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Damage identification in composite plate by genetic algorithm

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Abstract: Fiber reinforced composite plates are increasingly utilized in the manufacture of mechanical, civil aircraft and high performance structures due to their excellent fatigue resistance, longer durability as compared to metallic structure. Cracks induced in the mechanical elements cause severe failure. In the present scrutiny, methods have been developed for damage recognition in composite plate using genetic algorithm technique. Due to high stiffness-to-weight ratio, Glass fiber reinforced epoxy composite involved in the investigation. The first three relative natural frequencies are applied in fault recognition process and relative crack depth and location are anticipated using genetic algorithm. The results from GA model are found to be in close agreement with simulation results.

Keywords: composite plate, relative natural frequency, genetic algorithm.

I. Introduction

Fault recognition is one of the vital characteristics in Instrument machineries for economic advantagesand safety reasons. Vibration based techniques can be beneficial to identify flaws in constructions bymany nondestructivemethods. Genetic algorithm (GA) is an optimization methodology for solving both constrained and unconstrained problems. Genetic algorithms are based on principles of genetics and evolution. Finding the best solution among a number of possible solution is the strength of this evolutionary computation technique. Therefore GA is a powerful tool for solving different optimization problems.

II. Literature Survey

In preceding years, several stochastictechniques have been used for recognition of fault in structural members. A neural network technique for crack detection in sandwich composites have been presented by Agosto et al. [1]. In that research two carbon fibre/epoxy matrix face sheets laminated onto a urethane foam core.A crack recognition technique for identifying fault in a shaft have been proposed by Xiang et al. [2]. The fractured shaft was modeled by wavelet-based elements to acquireprecise frequencies. Genetic fuzzy hybrid learning algorithm (GFHLA) for training the radial basis function neural network (RBFNN) was anticipated by Zheng et al. [3]. Crack recognition of a cantilever beam using fuzzy logic systems and finite element analysis was analyzed by Parhi and Choudhury [4]. The fuzzy controller uses the hybrid membership functions as input and trapezoidal membership function as output. Natural frequency of laminated composite plate under fixed boundary condition using artificial neural networks (ANN) was evaluated by Sekharareddy et al. [5]. The ANN model was established using multilayer perceptron (MLP) back propagation algorithm. Dash [6] analyzed the multicrack detection of structures using fuzzy Gaussian technique. Fuzzy logic technique and curve fitting in Matlab for the problem of crack have been presented by Andhale and Wankhade [7]. Damage identification in steel cantilever beam using genetic fuzzy controller have been investigated by Agarwalla et al. [8]. First three relative natural frequencies and first three relative mode shape differences of fractured cantilever beam have been used for developing the GA-Fuzzy controller. Mungla et al. [9] analyzed to identify crack location and it's severity by the frequency based method and genetic algorithm (GA). The crack on the beam was generated using wire cut electro discharge machining process (WEDM).

III. Fault Recognition Strategy

The finite element analysis is developed for the fractured cantilever composite plate to find the natural frequencies at different crack depth and location. The length (L), width (W) and thickness (H) of plate are taken as 1000mm, 1000mm, 10mm respectively. Due to high stiffness-to-weight ratio, Glass fiber reinforced epoxy composite involved in this study.

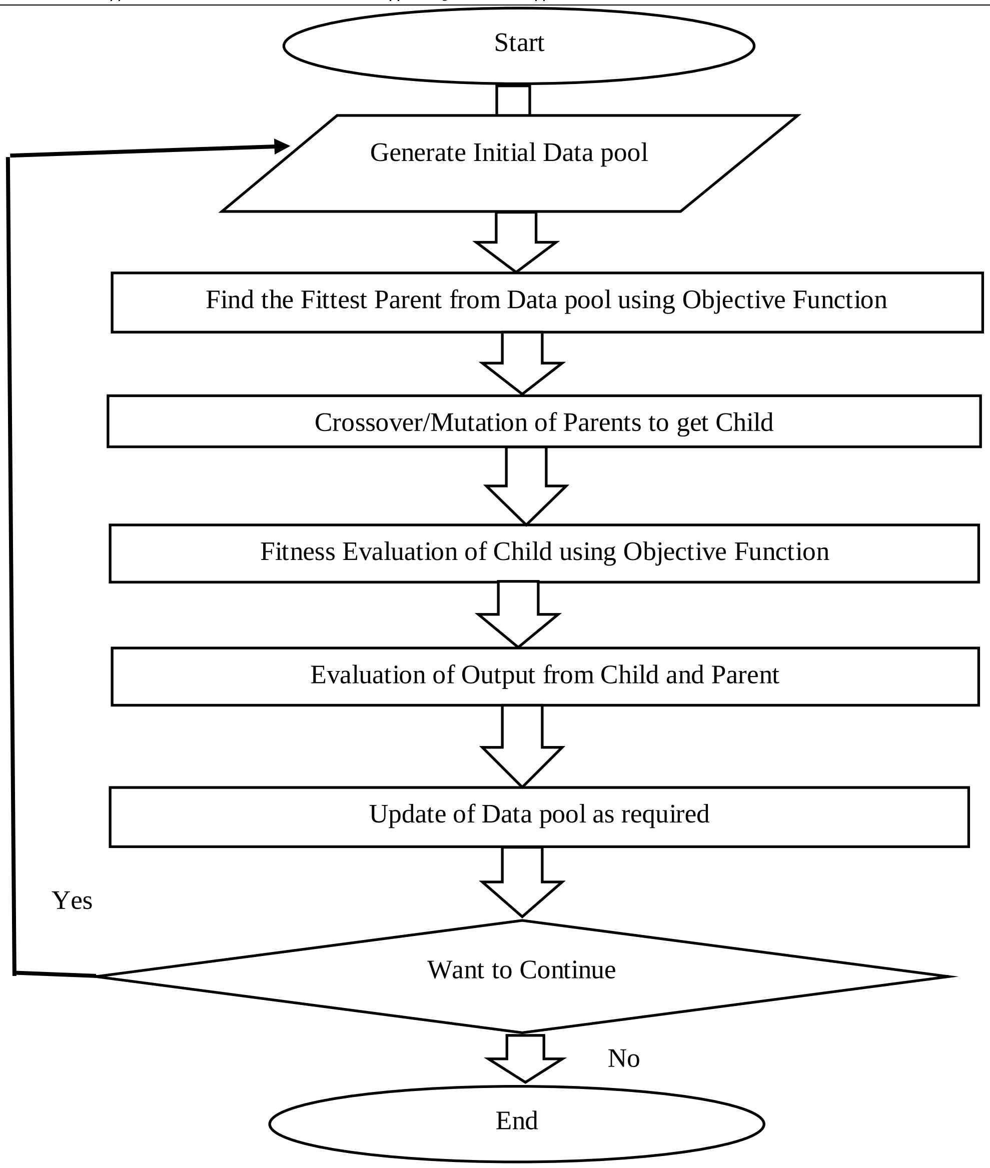

Fig. 1 Flow chart for the Genetic Algorithm Controller

The suitable formulation of a fitness function can lead to optimize solution in GA based method. The minimization of the objective function provides the best result in the search space. The calculated values of the relative first natural frequency (RFNF), relative second natural frequency (RSNF), relative third natural frequency (RTNF), relative crack depth (RCD) and relative crack location (RCL) from finite element analysis are utilized for generating the initial data pool of predetermined size. Each distinct data set from the created data pool signifies the chromosomes of the GA model. In the present study, a genetic controller is used to recognize the relative crack depth and relative crack location. The designed controller uses three inputs and two outputs. The first three relative natural frequencies are the inputs to the genetic controller and the relative crack depth and relative crack location are the outputs. Fig. 1 shows flow chart for genetic algorithm.

IV. Results And Discussion

The comparison of results between GA model and finite element analysis is shown in Table 1. It has been perceived that errors in the prediction of relative crack depth and relative crack location using genetic algorithm are within 2.18% and 4.47% respectively. Fig. 2 and Fig. 3 show that the values of GA controller may be less or may be more than the original values.

Table 1. Comparison of results between GA model and Finite element Analysis

Relative first natural frequency (RFNF)	Relative second natural frequency (RSNF)	Relative third natural frequency (RTNF)	Relative crack depth (RCD)	Relative crack location (RCL)	RCD using GA	RCL using GA
0.18111	0.07684	0.14978	0.8	0.97	0.789	0.986
0.17852	0.07488	0.14904	0.875	0.94	0.878	0.952
0.17936	0.07522	0.14909	0.825	0.91	0.807	0.923
0.18072	0.07573	0.14912	0.775	0.88	0.786	0.884
0.17568	0.07342	0.14863	0.925	0.85	0.942	0.888

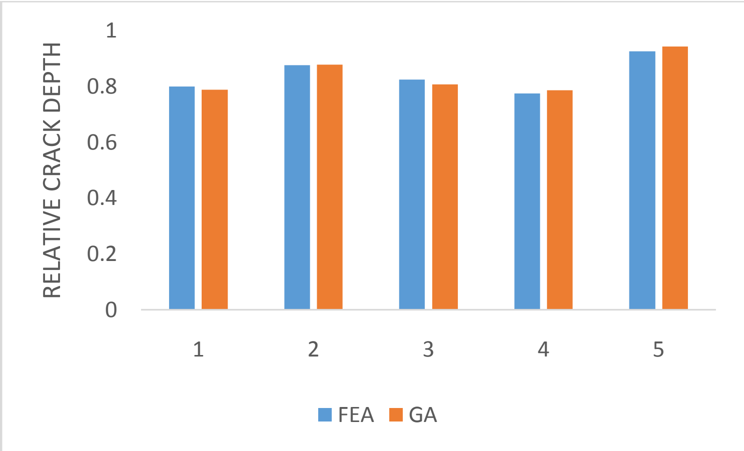

Fig. 2 Comparison of results for RCD

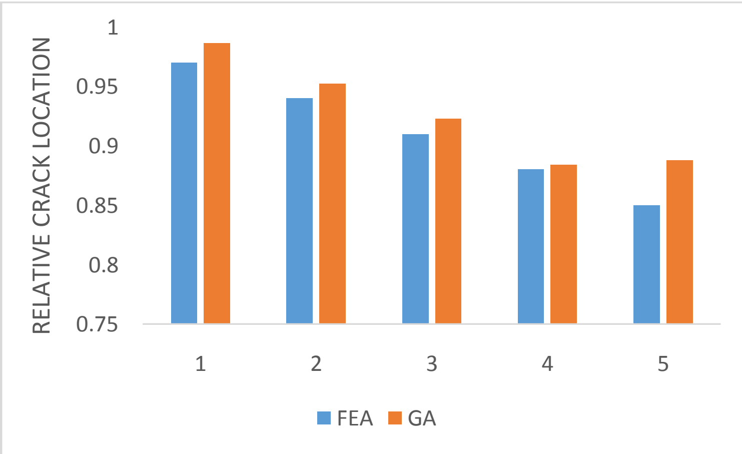

Fig. 3 Comparison of results for RCL

V. Conclusions

The subsequent conclusions can be drawn from currentinvestigation of the composite plate having v-notch:-

- The anticipated genetic algorithm provides results for crack depths and their locations in close vicinity to the finite element analysis.
- Genetic algorithm is applied to eliminate the errors in final results.
- GA strongly influences the computation time required as well as efficiency of results.
- GA provides results with peakprobableexactness, but the time required makes this methodoccasionallyunsuitable for fault recognition problems.

References

[1]. Agosto, F.J., Serrano, D. and Shafiq, B. (2008), "Neural network based nondestructive evaluation of sandwich composites",*Composites: part-B*, pp. 217-225.

[2]. Xiang, J.,Zhong, Y., Chen, X. and He, Z. (2008), "Crack detection in a shaft by combination of wavelet-based elements and genetic algorithm", *International journal of solids and structures,* pp.4782-4795.

[3]. Zheng, S., Li, Z. and Wang, H. (2011), "A genetic fuzzy radial basis function neural network for structural health monitoring of composite laminated beams", *Expert systems with applications*, pp. 11837-11842.

[4]. Parhi, D.R., Choudhury, S. (2011), "Smart crack detection of cantilever beam using fuzzy logic with hybrid membership functions", *Journal of engineering and technology*, Vol.3, pp. 270-279.

[5]. Reddy, M.R.S., Reddy, B.S., Reddy, V.N. andSreenivasulu, S. (2012), "Prediction of natural frequency of laminated composite plates using Artificial neural networks", *Journal of Engineering*, pp. 329-337.

[6]. Dash, A.K. (2012), "Analysis of adaptive fuzzy technique for multiple crack diagnosis of faulty beam using vibration signatures", *Hindawi publishing corporation*, pp. 1-16.

[7]. Andhale, Y.S. andWankhade, S.R. (2014), "Free vibration of cracked structure", Vol.2, Iss.6.

[8]. Agarwalla, D.K., Khan, A.S. andSahoo, S.K. (2016), "Application of genetic fuzzy system for damage identification in cantilever beam structure", *Procedia engineering*, pp.215-225.

[9]. Mungla, M.J., Sharma, D.S. and Trivedi, R. (2016), "Identification of a crack in clamped-clamped beam using frequency based method and genetic algorithm", *Procedia engineering*, pp.1426-1434.