BELBIC Control of DSTATCOM for Voltage Regulation

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Abstract: In the DSTATCOM controlled distribution feeders, the DC capacitor voltage balancing plays an imperative role to regulate the voltage at Point of Common Coupling (PCC). To perform faster compensation using this device, the load current has to be tracked accurately. Further, the dc capacitor voltage has to be maintained constant for perfect current tracking. The dc capacitor voltage is generally regulated with the use of conventional PI controller. In this study, two types of controllers have been proposed viz., fuzzy tuned PI controller and a Brain Emotional Learning Based Intelligent Controller (BELBIC).Apart from dc capacitor voltage regulation, these controllers improve the transient performance of the capacitor voltage as well. The DSTATCOM controlled distribution system taken up for study is modeled with a non linear load and an unbalanced load. As far as the reference currents of this system are concerned, they are generated using instantaneous symmetrical component theory. For performance comparison, the response of the system is obtained with fuzzy tuned PI controller and BELBIC controller. The simulated results validates that the BELBIC controller exhibits superior performance characteristics than the conventional PI and the fuzzy tuned PI controller. The control algorithm is evaluated using DSP (dSPACE 1104) and the results are studied under unbalanced non linear load conditions.

Keywords: power systems, artificial intelligence, Bio control, PI controller, fuzzy control, reactive power, compensator

1. INTRODUCTION

In the recent days, there has been a considerable interest in power quality. This is mainly due to the increase in non linear loads such as power electronic converter based adjustable speed drives, electronic ballasts etc., which have deteriorated the power quality. The power quality problems mainly include harmonics in currents, unbalance in load voltage and excessive neutral current apart from voltage sag and swell (IEEE std., 1992; Akagi et al., 2007). Therefore, compensation of reactive power for non-linear and unbalanced load is an important issue in the present power distribution systems. The distribution static compensator (DSTATCOM) is one type of custom power device used for reactive power compensation, load balancing and harmonic mitigation in the distribution systems (Chen et al., 2008). The main purpose of a DSTATCOM is to supply or absorb reactive power from the grid for improving power factor and voltage regulation. With change in control approach, the DSTATCOM can also be used as an active filter and a dynamic uninterruptable power source. It may be noted that the active filter in this context does the work of filtering the lower order harmonics apart from reactive power compensation. DSTATCOM is a Voltage Source Converter (VSC) based Flexible AC Transmission Systems (FACTS) device. When operated in a current control mode, it can improve the quality of power by eliminating harmonic content of load, balancing source currents for unbalanced loads apart from mitigating the poor load power factor (Ghosh et al., 2002; Ghosh et al., 2003; Ledwich et al., 2002; Ghosh et al., 2000).

In a DSTATCOM, the DC capacitor voltage balancing plays a crucial role. When the DSTATCOM performs compensation, the transient performance of the dc capacitor depends on the computational speed of the losses in the inverter. The fuzzy tuned PI controller and Brain Emotional Learning Based Intelligent Controller (BELBIC) are proposed to estimate the losses in the dc capacitor and improve the performance of the DC capacitor voltage. The fuzzy tuner is used to vary the Proportional and Integral gains of the controller during the transient period to correct for any discharge in capacitor voltage. The performance of the dc capacitor voltage is enhanced compared to a conventional PI controller. In the next method, the fuzzy tuned PI controller is replaced with BELBIC. Using BELBIC, the dc capacitor voltage exhibits a reduction in maximum overshoot, faster settling time, and the transient response is improved. To demonstrate the effectiveness of the controllers, the system is modeled in MATLAB and the results exhibits a superior performance for BELBIC compared to the fuzzy tuned PI and conventional PI controllers.

2. DSTATCOM MODEL AND CONTROL

The schematic diagram of the DSTATCOM controlled distribution feeder is shown in Fig.1. The loads are connected at the Point of Common Coupling (PCC) as shown in Fig.1. The DSTATCOM consists of Voltage Source Converter

(VSC). The operation of the VSC depends on the dc voltage stored across the capacitor. During a sudden load change, the capacitor voltage increases or decreases to provide required compensation. To achieve compensation, the reference currents have to be extracted effectively. Also the voltage across the dc capacitor V_{dc} should be maintained constant. In Fig. 1 L_f represents the leakage inductance of transformer, and R_f represents the switching losses of the inverter. The losses in the inverter are compensated by drawing additional power from the source given by (1).

$$v_{sa}i_{sa} + v_{sb}i_{sb} + v_{sc}i_{sc} = p_{la} + p_{loss} \tag{1}$$

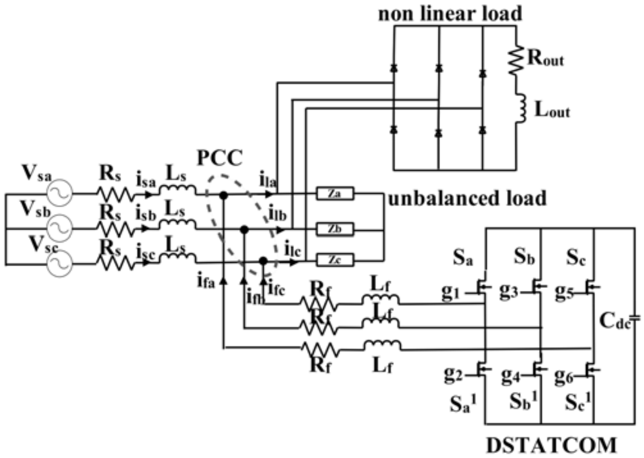


Fig. 1. Structure of DSTATCOM controlled distribution feeder.

where v_{sa},v_{sb} and v_{sc} are the source voltages and i_{sa},i_{sb} and i_{sc} are the source currents , p_{la} is the load average power and p_{loss} is the loss in the inverter modelled as R_f . The control algorithm to generate reference currents i_{fa}*, i_{fb}* and i_{fc}* using symmetrical component theory is given by (4).

$$i^*_{fa} = i_{la} - \frac{v_{sa} + (v_{sb} - v_{sc})\beta}{v^2_{sa} + v^2_{sb} + v^2_{sc}}(p_{la} + p_{loss}) \tag{2}$$

$$i^*_{fb} = i_{lb} - \frac{v_{sb} + (v_{sc} - v_{sa})\beta}{v^2_{sa} + v^2_{sb} + v^2_{sc}}(p_{la} + p_{loss}) \tag{3}$$

$$i^*_{fc} = i_{lc} - \frac{v_{sc} + (v_{sa} - v_{sb})\beta}{v^2_{sa} + v^2_{sb} + v^2_{sc}}(p_{la} + p_{loss}) \tag{4}$$

In (2),(3) and (4), i_{la},i_{lb} and i_{lc} are the load currents and $\beta = \tan \varphi/\sqrt{3}$, where φ is the angle between voltage and current and it can be forced to have any value . A suitable feedback control has to be used to generate the p_{loss} component such that the dc capacitor voltage is maintained constant. If the average value of current i_{dc} through the capacitor C_{dc} is zero over one cycle then

$$v_{dc} = \frac{1}{c_{dc}}\int i_{dc}dt \tag{5}$$

The deviation of V_{dc} from the reference value over the fundamental period gives an indication about the deviation of capacitor current i_{dc} from zero value. The error e_{rr} is given by

$$e_{rr} = v_{dcref} - v_{dc} \tag{6}$$

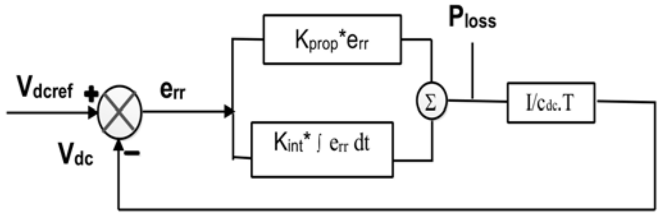


Fig. 2. DC- capacitor voltage control using PI control.

The p_{loss} component can be calculated as

$$p_{loss} = k_{prop}e_{rr} + k_{in}\int e_{rr}dt \tag{7}$$

Using (7) additional power equivalent to p_{loss} has to be extracted from source to maintain the capacitor voltage as a constant. Fig. 2 shows the dc capacitor voltage control with a convectional PI controller. The settling time of the dc capacitor voltage depends on the value of gains chosen for PI controller. If it is possible to change the value of proportional and integral gains during transient, a quicker settling time and reduction in peak overshoot of dc capacitor voltage can be obtained. Owing to this reason, two types of controller are proposed viz., fuzzy tuned PI controller and a BELBIC controller.

3. FUZZY TUNED PI CONTROLLER SCHEME

The structure of fuzzy tuned PI controller scheme is shown in Fig.3. The error between the dc reference voltage and the actual dc voltage and the rate of change of voltage error are obtained using (6) and (8). These values are fed as crisp inputs to the fuzzy logic controller and are converted into fuzzy sets by using min-max method. (Tzafestats et al., 1990)

$$\Delta e_{rr} = e_{rr} - e_{rr}(i-1) \tag{8}$$

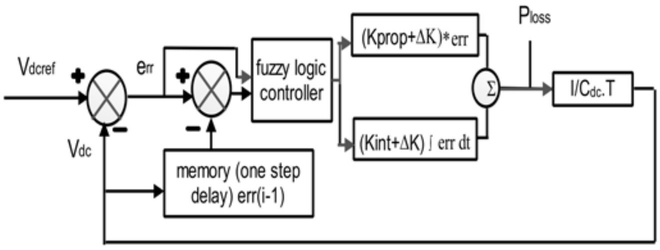


Fig. 3. DC capacitor voltage balancing using fuzzy logic controller.

Table 1. Membership function of output gain kprop.

Fuzzy set	Numerical range	Parameters	Shape of the membership function
Negative big	0 to 1	[-0.9 -0.8333 -0.5]	Triangular membership function
Negative small		[-0.6 -0.35 -0.1]	
Zero		[-0.3 0 0.3]	
Positive small		[0.1 0.35 0.6]	
Positive big		[0.4 0.8 1]	

Table 2. Membership function of output gain kint.

Fuzzy set	Numerical range	Parameters	Shape of the membership function
Negative big	0 to 1	[0.1 0.2 0.4]	Triangular membership function
Negative small		[0.2 0.35 0.5]	
Zero		[0.3 0.5 0.7]	
Positive small		[0.5 0.65 0.8]	
Positive big		[0.7 0.85 1]	

These inputs are fuzzified as Negative Big (NB), Negative Small (NS), Zero (ZO), Positive Small (PS) and Positive Big (PB). To have efficient and smooth control the output membership functions are framed as Negative Big (NB), Negative Small (NS), Zero (ZO), Positive Small (PS), and Positive Big (B)(Surya narayana et al., 2008). The rules of the fuzzy logic controller are framed form the membership functions as shown in Table 1 and 2 and are evaluated according to the compositional rule of inference. From the input membership functions twenty five IF-Then rules are framed as shown below.

1. If (Erris NB) and (Deltaerris NB) then (Dkp is NB)(Dki is PB)
2. If (Erris NS) and (Deltaerris NS) then (Dkp is NB)(Dki is PB)
3. If (Erris Z) and (Deltaerris Z) then (Dkp is NB)(Dki is NB)
4. If (Erris PS) and (Deltaerris PS) then (Dkp is NB)(Dki is PB)
5. If (Erris PB) and (Deltaerris PB) then (Dkp is NB)(Dki is PB)
6. If (Erris NB) and (Deltaerris PB) then (Dkp is PB)(Dki is NB)
7. If (Erris NS) and (Deltaerris PS) then (Dkp is PB)(Dki is NB)
8. If (Erris PS) and (Deltaerris NS) then (Dkp is PB)(Dki is NB)
9. If (Erris PB) and (Deltaerris NB) then (Dkp is PB)(Dki is NB)
10. If (Erris PS) and (Deltaerris Z) then (Dkp is NS)(Dki is NB)
11. If (Erris Z) and (Deltaerris PS) then (Dkp is PS)(Dki is PS)
12. If (Erris Z) and (Deltaerris PB) then (Dkp is Z)(Dki is PB)
13. If (Erris Z) and (Deltaerrs NS) then (Dkp is Z)(Dki is Z)
14. If (Erris NS) and (Deltaerris NB) then (Dkp is NS)(Dki is NB)
15. If (Erris NB) and (Deltaerris Z) then (Dkp is NB)(Dki is NB)
16. If (Erris PS) and (Deltaerris PB) then (Dkp is PS)(Dki is PB)
17. If (Erris Z) and (Deltaerris NB) then (Dkp is NB)(Dki is NB)
18. If (Erris PB) and (Deltaerris Z) then (Dkp is NB)(Dki is PB)
19. If (Erris PB) and (Deltaerris PS) then (Dkp is PS)(Dki is NS)
20. If (Erris PS) and (Deltaerris NB) then (Dkp is NS)(Dki is NS)
21. If (Erris PS) and (Deltaerris PB) then (Dkp is NS)(Dki is NS)
22. If (Erris NB) and (Deltaeris NS) then (Dkp is NS)(Dki is NS)
23. If (Erris NB) and (Deltaeris PS) then (Dkp is NS)(Dki is NS)
24. If (Erris NS) and (Deltaerris Z) then (Dkp is Z)(Dki is Z)
25. If (Erris PB) and (Deltaerris NS) then (Dkp is Z)(Dki is Z)

The crisp values are then given to the PI module. The PI controller generates the necessary signal to obtain the p_{loss} component of the dc capacitor (Zhen-Yu Zhao et al., 1993; Ajami et al., 2006). Table 1 and 2 shows the range of numerical values and function used for framing the membership function of input variable voltage error, change in error and the output functions of K_{prop} and K_{int} for a set voltage of 2000V. In the traditional PI controller the gains are fixed as K_{prop}= 0.1 and K_{int} = 0.005 by Ziegler Nicholas method (Yao Xu et al., 2014). The subsystem model of the fuzzy tuned PI controller is shown in Fig. 4.

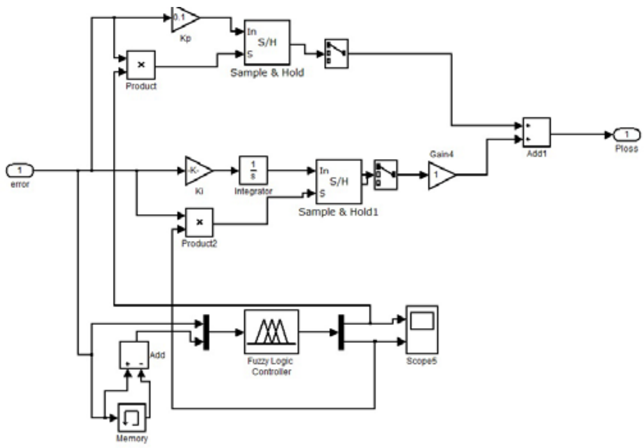


Fig. 4. Fuzzy tuned PI controller subsystem.

4. BELBIC CONTROLLER SCHEME

4.1 Control System Configuration using BELBIC Controller

The background knowledge obtained from papers (Hossein Rouhani et al., 2007; Saeed Jafarzadeh et al., 2008) shows that emotional intelligent controllers can be effectively used for the control of dc capacitor voltage of DSTATCOM. The computational mode of emotional learning is obtained from the functions of the brain with reference to the emotions and decision making. The main parts of the controller are orbitofrontal cortex and amygdala. The sensory input is given to the thalamus. The amygdala receives the input from the thalamus and sensory cortex. The emotional cue is also given to amygdala and learning takes place in amygdala. The learning rule is given by

$$v_i = k_1(EC - A_i) \tag{9}$$

where V_i is the amygdala gain, K_1 is the learning rate, EC is the emotional cue function and A_i is the amygdala output. The output of the amygdala is governed by

$$A_i = S_i * V_i \tag{10}$$

where S_i is the sensory input. The orbitofrontal cortex receives input from the amygdala, sensor cortex and the emotional cue function. The learning rule in orbitofrontal cortex is given by (11)

$$W_i = k_2(MO - EC) \tag{11}$$

Where K_2 is the learning rate of orbitofrontal cortex and MO is the model output. The orbitfrontal cortex is given by

$$O_i = S_i - W_i \tag{12}$$

From (10) and (12), the output function Model Output (MO) can be derived as

$$MO = A_i - O_i \tag{13}$$

The amygdala does not have the capability to unlearn any emotional response that it ever learned. The function of the orbitofrontal cortex is to respond to any inappropriate response when occurred. The gain functions K_1 and K_2 can be varied during the control process. The Emotional Cue (EC) is formed with the sensory input and the model output given by (14) as

$$EC = (-W_1 * (e * \frac{de}{dt}) + W_2 * abs(err)) * MO \tag{14}$$

In (14) W_1 and W_2 are the weights assigned to the gain functions, which are assigned arbitrarily in the proposed system as BELBIC is a learning procedure.

4.2 Algorithm for BELBIC Control

The flowchart of the BELBIC algorithm for dc voltage balancing and output voltage regulation is shown in Fig.5. The output voltages and currents are measured, and the output voltages are compared against the reference voltage. If the voltages are equal, the parameters need not be updated by the BELBIC. If the voltages are unequal, BELBIC algorithm action begins. The average output power consumed by the load is calculated using (1) and the dc capacitor voltage measured for each cycle of output is obtained. The error between the measured dc voltage and the reference is calculated and the rate of change of error is also calculated. To start the process the output dc voltage is assumed as the model output. The Emotional Cue (EC) is obtained using (14). The amygdala output and orbitofrontal cortex learning rule are calculated using (10) and (11). From this, the orbitofrontal cortex output is calculated. The initial values of K_1 and K_2 are assumed arbitrarily and changed during the process. If the value of EC is greater than zero, amygdala gain has to be increased; otherwise orbitofrontal cortex gain should be increased. The model output (MO) is again calculated using (13) and the P_{loss} that occurs in the capacitor is updated and the capacitor voltage is balanced. Finally using (2), (3) and (4) the reference currents are generated and reactive power is injected to the load to obtain the final compensation.

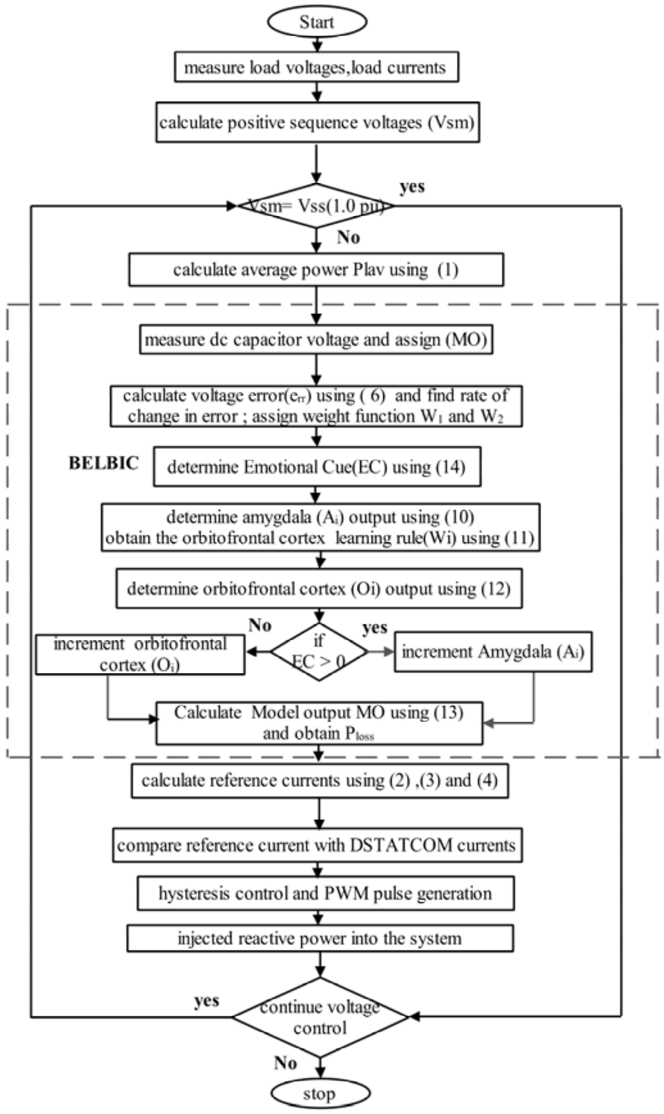


Fig. 5. BELBIC algorithm for dc capacitor voltage balancing and output voltage regulation.

5. SIMULATION RESULTS

5.1 System Parameters

The power system is modeled for the DSTATCOM controlled distribution feeder as shown in Fig.1 using the MATLAB/ Simulink software. The system parameters are shown in table 3. The load connected to the system is a non linear load. Another unbalanced load is connected to the system and disconnected at different instances of time. The objective is to maintain the output voltage as constant when the loads are connected and disconnected. The simulation results are obtained and the transient performance of the dc capacitor voltage balancing is obtained using PI controller, PI controller with a fuzzy logic controller, and finally with the BELBIC controller.

Table 3. System Parameters.

Rated source voltage	400 V (rms value)
Supply frequency	50 Hz
Source parameters	Rs = 10 ohms Ls =2mH
Compensator parameters	V_{dc} = 2000 V, C = 2200μF
Interface inductance	L_f= 0.1mH; R_f=0.25Ω
unbalanced load	Z_a= 60 Ω; Z_b= 60 +j25Ω; Z_c= 120+j25;
Non-linear load	three phase rectifier load

5.2 *Response of PI Controller*

The system performances are obtained first with the conventional PI controller and the response of the dc capacitor when the unbalanced load is connected is shown in Fig. 8(a). At the instant t= 0.15 sec the capacitor voltage decreases due to addition of the unbalanced load. As summarized in table 4, the system output voltage remains constant at 0.9956 p.u even though the unbalanced load is connected to the system. The dc capacitor voltage reaches 1.0 p.u at 0.2 sec and the PI controller takes 0.05 sec to reach the steady state value i.e. 1.0 p.u. The maximum over shoot is 12.5% and the steady state error is 2.4% as shown in Fig. 9(a). Later the unbalanced load is disconnected at t= 0.25 sec and the performance is obtained as shown in Fig.9(a). The output voltage remains constant at 0.9986 p.u. , and the time taken for the dc capacitor voltage to reach 1.0 p.u., settling time , maximum overshoot and steady state error are 0.33 sec,0.07 sec,20% and 2.2% as shown in table 5.

5.3 Response of Fuzzy Tuned PI Controller

A fuzzy tuner is added to the PI controller subsystem as shown in Fig.4. The responses of the system are shown in Fig. 8(b). The output voltage remains constant at 0.9956 p.u. The fuzzy controller takes action and the dc capacitor voltage reaches the reference value at t=0.18s. From the table 4, it can be observed that the settling time, maximum overshoot and steady state error are 0.03 sec, 7.5% and 1.6 % respectively.

When the unbalanced load is disconnected at t=0 .25sec and the dc voltage rises and again settles at t=0.28 sec as shown in Fig. 9 (b). For instance, the overshoot and the steady state error when the load is disconnected are 8% and 1.44% respectively. From figures 8(a), 8(b,) 9(a) and 9(b), and table 4 and 5, it is clear that the fuzzy logic controller has a good transient performance compared to a conventional controller.

5.4 Response to the BELBIC Based System.

The proposed BELBIC based controller for DSTATCOM for dc voltage balancing is simulated using MATLAB/Simulink. The subsystem models of the controller are shown in Fig. 6 and 7. The response of the system when the unbalanced load is connected at t= 0.15 sec is shown in Fig. 8(c) and the performance of the system are summarized in table 4. From table 4, it can be seen that the maximum over shoot is only 5% and steady state error is 1.2% only.

The unbalanced load is disconnected at t=0.25 sec and the transient performance of the dc capacitor voltage is shown in Fig. 9(c). The output voltage is 0.9986 p.u. and the maximum overshoot and steady state error are 5 % and 1.1% respectively as shown in table 5. The results conclude that an improvement in both the steady state and transient responses are obtained using the proposed BELBIC controller. The rise time and fall times are reduced along with the settling time with the proposed BELBIC controller. The results illustrate that a better response can be obtained using a BELBIC controller compared to a conventional PI controller and a fuzzy tuned PI controller. The output voltages when the load is connected and disconnected with the BELBIC algorithm are shown in Fig. 10 and Fig.11. The output currents when the unbalanced load is connected and disconnected when different types of controller are employed are shown in figures 12, 13, 14 and 15 respectively. From these figures it can be inferred, the BELBIC algorithm gives a superior performance compared to other types of controller.

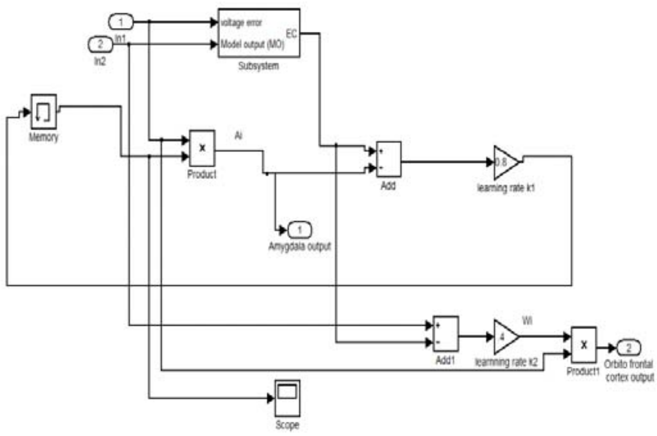


Fig. 6. Subsystem to generate orbitofrontal cortex output.

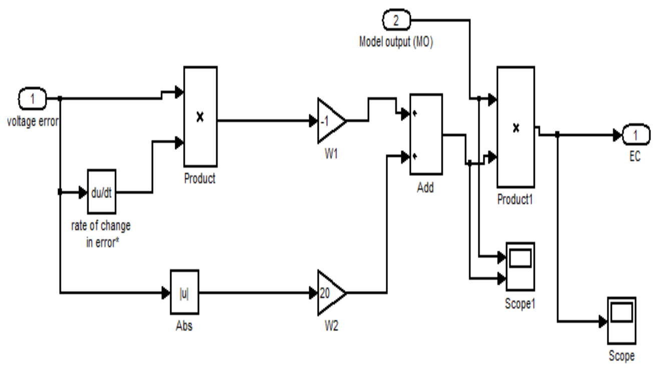
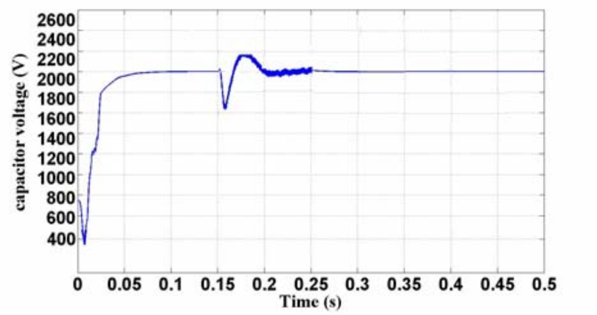
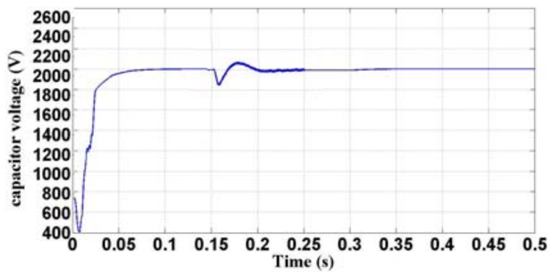


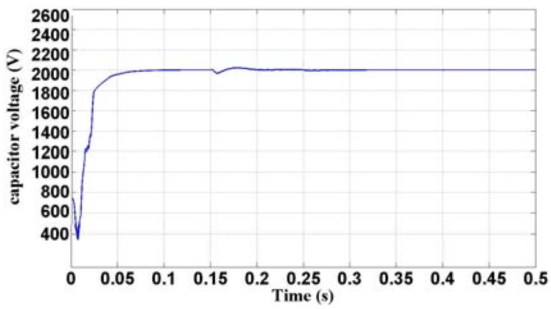
Fig. 7. Subsystem to obtain Emotional Cue (EC) output



(a)

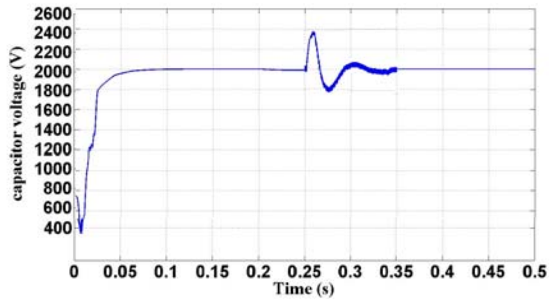


(b)

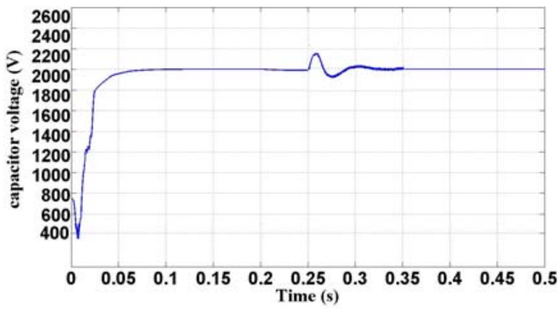


(c)

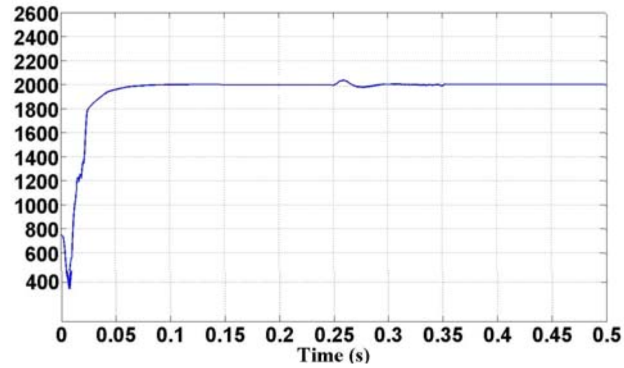
Fig. 8. Dc capacitor voltage output when a unbalanced load is connected at t= 01.5 sec (a) PI controller. (b) Fuzzy tuned PI controller. (c) BELBIC controller.



(a)



(b)



(c)

Fig. 9. Dc capacitor voltage output when the unbalanced load is disconnected at t= 0.25 sec (a) PI controller. (b) Fuzzy tuned PI controller. (c) BELBIC controller.

Table 4. Performance comparison of system parameters when unbalanced load is added at t=0.15 sec.

	PI control	Fuzzy tuned PI control	BELBIC control
Output voltage after change in load (pu)	0.9956	0.9956	0.9956
Time when dc capacitor voltage becomes 1.0 p.u. after load change(sec)	0.2	0.18	0.17
Δt to reach voltage 1.0 p.u. for change in load (dc capacitor voltage) (sec)	0.05	0.03	0.02
Maximum overshoot %	12.5	7.5	5
Steady state error (dc capacitor voltage) (%)	2.4	1.6	1.2

Table 5. Performance comparison of system parameters when unbalanced load is disconnected at t=0.25 sec

	PI control	Fuzzy tuned PI control	BELBIC control
output voltage after change in load (p.u)	0.9986	0.9986	0.9986
Time when dc capacitor voltage becomes 1.0 p.u. after load change(sec)	0.33	0.28	0.26
Δt to reach voltage 1.0 p.u. for change in load (dc capacitor voltage) (sec)	0.07	0.04	0.02
Maximum overshoot (dc capacitor voltage) (%)	20	8	5
Steady state error% (dc capacitor voltage)(%)	2.2	1.4	1.1

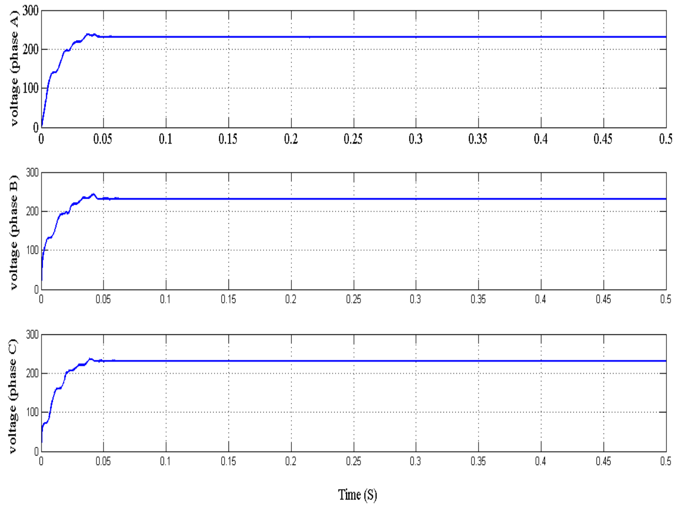


Fig. 10. Load voltage when unbalanced load is connected to the system (rms values).

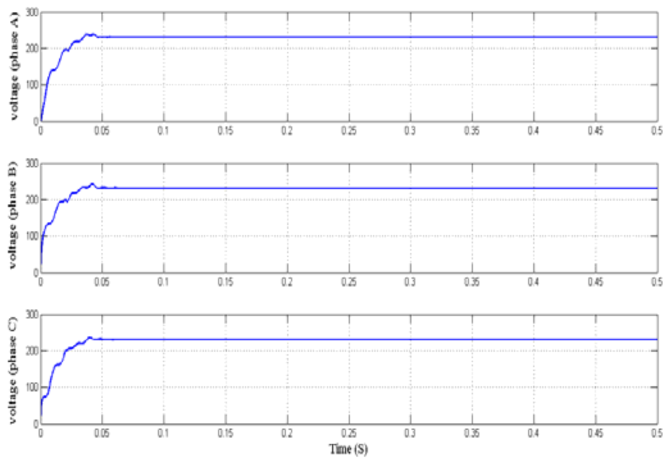


Fig. 11. Load voltage when unbalanced load is disconnected from the system.

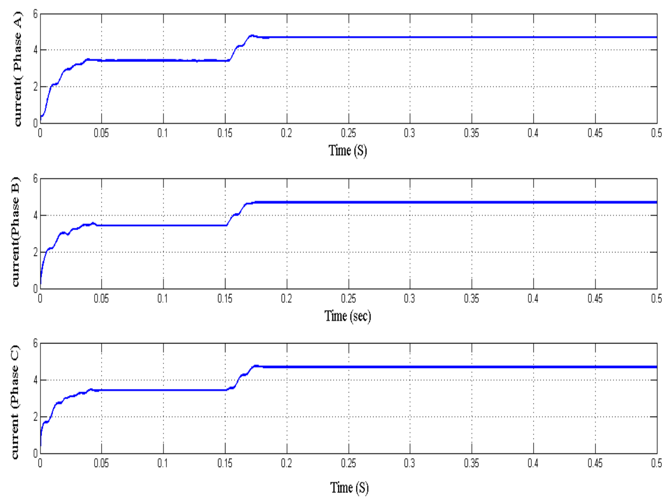


Fig. 12. Load current when unbalanced load is connected to the system (fuzzy tuned PI control).

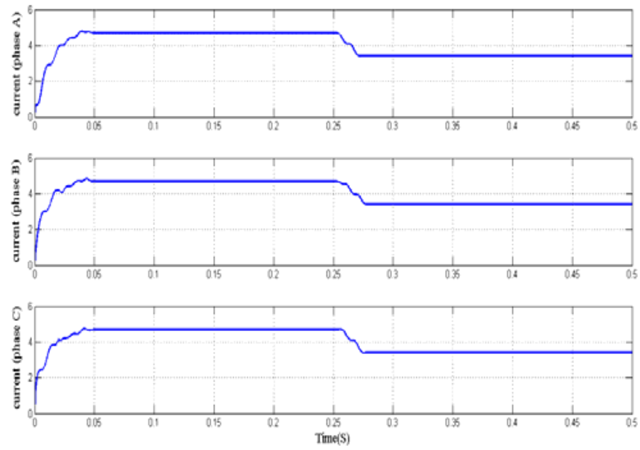


Fig. 13. Load current when unbalanced load is disconnected from the system (fuzzy tuned PI control).

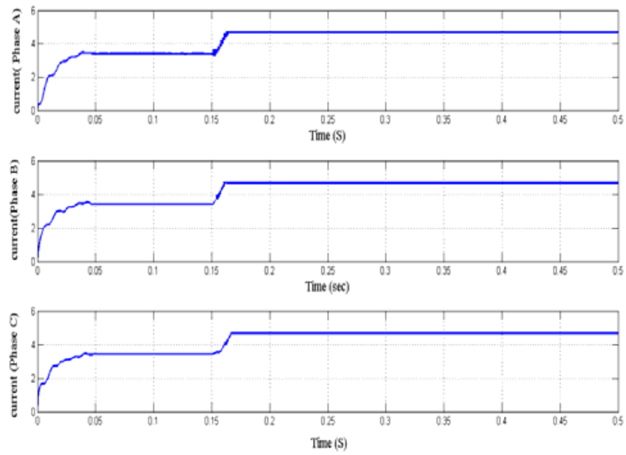


Fig.14. Load current when unbalanced load is disconnected from the system (BELBIC).

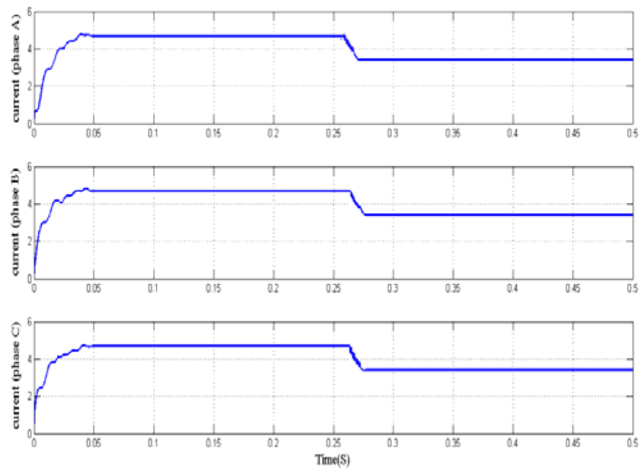


Fig. 15. Load current when unbalanced load is disconnected from the system (BELBIC).

5. IMPLEMENTATION USING BELBIC ALGORITHM

The VSI based DSTATCOM is constructed in laboratory as shown in Fig. 16. The DSTATCOM consists of IRF840 switches to obtain the required VSI. The inverter circuit is connected to the grid circuit through a coupling inductor. Gate pulses to the inverter circuit are obtained by using SPWM technique. Hall Effect sensors are used for measuring voltage and current. The BELBIC control algorithm is implemented using DSP (dSPACE 1104) with the interface of MATLAB, Simulink tool boxes. The details of the experimental setup are given in table 6. Before putting the DSTATCOM in operation the dc capacitor is pre charged to 230V and the capacitor voltages is maintained at 200V when the PWM pulses are generated.

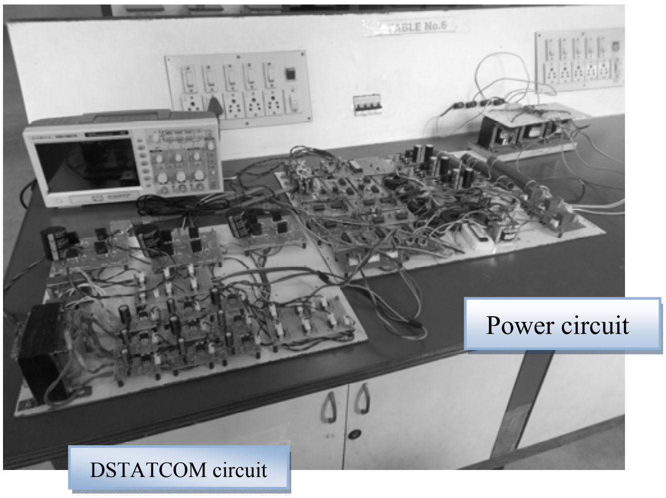


Fig. 16. Experimental setup of DSTATCOM.

The performance of the system is validated with diode rectifier as a non linear load and star connected rheostats as linear load. The experiment setup is conducted without and with DSTATCOM. When the grid voltage is less than or greater than the dc bus voltage, the DSTATCOM absorbs or injects the required voltage, thereby providing compensation at PCC. Fig. 17 shows the waveforms of the three phase voltages at PCC before the connection of DSTATCOM. The RMS values of voltages are V_{sa}= 200V, V_{sb}= 180V, V_{sc}= 180V. The PCC currents are non sinusoidal due to the presence of the nonlinear load as shown in Fig. 18 (RMS load currents of magnitude; i_{la} = 8.9 A, i_{lb} = 8.9 A, and i_{lc} = 6.2A). When the DSTATCOM is turned on, the PCC voltages becomes balanced as shown in Fig. 19 with RMS voltage of 200V and the currents become sinusoidal as shown in Fig. 20(RMS load currents of magnitude; i_{la} = 8.2 A, i_{lb} = 8.3A, and i_{lc} = 8.3A). These figures demonstrate that proposed active filter is capable of maintaining zero voltage regulation.

Table 6. Parameters related to experimental setup.

AC grid voltage	: 200 V
Linear load (unbalanced)	: R_1=R_2=R_3= 50 ohms L_1= 1.8mH; L_2=3.6mH; L_3= 3.6mH;
Non linear load (three phase full bridge rectifier load)	: R= 50 ohms L=3.6mH;
Coupling inductor	: 2.8 mH ;
Resistance of coupling inductor	: 0.5 ohms
Dc link capacitor	: 2200µF
Switching frequency	: 10khz
Reference dc bus voltage	: 200V

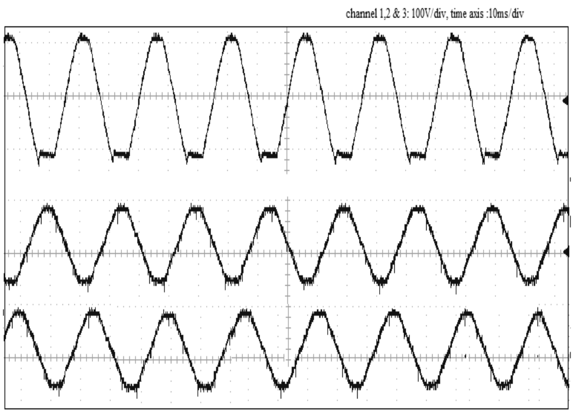


Fig. 17. Voltages at PCC before compensation.

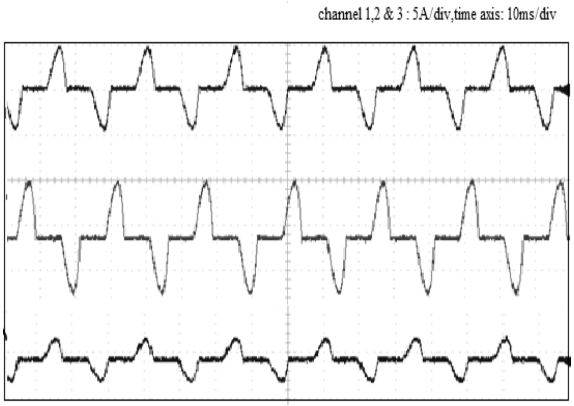


Fig. 18. Currents at PCC before compensation.

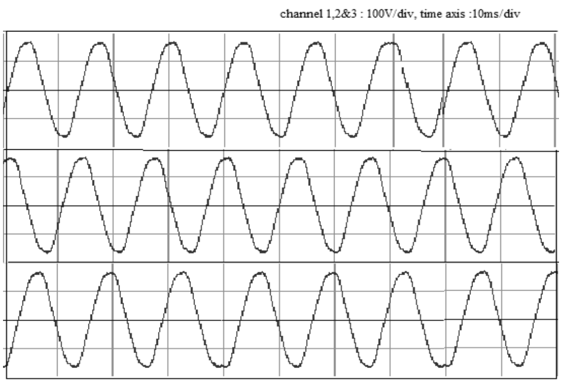


Fig. 19. Voltages at PCC after compensation.

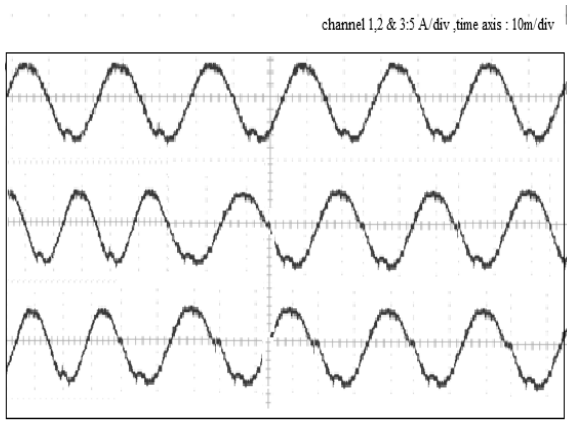


Fig. 20. Currents at PCC after compensation.

6. CONCLUSION

A new control model based on BELBIC algorithm which can adjust the gain dynamically, such that the performance of the system matches the desired response for changing operating conditions is proposed. In the simulation, a PI controller, fuzzy tuned PI controller and BELBIC schemes are presented to the performance parameters are obtained. The fuzzy supervisor dynamically varies the proportional and integral gains of the PI controller during the transient period to improve the performance of the system. The BELBIC algorithm uses a biologically inspired approach to obtain the performance of the system. From the results it can be concluded that a superior performance has been obtained with the accomplishment of a BELBIC controller compared to a PI and fuzzy tuned PI controllers.

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