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A REVIEW ON THE FREQUENCY RESTORATION IN A TWO AREA POWER SYSTEM

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ABSTRACT

In the process of achieving frequency restoration in multi area multi source, we came across several problems. First one is to place a controller to maintain and tune the gain parameters of different generation units to get the optimal response by proper optimization technique to simulate the environment for finding the optimal values. Here we are analyzing the Hybrid Differential Evolution Pattern Search based Fuzzy PID controller for AGC of multi area power system. In this work, a two area six-unit hydro, thermal, wind and diesel system were examined. Area-1 consists of hydro + thermal +wind and area-2 consist of hydro +thermal + diesel which is interlinked with a tie-line. The future scope will be on simulation results which validate the present work of hybrid pattern search differential evolution (HPS-DE) with other techniques in terms of frequency deviation, tie-line power deviation.

KEY WORDS: *Frequency Restoration, Fuzzy PID, HPS-DE, power generation, multi area multi source.*

1. INTRODUCTION

The world is fully enlightened throwing darkness aside with the bulk power generation. But power generation requires much attention with manual as well as automation. Frequency and tie-line power is the main concern in multi area power system, we have to kept and maintain it within specified limits. The main concern we have to put to get effective result is the selection of algorithm for tuning the parameters. Getting the optimal values for PID controller to make the system effective and efficient by the the artificial bee colony (ABC) and differential evolution (DE) are utilized. But artificial bee colony gives better results alone in both fractional and integer models when compared with differential evolution algorithm [1]. As ABC is a global optimization technique because of its robustness, fast convergence. It faces some disadvantages of accuracy in optimal values and premature convergence in later steps. For solving the accuracy problem in getting global optimal value, a chaotic search ABC (CABC) is proposed for tuning the PID control parameter [2].

2. LITERATURE REVIEW

Pretty Neelam et al. (2020), automatic generation control is responsible for regulating frequency under sudden power demands of the end users. Present work is analyzed with two test systems. In test system 1: the proposed hybrid teaching and learning based optimization pattern search algorithm tuned tilted integral derivative controller is better compare to newly published GA/DE optimized different classical controller for AGC in a deregulated environment. In test system 2: a two area six units system in deregulation is considered with appropriate boiler dynamics, govern dead band, generation rate constraint and time delay and the effectiveness of solar thermal power plant is studied in presence of thyristor controlled phase shifter and superconducting magnetic energy storage devices [3].

Naladi Rambabu et al. (2022), this article determines the optimal location of accurate high voltage direct current (AHVDC) tie line and energy storage devices (ESD) on system dynamics of three area thermal-precise wind turbine systems (PWTS) under deregulated scenario. A new controller called fractional order PI and integer order integral derivative with filter is utilized. Their gains are optimized by a crow search algorithm subjecting to minimization of a performance index named hybrid peak area integral squared error (HPA-ISE). System responses with parallel AC-AHVDC tie-line, ESD explore better performance and improves the system dynamics. The optimal location of AHVDC tie-line and ESD are found out in the distributed area.

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Investigation with ESD like RFB, UC, and both are carried out and found that optimal AC-AHVDC system with both RFB and UC outcomes best [4].

Mohamed Mokhtar et al. (2020), the problem of regulating the actual power of generating units in reaction to the change of the system frequency and the interchange of patch line power within stated limits is known as load frequency control. The effective operation of multi area power systems requires the total generation to be equal to the total load demand plus transmission losses. The goal of the LFC is to reduce the overall fluctuation of the system frequency as soon as possible with the appropriate power authority to recover the system frequency to its desired value. Objective to design a controller is to improve dynamic response such as decrease of settling time and overshoot of frequencies and tie-line power deviation [5].

Hassan Bevrani et al. (2020), it deals with a novel heuristic based recurrent Hopfield neural network designed self adaptive PID controller for automatic PID controller for automatic load frequency control of interconnected hybrid power system. Designing a self adaptive heuristic particle swarm optimization (PSO) gravitational search algorithm (GSA) based Hopfield neural network tuned PID and cascade controller for ALFC study of more realistic multi-source hybrid power system. Application of FACTS devices inimproving the power quality and stability of power system like UPFC which is extensively used in transmission lines for improving the transient stability, alleviating power oscillations, and providing voltage support to the system [6].

D. K. Chaturvedi et al. (2021), a multi objective optimization-based feature selection with the capability of eliminating features is implemented to create an efficient day ahead price Forecasting. To increase the forecasting accuracy, a backtracking search algorithm is applied as an efficient evolutionary search algorithm in the learning procedure of adaptive neuro fuzzy inference syatem. Investigation over the day ahead price forecasting is based on the price of electricity (POE) data and demand of electricity (DOE) data in different time intervals [7]. Electricity forecasting techniques :(1) artificial neural network (2) adaptive neuro fuzzy inference system.

J. L. Willems et al. (2019), here the cascaded ID-PD controller is applied for system dynamics control of a hybrid deregulated power system. Impact of solar thermal system and geothermal plant on system dynamics. With the presence of superconducting magnetic energy storage in addition to RES to regulate the system dynamics. For controlling the gains of secondary controller, Satin bowerbird optimization technique is used here. Sensitivity evaluation for the proposed cascaded ID-PD controller [8].

T. Hiyama et al. (2020), this paper presents a novel optimization model for the calculation of the water value of a hydro power plant. The coordination between the medium- and short-term generation scheduling in centralized electricity markets has usually been realized by means of future cost functions that express the expected power supply cost as a function of the systems state at the end of the short-term scheduling horizon. It works on scheduling medium term generation model for computation of the water value of a hydropower plant participating as a price taker in the electricity market operated by OMIE and as a price maker in the reserve market. Optimization process solved by Stochastic dynamic programming [9].

C. S. Chang et al. (2022), it presents a large new scale multi area multi source AGC power system in the restructured environment with different types of power plants such as thermal power plants with reheat turbine, gas, diesel and hydro power units. Proposes a new modified virus colony search algorithm based orthogonal learning to enhance the search space ability. It considers various contracts between Gencos, Transcos and Discos in the restructured regime with different types of unexpected conditions. Some of the Discos may violate their contract to increase their profit, therefore this violation should be added as extra load demand on local areas [10].

S. Bhowmik et al. (2004), a two area multi source power system comprised of thermal hydro wind units in each area is proposed to make scheme more realistic by considering non linearities such as GRC, GDB AND TD. For frequency regulation, a novel controller based on fractional order approach is proposed. To tune fractional order based TID controller parameters using Salp Swarm algorithm in a hybrid power system. The robust analysis of the controller is done for a wide range of variation of ±50 % in all system parameters and variation in time delay values. RFB helps in enhancing system performances in terms of reduced overshoot, undershoot with lesser settling time [11].

X. Yu and K. Tomosovic et al. (2004), this paper investigates the problem of event-triggered H∞ load frequency control (LFC) for multiarea power systems under hybrid cyber attacks, including denial-of-service (DoS) attacks and deception attacks. An event-triggered transmission scheme is developed under the DoS attacks to lighten the load of network bandwidth while preserving a satisfactory system performance. Then, a new switched system model accounting for the simultaneous presence of DoS attacks and stochastic deception attacks is established with respect to the LFC for multiarea power system [12].

3. METHODS and DEVELOPMENT

Initially individual power plants were going to supply the power upto large extent but with the increasing capacity and usage of

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power, we ran into deficit power supply. So adapting multi area multi source [13] environments, there will be less scarcity of power demand. Here we are developing a two area five-unit power system as shown in **Figure 1**.

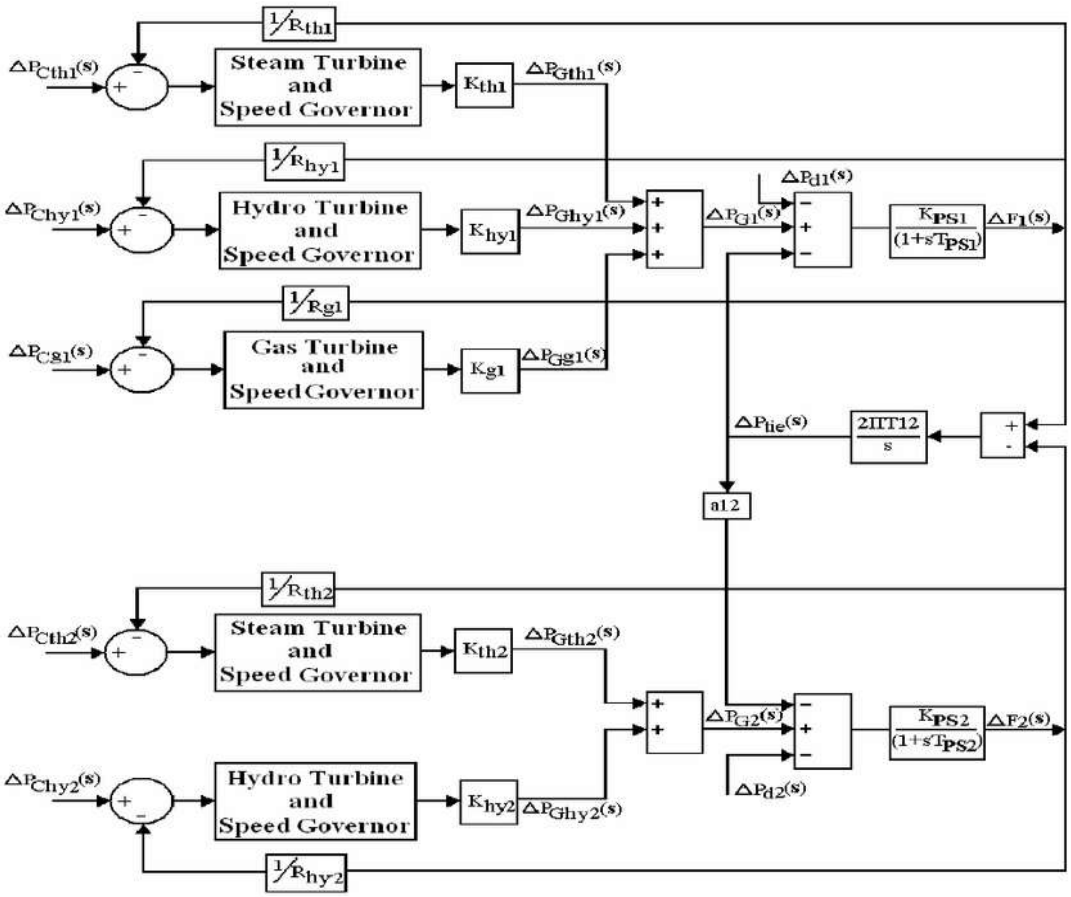

Figure 1: Block diagram of A Two Area Power System

In this two-area power system, generation of power from five units which are hydro, thermal, gas from area1 and thermal, hydro from area2 respectively. These two areas are interlinked with a tie line as shown above. As we are analyzing this system for maintaining frequency and tie-line power within specified limits, effective selection of algorithm with efficient controller is compulsory. From the literature review, it is better to use a hybrid pattern search- differential evolution (HPS-DE) based fuzzy PID for better dynamic response and fast convergence.

3.1 Fuzzy Proportional Integral Derivative Controller

Fuzzy logical approach uses artificial intelligence for error detection and correction. But it lacks a systematic design process, and improper tuning of parameters may lead to the divergence of system stability. Taking all these considerations into account, the fuzzy PID controller [14] was chosen here to solve the AGC problem. The structure of the fuzzy PID is shown in **Figure 2.**

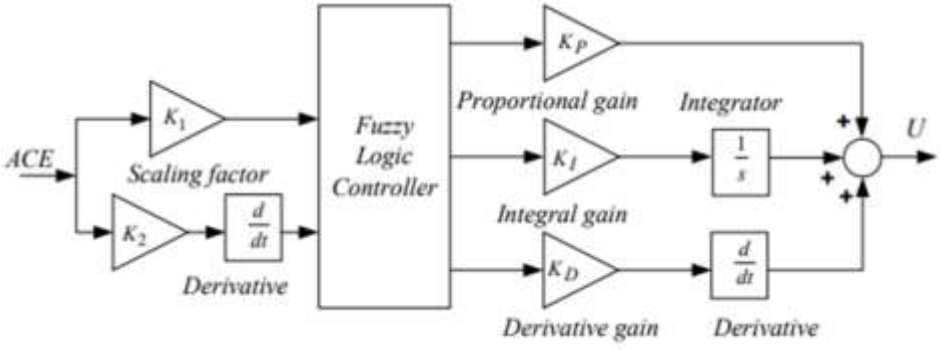

Figure 2: Structure of Fuzzy PID

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3.2 Hybrid Pattern Search- Differential Evolution Algorithm

In the current work, an effort has been prepared to analyze a hybrid DE method and PS technique to tune the controller parameters which is shown in below **figure - 3.**

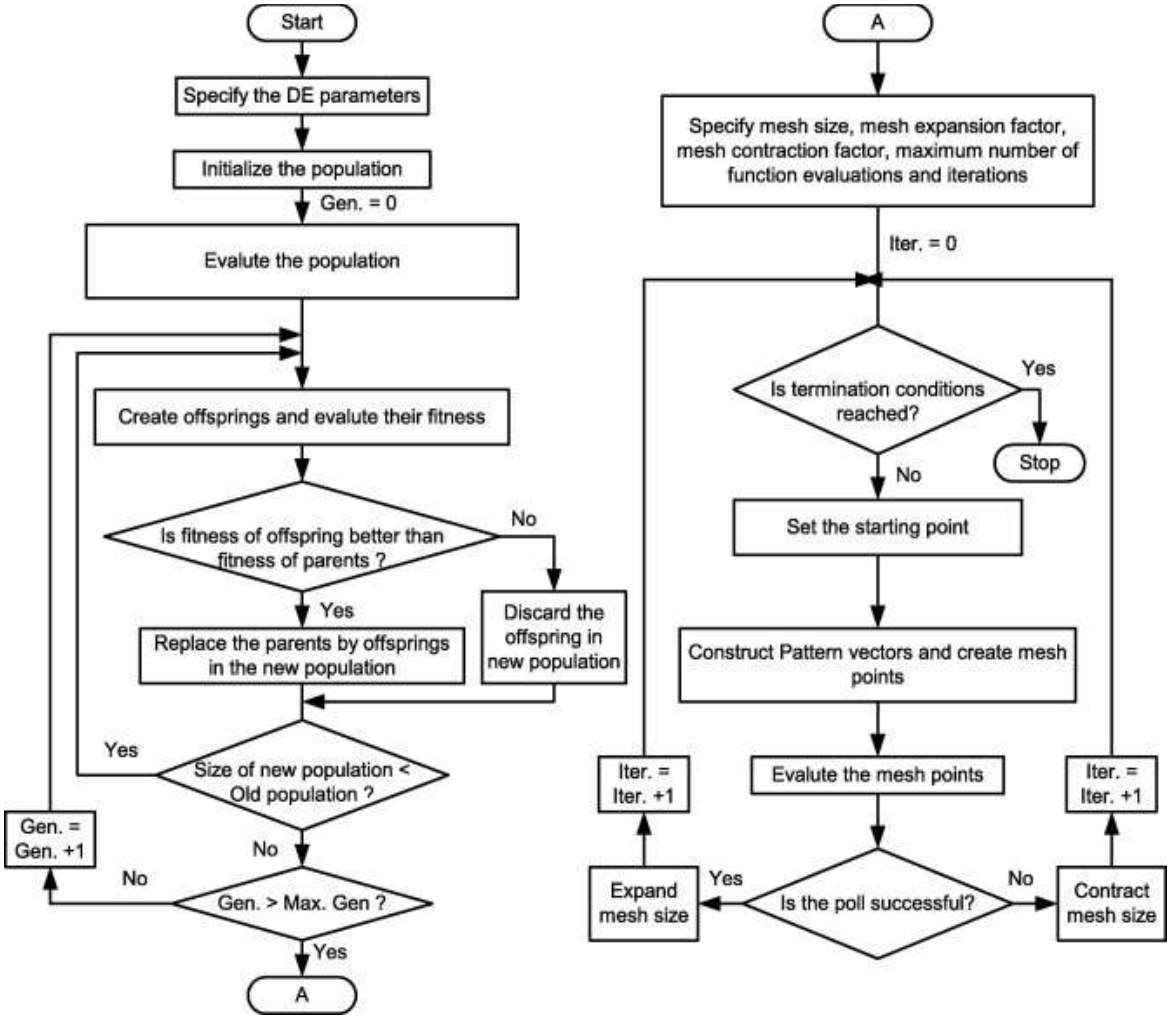

Figure 3: Flow Chart of HPS-DE

Differential Evolution (DE) technique [15] is a straightforward, capable, but effective technique and applied to numerous design problems. It gives remarkable performance for dynamic, multi-objective, constraint problems. Four main steps of differential evaluation are, namely initialization, mutation, crossover and selection. The PS method [16] is an easy concept, simple to realize and computationally competent. The PS method calculates a series of spots that could or could not come up to the finest position. The method initiates by a set of positions named mesh, about the original positions. The original positions or present positions are offered through the DE method. So the hybrid pattern search- differential evolution algorithm performs iterations and gives the optimal values.

4. NEED for FREQUENCY RESTORATION

All the loads in industries and utensils are manufactured to work under specified power ratings in terms of frequency, current and voltage. If ever the power supply varies from the generation side, then the loads consuming the power will go unstable and system will face severe malfunction [17]. So, there must be attention to maintain frequency deviation within specified limits [18]. For that purpose, effective controlling mechanisms need to be addressed in terms of obtaining fast convergence, robustness, accuracy in optimum values.

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5. CONCLUSION

Frequency restoration helps in maintaining the frequency within specified limits with fast restoration capability. It will be implemented in all generation systems as well as distribution systems. Now a days power generation takes place from different sources like renewable and non-renewable as power demand is increasing day by day. So not only keeping concern on generation but also in maintain and avoiding malfunctions in distributing as it going to affect end users severely. Then dynamic responses need to be improved in terms of frequency deviation and tie-line power deviation. From the analysis, there will be a much scope in avoiding frequency deviation and tie-line power deviation by using hybrid pattern search differential evolution (HPS-DE) based fuzzy PID controller in two area power system.

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