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Novel Dual-FCL Connection with Neuro fuzzy controller connected to smart grid with battery energy storage system

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Abstract:

The improving potential of power systems, bigger available fault currents may cause the existing circuit breakers to become under-rated. Extreme powerful pressure during serious faults may outcome in failing of circuit breakers to open. Larger fault currents may also negatively impact synchronization of the generators, reduce the life of electrical machines, or even cause complete failure of equipment. Fault present limiters (FCLs) are able to avoid all of these troublesome activities by restricting currents during faults and by improving the robustness of generator. The DUAL FCL positioning strategy is confirmed in a power network containing four buses in a ring agreement. The system receives power from turbo-generators (36 MW). This dual-FCL relationship decreases fault current efforts of the DG by 98.5% (from 41 to 1 kA), and preserves the circuit breakers within their duty limits when a three-phase fault happens at a bus linked with the DG. Otherwise, when a three-phase fault happens in the infinite system, this connection limits the fault present participation of the DG from 4.8 to 0.4 kA, and frequency oscillations of the DG from 0.14 to 0.01 Hz. The power continuity in the local network is improved; as the voltage sag at the bus linked with the DG is decreased by 98% during and after serious short-circuit faults. In this in order to control successfully Neuro-Fuzzy operator is used.

Introduction:

A fault is an unintentional short circuit, or partial short-circuit, in an electric circuit. A variety of factors such as lightning, downed power lines, or crossed power lines cause faults. During a fault, excessive current—called fault current— flows through the electrical system often resulting in a failure of one section of that system by causing a tripped circuit breaker or a blown fuse. A fault current limiter (FCL) limits the amount of current flow - ing through the system and allows for the continual, uninterrupted operation of the electrical system, similar to the way surge protectors limit damaging currents to house - hold devices. Currently, two broad categories of FCL technologies exist: high-temperature superconducting and solid-state Fault current limiters (FCLs) offer a variety of benefits for existing and future electrical distribution systems. These include sub-cycle operation in response to faults [1], [2], reduced damage at the point of fault [3], [4], and the opportunity for increased network interconnection [5]. Fault current limiting devices are becoming increasingly important because of the connection of distributed generation (DG) [6] and in systems where fault levels are inherently high, such as marine vessels [3], [7]. There is a desire for power networks to improve in reliability and efficiency, which may necessitate increased interconnection, which generally increases fault levels [8]. However, the coordination of protection can be difficult, expensive, or impractical on distribution networks with DG [9] and on networks which are highly-interconnected [10] because coordination often requires protection signalling. This paper analyzes the Neuro-fuzzy logic based control of Dual FCL, as well as offering the typical benefits to power system performance from fault current limitation.

Distibuted Generation:

Distributed generation (DG), also known as on-site generation, distributed resources (DR), distributed energy resources (DER) or dispersed power (DP) is the use of small-scale power generation technologies located close to the load being served. The DG marketplace includes energy companies, equipment suppliers, regulators, energy users and financial and supporting companies. For some facilities, DG can lower costs, improve reliability, reduce emissions, or expand energy options. DG may also add redundancy that increases grid security. Facilities can also recover and utilize heat from their DG systems, a practice known as combined heat and power.

DG Technologies

The portfolio of DG technologies includes reciprocating engines, microturbines, combustion turbines, small steam turbines, fuel cells, photovoltaics, and wind turbines. Each technology has varying characteristics and emission levels.

DG Applications

DG is currently being used by some customers to provide some or all of their electricity needs. There are many different potential applications for DG technologies. For example, some customers use DG to reduce demand charges imposed by their electric utility, while others use it to provide premium power or reduce environmental emissions. DG can also be used by electric utilities to enhance their distribution systems.

DG Interconnection

Most traditional DG is interconnection to the grid. The electric power system was designed to produce electricity at large power plants in remote locations, send it over high-voltage transmission lines, and deliver it on lower-voltage utility distribution systems to passive customers. Increasingly, electricity is produced by smaller, cleaner distributed generation units at or near customer sites and connected to the utility distribution system. The traditional one-way power flow – from power plants to customers – is turning into a two-way street.

Consulting Services Related to Distributed Generation

Since 1980, Resource Dynamics Corporation has helped clients position themselves in the distributed generation marketplace, through evaluation of end use markets, technologies and equipment; site identification; and regulatory and feasibility studies. We have produced numerous studies that analyzed both the market and technical potential for distributed generation technologies. In addition, we have created software programs and training modules that helped stakeholders understand the applicability of distributed generation, and we have provided strategic planning and expert testimony on issues related to distributed generation.

RDC has been involved in numerous projects over the last 30 years examining distributed generation. RDC conducted the USDOE’s first market study on micro-power applications of distributed generation in 1999. More recently, RDC was selected by national laboratory in a competitive

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solicitation to support DOE's work on opportunity fuels for distributed generation.

Fault Current Limiters:

Before technologies can be considered for the application of limiting a distributed generator‟s fault current contribution, the operating conditions and requirements of such a limiter must first be established. The existing technologies can then be evaluated for their suitability for such an application by ensuring that any proposed device meets the requirements. The first requirement for the FCL is that it must operate at the distribution voltage level. According to a utility survey in [13] in which utilities were asked to describe their present distribution systems and predicted future system, utilities responded that the most prevalent voltage class is at 15kV. A typical radial distribution system is shown in Figure 2.

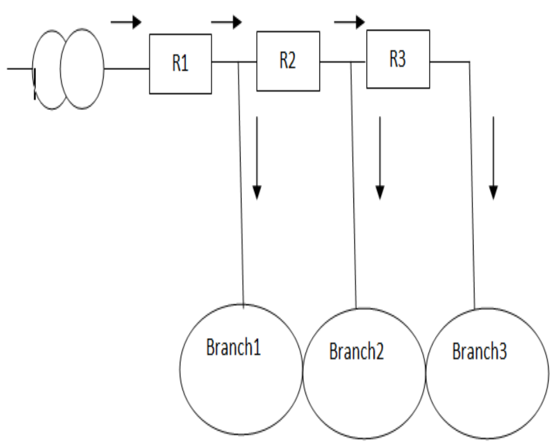
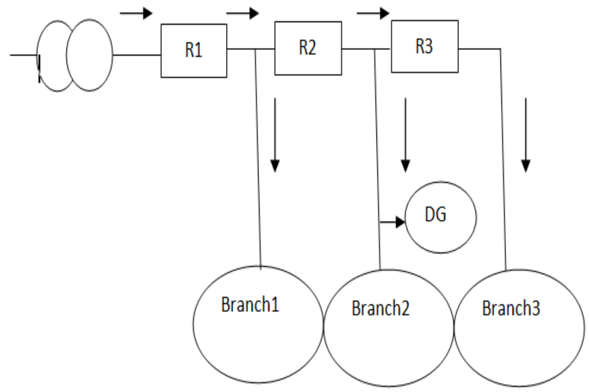


Fig 2: Radial distribution with Relay protection

The distribution system shown in Figure 3 is an example in which the addition of DG to the system in Figure 2 would impact the existing relay coordination. If a fault were to occur in Branch 1 or Branch 3, the DG would likely contribute to the fault current, with the current flowing from the DG back onto the main feeder, towards the fault. The current that flows through relay R2 would then be different than if the DG had not been added, so that the coordination between the 3 relays, R1, R2, and R3, would be affected.



To prevent the DG from supplying fault current onto the main feeder, the FCL should be placed between the DG and the main feeder, along the distribution line off of the main feeder leading to the DG and Branch 2 as shown by the X in Figure 3. The fault current limiter‟s operation must follow specific guidelines in such a placement. When there is no fault in the system, the FCL must not affect the system. If a fault occurs in the system outside of Branch 2, the FCL must limit the current that will flow from the DG to the fault. In the last mode of operation, for faults inside Branch 2, the FCL must not operate, preserving the fault current seen by the relay, R2. To be able to operate in the manner described, limiting the fault current in one direction while having no effect on the other, the fault current limiter needs the ability to be selectively turned on and off based on the direction of the sensed current. Finally, for the FCL to be viable, it will need to introduce almost no losses during the steady-state operation of the system, and be able to sustain repeated operations with low maintenance. A. Passive Limiters: Traditionally, fault current limiters implemented in practice and researched have been of the passive type: devices that are permanently connected to the power system and do not need to be”turned on” or controlled by an external signal. When a fault occurs, the nature of these devices is such that the over current is automatically reduced or limited. Passive devices include series inductors [14], and superconducting fault current limiters [15], [16]. While series inductors are inexpensive and require low maintenance, they cause a voltage drop during steady state operation and have poor limiting performance compared to newer FCL.

III. Neuro-Fuzzy Controller :

We consider a multi-input, single-output dynamic system whose states at any instant can be defined by “n” variables X1, X2,...,Xn. The control action that derives the system to a desired state can be described by a well known concept of “if-then” rules, where input variables are first transformed into their respective linguistic variables, also called Fuzzification. Then, conjunction of these rules, called inferencing process, determines the linguistic value for the output. This linguistic value of the output also called fuzzified output is then converted to a crisp value by using Defuzzification scheme. All rules in this architecture are evaluated in parallel to generate the final output fuzzy set, which is then defuzzified to get the crisp output value. The conjunction of fuzzified inputs is usually done by either min or product operation (we use product operation) and for generating the output max or sum operation is generally used. For Defuzzification, we have used simplified reasoning method, also known as modified centre of area method. For simplicity, triangular fuzzy sets will be used for both input and output. The whole working and analysis of fuzzy controller is dependent on the following constraints on Fuzzification, Defuzzification and the knowledge base of an FLC, which give a linear approximation of most FLC implementations. Constraint 1: The Fuzzification process uses the triangular membership function .Constraint 2: The width of a fuzzy set extends to the peak value of each adjacent fuzzy set and vice versa. The sum of the membership values over the interval between two adjacent sets will be one. Therefore, the sum of all membership values over the universe of discourse at any instant for a control variable will always be equal to one. This constraint is commonly referred to as fuzzy partitioning. Constraint 3: The Defuzzification method used is the modified centre of area method. This method is similar to obtaining a weighted average of all possible output values. An example of a very simple neuro fuzzy controller with just four rules is depicted in Figure 5. This architecture can be readily understood as a “neural-like” architecture. At the same time, it can be easily interpreted as a fuzzy logic controller. The modules X1 and X2 represent the input variables that describe the state of the system to be controlled. These modules deliver crisp input values to the respective membership modules (µ-modules) which contain definitions of membership Functions and basically fuzzify the input. Now, both the inputs are in the form of linguistic variables and membership associated with the respective linguistic variables. The µ-modules are further connected to Rmodules which represent the rule base of the controller, also known as the knowledge base. Each µ-module gives to its connected R-modules, the membership value µ(xi) of the input variable Xi associated with that particular linguistic variable or the input fuzzy set. The R-modules use either min-operation or product operation to generate conjunction of their respective inputs and pass this calculated value forward to one of ν- modules. The ν-modules basically represent the output fuzzy sets or store the definition of output linguistic variables. If there are more than two rules affecting one output variable then either their sum or the max is taken and the fuzzy set is either clipped or multiplied by that resultant value. These ν-modules pass on the changed output fuzzy sets to C-module where the Defuzzification process is used to get the final crisp value of the output.

CONCLUSION:

A Neuro-fuzzy logic controller based novel dual-FCL connection is designed for connecting new DGs to the utilities. The fault current contributions of the DGs are limited, so it is not necessary to change the original protection relay scheme or to upgrade the existing CBs. Comparing to a single FCL device, this dual-FCL connection costs only one more three-phase HTS wire and one more power switch to increase the synchronism between the new DGs and the utilities. Also, the power continuity at the bus connected to the new DG is enhanced because voltage sag is eliminated. It is indicates the Dual FCL is able to work more accurately with ANFIS controller compared with PI controller.. In future, the system can be further developed using Optimization technique or with „N" FCL Connection. The topology and control scheme of the dual-FCL connection are proposed, analysed and verified by simulation tests.

References:

[1]. yucheng Zhang, and Roger A. Dougal "Novel Dual-FCL Connection for Adding Distributed Genration to a Power Distribution Utility" IEEE Trans. Appl. Supercond., vol. 21, no. 3,june 2011.

[2]. J. R. S. S. Kumara, A. Atputharajah, and J. B. Ekanayake et al., "Over current protection coordination of distribution networks with fault current limiters," in Proc. IEEE Power Eng. Soc. General Meeting, 2006, pp. 1–8.

[3]. J. D. Glover and M. S. Sarma, Power System Analysis and Design, 3rd ed. San Anselmo, CA: Brooks/Cole, 2001.

[4]. V. Sokolovsky, V. Meerovich, and I. Vajda et al., "Superconducting FCL: Design and application," IEEE Trans. Appl. Supercond., vol. 14, no. 3, pp. 1990–2000, Sep. 2004.

[5]. IEEE Standard Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis, IEEE C37.04-1999.

[6]. IEEE Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis, IEEE C37.010-1999.

[7]. T. Lovett, R. A. Dougal, A. Monti, and E. Santi, "A Multilanguage environment for interactive simulation and development of controls for power electronics," in Proc. IEEE Power Electron. Specialists Conf., Vancouver, Canada, 2001, vol. 3, pp. 1725–1729.

[8]. Y. Zhang, R. A. Dougal, and S. B. Kuznetsov, "Influence of inductive fault current limiter on generator synchronization," Naval Eng. J., to be published.

[9]. W. I. Rowen, "Simplified mathematical representations of heavy-duty gas turbines," ASME J. Eng. Power, vol. 105, pp. 865–869, 1983.

[10]. P. Kundur, Power System Stability and Control. New York: McGraw- Hill, 1993.

[11]. N. Idir, Y. Weens, and J.-J. Franchaud, "Skin effect and dielectric loss models of power cables," IEEE Trans. Dielectrics Electr. Insulation, vol. 16, no. 1, Feb. 2009.

[12]. Woodward, "Speed droop and power generation," application note 01302 [Online]. Available:http://www.canadiancontrols.com/documents/technical/Speed%20Droop%20and%20Power%20Generation. Pdf

[13]. M. Andrus, S.Woodruff, and W. Ren, "Simulations of islanded generator synchronization in a notional integrated power system," [Online]. Available:http://esrdc.caps.fsu.edu/library.lookup.date.php