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Advanced Tuning of PI controller for Voltage regulation Using STATCOM

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Abstract: *To Maintain Voltage Regulation A STATCOM Provides The Fast And Efficient Reactive Power. In order to understand various STATCOM control methods are discussed in the literature. But in those methods they use the trial and error approach methods so the performance is trade off. so at different operating points the control parameters may not be effective for the optimal performance. In order to overcome this problem an adaptive control technique came in to picture, in which the control gains automatically self adjusted as per our desired response even with the change of operating condition that's why we named as autonomous adjustment. In the simulation test, the adaptive PI control shows consistent excellence under various operating conditions, such as different initial control gains, different load levels, change of transmission network, consecutive disturbances, and a severe disturbance. when there is a change of system conditions the conventional STATCOM control with tuned, fixed PI gains usually perform fine in the original system, but may not perform as efficient as the proposed control method.*

Keywords: *Adaptive management, plug and play, proportional-integral (PI) management, reactive power compensation, STATCOM, voltage stability*.

I. INTRODUCTION

In order to maintain security and reliability voltage stability is a critical Consideration of power system.. for improving power system stability The static power system static compensator (STATCOM), a popular device based on gate turnoff (GTO) thyristors, for reactive power control has gained much interest in the last decade . In the past, various control methods, mainly focus on the control design instead of how to set proportional-integral (PI) control gains .In order to maintaining the time and to obtain the better voltage stability A few, but limited previous works in the literature discussed. those are like linear quadratic regular (LQR), a new STATCOM state feedback design based on a zero set concept and a fuzzy PI control method , the population-based search technique but with these methods highly efficient results may not be always achievable under a specific operating condition because they needs a long running time to calculate the controller gains, and the variety of operation conditions still has to be made during the designer's decision-making process. Different from these previous works, the motivation of this paper is does not have slower response, over-shoot, or even instability to the performance even though , the change of the external condition so that can ensure a quick and consistent desired response.

The PI control parameters for STATCOM can be computed automatically, When a disturbance occurs in the system .i.e. PI control parameters can be self-adjusted automatically and dynamically. Based on this fundamental motivation, an adaptive PI control of STATCOM for voltage regulation is came in to picture. This method will not be affected by the initial gain settings, changes of system conditions, and the limits of human experience and judgment. So this is a ―plug-and-play‖ device. In addition, in various operating conditions. It performs fast and dynamic.

II. STATCOM MODEL AND CONTROL

The equivalent circuit of the STATCOM is shown in Fig. 1. during this facility, the resistance RS in series with the voltage source electrical converter represents the total of the electrical device winding resistance losses and therefore the electrical converter conductivity losses. The inductance LS the outflow inductance of the electrical device. The resistance RC in in shunt with the electrical device C represents the total of the switch losses of the electrical converter and therefore the power losses within the electrical device. In Fig. 1, In Fig. 1, Vas,Vbs and Vcs are the three-phase STATCOM output voltages Val ,Vbl and Vcl are the three phase bus voltages; and ias ,ibs and ics are the three-phase STATCOM output currents.

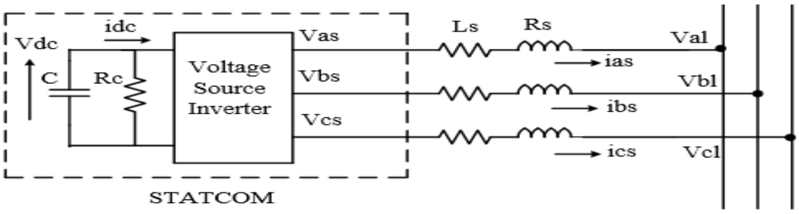

Fig 1. Equivalent Circuit of STATCOM

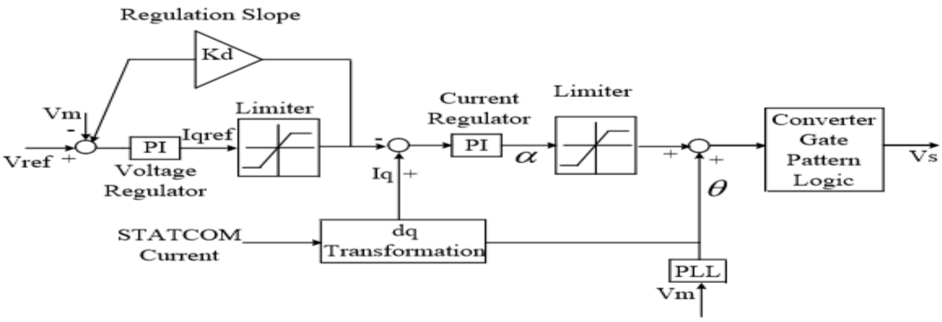

Fig. 2. Traditional STATCOM PI control block diagram

III. ADAPTIVE PI CONTROL FOR STATCOM

The STATCOM with fixed PI control parameters may not reach the desired and acceptable response in a power system when the power system operating condition (e.g., loads or transmissions) changes. An adaptive PI control method is presented in this section in order to obtain the desired response and to avoid performing trial-and-error studies to find suitable parameters for PI controllers when a new STATCOM is installed in a power system. With this adaptive PI control method, the dynamical self-adjustment of PI control parameters can be realized.

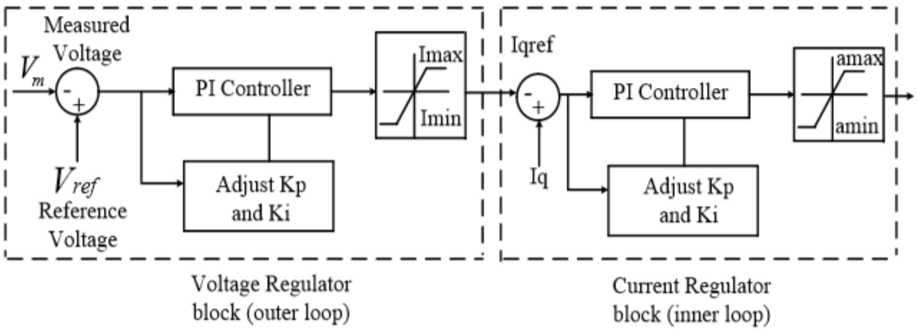

Fig. 3 Adaptive PI control block for STATCOM.

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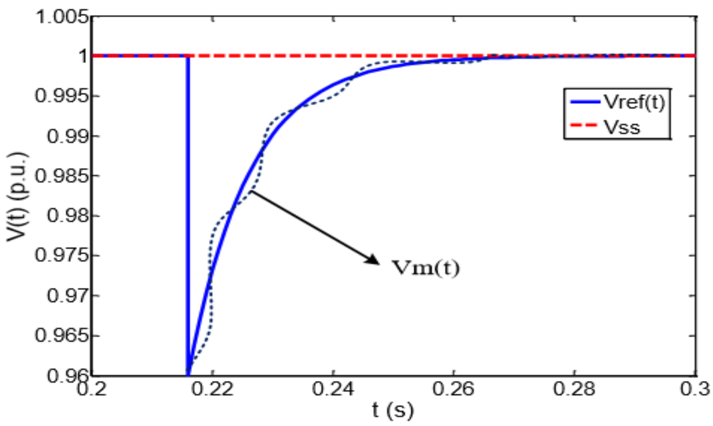

Fig. 4 Reference voltage curve

IV SIMULATION RESULTS

(I) Response of the Original Model

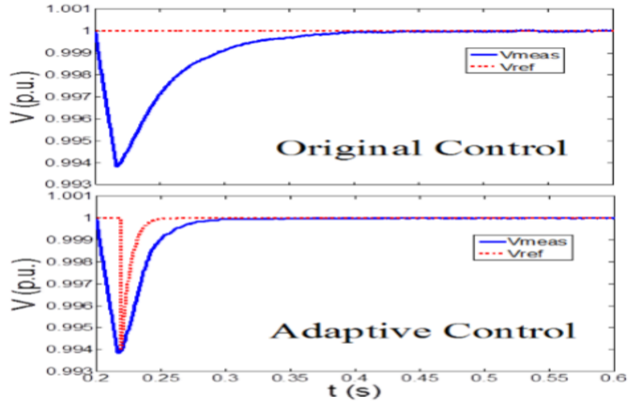

Fig.5 Results of the voltages using the same network and loads

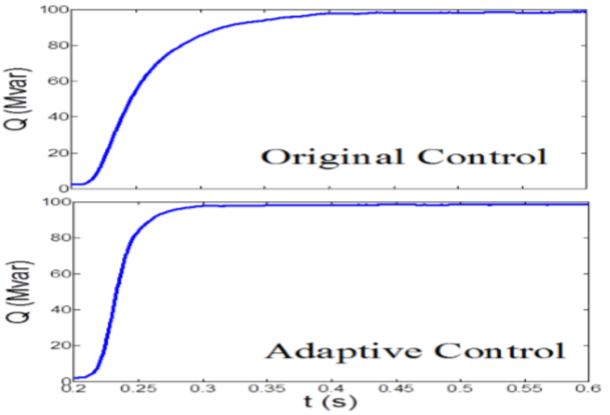

Fig.6 Results of the output reactive power

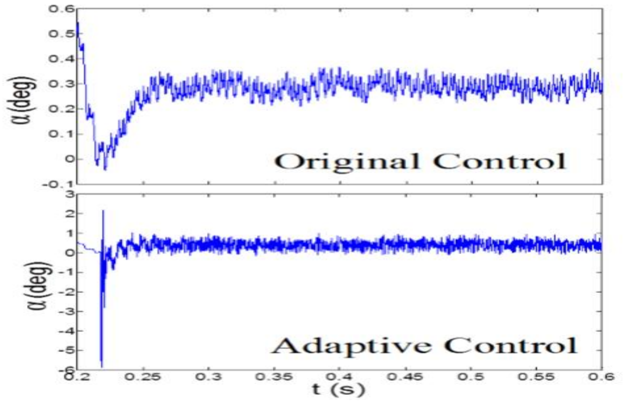

Fig.7 Results of α using the same network and loads.

	Original Ctrl.	Adaptive Ctrl.
Lowest Voltage after disturbance	0.9938 p.u.	0.9938 p.u.
Time (sec) when V=1.0	0.4095 sec	0.2983 sec
Δt to reach V=1.0	0.2095 sec	0.0983 sec
Var Amount at steady state	97.76 MVar	97.65 MVar
Time to reach steady state Var	0.4095 sec	0.2983 sec

Table 1 Performance comparison for the original system parameters

(II) Change Of Gain Values

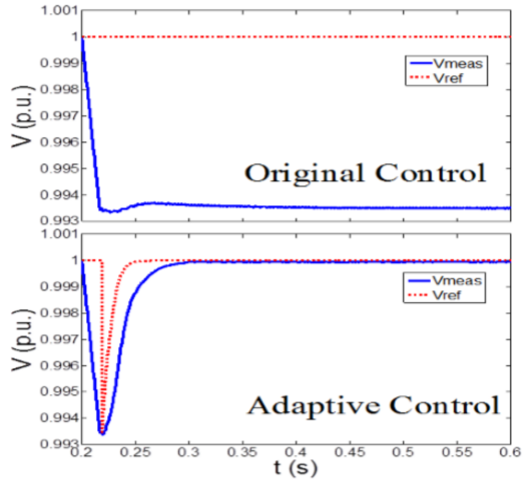

Fig. 8 Voltages with changed Kp and Ki in the original control

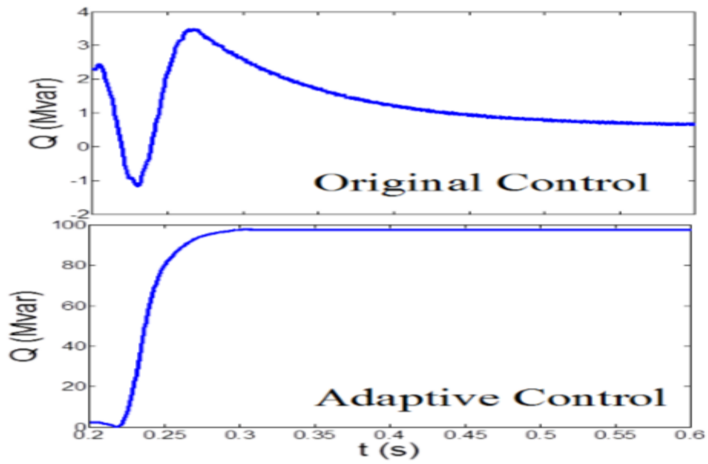

Fig. 9 Output reactive power with changed Kp and Ki

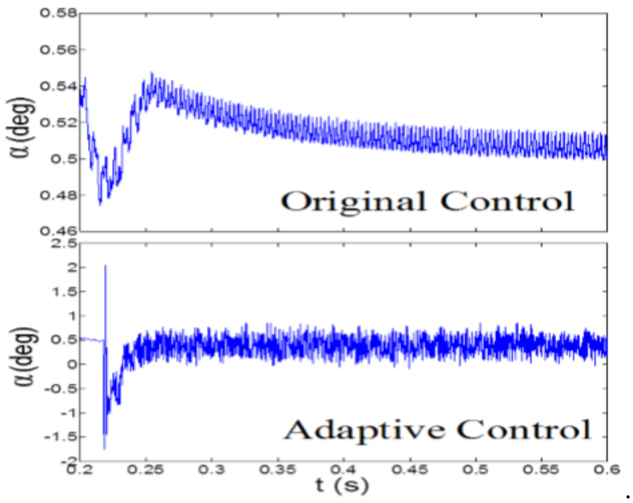

Fig.10 Results of α with changed Kp and Ki in the original control

(III). Response of the Change of Load

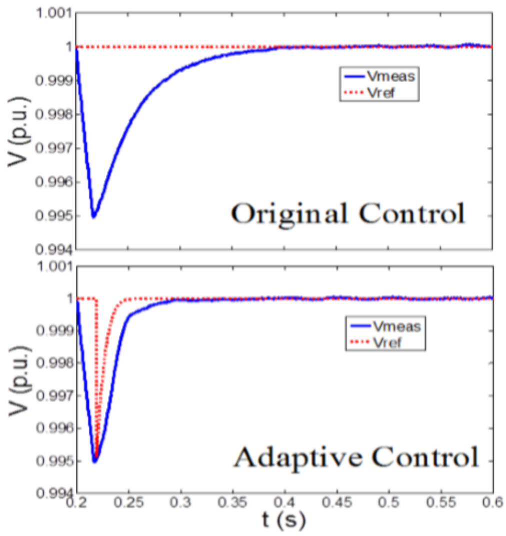

Fig. 11 Results of measured voltage with change of load.

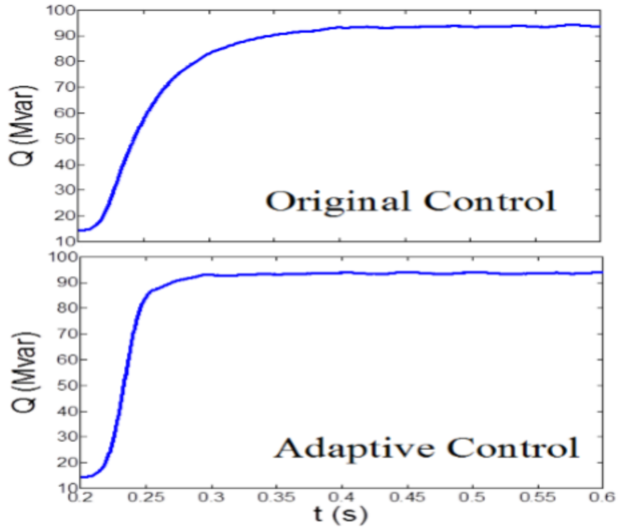

Fig. 12 Results of output reactive power with change of load

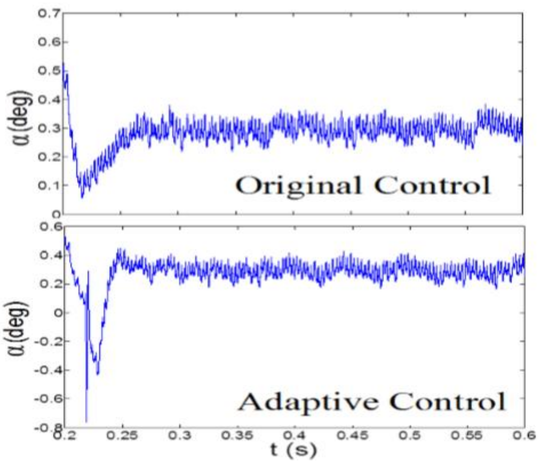

Fig. 13 Results of α with change of load

	Original Ctrl.	Adaptive Ctrl.
Lowest Voltage after disturbance	0.9949 p.u.	0.9949 p.u.
Time (sec) when V=1.0	0.4338 sec	0.3125 sec
Δt to reach V=1.0	0.2338 sec	0.1125 sec
Var Amount at steady state	93.08 MVar	92.72 MVar
Time to reach steady state Var	0.4338 sec	0.3125 sec

Table 2 Performance comparison with a change of load.

(IV). *Response of the Change of Transmission Network*

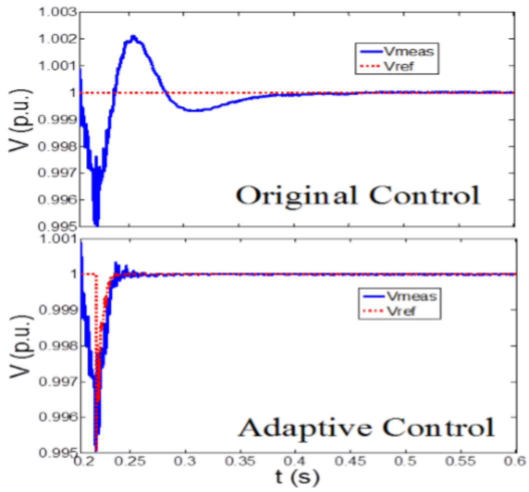

Fig.14 Results of measured voltage with change of transmission network.

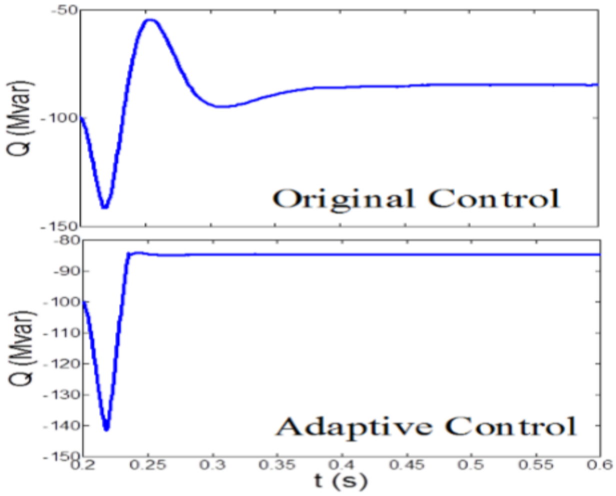

Fig.15Results of output reactive power

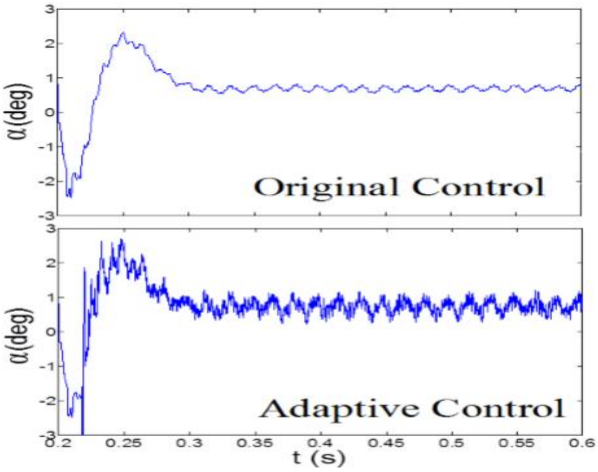

Fig. 16 Results of α with change of transmission network.

	Original Ctrl.	Adaptive Ctrl.
Lowest Voltage after disturbance	0.9954 p.u.	0.9954 p.u.
Time (sec) when V=1.0	0.4248 sec	0.2744 sec
Δt to reach V=1.0	0.2248 sec	0.0744 sec
Var Amount at steady state	-84.92 MVar	-85.02 MVar
Time to reach steady state Var	0.4248 sec	0.2744 sec

Table 3 Performance comparison with changed transmission

(V) Response of the Change of Two consecutive disturbances

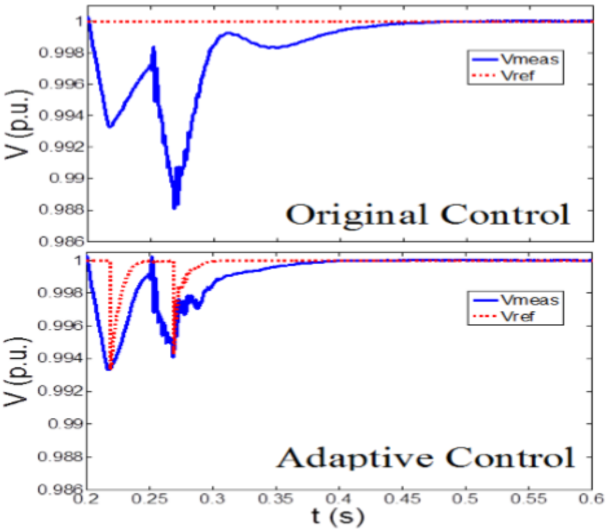

Fig.17 Results of measured voltage in two consecutive disturbances

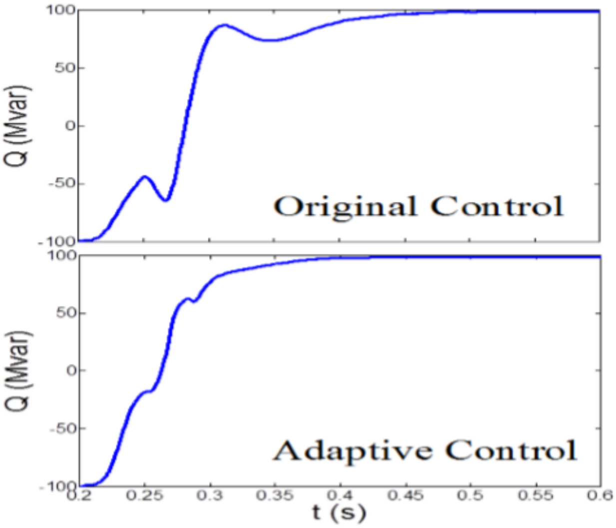

Fig.18 Results of output reactive power

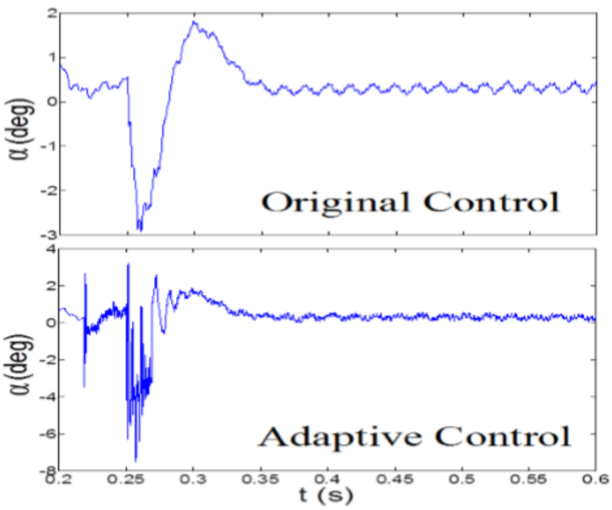

Fig. 19 Results of α in two consecutive disturbances.

(VI). *Response of the Severe disturbance*

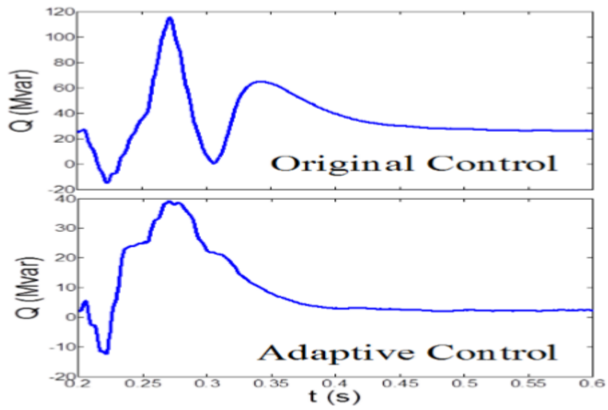

Fig.20 Results of measured voltage in a severe disturbance

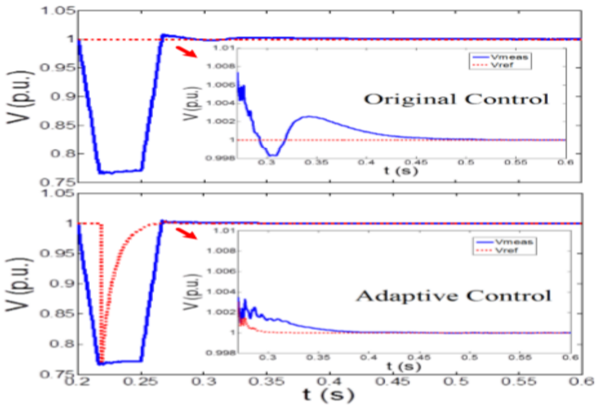

Fig. 21 Results of output reactive power in a severe disturbance

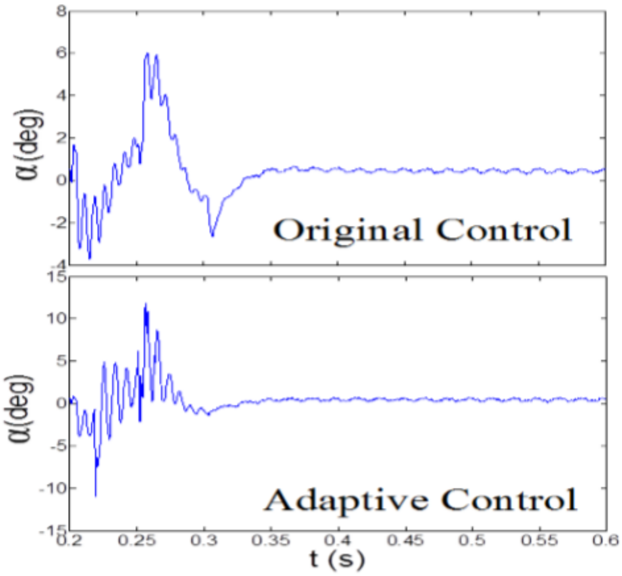

Fig.22 Results of α in a severe disturbance.

V CONCLUSION

In the literature, varied STATCOM management strategies are mentioned together with several applications of PI controllers. However, these previous works acquire the PI gains via a trial and-error approach or in depth studies with a exchange of performance and relevance. Hence, management parameters for the optimum performance at a given in operation purpose might not forever be effective at a special in operation purpose. to handle the challenge, this paper proposes a replacement management model supported adaptational PI management, which may self-adjust the management gains dynamically throughout disturbances in order that the performance forever matches a desired response, regard less of the modification of in operation condition. Since the adjustment is autonomous, this provides th "plug-and-play" capability for STATCOM operation. within the simulation study, the planned adaptational PI management for STATCOM is compared with the traditional STATCOM management with pretuned mounted PI gains to verify the benefits of the planned technique. The results show that the adaptational PI management provides systematically wonderful performance below varied in operation conditions, like totally different initial management gains, totally different load levels, modification of the transmission network, consecutive disturbances, and a severe disturbance. In distinction, the traditional STATCOM management with mounted PI gains has acceptable performance within the original system, however might not perform as economical because the planned management technique once there\'s a modification of system conditions.

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