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Damping of Power System Oscillations with UPFC Controllable Parameters using Real-Coded Genetic Algorithm

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***Abstract*— This paper deals the method to get damping of continuous fluctuation in the power system with the help of UPFC. Oscillations are generate in an interrelated power system while the system is subjected to error or interruption. The deviation of frequency in power system is in the series of 0.2 to 3.0 Hz. The UPFC can give instantaneous, actual time control of necessary system parameters similar to transmission voltage, phase angle and impedance. The unique environment of UPFC is that the parameters can be restricted separately or concurrently. The linear form of the UPFC is in use and the tuning of the convenient parameters is completed with the assist of Real-Coded Genetic Algorithm (RCGA).**

The planned convenient damping parameters have been obtain from MLPH form to study the damping of system when subjected to 3 phase error with conservative process in evaluation by RCGA. The UPFC is install in Single Machine Infinite Bus (SMIB) for the study of presentation of the power system and is replicated for 3 phase fault with MATLAB/SIMULINK and the relative among the optimization of regulator parameters with both predictable method and RCGA technique have been analyze and compare.

Index Terms*— *Flexible AC Transmission System (FACTS),Linearized Phillips-Heffron model (LPH model), Modified Linearized Phillips-Heffron model (MLPH model), Real-Coded Genetic Algorithm (RCGA), Single Machine Infinite Bus (SMIB), Unified Power Flow Controller (UPFC).

I.INTRODUCTION

The intention is to give a bodily based explanation, even as conforming to definitions from system hypothesis, is simply understand and enthusiastically apply by power system engineering practitioners. "Power system strength is the capacity of an electric power organization, intended for a gives preliminary operating situation, to recover a state of operating balance subsequent to organism subjected to a bodily trouble, among the majority system variables enclosed so that basically the whole system leftovers unbroken." strength consideration has been accepted as an necessary part of power system preparation for a long time. through interconnected systems frequently rising in size and extend in excess of vast physical regions, it is flattering gradually more complex to uphold synchronism b/w a variety of parts of a power organization.

A representative current power organization is a high-order multivariable procedure whose dynamic reaction is prejudiced by a extensive array of appliances with dissimilar characteristics and reaction rates. constancy is a situation of balance b/w opposite forces. Depend on the system topology, organization working situation and the form of trouble, dissimilar sets of opposite forces may practice continued inequity leading to dissimilar forms of unsteadiness. In this division, we give a orderly foundation for categorization of power organization strength

II.MODELING OF SINGLE MACHINE INFINITE BUS (SMIB) SYSTEM WITH UPFC

What is most interesting for transmission planners is that FACTS technology opens up new opportunities for controlling power and enhancing the usable capacity of the present transmission system. The opportunities arise through the ability of FACTS controllers to control the interrelated parameters that govern the operation of transmission systems including series impedance, shunt impedance, current, phase angle, and damping of oscillations at various frequencies below the rated frequency. These constraints cannot be overcome otherwise, while maintaining the required system stability, by mechanical means without lowering the useable transmission capacity. By providing added flexibility, FACTS controllers can enable a line to carry power closer to its thermal rating. Mechanical switching needs to be supplemented by rapid-response power electronics. Among the FACTS components, Unified Power Flow Controller (UPFC), is the most complete. It is able to control independently the throughput active and reactive powers. The UPFC is capable to act over three basic electrical system parameters: line voltage, line impedance, and phase angle, which determine the transmitted power.

Power Flow through an alternative current line is a function of the line impedance, the magnitude of the sending-end and receiving-end voltage and the phase angle between these voltages. The power flow can be increased, firstly by decreasing the line impedance with a capacitive reactance, secondly by increasing the voltages and finally by increasing the phase angle between these voltages. In our work, the power flow is controlled by controlling the sending and receiving bus voltage.

Also, the control of the shunt and series element of the UPFC will be studied. The Unified Power Flow Controller (UPFC) consists of two voltage sourced converters using power switches, which operate from a common from DC circuit of a DC-storage capacitor. This arrangement functions as an ideal ac to ac power converter in which the real power can freely flow in either direction between the ac terminals of the two converters and each converter can independently generate (or absorb) reactive power at its own ac output terminal.

The basic components of the UPFC are two voltage source inverters (VSIs) sharing a common dc storage capacitor, and connected to the power system through coupling transformers. One VSI is connected to in shunt to the transmission system via a shunt transformer, while the other one is connected in series through a series transformer.

The series inverter circuit is restricted to injected a balanced 3-phase voltage system Vse, of convenient magnitude and phase position in sequence with the line to regulate real and useless power flow on the transmission line. hence this inverter circuit will replace true and wattles power flow with the transmission line. The useless power is electronically provide by the series inverter circuit, with the a true power is transmitted to the dc terminals. The parallel inverter circuit is operating in such a manner as to require this dc terminal power (+ve or _ve) commencing the line keeps the voltage crosswise the storage space capacitor Vdc invariable. thus the net true power received from the line through the UPFC is the same only to the victims of the inverter circuits and their transformers. The remain capability of the shunt inverter circuit can be utilized to replace the useless power with the line hence to give a voltage regulation on the relation position.

The UPFC has been installed in Single Machine Infinite Bus (SMIB) system as shown in fig. 1.

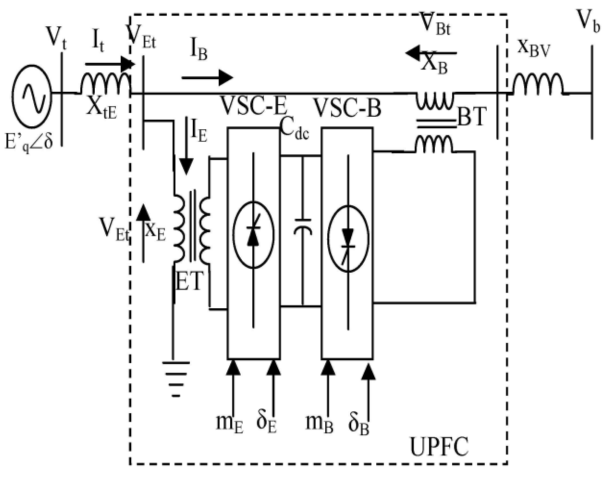


Figure I: UPFC installed in SMIB

The two VSIs be able to work separately of every other by separate the dc part. hence in that case the shunt inverter circuit is working as a STATCOM that produces or receives the useless power to control the voltage magnitude at the connect position. as a substitute the series inverter circuit is working while SSSC that produces or absorb the useless power to control the current stream, and therefore control the flow of power on the transmission line.

The UPFC is several possible working modes. During meticulous, the shunt inverter circuit is working in such a way to injected a convenient current, ish into the transmission line. The shunt inverter circuit can be controlling the two differencing modes:

VAR manage type: The mention i/p is an inductive and capacitive VAR demand. The shunt inverter circuit regulate translates the var orientation into a corresponds to shunt current demand and adjust gating of the inverter circuit to begin the preferred current. used for this mode of control a feedback signal instead of the dc bus voltage Vdc, is also needed.

***Mechanical Voltage Control type*:** The shunt inverter circuit useless current is mechanically regulate to maintaing the transmission line voltage at the position of correlation to a orientation value. used for this mode of control voltage feedback signals are obtain from the sending end bus feeding the shunt couple transformer. The series inverter circuit controls the magnitude and position of the voltage inject in series with the line to authority of flow of power flow on the line. The real value of the inject voltage can be obtain in a number of behaviors.

Straight Voltage insertion type: The orientation i/ps are in a straight line the magnitude and phase position of the sequence voltage.

Phase position Shifter Emulation type: The orientation i/p is phase dislocation b/w the sending end voltage along with the receiving end voltage of the system .

Procession Impedance Emulation type: The orientation i/p is an impedance value to inserted in series along with the line impedance.

***Mechanical Flow of Power Control type*:** The orientation i/ps are values of true power and useless power to maintaining on the transmission line even though system change.

III.REVIEW OF REAL CODED GENETIC ALGORITHM

The **genetic algorithm (GA)** is a search heuristic that mimics the process of natural evolution. This heuristic is regularly used to produce useful solution to optimization and search problems. Genetic algorithms belongs to the larger class of evolutionary algorithms (EA), which produce solution to optimization troubles utilizing techniques motivated by normal progress, such as inheritance, mutation, selection, and crossover.

Genetic Algorithms are the relations of computational model motivated by progression. Those Algorithms predetermine a potential explanation to a definite problem on a easy DNA like Data construction and apply recombination operator to those structures so as to conserve dangerous in order heritable algorithms are repeatedly viewed as function optimizers even though the range Of troubles to that heritable algorithms has been apply is fairly broad An realization of a genetics of algorithm begin with a population of naturally random chromosomes. One then evaluate those structures and allocate reproductive opportunity in such a system that those DNAs. That represent a enhanced solution to the objective trouble are given extra chances to generate than those DNAs which are of poorer qualities of solution.

The kindness of a explanation is naturally definite with admiration to the current peoples. This fastidious explanation of a heritable algorithm is deliberately conceptual, because in some intelligence the word heritable algorithm has two meanings In a severe analysis the heritable algorithm refers to a model introduce and investigate, by John Holland and through students of Holland that is still the case that the majority of the accessible. theory for genetics algorithms apply either exclusively or mainly to the model introduce by Holland as well as variation on what will be referrers to in this document as the canonical genetics of algorithm current hypothetical advanced in model genetics of algorithms also be appropriate mainly to the canonical genetics of algorithm. In a broader practice of the word a genetics of algorithm is any people's based representation that utilizes choice and recombination operator to produce new model points in a seek space.

Many genetics of algorithm models has been introduce by researchers mostly operational from an investigational point of view Many of those researchers are applications sloping and are naturally involved in genetics of algorithms as optimization apparatus. The aim of this lesson is to current genetics of algorithms in such a way that students Newton, this field can grab the essential concepts at the back genetics of algorithms, as they work during the class It must allow the extra complicated reader to receive this matter with relation ease The lesson also covers topic such as inversion that have at times been misunderstand and misrepresented by researchers modren to the field The lesson begins with a very small level argument of optimization to together introduced basic thoughts in optimization as well as fundamental concept that communicate to genetics of algorithms. In this division a canonical genetics of algorithm is reviewed. In this section the attitude of hyper plane example filings explore and some essential crossover operators are introduce. In division a variety of versions of the diagram theorem are developing in a step by step manner and other intersect operator are discuss In division binary alphabets and their belongings on agitated plane example are consider, In division a succinct censure of the scheme theorem is consider and in division an correct model of the genetics of algorithm is developing The last 3 divisions of the lesson cover another forms of genetics of algorithms and evolutionary computational models together with specific similar implementations.

IV. SIMULATION CIRCUIT & RESULTS

A three phase fault is simulated at the load end at 0.1 s and cleared after 0.3s with the UPFC located at the midpoint of the transmission line. For comparison, the system response is obtained with conventional controller tuned with lead-lag compensator, simple GA (SGA) and real-coded GA (RCGA). It is observed from the figure.4 that with the conventional controller implemented in simple Linear Phillips-Heffron (LPH) model, the system rotor phase angle oscillates continuously at the post fault condition and damping is not achieved. For conventional controller implemented in Modified Linear Phillips-Heffron (MLPH) model, damping is achieved after duration of l00ms and when compared to LPH model steady state is achieved. With conventional GA based UPFC controller, though the damping has improved, the oscillations prolonged till 70ms and the change in magnitude is high. But with the improved GA-based UPFC controller, the oscillations have been completely damped out nearly 60ms and the system comes back to original steady state condition with lesser oscillation.

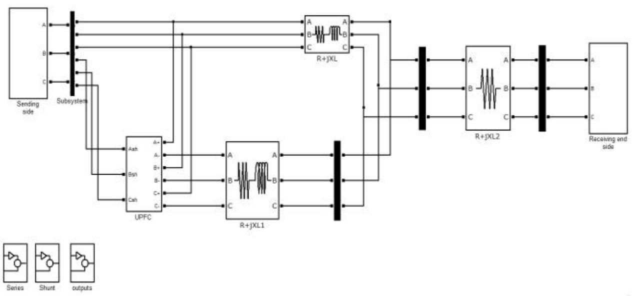
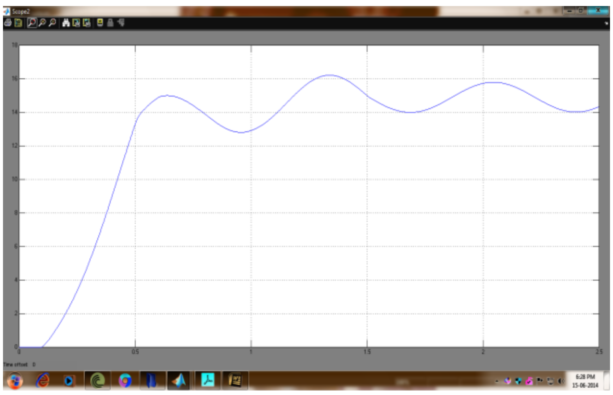
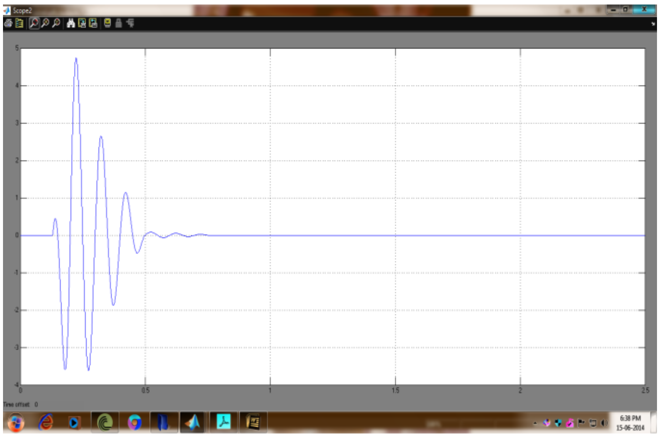


Fig.2. Simulation circuit for Real Coded Genetic Algorithm based UPFC Controller

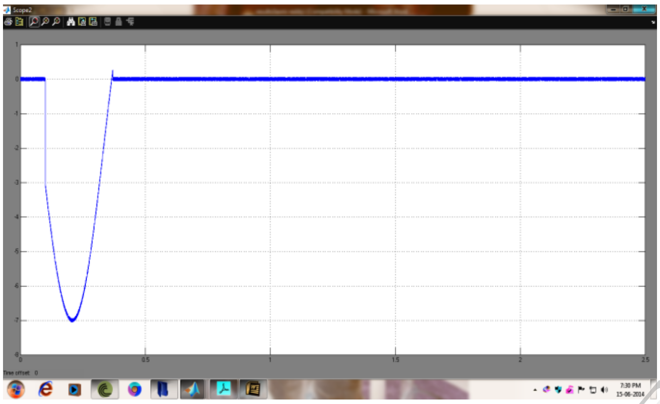
Without upfc:-



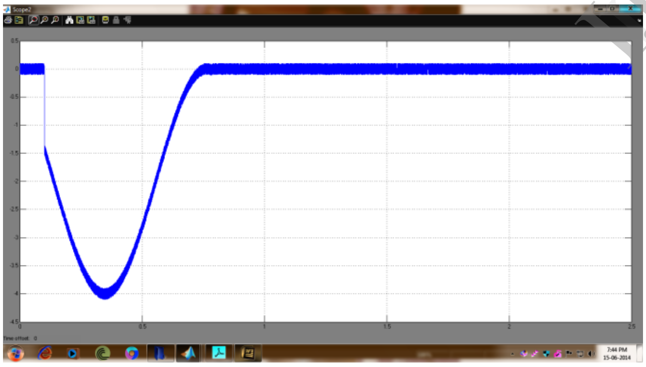
conventional upfc:-



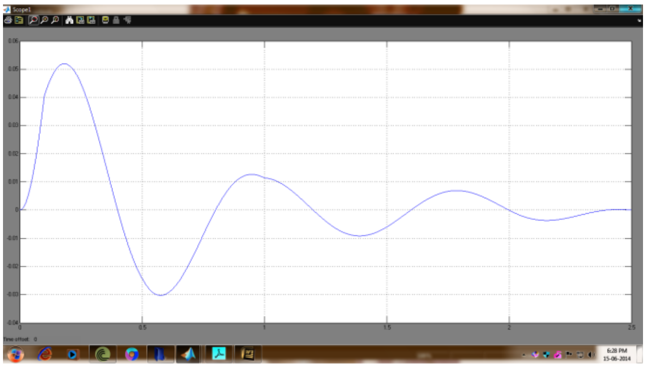
Ga upfc:-



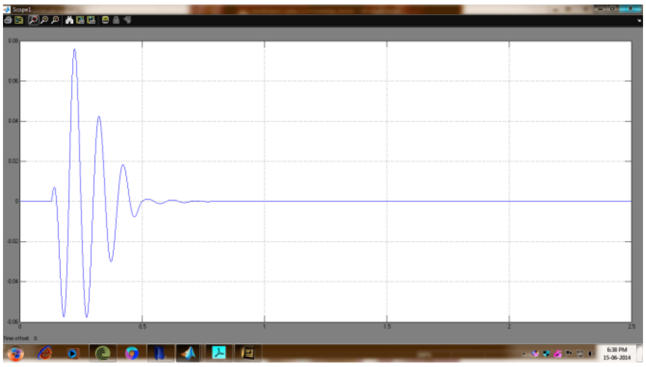
rcGa upfc:-



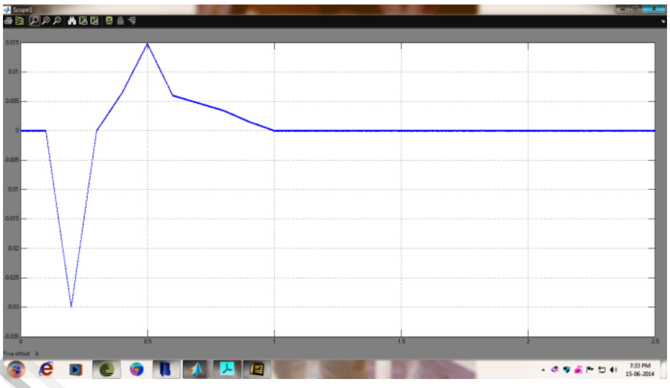
without upfc:-



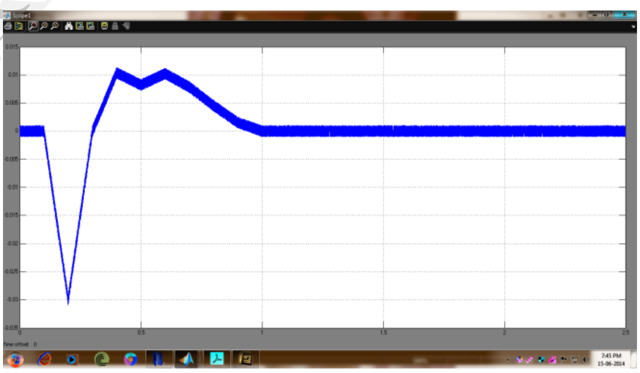
conventional upfc:-



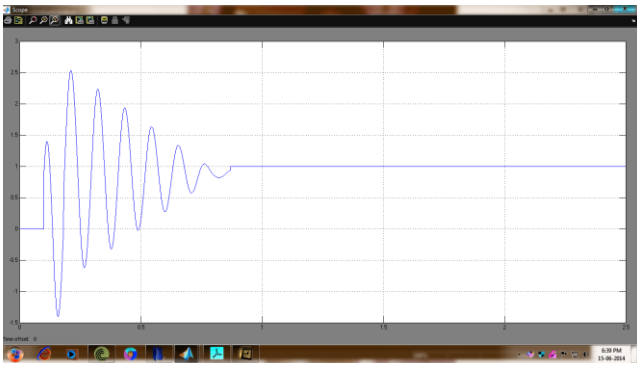
Ga upfc:-



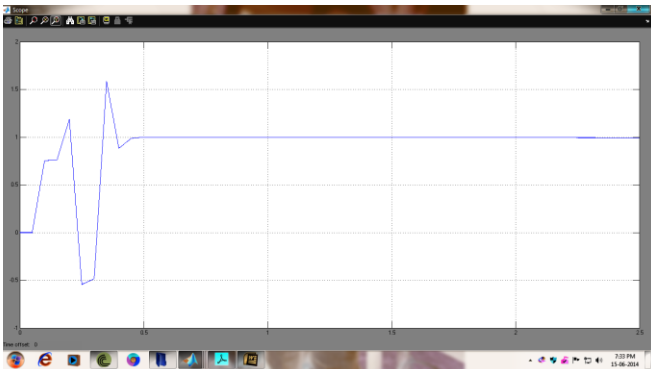
rcGa upfc:-



conventional upfc:-



Ga upfc:-



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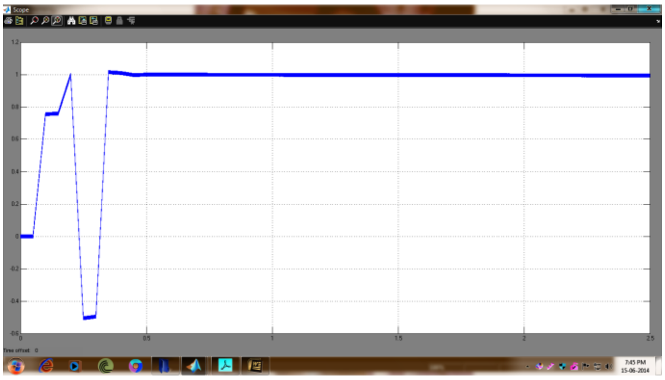
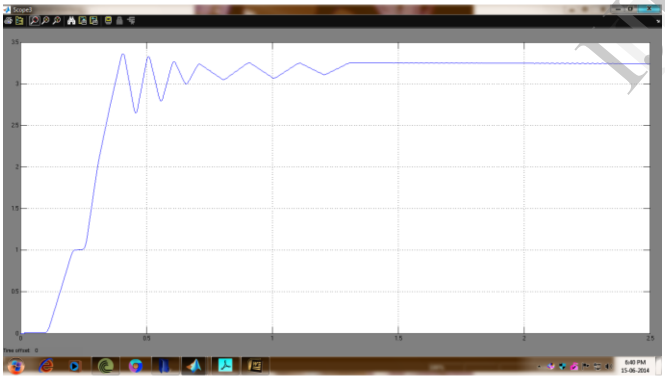
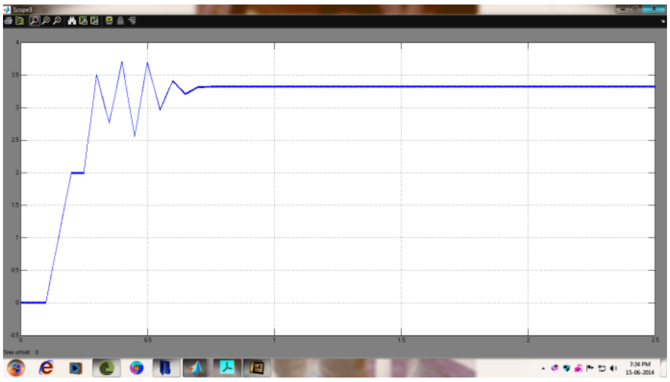


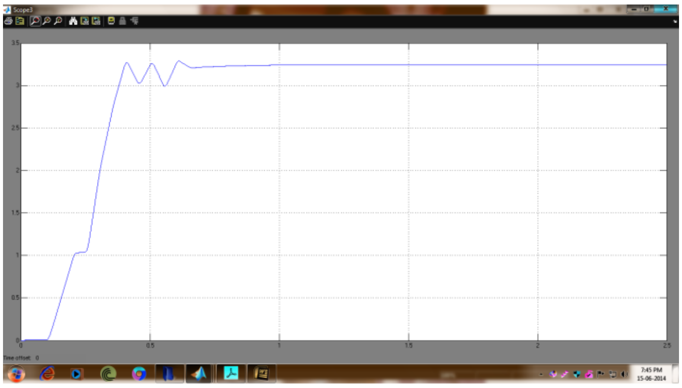
conventional upfc:-



Ga upfc:-



rcGa upfc:-



V. CONCLUSION

It presents an improved GA technique for controller parameter tuning in auxiliary controller for UPFC. In this improved GA based approach, the optimization variables are represented as floating point numbers in the genetic population, and the cross over and mutation operators that can directly deal with floating point numbers were used. The performance of the algorithm in obtaining the optimal values of controller parameters has been analyzed through computer simulation. The simulation results show that the improved algorithm has resulted in minimum value of ISE, peak overshoot and minimum settling time than the conventional method and the traditional Binary coded GA.

Also it shows that the improved GA is able to tune the controller parameter satisfactorily. Further the improved algorithm takes less time for convergence when compared with the conventional GA.

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