FUZZY LOGIC BASED LF CONTROLLER FOR HYBRID POWER GENERATION

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Abstract: To meet the increased demand of the customers, as there is scarcity in fossils fuels and already these fuels have been exposed to the maximum extent, all the developing countries have to search for an alternate source of energy in place of fossil fuels like coal, lignite, nuclear. Hence, the viable alternate sources are solar power, wind power, tidal power etc. In this paper, based on solar power generation as alternate source and considering Diesel generator as another source of power, a Hybrid network has been designed. Here in this paper, maximum power point tracking concept is used to make fixed DC output voltage. This is achieved through positive output elementary split inductor type boost converter (POESITBC). Then the fixed DC output is converted to AC voltage through Inverter. In this paper, the PV panels with POESITBC network and diesel power generator is connected to get appropriate power without producing any destruction for the surroundings using FLC plus Proportional double integral controller. Using MATLAB Simulink platform, the designed model is validated.

Keywords: Positive output elementary split inductor type boost .converter (POESITBC),FLC plus Proportional double integral controller, MATLAB Simulink.

I.INTRODUCTION

Among these renewable source, photovoltaic (PV) is more attractive because of its sparkling, steadiness operation and also, the cost of PV panel is less For solar power generation, availability of sun is the important point. Papers in [1]-[2] describe about the maximum power point tracking using stand alone PV. Variations that happen to the load of power system impinge on the frequency and in addition it will make the power quality crisis on the customer's great susceptible equipment. So, this frequency must be regulating surrounded by the boundary. In the power system the load changes are capricious without control and there is disturbance in real and reactive power. For protecting frequency in power system a load frequency control (LFC) is essential. The LFC helps to sustain the frequency and tie-line power inside the set limit [3]. The conventional controllers such as proportional, proportional integral and proportional integral derivative are utilized for LFC. However, these control methods has the capacity to control the two areas, performed well under load variation, and good robustness. It also has some crisis such as damping oscillation, long settling time and maximum overshoot of frequency. As the load varies constantly the control is actually difficult due to the gain value of the controller is fixed in these controllers [4]. Still, the conventional plus AIC is much complex, the main goal of the LFC is to maintain the steady state error as zero in an interconnected multi area power system without multifaceted control. As a result the research moves towards a single control such as fuzzy logic control (FLC) and it has been applied for power system control [5]-[7]. FLC has better control over the other controllers in dynamic operating conditions. Here in this paper, maximum power point tracking concept is used to make fixed DC output voltage. This is achieved through positive output elementary split inductor type boost converter (POESITBC). Then the fixed DC output is converted to AC voltage through Inverter. The PV panels with POESITBC network and diesel power generator is connected to get appropriate power without producing any destruction for the surroundings using FLC plus Proportional double integral controller. The designed model is validated through Using MATLAB simulink platform.

2. MODELING OF HYBRIDNETWORK

A. Design of PV panel

Small solar cells are embedded in a PV Panel and the cells are either connected in series or parallel to make a PV panel. The small solar cells do the similar operation of the PN junction diode. When it operates in forward bias the power will flow.

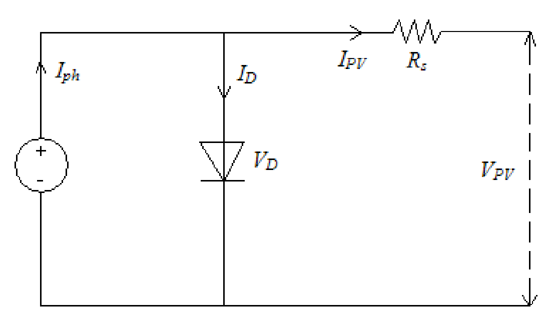


Fig: 1- PV Panel

Here Ipv= Iph- ID

For fixed DC output, for implementing MPPT concept, positive output elementary split inductor type boost converter (POESITBC) is used and is shown in Fig:2.

The operating specifications of POESITBC as follows:
fsw = 100KHz (switching frequency)
VPV(min) = 45.6V (Minimum output voltage)
VPV(max) = 56.8V (Maximum output voltage)
Vo(max) = 230V (Maximum output voltage)
Io = 0.97 A (Load current)
L1,L2 = 100μH
C = 300μF

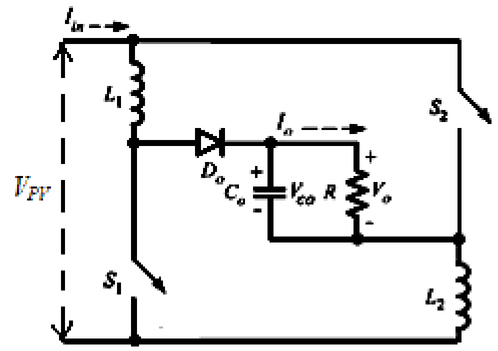


Fig: 2- Positive output elementary split inductor type boost converter (POESITBC)

Transfer function of the proposed model is designed using the above specification.

B.Design Of Diesel Generator Network s

Transfer function model of diesel generator network can be written in equations given under:

Transfer function of the Diesel Generator	$\frac{K_G}{T_G s+1}$
Transfer function of the Turbine	$\frac{K_T}{T_T s+1}$
Transfer function of the Governor	$\frac{K_{GO}}{T_{GO} s+1}$
Transfer function of the Re-heater	$\frac{K_R T_R s+1}{T_G s+1}$

C. Design Of Controller

1.Fuzzy logic Controller:

The universal step-step design evaluation of the FLC is as given under:

Step 1: Identification of inputs and outputs,

Step 2: Fuzzification of the inputs,

Step 3: Rules and inference engine, and

Step 4: Defuzzification of the output.

The fuzzy sets are [NB, NS, Z, PS, PB] where, NB (negative big), NS (negative small), Z (zero), PS (positive small), PM (positive medium), PB (positive big), respectively. The rules of the FLC are obtained based on the system performance. In this case, 25 rules are framed as shown in Table-I. Then, weighted average method (defuzzification-method) is used to finish the controller operation.

D. Design of Proportional Double Integral controller(PDIC)

In this paper, the PDIC parameters, proportional gain(Kp) and double integral times (Tis), are evaluated using Zeigler –Nichols tuning method .The PDIC parameters, proportional gain (Kp) and double integral times (Tis), are obtained by using Zeigler–Nichols tuning method [14],[15]. Using this method the values of Kp = 0.1 and integral times Tis= 0.11s and 0.1s (this value is chosen based on the Combined Network change in frequency response) are found.

3.SPECIFICATION:

The details of the Hybrid network are shown in Table-2 Specification of the Diesel network

Parameters name	Symbol	Value
Regulation of the speed governor in generator	R	0.4 Hz/p.u MW
Hydraulic amplifier time constant	T_{H1}	0.08 s
Time constant of turbine	T_T	0.3 s
Power system gain constant	K_G	120
Power system time constant	T_G	20 s
Governor gain constant	K_{Go}	1.0
Governor time constant	T_{Go}	0.08 s
Re-heater time constant	T_R	10 s
Synchronizing power coefficient	a12 and a22	-1
Frequency bias constant	β	0.8

TABLE 2
Fuzzy Rules Base Table Of Hybrid Network

e / ce	NB	NM	NS	Z	PS	PM	PB
NB	NB	NB	NB	NB	NM	NS	Z
NM	NB	NM	N M	NM	NS	Z	PS
NS	NB	NM	NS	NS	Z	PS	PM
Z	NB	NM	NS	Z	PS	PM	PB
PS	NM	NS	Z	PS	PS	PM	PB
PM	NS	Z	PS	PM	PM	PM	PB
PB	Z	PS	PM	PB	PB	PB	PB

4. DESIGN OF HYBRID NETWORK

In this paper, two renewable sources viz. Solar power in one area and Diesel generator as another source and combined network is designed. Each source has FLC & PDIC controller as input to the Transfer function of the PV panel with POESITBC. The simulink block diagram is shown in the Fig :3.

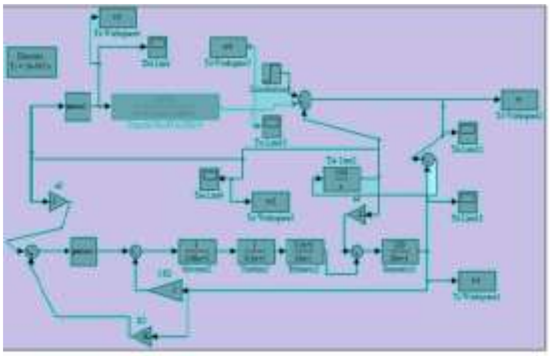
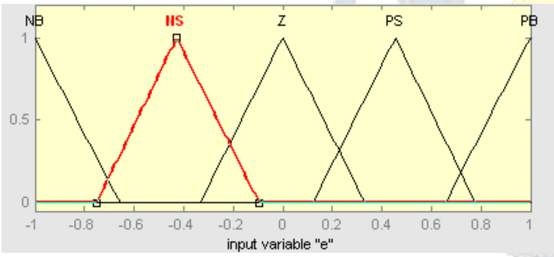


Fig:3 -Simulink block diagram of FLC & Proportional Double Integral controller based combined network

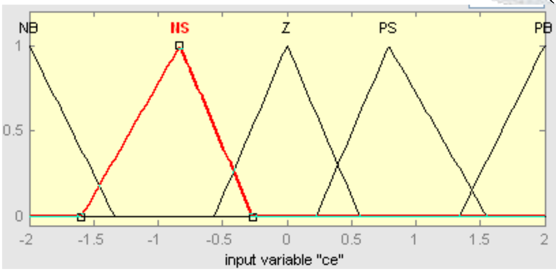
In FLC, the inputs are change in error & error. FLC along with Proportional Double integral controller and with DC input applied to the Inverter transfer function model is observed and output is represented. With the application of load disturbance and tie line power to Diesel generator, the variations in frequency are observed.

5. SIMULATION RESULTS

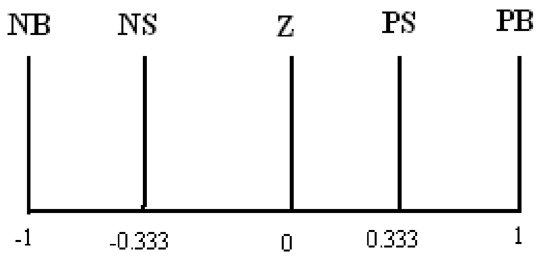
In this section, it is proposed to discuss the performance of the system with the proposed FLC plus proportional double integral controller based LFC for Hybrid network. Fig4represent the inputs and output of FLC controller.Fig5 stands for the input of the inverter transfer function.Fig6 shows the output at the inverter transfer function. Figs7 &8 and 9show the diesel generator output, tie-line output and PV network output of the Hybrid network respectively. From these Figs, it is clearly showed that the output of Hybrid network by means of FLC plus proportional double integral controller has less overshoots, quick settling time and small steady state error.



(a)



(b)



(c)

Fig4.Membership's functions of FLC, (a) error (e), (b) change in error (ce), and (c) output (o)

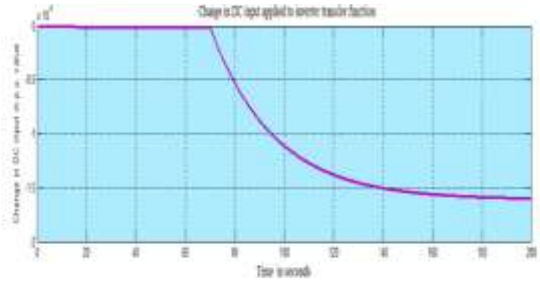


Fig 5. Change in DC input applied to inverter transfer function

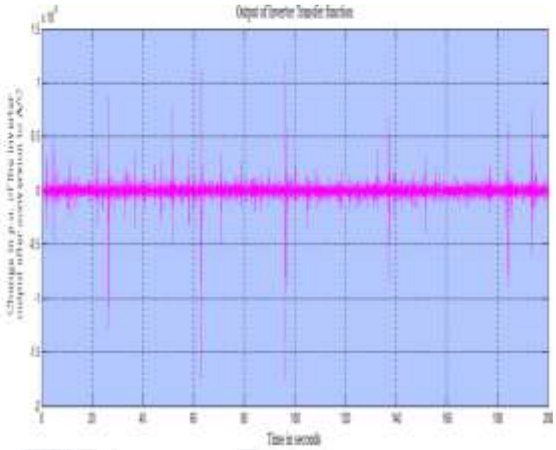


Fig 6. Output of inverter transfer function

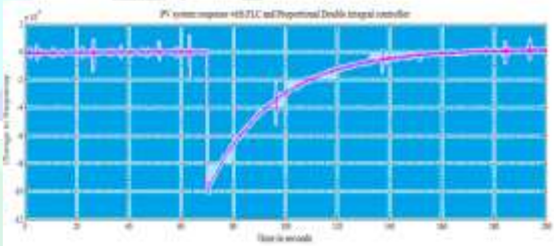


Fig 7. PV system response with FLC and proportional double integral controller and load disturbance

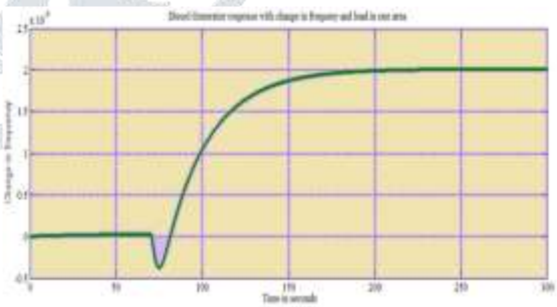


Fig8 . Diesel generator response with FLC and proportional double integral controller and no load

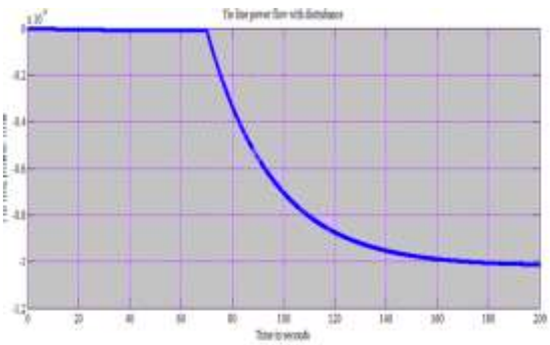


Fig 9. Tie line variations with FLC & Proportional double integral controller

6. CONCLUSION

In this paper, the a novel FLC plus proportional double integral controller based Load frequency Control for Hybrid network has been assembled efficiently using MATLAB/Simulink software platform. The main merits of this controller over the conventional controllers are stability during load variations, excellent transient and dynamic responses. This results illustrates that has less overshoots, quick settling time and small steady state error.

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