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"A REVIEW ON ROBUST LOAD FREQUENCY CONTROL IN TWO-AREA POWER SYSTEMS WITH THE HELP OF SCA"

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ABSTRACT

Load frequency control (LFC) has emerged as one of the potential research areas in the field of power system. In an interconnected power system, if a load demand changes randomly, both frequency and tie line power vary. The main aim of load frequency control is to minimise the transient variations in these variables and also to make sure that their steady state errors is zero. Many modern control techniques are used to implement a reliable controller. The objective of these control techniques is to produce and deliver power reliably by maintaining both voltage and frequency within permissible range.

The proposed SCA based controller gives good results as compared with other technique. For two area interconnected system, proposed controller gives 40 % lesser settling time and 29 % lesser peak overshoot as compared to ANFIS for the same system parameters and same system model. This work studies the reliability of various control techniques of load frequency control of the proposed system through simulation in the MATLAB-Simulink environment.

Key Words: *Sine-cosine algorithm, Two area system, Area control error, Integral error.*

I. INTRODUCTION

The development of electrical power was envisaged in the nineteenth century, and in the late nineteenth century electrical power generating units were installed throughout the world. The fast growth of these units was witnessed in the twentieth century. In India at the time of independence, the total generating capacity of electrical power was around 1362 MW. In early stages, the electric-power generating stations were installed around big cities, and the need for commissioning transmission systems was not given due consideration at that time. Under the five-year plans, a huge volume of industrial units was planned, and consequently the need for development of more electric power coupled with a large network of transmission systems at a faster rate was evident. The schemes for this have been implemented first at the state level and then at regional levels. The power industry is trying hard to meet the load demands on the system. In the new millennium much more efforts will be needed to meet the requirements of load demands, not by generating electrical power according to our load demands, but also by meeting the economic and environmental standards set up through legislation from time to time. Presently the total installed capacity of electrical power in India is around 128,000 MW. The breakup of this power according to different types of generating modes is hydro 32,326 MW; thermal 81,207 MW; nuclear 3360 MW; nonconventional 6,190 MW [1]. In India, due to various technical, economical, and environmental considerations, the electric power generating units have been installed at remote locations from load centres. However, they have to operate in an 2 interconnected fashion to share the benefits of utilizing variability in generation mixes and load patterns and other technological advantages. Therefore, there is a

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requirement of such transmission links which are capable of exchanging large chunks of electrical power between widely spread power pools effectively and efficiently.

II. Literature Review

Mokhtar Shouran et al. in [1] discussed that on using the Bees Algorithm (BA) to tune the parameters of the proposed Fuzzy Proportional–Integral–Derivative with Filtered derivative (Fuzzy PIDF), Fractional Order PID (FOPID) controller and classical PID controller developed to stabilize and balance the frequency in the Great Britain (GB) power system at rated value. These controllers are proposed to meet the requirements of the GB Security and Quality of Supply Standard (GB-SQSS), which requires frequency to be brought back to its nominal value after a disturbance within a specified time.

Amin Safari, Farshad Babaei, MeisamFarrokhifar in [2] discussed that large frequency oscillations happen when the unbalanced power is not compensated by Load Frequency Controller (LFC) system. In recent years, the using of electric vehicles (EVs) has increased with renewable generation sources such as solar cells, wind turbines, fuel cells, and so on. The large-scale integration of these new types of generation sources and demand in power grids will have a significant impact on operations, planning and stability control. This work sets out to design an effective PID controller for LFC in an island Micro-grid (MG) and also proposes a model for EVs to contribute to LFC system.

Li Jin, Yong He et al. [3] discussed an effective method such that the robust load frequency control (LFC) scheme can be designed efficiently for the large-scale power system with time delay. A novel constraint time-delayed ordinary differential equation (CTODE) model is proposed, based on which a new bounded real lemma (BRL) is established for the $H\infty$ performance analysis. The CTODE model is investigated considering the small number of remote signals influenced by delays in the LFC scheme. It consists of three parts, i.e., a delayed part includes the remote states, whose order is far less than that of the original system and remains unchanged with the increased scale of the power system, and a delay-free (related) part involves the local signals irrelevant (subjected) to the delayed states.

Sunil Kumar Bhatta et al. in [4] addressed a robust three-dimensional fuzzy-PID controller (Fuzzy-3D PID) to control frequency of a diverse energy source integrated hybrid power system under various loadings. In order to obtain stability over system frequency under any disturbances, a secondary control loop called load frequency control (LFC) loop is required in the system. LFC tries to monitor power generation irrespective of load demand. Further, a novel hybridized harmonysearch and random search (hyHS-RS) algorithm is proposed to optimally design the suggested Fuzzy-3D PID controller.

Amir Bagheri, Ali Jabbari, Saleh Mobayen in [5] discussed that in today's electric networks, micro-grids are highly integrated into power system regarding their technical, environmental, and economic advantages. Due to the stochastic behavior of loads and intermittent nature of renewable energy resources, the micro-grids are subjected to frequency oscillations especially in the islanded mode of operation. In this paper, an intelligent Terminal Sliding Mode Control (TSMC) based on Artificial Bee Colony (ABC) optimization algorithm is proposed for load-frequency control in islanded micro-grids composed of several energy resources.

Reza Alayi Farhad Zishan, et al. in [6] studied the load frequency control (LFC) of a multi-source microgrid with the presence of renewable energy sources. To maintain a sustainable power supply, the frequency of the system must be kept constant. A Proportional– Integral–Derivative (PID) controller is presented as a secondary controller to control the frequency of the microgrid in island mode, and the integral of squared time multiplied by error squared (ISTES) is used as a performance index. The use of the Craziness-Based Particle Swarm Optimization (CRPSO), which is an improved version of Particle Swarm Optimization (PSO), improves the convergence speed in optimizing the nonlinear problem of load and frequency controller design.

Xiaodong Wang, Yingwei Wang, Yingming Liu in [7] discussed that the frequency stability of power systems can be improved by the participation of high-penetration wind power in grid frequency regulation. However, the wind turbine (WT) fatigue load will be increased after the wind power participates in the load frequency control (LFC). This paper proposes a control method that takes into account the WT fatigue load and the frequency response of the power system.

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Abhishek Saxena, Ravi Shankar in [8] discussed that an effort has been revealed in this paper to develop a novel quasi-oppositional harmony search (QOHS) algorithm-based PID controller for frequency stability in a two-area power system including multiple sources. Both regions with multi- source scheme comprised of a reheat thermal unit and a hydro unit.

Mohamed A. Mohamed, et al. in [9] discussed that with the rapid growth of renewable energy resources, wind energy system is getting more interest everywhere throughout the world. However, its extensiveuse in power systems prompts many power system dynamics and stabilityproblems.Load variation and anomalous operating conditions prompt inconsistencies in frequency and planned power trades. These inconsistencies should be remedied by load frequency control.

Naladi Ram Babu, Lalit Chandra Saikia in [10] discussed that load frequency control (LFC) of an unequal three-area thermal system integrated with dish stirling solar thermal system (DSTS) in area-1, 2 and thermal system in area-3. The DSTS system is provided with various solar insolations namely fixed and random insolation. A new secondary controller named by PI minus DF is proposed for LFC study. A new algorithm named by coyote optimization algorithm (COA) is used for controller gain optimization. Performance comparison among various controllers like PID, PIDF are compared with the proposed PI-DF controller and is found to be best over others.

III. INTRODUCTION TO LOAD FREQUENCY CONTROL

In the steady-state operation of the power system, the load demand is increased or decreased in the form of Kinetic Energy stored in the generator prime mover set, which results in the variation of speed and frequency accordingly. Therefore, the control of load frequency is essential to have a safe operation of the power system. Moreover, frequency is also a major stability criterion for large-scale stability in multi-area power systems. To provide the stability, a constant frequency is required which depends on active power balance. If any change occurs in active power demand/ generation in power systems, the frequency cannot behold as its rated value. Hence, oscillations increase in both power and frequency. Thus, the system is subjected to a serious instability problem. To improve the stability of the power networks, it is necessary to design load frequency control (LFC) systems that control the power generation and active power at tie lines of an interconnected system. In interconnected power networks with two or more areas, the generation within each area has to be controlled to maintain the scheduled power interchange. The load frequency control scheme has two main control loops.

Representation of Load Frequency Control

A complete block diagram representation of an isolated power system comprising the turbine, generator, governor, and load is easily obtained by combining the block diagrams of individual components. In this case, no controller action is applied given actual system performance due to a step change of load. The dynamic behavior for the nominal system as the change in frequency consists of a Hydraulic Amplifier, Turbine, and Generator model.

IV. INTRODUCTION: SINE COSINE ALGORITHM (SCA)

The Sine Cosine Algorithm (SCA) is a new optimization technique for solving optimization problems. The SCA creates multiple initial random candidate solutions and requires them to fluctuate outwards or towards the best solution using a mathematical model based on sine and cosine functions. Several random and adaptive variables also are integrated to this algorithm to emphasize exploration and exploitation of the search space in different milestones of optimization.

The SCA algorithm was proposed by Seyedali Mirjalili in 2016. It is a population-based metaheuristic algorithm applied to optimization problems. As is common to algorithms belonging to the same family, the optimization process consists of the movement of the individuals of the population within the search space, which represent approximations to the problem.

IV. CONCLUSION

In electric- power generation, disturbances caused by load fluctuations may cause changes in the desired frequency value and tie-line loadings. Load frequency control is thus very important in power system operation for supplying

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sufficient and reliable electrical power of good quality. There are essentially two objectives of load frequency control. Firstly, the system frequency is to be maintained at or, very close to specified nominal value. Secondly, tie-line deviations must also be made zero as fast as possible.

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