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A Study on Application of Genetic Algorithm in Engineering

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ABSTRACT: The application of Genetic Algorithms (GA) in handling the engineering problems has been a key issue among researchers and practitioners in the area of systems and engineering research, operations research and management sciences in the past decades. Conventional methods and stochastic search limitations paved the way to wide applications of GA optimization techniques in tackling problems related to engineering and sciences. This paper project a state-of-the-art survey of applications of GA technique in engineering.

I. INTRODUCTION

GA is a type of evolutionary algorithm (EA) that is found to be useful in so many engineering applications which also includes numerical and combinatorial optimization problems, filter design as in the field of Signal processing, designing of communication networks, semiconductor layout, spacecraft [1,2] and so on. GA founded on the bases of natural biological evolution process which is used to mimic nature in searching for optimal solution of a specific problem [3]. In the explanation of GA, the description of chromosome and fitness functions is of supreme importance. Chromosomes are intellectual representation of candidate solutions. Fitness function is used in quantifying the desirability of a solution, which is closely linked with the objective of the algorithm or optimization procedure. The fitness level is used in appraising candidate solutions, that is, the values being generated characterize the presentation of candidate solutions [4].In GA, the most favourable search space areas are being discovered through the utilization of probabilistic rule, hence minimizing the risk of convergence to local minima. This is attained by simultaneously considering many points in the exploration space and favouring the mating of the fitter individuals [3, 4]. GA is a robust search algorithm that enables the quick location of high quality solution areas in a complex and large search space. Among the numerous advantages of GA is its capability of considering individual population with each population representing a solution to the problem & it gives superiority over other exploration algorithms. The fundamental principle of GA includes selection, reproduction, population solution, encoding and decoding, fitness function evaluation and convergence [4,5].

II.APPLICATION OF GENETIC ALGORITHM

A. Functional magnetic resonance imaging (fMRI)

A common framework for the optimization of experimental design in functional magnetic resonance imaging (fMRI) using GA was suggested in [6]. A technique for choosing design factors and a particular sequence of events in functional magnetic resonance imaging (fMRI) was presented. GA was developed to maximize statistical power and psychological validity by choosing a design factors and a particular succession of events in functional magnetic resonance imaging. Also, the merits of using GA structure for optimization were also investigated by ; the competence of operating with any type of model, permitting for very precise parameterization of experimental states, including nonstandard trial models and experimentally examined scanner autocorrelation, and its flexibility concerning fitness criteria.The outcomes obtained demonstrate that the GA optimization generated designs execute better than the arbitrary designs.

B. Real time FFT Processor architectures

High power and performance necessity which are serious design issues in wireless system was addressed in [7] & it proposes the utilization of GA for the optimization of word length for both data and coefficients in real time pipelined fast Fourier transform (FFT) processor design. It was revealed that different domain ranges influences on the speed of

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the exploration, value and the turbulence & the GA converges towards a given solution. However, this method has an improved performance with lesser error at their outputs and can be used for most digital signal processing tasks that need real time operation.

C. Metamaterial-Based Electrically Small Antennas

Hybrid optimization technique to analyse meta-material based electrically small antennas was proposed in [8]. A hybrid of GA-Mat lab based model was used in the optimization of the far-field radiation behaviours of a system. The system is a model of an ideal radiating system made up of an electrically small electric dipole antenna put in an electrically small multi-layered metamaterial shell system [8]. GA optimization results were engaged to get the upper and lower solution space bounds that were required to calculate the supreme total radiated power obtained from the MATLAB optimization package, thereby optimizing the total radiated power of this system.By applying this technique of GA-MATLAB mix which gives a better performance in design of antennas.

D. Unified power quality conditioner

An innovative system for the parameters optimization of the Unified Power Quality Conditioner (UPQC) using Genetic Algorithm (GA) was presented in [9]. This work aims at augmenting the behaviours of UPQC compared to frequency variations. A new-fangled GA based method was offered intending to make UPQC resolve most power problems taking advantages of series and shunt active power filters to balance the deformations of both source voltages and load currents while taking into account the complex structure that utilizes several elements working as one. It was shown that the GA optimized parameter has an improved performance and more effectual when compared to the traditional methods.

E. Sigma-delta Modulators for Wireless Transceivers

A GA-based optimization of sigma-delta modulators for wireless transceivers was presented in [10]. It was aimed at designing and optimization of a very linear sigma-delta modulator for wireless applications. They projected the utilization of a multi-bit 2-2 adapted cascaded sigma-delta modulator design that is suitable for Wireless Local Area Networks WLAN receivers [10]. A search engine based on GA was built for the fast and simple design of sigma-delta modulator which can competently search for solutions with diverse characteristics and enables trade-off's amongst diverse designs deliberations. The design models and mathematical results showed the effectiveness of the projected method as it has been effectually used to progress the performance of a 2-2 cascaded feed forward sigma-delta ADC which is projected for WLAN applications. Moreover, it was employed for traditional second order feedback topology to realize peak SNR values with noble constancy.

F. Reactive power problem

A multi-objective GA for reactive power optimization was presented in [11]. The work attempts to solve the reactive power dispatch problem by minimizing the losses and maximizing of the voltage stability margin applying Multi-objective Genetic Algorithm (MOGA) [11]. The paper also attempts to assign reactive power sources in such a manner to achieve the minimization of the active power transmission loss and maximization of the voltage stability margin. This method proved to be more efficient than other methods as estimated on the IEEE 30-bus and IEEE 57- bus test system.

G. Sensor network optimization

A competent technique based on GA to solve sensor network optimization problem was described in [12]. It Attempts to solve the problem of minimizing the number of cluster heads in a wireless sensor network for enlightening the efficiency of the algorithm and reduce channel contention was undertaken. Another concern is that overall sensor network lifetime can be reduced due to the effect of long communication distances between sensors and a sink [12]. This method was to cluster a sensor network into a number of autonomous clusters employing the GA technique so as to significantly diminish the entire communication distance. GA method produced competent results thus making it dependable for solving the problem of clusters and their placement in a wireless sensor network.

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H. Power Consumption in VLSI Circuit

Khan et al. [13], was proposed a modular technique for optimization of power consumption in VLSI circuit. Appropriate optimization technique reflecting on the various potentials in multiplier design was employed [13]. Reduction in Power dissipation in a VLSI circuit was offered considering the inconsistent effect of the design parameters on the overall performance of the system. Outcomes obtained show that data complexity and various arrangement of gate level digital circuit has considerable influence in power dissipation and that the physical design of the chip can be optimized using GA.

I. Gridable Vehicles

A GA based cost-emission optimization of unit commitment integrating with Gridable vehicles was presented by Wu, et al [14]. This work suggests a multilayer structure of vehicle-to-grid (V2G) system supported by the concept of Gridable vehicles (GVs). Analysis on unit commitment incorporating with GVs using the suggested structure was proposed too [14]. GVs can take and store energy from the power grid as loads, as well as give energy back to the grid as resources. GA was utilized in minimizing the total running cost while examining the constraints and minimizing the emissions caused by the V2G system by intelligently scheduling the generating units and GVs. Experimental analysis and results shows the decrease in system emissions, running cost and improvement in the system reserves. Subsequently the spinning reserve and reliability of the system were enhanced.

J. Spur gear optimization

Spur gear optimization using GA was proposed by Mohan and Seshaiah (2012). The objectives of the spur gear design were to diminish centre distance; minimize weight of the meshing gear set and minimize tooth deflection [15]. Additionally, the problems associated with the usual design process which gives out a single result for manufacturing was addressed. The design results, evaluation, comparison and analysis show that GA methods gave more number of solutions out of which the best solution is chosen by fitness value, while traditional method gave only one or two optimal solutions.

K. Instruction scheduling for low power

Instruction scheduling for low power using GA was done by Hai and Binh (2013). This work is aimed at optimizing power consumption in embedded system engineering with emphasis on embedded systems that use battery power source thereby plummeting power cost of processor(s) and extending the lifetime of the system. In designing the GA for the scheduling problem, Hai and Binh employed the technique introduced by C. Moon et al. using analytically two open source simulation tools namely, Simple Scalar Tool Set and Simple Power algorithms [16]. The simulation results showed that GA is a superior technique for the problem of scheduling for low power, with a large search space and an intricate optimal solution thus authorizing efficiency of the work.

L. Orthogonal frequency division multiplexing(OFDM) & field-programmable gate array(FGPA)

The Optimization of OFDM systems using GA in FPGA was proposed in [17]. The work aimed at evading the complications and challenges of the intricate prohibitive task of optimal subcarrier, bit and power allocation in practical communication systems. Projected solution dividing the problem into two by first finding the optimal allocation of subcarriers to users, and then finding the optimal allocation of bit and transmit power for each user was put forward. The keyshortcoming of the algorithms earlier projected is their high computational complexity. In addition, this subcarrier and power allocation to each user at basestation maximize the user data rates, subject to constraints on total power and bit error rate. The planned genetic search aids quick convergence and can take care of large allocations of subcarriers to users with no performance degradation. The GA technique was utilized because of its suitability for optimum resource allocation.

III. CONCLUSION

This paper presents about numerous applications of GA in power optimization related problems. The need for the optimization of parameters or factors in order to attain precise goals, progress the performance and competence of system power was scrutinized. In addition to that various GA optimization methods used by scholars & scientist around

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the world for optimization and now a days it has been improved by hybridizing GA technique with other heuristic methods forsolving optimization problems in different fields of engineering.

REFERENCES

[1] OlesyaPeshko "Global Optimization Genetic Algorithms" McMaster University Hamilton, Ontario ppt presentation 2007 page 25
[2] Rajib Kumar Bhattacharjya. "Introduction To Genetic Algorithms" Department of Civil Engineering. Indian Institute of Technology Guwahati. 19 October 2012
[3] G.C. Chen, and J.S. Yu, "Particle Swarm Optimization Neural Network and Its Application in Soft-Sensing Modeling," Lecture Notes in Computer Science Vol. 3611, pp. 610– 617, 2005.
[4] S.F. Ding, L. Xu, C.Y. Su, et al., "Using Genetic Algorithm to Optimize Artificial Neural Networks," Journal of Convergence Information Technology, Vol. 5, pp. 54-62, 2010
[5] A.He, K. K. Bae, T. R. Newman, J. Gaeddert, K. Kim, R. Menon, L. Morales-Tirado, J. J. Neel, Y. Zhao, J. H. Reed, and W. H. Tranter, "A survey of artificial intelligence for cognitive radios," IEEE Trans. Veh. Technol., vol. 59, no. 4, pp. 1578–1592, May 2010.
[6] Tor D. Wager and Thomas E. Nichols, "Optimization of experimental design in fMRI: a general framework using a genetic algorithm". NeuroImage 18 pp 293–309, 2003.
[7] NasriSulaiman and TughrulArslan, "Non-Uniform search domain based Genetic algorithm for the optimization of real time FFT Processor architectures", 2006 IEEE Congress on Evolutionary Computation. Vancouver, BC, Canada July 16-21, 2006.
[8] AycanErentok and Richard W. Ziolkowski, "A Hybrid Optimization Method to Analyze Metamaterial-Based Electrically Small Antennas" IEEE transactions on antennas and propagation, vol. 55, no. 3, pp 731-741 March 2007.
[9] ChellaliBenachaiba, OttmaneAbdelkhalek, Samira Dib, Mohamed Haidas. "Optimization of parameters of the unified power quality conditioner using genetic algorithm method" ISSN 1392 – 124X information technology and control, Vol.36, No.2, 2007.
[10] Babita R. Jose, P. Mythili and J. Mathew. "GA-based Optimization of Sigma-delta Modulators for Wireless Transceivers" Engineering Letter, 16:4, EL_16_4_02. November 2008.
[11] P. ArunaJeyanthy and D. Devaraj."Multi-objective genetic algorithm for reactive power optimization including voltage stability" International Journal of Engineering Science and Technology Vol. 2 (7), pp 2715-2729, 2010.
[12] Ehsan Heidari and Ali Movaghar. "An efficient method based on genetic algorithms to solve sensor network optimization problem" International journal on applications of graph theory in wireless ad hoc networks and sensor networks (GRAPH-HOC) Vol.3, No.1, March 2011.
[13] Zamin Ali Khan, S. M. Aqil Burney, JawedNaseem, KashifRizwan. "Optimization of Power Consumption in VLSI Circuit" IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 2, pp 648-653, March 2011.
[14] Diyun Wu, K.T. Chau, Chunhua Liu and ShuangGao. "Genetic Algorithm Based Cost-emission Optimization of Unit Commitment Integrating with Gridable Vehicles" Journal of Asian Electric Vehicles, Volume 10, Number 1, pp 1567-1573, June 2012.
[15] YallamtiMurali Mohan and T.Seshaiah."Spur gear optimization by using genetic algorithm" International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622, Vol. 2, Issue 1, pp. 311-318 311, Jan-Feb. 2012.
[16] Bui Ngoc Hai and Nguyen Ngoc Binh. "Instruction Scheduling For Low Power Using Genetic Algorithm" International Journal of Information Technology & Computer Science (IJITCS), ISSN No : 2091-1610, Volume 7, No 3, pp 33-38 : Issue on January / February, 2013.
[17] S.Venkatachalam and T.Manigandan. "Optimization of OFDM systems using Genetic Algorithm in FPGA" TECHNIA – International Journal of Computing Science and Communication Technologies, ISSN 0974-3375, Volume 5 Number 2, pp 854-859, January 2013.