EMOTIONAL INTELLIGENT CONTROLLER APPLIED TO UNIFIED POWER QUALITY CONDITIONER

SatyanarayanaVanapalli, M. VenuGopala Rao

Abstract: ***Feeling based showing has gotten thought in sagacious cerebrum science nearly as in structure of phony control systems starting late. Estimations are the strong work control for taking speedier decisions in mammalian personality. This paper proposes an adroit control plot reliant on enthusiastic learning of mammalian personality for standard of DC interface voltage of a Unified Power Quality Conditioner known as UPQC. The controller proposed in this paper is generally known as Brain Emotional Learning Based Intelligent Controller (BELBIC). The control of DC interface voltage of UPQC envision significant work in its control. This splendid controller works subject to the irrefutable data given to limbic course of action of mammalian personality and duplicate warm blooded creature cerebrum. BELBIC controller has a quick structure and had the purpose of constrainment of heavenly auto learning features. The section of auto learning makes this controller fitting for adjusting the DC accomplice voltage of UPQC. A positive model of BELBIC controller is shown in this paper with the help of MATLAB/SIMULINK based distraction looks current, voltage consonant compensation and modification of DC Link voltage using UPQC giving a non-direct weight. The execution qualities of UPQC are bound to IEEE Standards.***

Keywords: ***Emotional Intelligent Controller, Power Quality, Voltage sag / swell, Brain Emotional Learning Based Intelligent Controller, Unified Power Quality Controller.***

I. INTRODUCTION

Power Quality (PQ) issues have been exists in power structure utility for quite a while, yet from late decades they have changed into a basic issue of worry generally in context on broadened utilization of solid state and power electronic contraptions. In any case, this PQ issue conveys an epic cost to business in lost productivity and equipment hurt. Utilities and customers are spending gigantic degrees of money for screen, consider and for improvement of PQ.

The UPQC is a striking custom power contraptions used for pay of PQ issues related to twistings in both source and weight voltages moreover streams. UPQC joins a course of action and shunt Active Power Filters (APFs) related with a normal DC interface [1]. A shunt APF is to remunerate current harmonica [2-4] unbalance power parts present in weight current [5] and keeps the power structure from the undesired effects achieved by these mutilations. Fitting pay for a particular PQ issue can be given if the issue related to PQ is seen or examined really. Seeing the symphonious

floods of the stack current is the most essential in the control structure Shunt APF for symphonious current pay and seeing right piece of Sag/Swell or consonant or sub-consonant pieces in supply voltages in the control structure of plan APF.

The dynamic requesting of UPQC is by and large subject to the accuracy and time change of the reference signals. Standard control approaches subject to P.I, P.I.Dworks on direct reliable considerations, which may carelessness to perform under parametric groupings, load disquieting impact, etc.

Number of eccentric techniques made starting late, rose up out of conventional controllers these bizarre controllers can learn, recall and pick. Inherited checks have essential impact on power electronic applications. Man-made learning frameworks duplicate human or ordinary information in a machine like processor or PC that can figure intensely how human can think. A structure with AI can be introduced in standard control systems can be used to oversee complex issues. Gained figurings are used to manage streamlining issues for finding the perfect game-plan.

Eager taking in is a person from prudently provoked sharp estimations. Regularly insP.Ired sharp controllers(BIIC) have grabbed thought for overseeing complex sorting out issues. The best extraordinary position with these BIIC is that the limit of perceiving, which are of high computational multifaceted nature [6,7]. The standard property in these BIIC is that they can get the improvements or modify the getting the hang of as displayed by the run of the mill changes, this segment makes BIIC as automatic understudies. Vivacious learning (EL) is a saint among the most essential parameter in learning, in this EL the evaluation relies on propensity signs. EL is one of the learning framework that was insP.Ired by the learning strategy that happens in Limbic game-plan of mammalian cerebrums [8].

Neurologically made prototypical model of Amygdala game-plan of mammalian cerebrum is showed up in [9]. Another control estimation subject to BELBIC is proposed in [10]. The BELBIC controller therefore proposed found unmistakable applications in the field of electrical and control sorting out applications. Making exhibits the fittingness out of BELBIC for control of speed of Interior enduring magnet synchronous motor [11,12], control of multivariable, nonlinear least - sort out systems [13], bits of garments washers [14], multi-target objectives [15], improvement control structure transient unfaltering quality [16], dynamic response of D-STATCOM[17].

Any sweeping control structure used for control of UPQC must be crucial and snappier in looking over the point of confinement of abstracting voltage and current curves viably.

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BELBIC based control envision for progress of dynamic execution of UPQC with the help of EPLL based control estimation proposed by [3]. Structure Configuration is outlined in Section II, UPQC Control System is presented in Section III, and Control of DC Voltage using BELBIC is showed up in bit IV. Reenactment results are showed up in Section V.

II. SYSTEM CONFIGURATION

Conventional UPQC consists of integration of series active power Filter (SeAPF) and Shunt Active Power Filter (ShAPF), connected back to back to a common DC link bus [18]. Block diagram of issues have been exists in power framework utility for a long time, yet from recent decades they have turned into a noteworthy issue of concern for the most part because of increased use of strong state and power electronic gadgets. In any case, this PQ issue speaks to a colossal expense to business in lost efficiency and hardware harm. Utilities and clients are spending gigantic measures of cash for screen, think about and for development of PQ.

The UPQC is an extraordinary custom power gadgets utilized for pay of PQ issues identified with contortions in both source and burden voltages also flows. UPQC comprises of an arrangement and shunt Active Power Filters (APFs) associated with a typical DC interface [1]. A shunt APF is to reward current harmonica [2-4] unbalance power parts present in burden current [5] and keeps the power framework from the undesired impacts brought about by these mutilations. Appropriate remuneration for a specific PQ issue can be given if the issue identified with PQ is distinguished or analyzed legitimately. Distinguishing the symphonious

flows of the heap current is the most significant in the control structure Shunt APF for symphonious current remuneration and recognizing right dimension of Sag/Swell or consonant or sub-consonant segments in supply voltages in the control structure of arrangement APF.

The dynamic order of UPQC is totally subject to the precision and time tweak of the reference signals. Customary control approaches dependent on P.I, P.I.Dworks on direct scientific ideas, which may neglect to perform under parametric varieties, load unsettling influence and so forth.

Number of eccentric methods developed as of late, contrasted with traditional controllers these flighty controllers can learn, recollect and decide. Hereditary calculations have noteworthy effect on power electronic applications. Man-made intelligence systems copy human or common knowledge in a machine like processor or PC that can figure shrewdly how human can think. A framework with AI can be implanted in traditional control frameworks can be utilized to take care of complex issues. Hereditary calculations are utilized to tackle streamlining issues for finding the ideal arrangement.

Enthusiastic learning is an individual from mentally persuaded keen calculations. Naturally insP.Ired wise controllers(BIIC) have picked up consideration for taking care of complex designing issues. The best favorable position with these BIIC is that the capacity of realizing, which are of high computational multifaceted nature [6,7]. The regular property in these BIIC is that they can receive the progressions or modify the getting the hang of as indicated by the natural changes, this component makes BIIC as self-governing students. Passionate learning (EL) is a standout amongst the most significant parameter in learning, in this EL the evaluation depends on feeling signals. EL is one of the learning technique that was insP.Ired by the learning procedure that occurs in Limbic arrangement of mammalian cerebrums [8].

Neurologically made prototypical model of Amygdala arrangement of mammalian cerebrum is exhibited in [9]. Another control calculation dependent on BELBIC is proposed in [10]. The BELBIC controller in this way proposed found various applications in the field of electrical and control designing applications. Writing demonstrates the agreeableness of BELBIC for control of speed of Interior lasting magnet synchronous engine [11,12], control of multivariable, nonlinear least - stage frameworks [13], clothes washers [14], multi-target imperatives [15], improvement control framework transient steadiness [16], dynamic reaction of D-STATCOM[17].

Any extensive control system utilized for control of UPQC must be basic and quicker in evaluating the ability of abstracting voltage and current twists precisely.

BELBIC based control conspire for development of dynamic execution of UPQC with the assistance of EPLL based control calculation proposed by [3]. Framework Configuration is portrayed in Section II, UPQC Control System is introduced in Section III, and Control of DC Voltage utilizing BELBIC is displayed in segment IV. Reenactment results are exhibited in Section V..

III. UPQC CONTROL SYSTEM

The sanctioning of UPQC is subject to the reference signals determined and twisted signs are proficientlyabstracted, DC current controller utilized for inferring genuine signs with improved precision. In ordinary P.I plot the yield is utilized for age of reference signals. The DC-Link voltage constrained by shunt filterby disregarding the power misfortunes is given by

$$P_{Loss} = \frac{1}{2}\frac{dv_{dc}^2}{dt} \qquad (1)$$

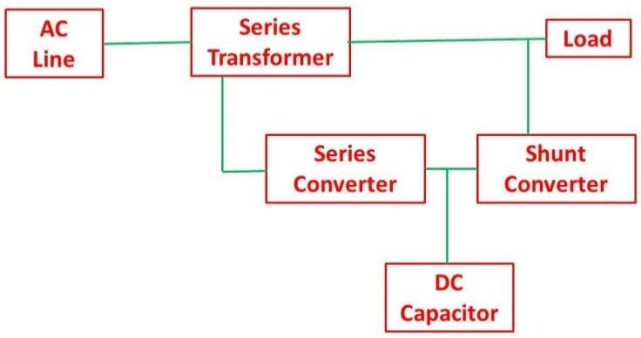

Figure 1:Block Diagram of UPQC

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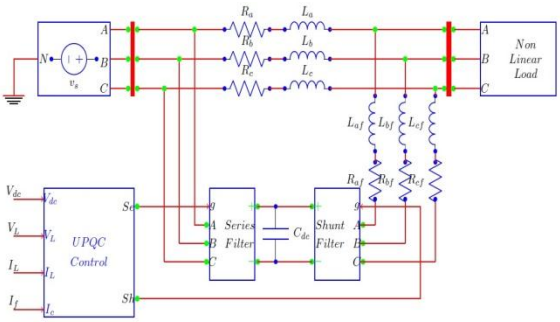

Figure 2:Circuit representation of UPQC with Control

IV. CONTROL OF DC LINK VOLTAGE USING BELBIC CONTROLLER

1. Structure of Limbic System

Energized understanding is a fundamental association process that happens in the psyche of all around made animals. Decisions are taken subject to refreshes gotten by cerebral cortex. The cerebral cortex generally made out of supervisor parts referenced underneath. Computational model of Brain Learning System (BLS) is shown in Figure 3.

1. Amygdala
2. Orbitofrontal Cortex
3. Thalamus
4. Sensory Cortex
5. Hypothalamus

Amygdala is a little almond - shaped organ that was organized in the sub - cortical district of the cerebrum and recognize a key occupation in fiery strategy. This part is outfitted for talking with the conspicuous cortex and limbic system. Amygdala maps updates from material to their related invigorated responses.

Amygdala gets non - faultless enthusiastic lift signals known as trademark advancement from Thalamus.Cerebral cortex is the best part and outer layer of cerebrum and is the critical wellspring of learning. The cerebral cortex has backwards sides of the equator and a strong correspondence exists with each other. The vivacious learning occurs in Amygdala. This model proposed in [19] for Stabilizing DC Link Voltage of UPQC.The model incorporates two fundamental parts Amygdala and Orbitofrontal Cortex.The Thalamus gets clear information. The yield of Thalamus close to the yield of Sensory Cortex are the duties regarding Amygdala. Amygdala gives its decision subject to vivacious sign reliant on which learning occurs.

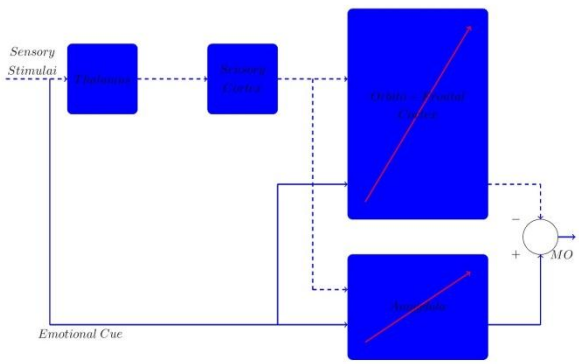

Figure 3:Computational model of Brain Learning System (BLS)

2. Modelling the process of learning

The learning rule is given by

$$\Delta_i = K_a\left(E_c - \Omega_i\right) \quad (2)$$

Δ_i denotes gain of Amygdala, K_a denotes learning rate of Amygdala, E_c = Emotional cue function and is = Ω_i Amygdala output.

The output of Amygdala Ω_i is given by

$$\Omega_i = S_i * \Delta_i$$

S_i = sensory input.

The contributions to Orbitofrontal cortex restrains improper connections when an objective changes gets are yield of Amygdala, Sensory Cortex and Emotion signal capacity. The learning rule for Orbitofrontal Cortex is given by $\omega_i = K_0\left(\Theta - E_c\right)$ (4)

Where K_0 is the learning rate of Orbitofrontal Cortex, ω_i is the model output.

The output of Orbitofrontal Cortex is given by

$$O_i = S_i - \omega_i \quad (5)$$

From equations (3) and (5) the Model output is derived as

$$Y = \Omega_i - O_i \quad (6)$$

The emotional cue is formed with the sensory inputs and the model output. The relation between emotional cue, sensory inputs and model output is given by

$$E_c = \left(\alpha e + \beta \Delta e\right)Y \quad (7)$$

Where $e, \Delta e$ are the sensory inputs.

3. BELBIC Controller applied to UPQC

The power loss component of UPQC is estimated using equation (1). Let is the per unit value of DC Link Capacitor voltage. The error e of DC Link voltage is given by

$$e = V_{\mathrm{Re}f} - v_{dc} \quad (8)$$

The sensory inputs to the BELBIC controller are the error e and Change in error Δe of the DC Link voltage. The emotional cue is evaluated from the equation (7), the model output is P_{Loss}. Model available in MATLAB / SIMULINK based toolbox for BELBIC controller available in [20] is taken and applied for stabilizing DC Link voltage of UPQC.

V. SYSTEM DESCRIPTION

The perfect open portal for stable action of the converter paying little notice to various annoying impacts caused and execution of weight current under these conditions have been appeared. To audit the dynamic execution of UPQC with the BELBIC control plot a test structure containing UPQC giving nonlinear weight having THD 22.24% is taken for examination.

Case - I: Normal Conditions supplying a nonlinear load.

Case - II:Source Voltage and negative sequence components are considered for analysis.

VI. RESULTS

The succinct characteristics surveyed for Source Voltage, Load Voltage and Voltage Injected by strategies for SeAPF

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of UPQC compelled by using BELBIC for Case - I and Case - II are showed up in Figures 4 and 6, Load Current and Current installed by ShAPF are shown in Figures 5 and 7. Symphonious examination of Load Voltage and Grid Currents for the tests I and II are comfortable in Figures 8 with 11 self-rulingly. Voltage of DC Link capacitor is displayed in Figures 12 and 13 for the cases I and II openly. From this time forward the yield banner and weight indications of Amygdala, Orbitofrontal Cortex and Thalamus for the both the cases are showed up in Figures 14 to 19 openly.

S. No	Case	% THD in Grid	
		Voltage	Current
1	For Current harmonic elimination	0.77	3.73
2	For Voltage harmonic elimination	3.70	4.54

Table I:THD Content present in Grid Voltages and Grid Currents with UPQC connected to the system controlled with BELBIC Controller.

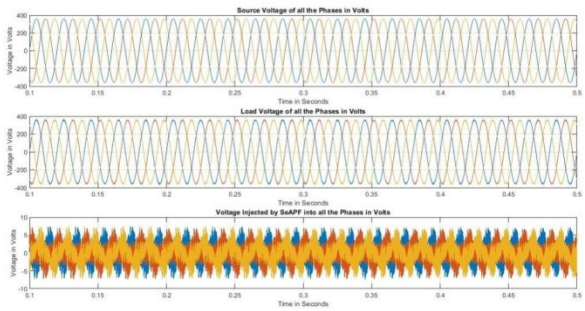

Figure 4:Profile of Supply, Load and Compensated Voltages for Case – I

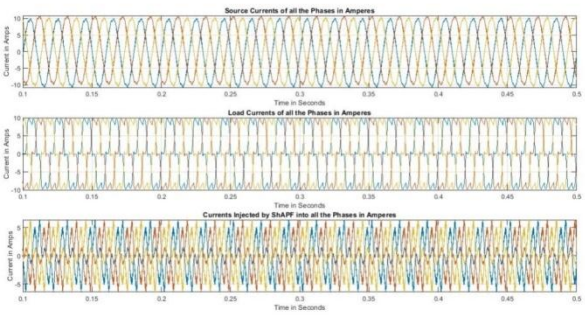

Figure 5:Profile of Supply, Load and Compensated Currents for Case – I

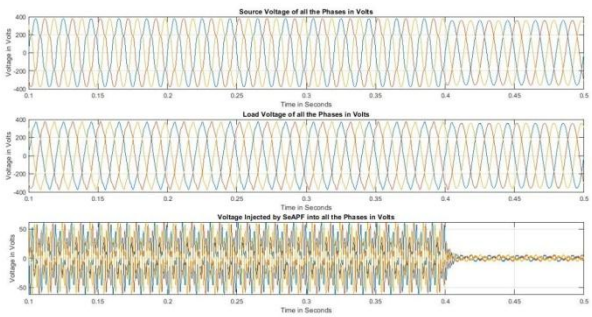

Figure 6:Profile of Supply, Load and Compensated Voltages for Case – II

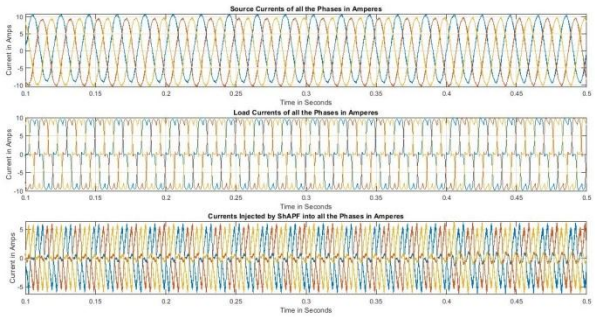

Figure 7:Profile of Supply, Load and Compensated Currents for Case – II

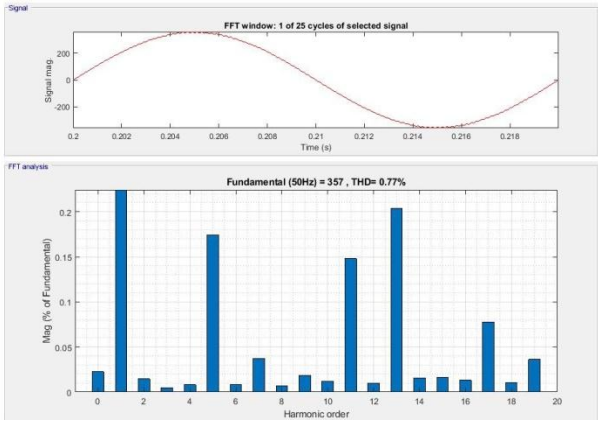

Figure 8:FFT Analysis of Load Voltage for Case – I

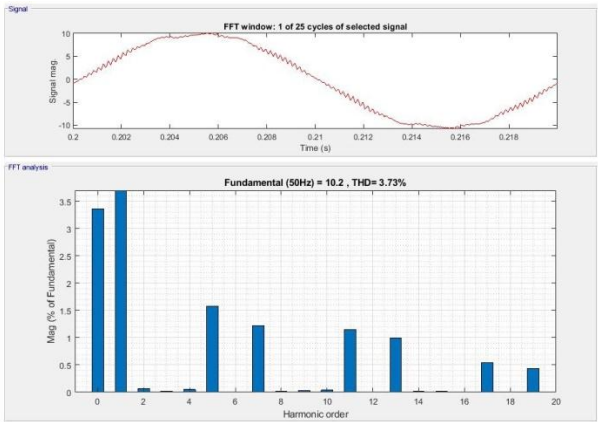

Figure 9:FFT Analysis of Grid Current for Case – I

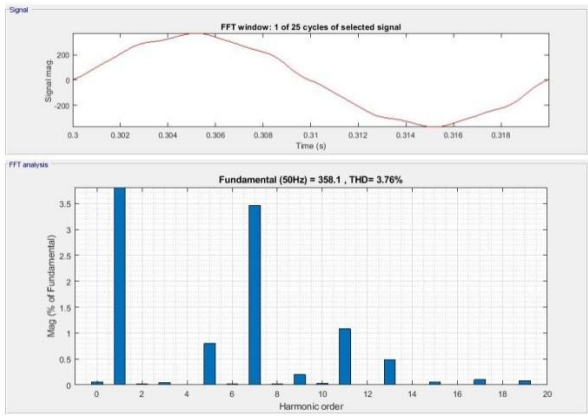

Figure 10:FFT Analysis of Load Voltage for Case – II

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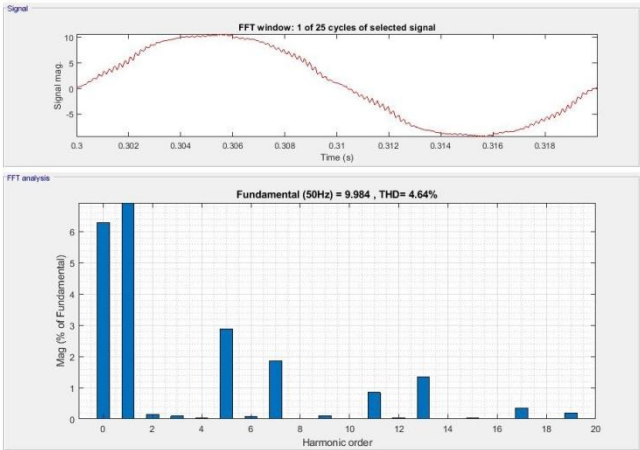

Figure 11:FFT Analysis of Grid Current for Case – II

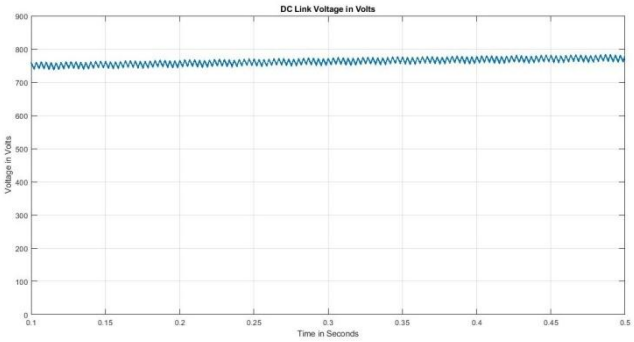

Figure 12:DC Link Voltage in Volts for Case – I

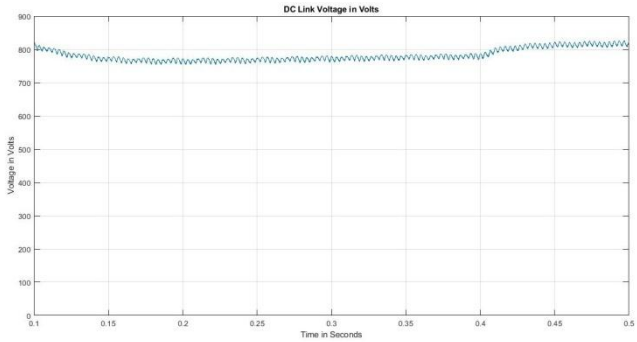

Figure 13:DC Link Voltage in Volts for Case – II

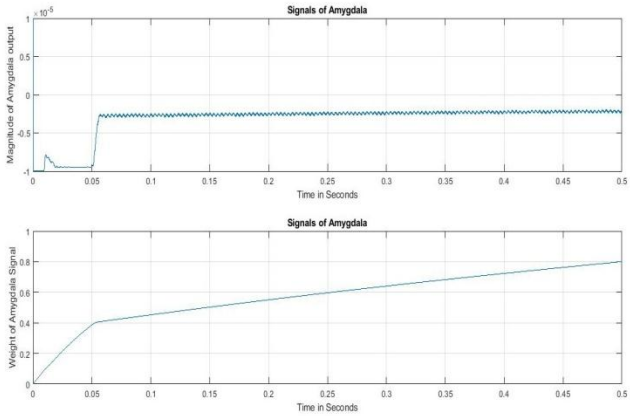

Figure 14:Signals of Amygdala for Case – I

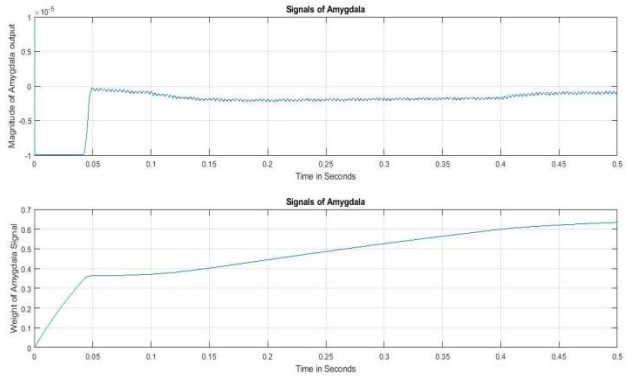

Figure 15:Signals of Amygdala for Case – II

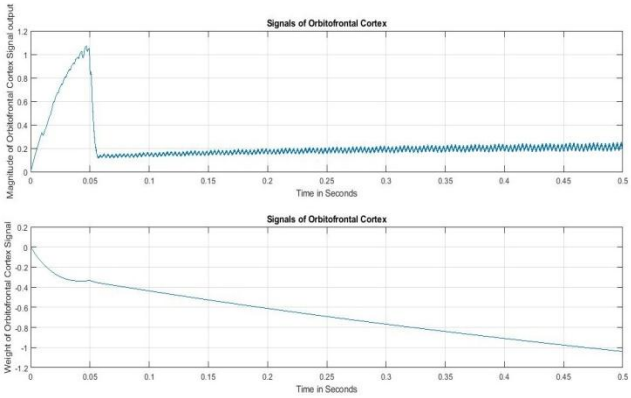

Figure 16:Signals of Orbitofrontal Cortex for Case – I

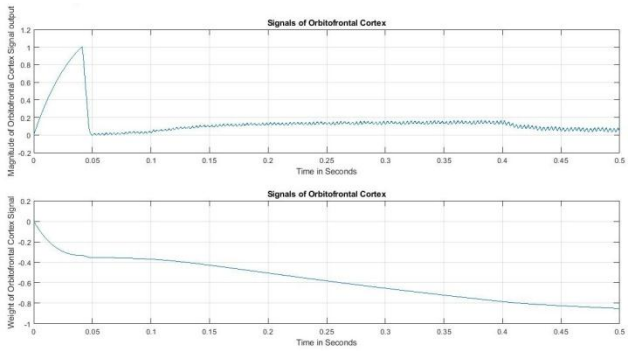

Figure 17:Signals of Orbitofrontal Cortex for Case – II

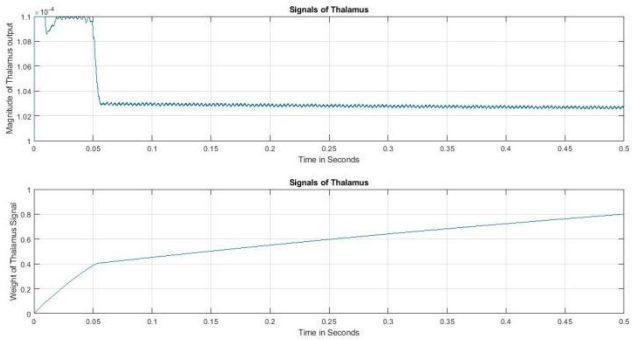

Figure 18:Signals of Thalamas for Case – I

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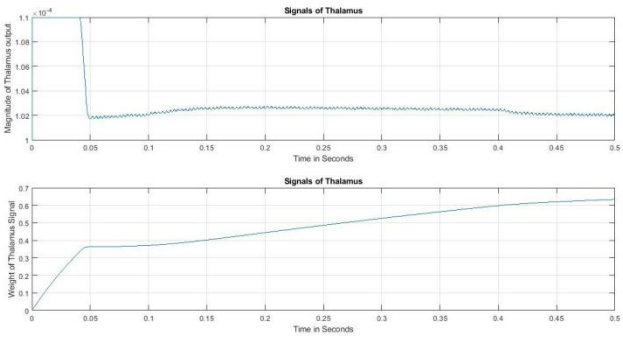

Figure 19:Signals of Thalamas for Case – II

VII. CONCLUSION

Another control plot reliant on BELBIC controller masterminded self-administering learning rate change is connected with an UPQC for Capacitor voltage altering, Current and Voltage sounds. The execution of the structure organizes the perfect response for changing working conditions is proposed. In this examination appearing of BELBIC controller is displayed and the controller can be gently associated with UPQC for Power condition applications. This is created by settling the Capacitor voltages. From the results got it might be derived that a pervasive introduction of UPQC can be gotten with the accomplishment of BELBIC controller.

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