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Load Frequency Control of a Hydrothermal Power System under Deregulated Environment

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Abstract:-Recently the fractional calculus has received extensive attention. Fractional order controller is widely used for different applications. In this project Three Degree Of Freedom Fractional order Integral Derivative (3DOF-FOID) controller has been proposed. The controller was designed; control the deviation in frequency and Tie-line power for two area hydro thermal power system. This project uses integral square area error as a performance index for design of 3DOF-FOID controller. The 3DOF-FOID controller parameters are optimized by using Biogeography algorithm. The performance and robustness of the proposed controller has been compared with the other classical controllers under different loading conditions. It is shown the performance of 3DOF-FOID controller optimized with Biogeography algorithm was better than classical controller in terms of transient stability.

Keywords:-Deregulated Power System - LFC -AGC – Biogeography Optimization (BBO) -3DOF-FOID Controller.

I. INTRODUCTION

During the nineties many electric utilities and power network companies world-wide changed their way of operation and business, from vertically integrated structure to open market structure. These systems are called by the name deregulated power systems. The goal of deregulation is to enhance competition and bring consumers new choices and economic benefits the former vertically integrated utility, which performed all the functions involved in power generation, transmission, and distribution is disaggregated into separate company's viz. GENCOs DISCOs and TRANSCOs each devoted to individual function. In this market structure, the main service provided is the primary energy transaction through active power transfer from Gencos to Discos to satisfy the active power requirements of the consumers. This may be through pool transactions and/or bilateral/multilateral transactions. These transactions have to be cleared by an impartial entity called Independent System Operator (ISO). Apart from this function the ISO has to provide/ control a number of ancillary services which are required for secure grid operation. Ancillary services are defined as all those activities on the interconnected grid that are necessary, to support the transmission of active power while maintaining reliable operation and ensuring the required degree of quality and security.

Frequency is basically subject to the Active Power and voltage is mostly dependent on the reactive power. Therefore the issue of controlling Power systems might be differentiated into two area controls. The control of Active Power and frequency is called as load frequency control (LFC). The most vital undertaking of LFC is to keep up the frequency constant against the differing Active Power loads, which is also referred as un- known external disturbance.

II. METHODOLOGY

The considerations and methodologies adopted for implementing the above mentioned objectives, comprises the power system investigated, the proposed fractional controller, and the technique used for simultaneous optimization of the controller parameters.

A. Power System Investigated

Investigation is carried out on a two area deregulated hydro-thermal system, having area capacity ratio of 1:6. Area1 is having two thermal GENCOs, while area2 comprises of one hydro and one thermal GENCO. The schematic diagram of the proposed system is shown in Fig, while the transfer function model is shown in Fig.2. The upper and lower section of Fig.2 shows different GENCOs participating for different DISCOs as per cpfs. The apf for each GENCO are chosen based on their generation schedule. Each thermal area is equipped with single reheat turbine, GRC of 3% per minute and GDB of 0.06% (0.036 Hz). Area2 is a hydro-thermal system equipped with electric governor and GRC of 270% per minute for raising generation and 360% per minute for lowering generation.The controller gains and electric governor parameters are optimized using BBO technique Performance index (J) is a minimization function and is taken as integral of squared error (ISE). System dynamics is evaluated considering 1% step load perturbation in area1.

III. 3DOF-FOID CONTROLLER

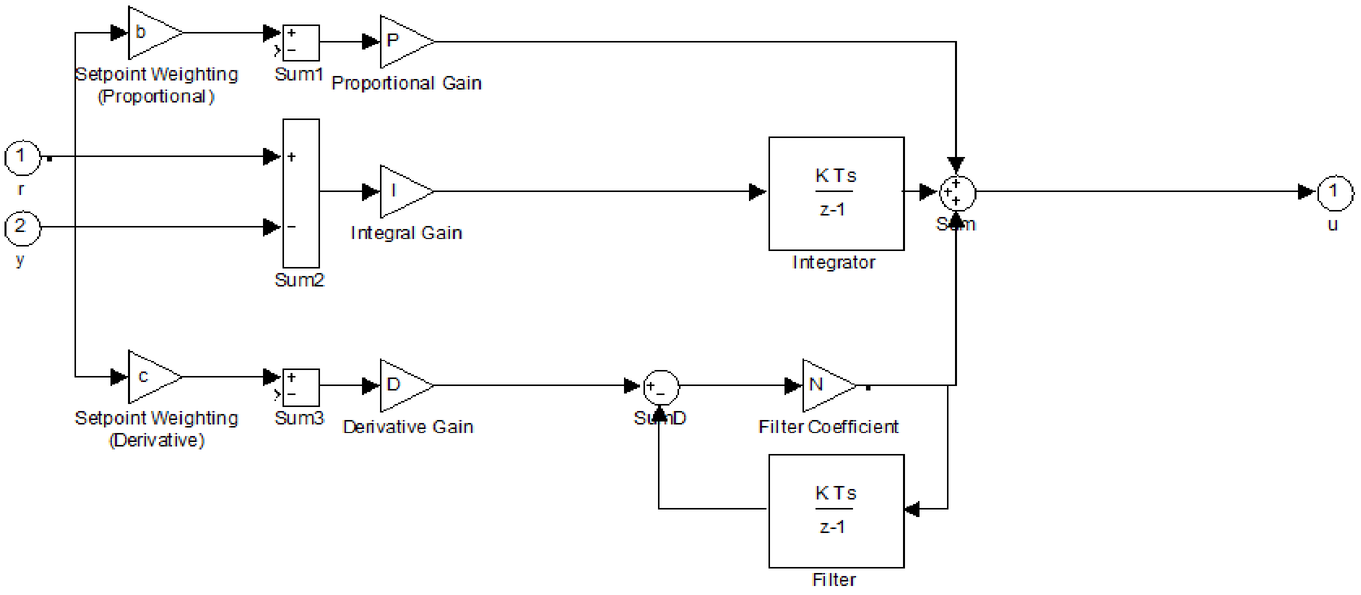

Fig1: Block Diagram for the Proposed Controller

IV. MODELLING OF INTER CONNECTED HYDRO THERMAL SYSTEM

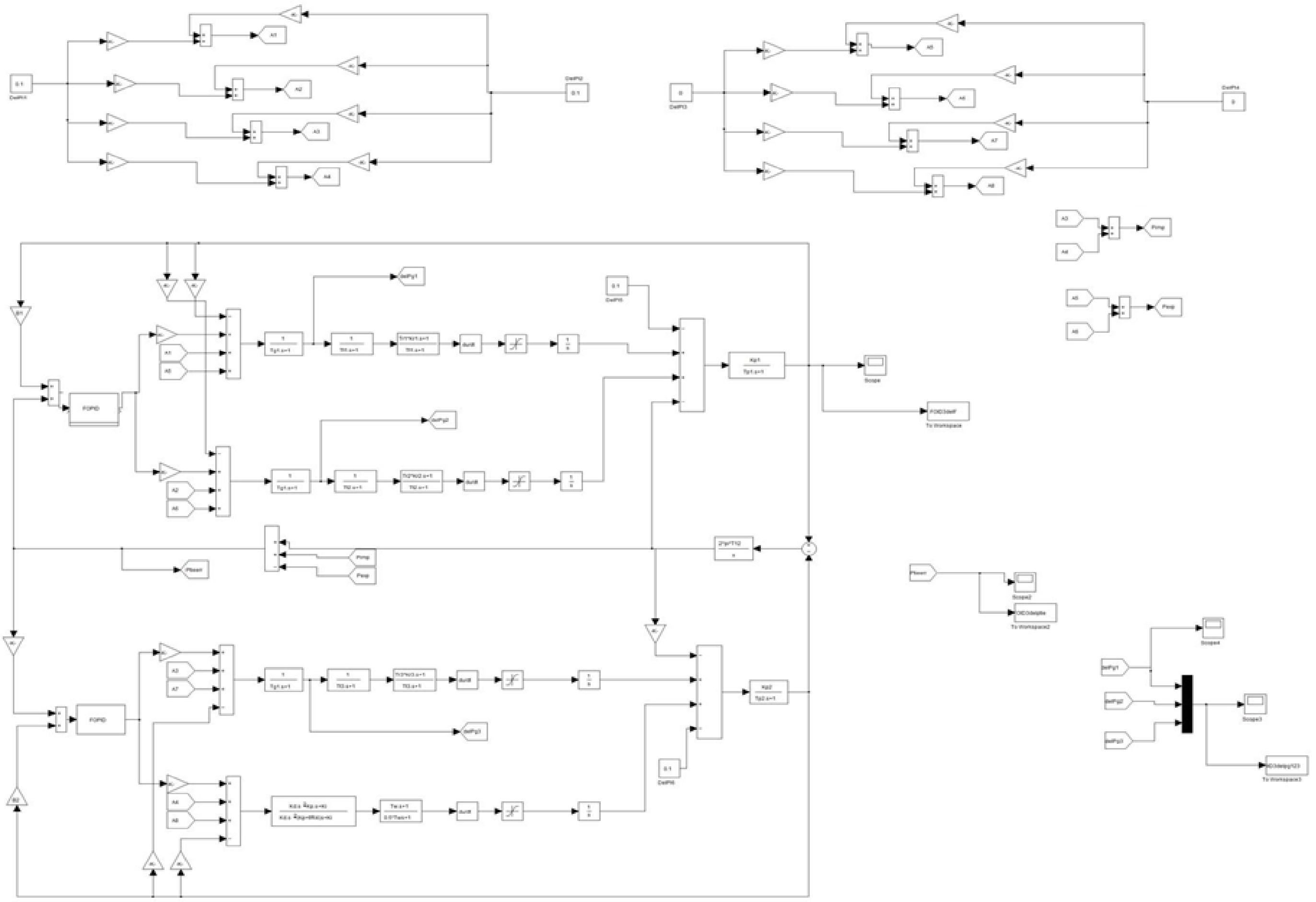

Fig.2: Block Diagram for Transfer Function of a Proposed Sytem.

V. BIOGEOGRAPHY OPTIMIZATION

BBO technique optimises the function and iteratively improves the candidate solution with reference to fitness function. The variables, which characterise habitability of the species in any particular habitat, are called suitability index variables . Habitat suitability index is a function of SIVs. The number of species in a habitat is a measure for selecting the immigration and emigration rate l and μ respectively. High HSI habitat resembles feasible solution while, solution degrades with low HIS habitat. The application of mutation in BBO increases the biological diversity of the population.

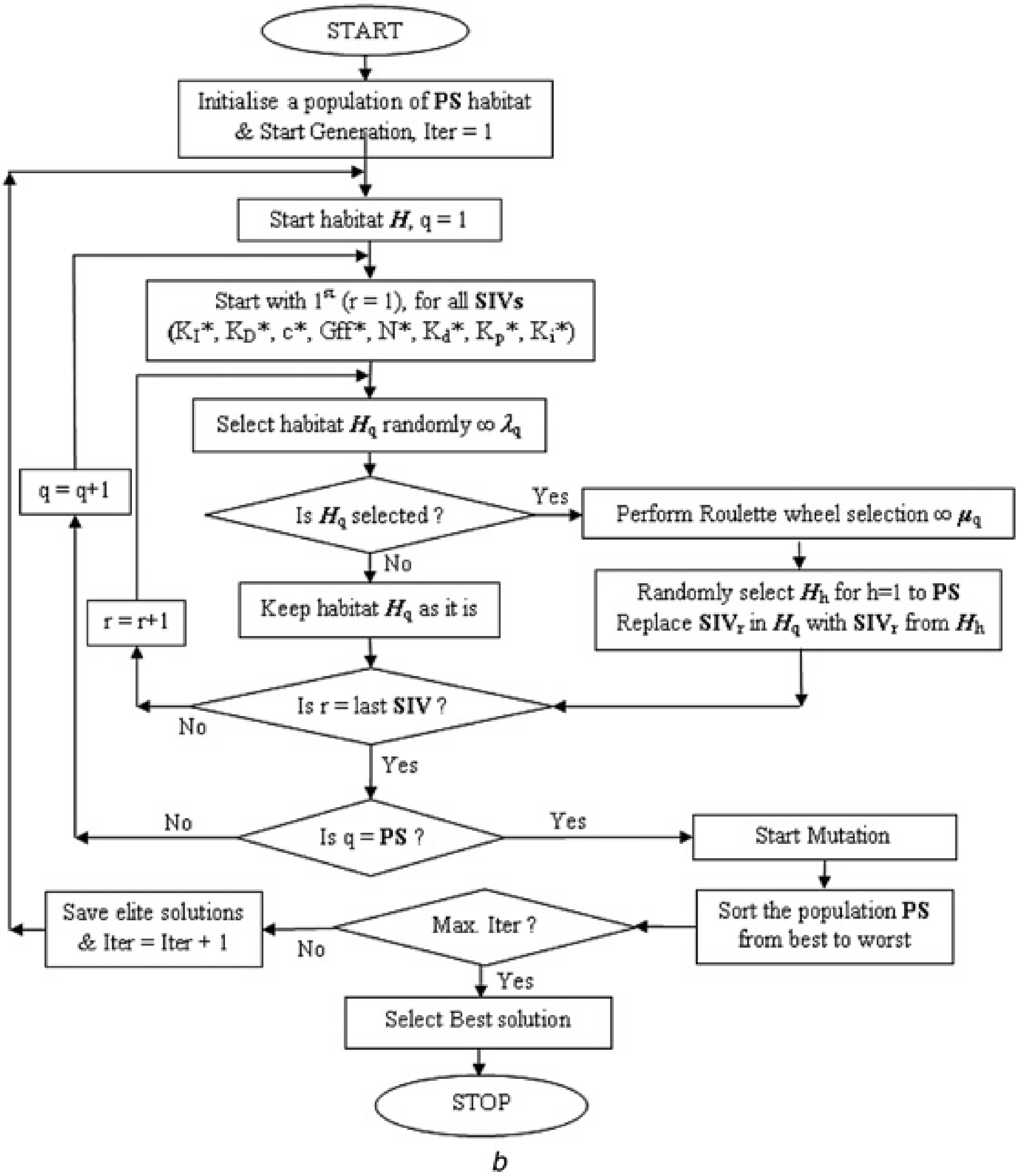

Fig 3: Flow Chart for BBO

VI. SIMULATION RESULTS

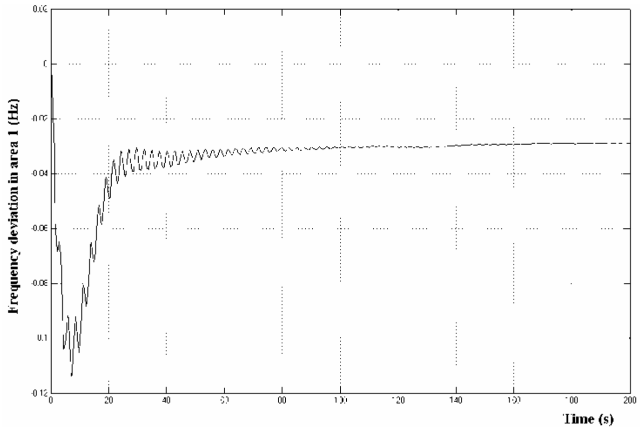

Fig. 4: Frequency Deviation in Thermal Area

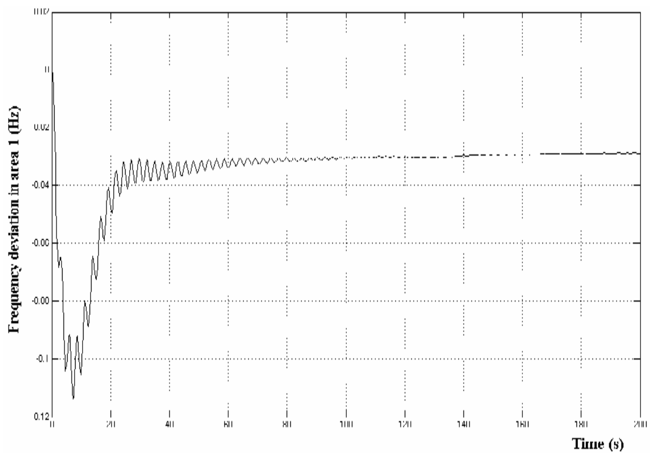

Fig. 5: Frequency Deviation in Hydro Area

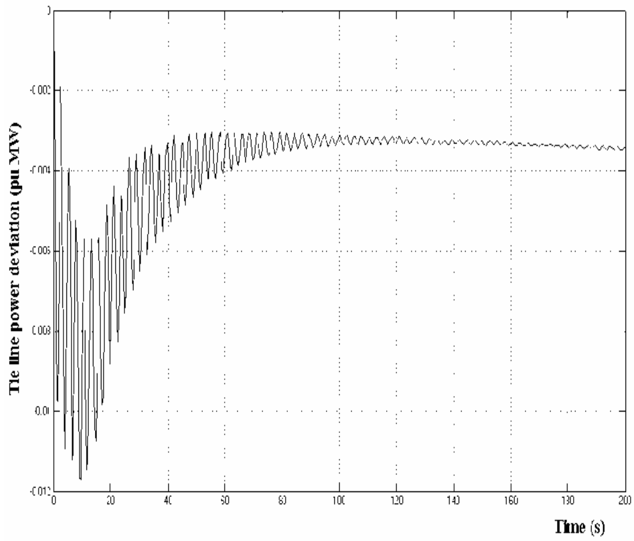

Figure 6: Tie Line Power Deviation

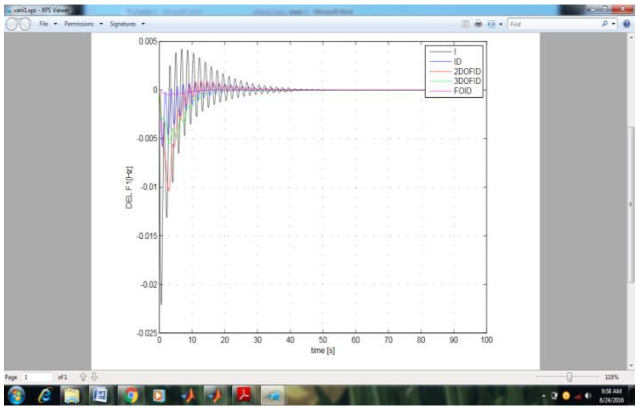

Fig 7: Comparison of Frequency in Hydro Area with I,ID,2DOFID,3DOFID,FOID controllers

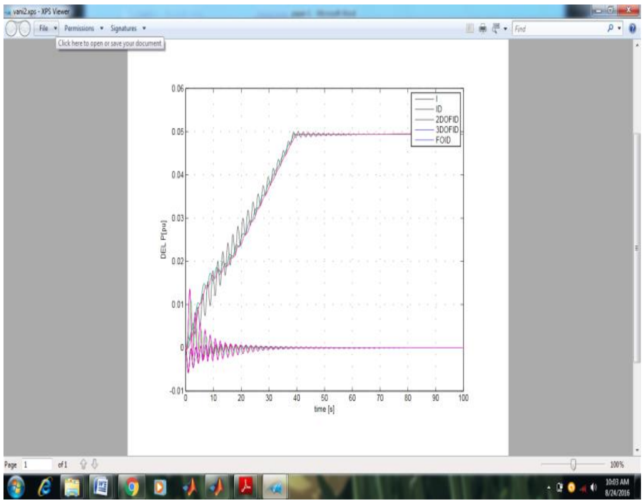

Fig 8: Comparison of Frequency in thermal Area with I,ID,2DOFID,3DOFID,FOID Controllers.

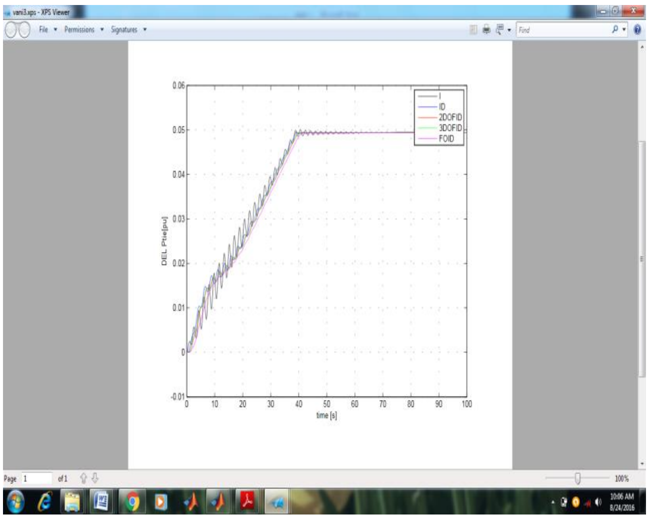

Fig 9: Comparison of tie–line power with I, ID, 2DOFID, 3DOFID, FOID Controllers.

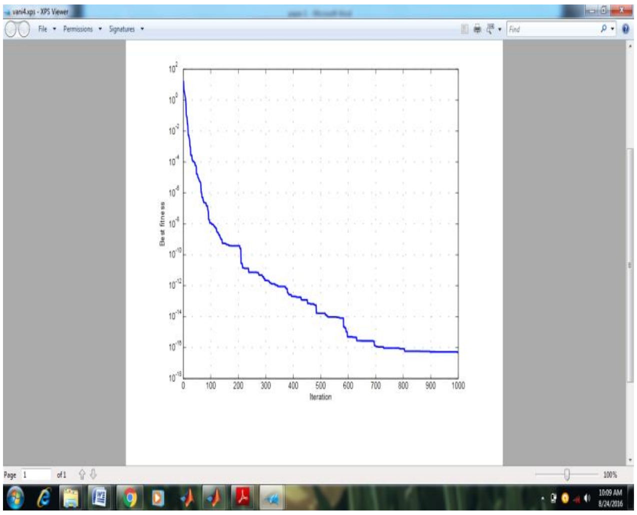

Fig. 10: Migration Curve for BBO.

VII. CONCLUSION

BBO technique is used to simultaneously optimise the controller gains and electric governor parameters Kd, Kp, Ki. BBO optimised 3DOF-FOID controller gains and electric governor parameters are found to be robust enough to withstand the changes in system loading condition and inertia constant. a power system. The performance of the given proposed controller has more accurate than that of the other conventional I,ID,2DOFID and 3DOFID controllers at load conditions.

APPENDIX

maxIt =1000;
n Pop =50
Iterations= 1000:
Best Cost = 1.8291e-018
bestfitvales =1.5090 0.3020

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