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Electrical Load Frequency Control using AI Techniques for EV Connected Power System

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ABSTRACT: There are several challenges associated with electric vehicles. This work discusses the effect of electric vehicles on the load frequency deviation. This project shows a case study of designing a controller that can withstand optimal results in a two-area power system when the input parameters of the system are changed. Load Frequency Control (LFC) is used to regulate and control the output frequency signal of the electric generated power within an area in response to changes in system loads. The gain constants in the case of conventional controllers remain same throughout, for changes in the load value. However, Load cannot be the same throughout, load deviates from time to time. This work presents a new design of various types of load frequency controllers based on different types of Artificial Intelligent (AI) optimization techniques such as Fuzzy logic, ANN tuner for a single area power system. The performance of the controller under study shows an enhancement in the frequency deviation signal as well as the peak overshoot and settling time for the frequency output signal. The performance of the proposed scheme is validated using MATLAB/ SIMULINK tools.

KEYWORDS: Multi- Area Power System., Electric Vehicles, Load Frequency Control, Artificial Neural Networks (ANN), Adaptive Neuro Fuzzy Inference Systems (ANFIS)

I. INTRODUCTION

The input mechanical power is utilized to control the frequency of the generators and the variation in the frequency and tie-line power are detected, which is the extent of the alteration in the rotor angle. A decently outlined power framework ought to have the capacity to give satisfactory levels of power quality by keeping the frequency and voltage size inside the middle of as far as possible. As the loading in a power system is not constant so the controllers for the system must be aimed to provide quality service in the power system. The power flow and frequency in an interconnected system are well regulated by AGC. The main purpose of the AGC is to retain the system frequency constant and almost inert to any disturbances. Generally, two things are being controlled in AGC i.e. voltage and frequency. Both have separate control loops and independent of each other. Apart from controlling the frequency, the secondary majors are to maintain a zero steady-state error and to ensure optimal transient behaviour within the interconnected Areas.

The objective is to design a controller to apprehend preferred power flow and frequency in a two Area power system. Changes in the power system load influence chiefly the system frequency, while the reactive power is less delicate to changes in frequency and is fundamentally reliant on vacillations of voltage size. Therefore, the control of the true and reactive power in the power system is managed independently. The load frequency control fundamentally manages the control of the system frequency and genuine power in as much as the programmed Voltage controller circle directs the progressions in the reactive power and voltage extent. Load frequency control is the premise of numerous progressed ideas of the vast scale control of the power system.

II. LITERATURE SURVEY

Literature review has helped to attain the conceptual clarity and to frame my theoretical perspective. Anestis G. Anastasiadis et al. “Effects of Increased Electric Vehicles into a Distribution Network”. This paper introduced that Grids face another and significant test: the approaching mass infiltration of module Electrical Vehicles (EVs). By and by, the models of transmission and conveyance networks are yet cantered on the customary plan and operational standards.

Anil Annamraju and Srikanth Nandiraju “Coordinated control of conventional power sources and PHEVs using Jaya algorithm optimized PID controller for frequency control of a renewable penetrated power system”. This paper talked

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about that in sustainable infiltrated power frameworks, recurrence unsteadiness emerges because of the unpredictable idea of sustainable power sources (RES) and burden unsettling influences.

Neofytos Neofytou et al. "Modeling Vehicles to Grid as a Source of Distributed Frequency Regulation in Isolated Grids with Significant RES Penetration". This paper examined that the fast improvement of the innovation utilized in electric vehicles, and specifically their entrance in power systems, is a significant test for the territory of electric force frameworks.

III. SYSTEM DATA FOR PROPOSED MODEL

Load Frequency Control (LFC) is being used for several years as part of the Automatic Generation Control (AGC) scheme in electric power systems. One of the objectives of AGC is to maintain the system frequency at a nominal value (50 Hz).The frequency is sensed by a frequency sensor. The change in frequency and tie-line real power can be measured by a change in rotor angle δ. The load frequency controller amplifies and transforms the error signal, i.e., (Δfi) into real power command signal ΔPci, which is sent to the prime mover via governor (that controls the valve mechanism).

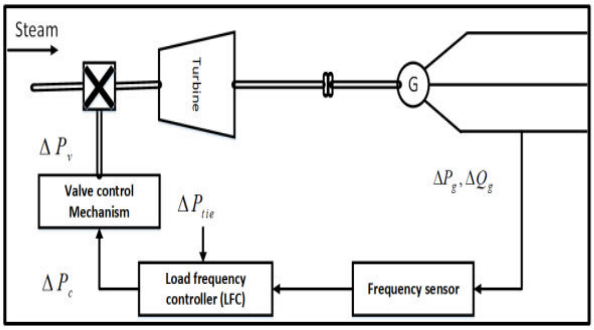

Fig. - Block diagram Load frequency control

The LFC problem in power systems has a long history. In a power system, LFC as an ancillary service acquires an important and fundamental role to maintain the electrical system reliability at an adequate level. It has gained importance with the change of power system structure and the growth of the size and complexity of interconnected systems.

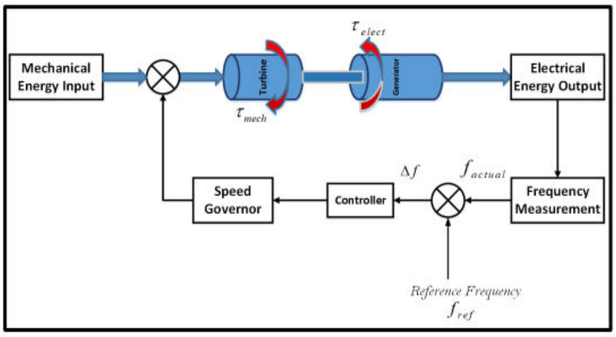

Fig.- Block diagram of AGC

To provide 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 the interconnected systems.

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IV. ELECTRIC CAR MATHEMATICAL MODEL

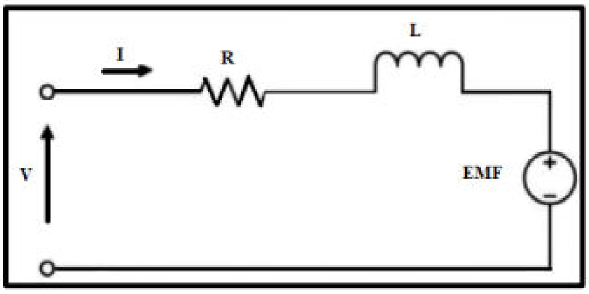

Fig - Equivalent circuit of DC motor

We know that:

•The voltage across a resistor can be written: I*R

•The voltage across an inductor can be written: $L * dI\ dt$

•According to Kirchhoff's law, the sum of all voltages across a closed path in a circuit is equal to zero. Thus,

$$V = (t) * R + L * dI\ dt + (t)\ (24)$$

The Torque in an electric DC motor can be written:

$$T(t) = KT * I(T)$$

With the motor torque, constantly defined its manufacturing characteristics

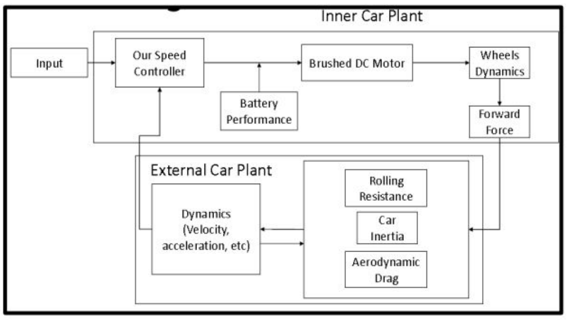

Fig - Model diagram of Electrical Vehicle

.V. SIMULATION RESULTS

In this section, the results obtained after the simulating model. The load variation and EV charging are set to start at 5 sec.

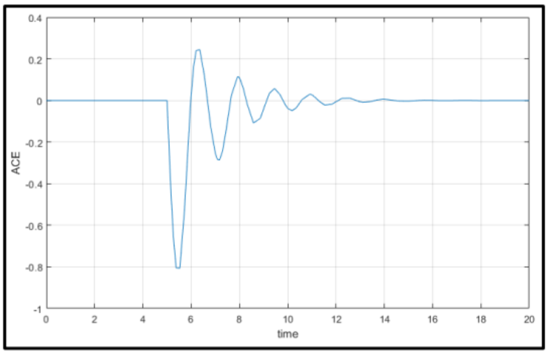

Fig - ACE for ANN-PI controller

Figure depicts the graph of area control Error (ACE) for the PID controller-based model. This value is supplied to the PID block as an input. The simulation is done for 50 seconds in total.

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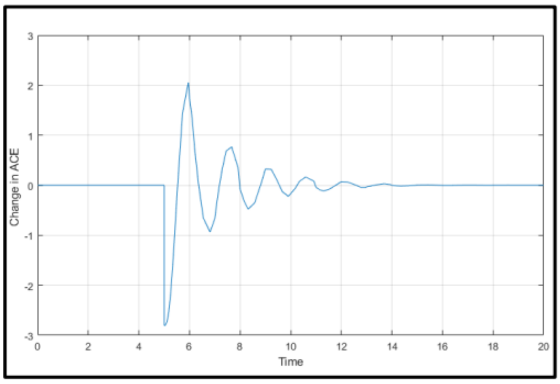

Fig - Change in ACE for ANN-PI controller

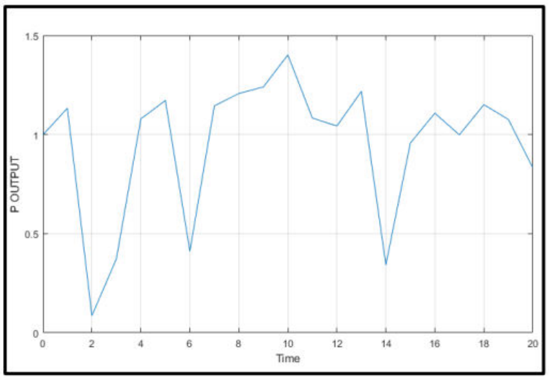

Fig - Output signal from ANN for Proportional gain

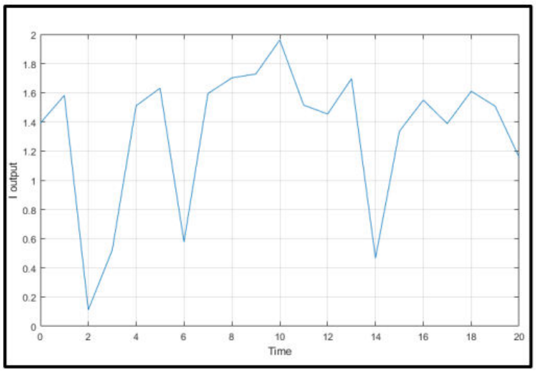

Fig - Output signal from ANN for Integral gain

VI. CONCLUSION

In this chapter, a detailed discussion over various sections of the power system is done along with their mathematical modelling. This modelling will help in designing this in Simulink. Also, the importance of LFC is discussed and how the change in frequency can be maintained in the system by regulating governor output is discussed. Also, further, a brief introduction to electric vehicles is done along with its Simulink model and characteristics. In the next chapter, we will discuss various control methodologies proposed in the present work in detail

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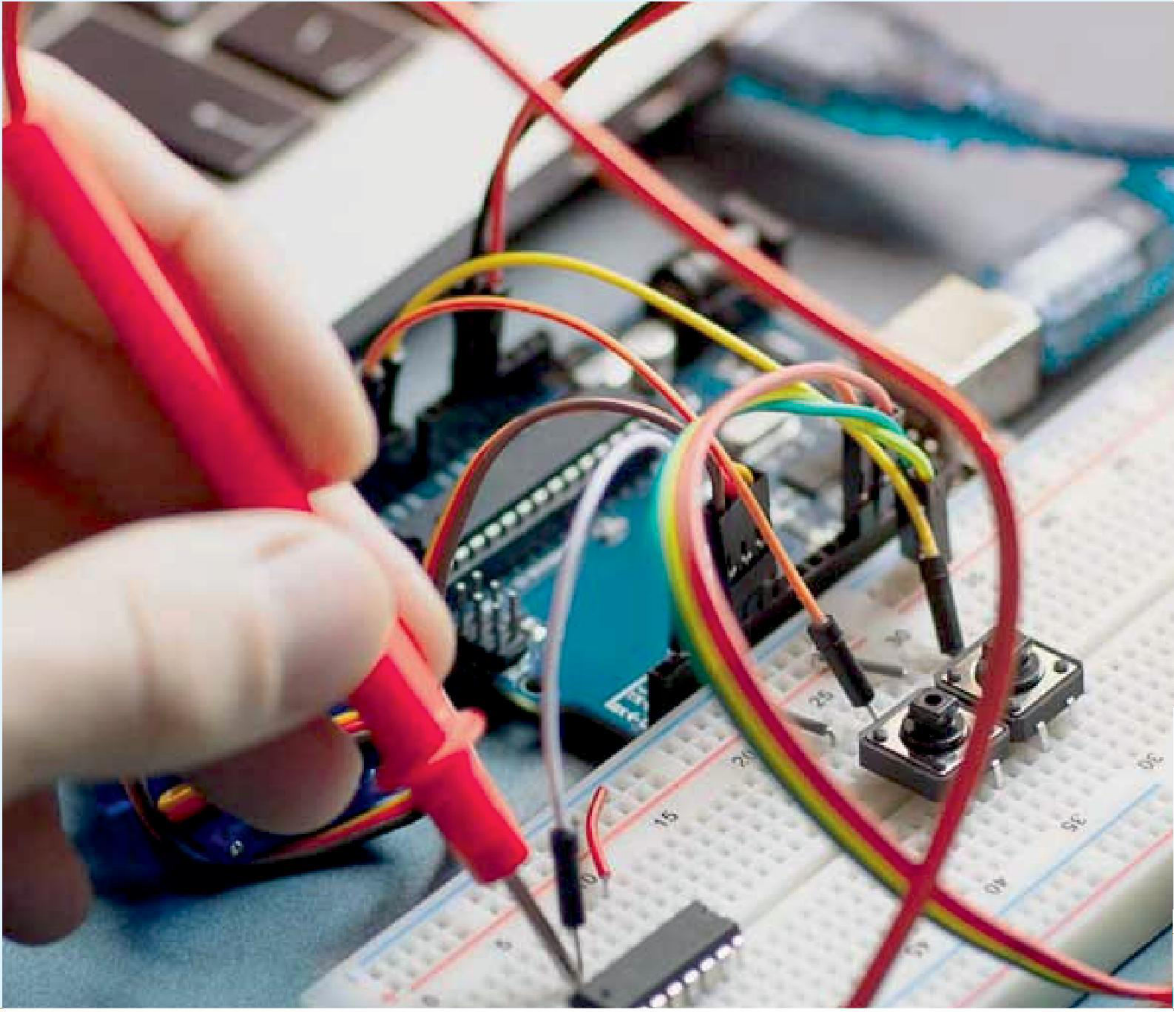

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