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Development of Power System Stabilizer Using Modern Optimization Approach

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ABSTRACT

The utilization of energy has increased manifold because of the industrial revolution. The development of the induction motor by Nikola Tesla in 1888 triggered the increasing demand of electrical energy in the industrial world and also its usage for artificial lighting. Higher amount of energy required for present society is provided by means of electrical energy.

Highly complicated power systems have been constructed to deal with the increasing demand. The development in electric power production is focused on the interconnecting the transmission lines, generators and loads into huge integrated systems, which helps in providing reliable and quality power system to the consumers.

Power system stability is an idea that focuses on the way the system adjusts with the occurrence of disorder. These disorders can result because of switching-off a load or a modification in the mechanical input to the system. Because of these disturbances oscillations may happen in the system that could ultimately build up to a larger extent, resulting in the synchronous generators to go out of step and lose synchronism.

Due to the importance of the power system and its stability, there are several techniques developed by various researchers for the stabilization of the power systems. The paper addresses enhanced Artificial Bee Colony (ABC) technique applied to design a robust power system stabilizer (PSS) in order to improve transient and dynamic stabilities of a turbo-alternator connected to an infinite bus system comparisons wind, thermal and solar power generations the design of the proposed controller initially is formulated as an optimization problem and then enhanced ABC is employed for obtaining optimal controller parameters. The results shows that the proposed algorithm are better in performance than the conventional methods.

KEYWORDS: *Transmission lines, ABC (Artificial Bee Colony), power system stabilizer (PSS), optimal controller, system stabilizer*

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I. INTRODUCTION

The consumption of energy has increased extensively due to the industrial revolution. The development of the induction motor by Nikola Tesla in 1888 stimulated the improving demand of electrical energy in the industrial world and also its usage for artificial lighting. Higher amount of energy need for present society is provided by electrical energy. A highly complicated power system has been constructed to deal with the increasing demand. The electric power production development is mainly focused on the interconnected transmission line network linking generators and loads into huge integrated systems which helps in better supply of power and a few of which have the link of the entire continent. This huge venture of providing electrical energy suffers various engineering difficulties that pose the engineer with a range of challenges. The systems that are developed according to this are highly complicated in their planning, construction, and operation. These various difficulties motivate the engineer's managerial abilities their knowledge in designing a better system. The complete design should be based on automatic control without requiring any time consuming input from the system operators. Power system's flourishing function is highly based on the engineer's capability to afford continuous and dependable service to the loads. The consistency of the supply power refers greatly more than simply being available. Preferably, the loads should be provided with constant frequency and voltage every time.

Practically, this represents that both frequency and voltage should be maintained within close tolerances therefore the consumer's system may function adequately. Consider an illustration that a voltage drop of 10-15% or a reduction of the frequency of the system by just a hertz may result in halting of the motor loads on the system. Therefore it will be perfectly indicated that the power system stabilization should be maintained with higher standard for uninterrupted power supply.

Stability of the Power system is an idea that focuses on the way the system adjusts with the occurrence of disorder. These disorders are the resulting of switching-off a load or a modification in the mechanical input to the system. Because of these changes in the system, oscillations happen in the system that could ultimately build up and bigger to result in the synchronous generators to lose synchronism and go out of step.

Because of using fast static excitation system, while offering a gain in stability limits, can also cause poor system damping in case of some loading conditions. Methods of Power System Stabilization have been suggested for a long period to enhance the power system damping. Conventionally, lead-lag networks have been used as power system stabilizers. Much has been used on the manner to adjust the factors of the lead lag controller. These controllers in the past have been adjusted for both single and multiple operating points of power system. The techniques used for adjusting range from pole placement, to recent one using the heuristic optimization technique for Particle Swarm Optimization (PSO) has been proposed by Mozafari et al, (2005).

One of the major problems in power system operation is related to small signal instability caused by insufficient damping in the system. The most effective way of countering this instability is to use auxiliary controllers called power system stabilizers, to produce additional damping in the system.

The highly complicated, dynamic activities and nonlinearity of power systems, along with their approximately continuously time variant nature, have led to a great challenge to power system control engineers for several years. A critical factor stumble upon the generating plant level is to maintain synchronism or stability of synchronous generators when exposed to rigorous variations at different operating situations. An inexpensive and successful ways to increase the power system stabilization is the most important consideration in the present situation.

II. LITERATURE REVIEW:

When a disturbance takes place, introduced voltage from the phase shifter is given to damping control of generator swing. Consequently, this controller is expected to enhance steady-state stability. This apparatus is also estimated to be a potential fault current limiter by utilizing the leakage reactance of a series transformer. An uncomplicated and novel control approach for damping electromechanical oscillations through control of power converter firing angles α1 and α2 of SMES unit was proposed by (Rabbani et al, 1999). Both active and reactive power modulations are exploited under uneven -mode of operation. The option of uneven mode is discussed in detail by this author. The gains of this SMES controller are given once offline based on the power system and the rating of the SMES unit. This control

Algorithm is uncomplicated and its realization will necessitate very little hardware.

Katsuya et al, (2000) presented a technique to stabilize a power system with elongated distance mass power transmission from a remote huge power plant through a synchronous condenser with rapid excitation control. Excitation controls of a generator have accomplished enormous success as a PSS. Synchronous condensers have been implemented in great numbers to power systems for the purpose of controlling the system voltage and reactive power with elevated consistency. In this technique the synchronous condenser with a devised excitation control has been implemented for the stabilization of a generator power swing by establishing the synchronous condenser at a bus in the transmission line near the generator. A design based on the damping and synchronizing torques was developed by this author. The application of H-infinity control is also taken into account to build up a robust control system.

A control scheme of the Static Synchronous Series Compensator (SSSC) for fault current limiting and power system stabilization has been proposed by (Duangkamol et al, 2000). The apparatus introduces a voltage of variable magnitude in sequence with a transmission line. This introduced voltage is in quadrature with the line current. In normal condition, it is controlled with the aim of compensating for reactance of the transmission line.

When SSV of the augmented closed-loop system is less than one, then the proposed approach is said to achieve the robust performance. D-K iteration (open and closed loop interconnected structure) technique is used to provide solution to this problem, which gives a lower and upper bound of synthesis.

Simulation results illustrated that the proposed approach attains a better robust performance over a wide range of operating conditions as compared to the conventional power system stabilizers and H-infinity control (achieving robust performance or stabilization) power system stabilizer by (Soliman et al, 2000). The electric energy of Plug-in Hybrid Electric Vehicle (PHEV) is charged mainly during night time when the electricity price is low. Therefore, (Takagi et al, 2009) proposed a charging power control of PHEVs to compensate the Load Frequency Control (LFC) capacity in the night time. The author proposes a control technique based on Area Control Error (ACE) and frequency characteristic of PHEV

III. MODELLING OF WIND POWER SYSTEM WITH PSS

Power System experience low-frequency oscillations due to disturbances. The oscillations may maintain and grow to cause system separation if adequate damping is not available. To increase system damping, the generators are equipped with power system stabilizers (PSSs) that provide supplementary feedback stabilizing signals in the excitation systems.

In this work, a single synchronous generator connected through a parallel transmission line to a very huge network approximated by an infinite bus (SMIB). The Power System Stabilizer (PSS) is an additional excitation controller utilized to damp generator, electro-mechanical oscillations is produced in order to stabilize the grid and to protect the shaft line.

In the proposed method, the H robust technique named as Enhanced Artificial Bee Colony (EABC) is implemented in order to improve the stability and the damping performances in the exciter part of the synchronous generator of wind turbine.

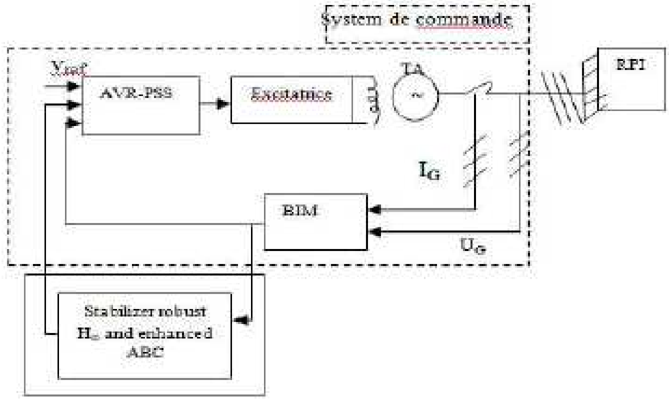

Fig 1:- 1 Block diagram of the modern SMIB power system

The developed simulink model of the power system is shown in the following figure Fig.2

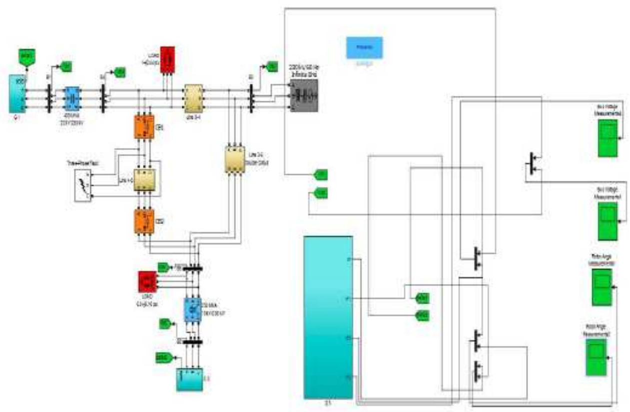

Fig.2: Simulation Model of Power System

IV. Results & Analysis

Simulation results are carried out with EABC using developed Simulink model and the responses are recorded in the figure 3.3 active power, terminal voltage, stator angle voltage, speed deviation. For the comparative analysis, the same procedure is performance measures such as damping coefficients, static error, settling time and peak time are calculated

In this PSS design, an important subject is to evaluate the designed PSS under power system condition changing. The robustness of PSS should be evaluated in various loading conditions and system operating conditions.

The variation of operating conditions related to the variation of transmission line parameters and the active and reactive powers. Certain attention was dedicated to the problem of the reactive power consumption, which is very important for all electric power systems and generating stations.

V. CONCLUSION

A standard technique for automated designing a power system stabilizer using enhanced Artificial Bee Colony Optimization technique applied on the AVR-PSS system of a turbo alternator to increase transient stability and its robustness for a single machine infinite bus system. Three cases were considered, control with conventional PSS, PSS with H∞ technique and using a robust PSS based on enhanced ABC optimization. The method presented in this work illustrate that the efficiency, performance, reliability and robustness of the power system has been increased.

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