution network and are called dispensed energy sources [DER] [1]. Nowadays, integration of disbursed energy sources [DER] in sub transmission and distribution system is growing unexpectedly. It consequences in higher voltage profile, better electricity reliability and reduction in transmission and distribution losses [.DER] , small scale electricity generation source located near wherein energy is used [E.G.- a home or business], offer an opportunity to or an enhancement   of conventional.

5. Equation

The mathematical expression for the fitness function is given as [27].

$$J = \min. \left[\left(\alpha_1 * \sum_{i=1}^{N_r} T_{i,k} \right) + \sum_{P=1}^{PR} (\text{Penality})^P \right] \qquad (1)$$

α_1 Is weighting factor for minimising the total operating time of all primary relays. Nr is total number of relays. PR is number of primary/backup relay pairs. Operating time of an over current relays is non-linear function of TDS and PS as under

$$T_{i,k} = TDS * \left[\frac{\alpha}{(M)^\beta - 1} + L \right] (2)$$

Where α and β are the relay constants as per International Electro Technical Commission (IEC) standard [33]. Their values are 0.14and 0.02, respectively, for a standard time inverse over current relay. The expression for plug setting multiplier (M) is given as

$$M = \frac{I_{fl}}{I_{pick}} \quad (3)$$

The second term in (1) maintains the CTI greater than 0.2 s. If CTI is below 0.2 s, a very high penalty is generated as per (4) and is added in the fitness function given in (1). If there is no CTI violation, then zero penalties are added in (1) as per (4). In this way penalty is calculated for each primary/backup over current relay pair 'PR'. The expression for k is given in (5).

$$\text{Penality} = \{k, \forall \Delta t_{mb,k} < 0.2, \qquad else 0 \qquad (4)$$

$$k = \alpha_2 * |0.2 - \Delta t_{mb,k}|^2 * (\Delta t_{mb,k} < 0.2) \qquad (5)$$

Where $\Delta t_{mb,k}$ selectivity margin and also known as CTI and α2 is weighting parameter used for controlling lower limit of CTI above0.2 s.

The optimal coordination problem of DOCR using optimization technique consists of minimizing an objective function subject to certain coordination criteria and limits on problem variable. The relay which is operating first to clear the fault is called the primary relay. A fault close to relay is known as the close-in fault for relay and a fault at the other end of lines is known as far- bus fault for the relay. Conventionally, objective function in coordination studies is constituted as summation of operating time of all primary relays, responding to clear all close-in and far-bus faults.
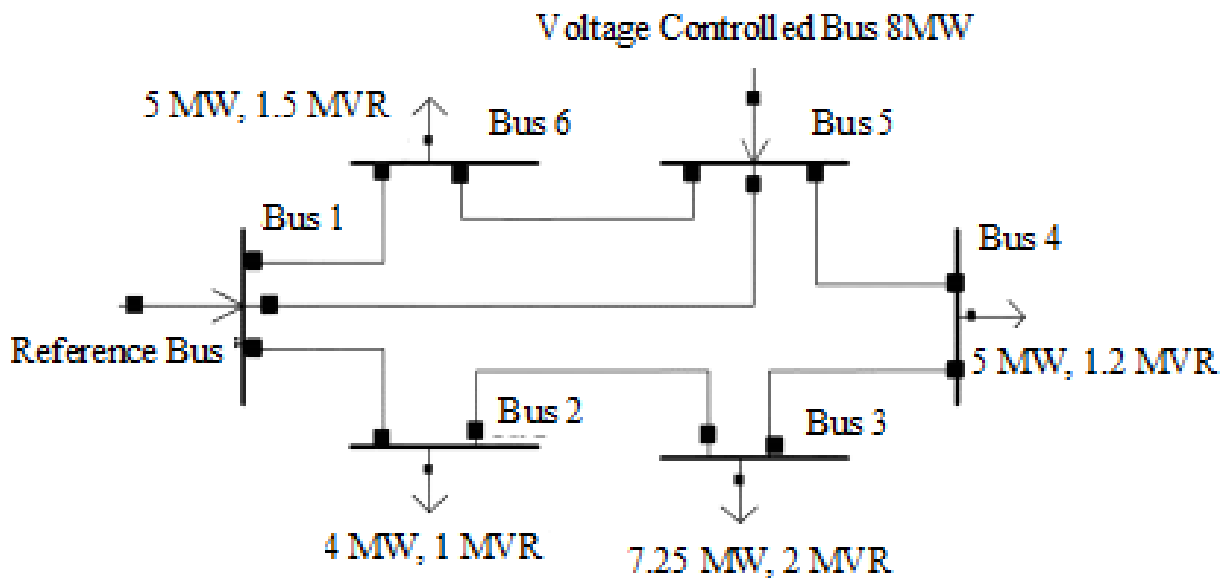

Fig. (2) 6 Bus network power system

6. Result and Discussion

In this paper, an optimization methodology is provided to clear up the hassle of coordinating directional overcurrent relays in an interconnected energy gadget. The working time of the relay changed into determined the usage of MATLAB and is determined to be 1.6908s for 3bus gadget and 17.1518s for 8 bus machine. This cost is in addition optimized the usage of Modified Particle Swrm Optimization technique in C#. A Linear Programming problem system was offered in this venture for the most useful coordination of Directional over Current Relays. It is observed that MPSO calls for only 5 particles for the optimization of the goal function. Therefore the proposed algorithm turned into used to reap the superior setting of the

operation time of the directional over current relays within the case have a look at system, a 3-bus device and an 8-bus gadget. The operating time values are located to be 1.3233s for three bus gadget and 13.097s for 8 bus System. On analyzing these two cases and comparing the consequences with the ones received from MATLAB, it's miles seen that the goal feature of the DOCR relay is minimized. The optimization of the coordination of Directional over present day relays can be similarly progressed by way of considering or formulating new coordination constraints. [29]

7. Conclusion

All techniques are more suitable as compare to conventional and optimization techniques for optimal parameter setting in distribution power system network for performance different point of view. The most vital undertaking when putting in directional relays at the machine is deciding on their appropriate setting such that their fundamental protective characteristic is met below the requirements of sensitivity, selectivity, reliability and velocity [25] .The over modern-day relay coordination in distribution gadget network may be very tremendously constraint optimization problems of chasing objective for stepped forward energy machine reliability. Several articles over calculation of the time dial and pick up contemporary (TDS and Ipu) placing of the relays is the center of the coordination. A Linear Programming problem formulation was presented in this project for the optimal coordination of Directional over current Relay.

8. Author Name (s) and Affiliation (s)

Huma Anwar (Azad Institute of Engineering & Technology, Lucknow)

Imran khan (Azad Institute of Engineering & technology, Lucknow)

Anwar Ahmed (Azad Institute of Engineering & technology, Lucknow)
Apoorva Srivastava (Babu Banarasi Das National Institute of Technology & Management, Lucknow)

Affiliation-
Huma Anwar, Imran khan, Anwar Ahmed, Apoorva Srivastava
1. *Azad Institute of Engineering & Technology, Lucknow*
2. *Azad Institute of Engineering & Technology, Lucknow*
3. *Azad Institute of Engineering &Technology,Lucknow*
4. *Babu Banarasi Das National Institute of technology& Management, Lucknow*

humaanwarhuda@yahoo.com,pe.imran@gmail.com,anwara931@gmail.com,apoorva019@gmail.com

9. Acknowledgment

10. References

[1]. Sudipta, G.S., Goshal, P., Ghosh, S., "Optimal sizing and placement of distributed generation in a network system," International journal of electrical power and energy system, 32(8), 849-856, 2010.
[2]. N.L Panwar[a,*],S.C.Kaushik[b],SurendzeraKothari[a], "Role of renewable energy source in the environmental protection-A review," pp.1513-1524, 2010.
[3]. https:\\en.wikipedia.org\wiki\Renewable_energy_in_india
[4]. Central Electricity Authority. "Draft National Electricity," Ministry of Power Government of India, Delhi, 1(16), 2016.
[5]. https:\\www.wbdg.org/resources/distributed-energy-resources-der
[6]. Sadeghi,H., "A novel method for adaptive distance protection of transmission line connected to wind farms",Electr. Power Energy Syst., 43(1) pp.1376-1382, 2012.

[7]. Mahat,P.,Chen,Z.,Bak-Jensen,B.,et al.: "A simple adaptive overcurrent protection of distribution system with distributed generation '',IEEE Trans.Smart Grid,2010,2,(3),pp.428-437.

[8]. Noghabi,A.S,Sadeh,J.,Mashadi,H.R.:, "Optimal coordination of directional over current relays considering different topologies using interval linear programming,"EEETrans.Powerdeliv ,2010,25,(3),pp.1384-1354.

[9]. Wan,H.,Li,K.K.,Wong,K.P., " multi-agent approach to protection relay coordination with distributed generators in the industrial power distribution system,"IEEE Trans.Ind.Electron.,2010,46(5),pp.2118-2124.

[10]. Albert R.E.,Nisja M.J.,Feero W.E., Rockefeller G.D And WangerCl, "Digital computer protective devices coordination program-I –general program description".,IEEE Transaction On Power Apparatus And System ,vol-83,pp.402-410,april 1964.

[11]. Zocholl S.E., Akamine J.K, Hughes A.E., Sachdev M.S, Scharfl L. And Smith H.S (IEEE committee report), "Computer representation of over current relay characteristics, IEEE transaction on power delivery ",vol-4,no-3,pp.1659-1667,1989.Smolleck H.A., "A simple method for obtaining feasible computational model for time characteristics of industrial power system protective device.", Electric Power System Research,vol-2,pp.129-134,1979.

[12]. Whiting, J.P., And Lidgate, D., "Computer predictions of IDMT relay setting and performance for interconnected power system,"IEEE generation, transmission and distribution, 130(3), 139-147, 1983.

[13]. Jenkins, L.Khincha, H.P., Shiva Kumar, S., and Dash, P. "An application of function dependencies to the topological analysis of protection scheme,"IEEE Transaction on Power Delivery, 7(1), 77-83, 1992.

[14]. Ramasawami, R., And M.C-Guire, P.F., "Integrated coordination and short circuit analysis for the system protection,"IEEE Transaction on Power Delivery, 7(3), 1112-1120, 1992.

[15]. Damaorg,M.J., Ramaswami, R.Venkata, S.S., &Postforoosh, J.M. , "Computer aided transmission protection system design, part-l, algorithm ,"IEEE Transaction on Power Apparatus and System, 103(1), 51-59,198Knable, A.H. (1967).Electrical Power System Engineering: problem and solutions .New York: McGraw-Hill.

[16]. Shah,K.R.,Detjen,E.D.,AndPhadke,A.G.Feasibilityofadaptive, " distribution protection system using computer overcurrent relaying concept ,".IEEE TransactionOnIndustryApplications,24(5)792-797,1988.

[17]. Uradanteo Alberto J.,NadiraRamu And PerezJimenej L., ",Optimal coordination of directional over current relay in interconnected power system,"IEEE Transaction Of Power Delivery ,vol-3;no-3,pp.903-911,july1988.

[18]. Abyaneh H.A and Keyhani R., "Optimal coordination of overcurrent relays in the power system by dual simplex method proceedings," AUPEC Conference, Perth, Australia, vol-3, pp., 440-445, 1995.

[19]. Birla, D, Mahaeshwari, RP. Gupta.H.O. Deep, K, And Thakhur, M. "Applications of random search technique in directional overcurrent relay coordination." International journal of emerging electric power system, 7(1), 1-14, 2006.

[20]. So.Cw And Li K. K, "Over current relay coordination by evolutionary programming", electric power system research,vol-53,pp.83-90.,2000

[21]. Manohar Singh, Protection coordination in distribution system with and without distributed energy resources-a review. 21 July, 2017.

Thakur, M., "New real coded genetic algorithm optimization,"ph.d.thesis, department

[24]– 8887) Volume 10– No.2, November e-11 September-2013.

[25]-Manohar Singh, B.K. Panigrahi , A.R. Abhyankar, Optimal coordination of directional over-current relays using Teaching Learning-Based Optimization (TLBO) algorithm2013 Elsevier Ltd. All rights reserved. http://dx.doi.org/10.1016/j.ijepes.2013.02.011

[26]-BarenyL.Capheart, "Distributed Energy Resources[DER], ". 2017.

[27]-A.Rathinam, D.Sattianadan, K.Vijayakumar, OptimalThakur, M., "New real coded genetic algorithm optimization,"ph.d.thesis, department of mathematics, Indian institute of technology roorkee, India, 2007.

[28]-M. H. Hussain[a],*, S. R. A. Rahima, I. Musirin[b], "Optimal Overcurrent Relay Coordination: A Review," Procedia Engineering 53, 332 – 336, 2013.

[29]-Shimpy Ralhan1, Shashwati Ray, Optimal Coordination of Directional Overcurrent Relays using Interval Two Phase Simplex Linear Programming , International Journal of Advanced Computer Research (ISSN (print): 2249-7277 ISSN (online): 2277-7970) Volume-3 Number-3 Issu Coordination of Directional Overcurrent Relays using Particle Swarm Optimization Technique , International Journal of Computer Applications (0975 – 8887) Volume 10– No.2, November 2010.