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Advanced Civil Engineering Optimization by Artificial Intelligent Systems: Review

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Abstract

Artificial intelligence is the ability of computer systems to perform tasks which otherwise need human brain. Those tasks include visual perception, decision-making, speech recognition and translation between languages. Large amount computing resources is required to traditionally design and optimize complex civil structure in traditional method. This can be effectively eased by using intelligent systems. This paper lists out some of the methods and theories in the application of artificial intelligent systems in the field of civil engineering.

Keywords: Artificial, Intelligence, Fuzzy, Civil, Construction, Optimization

I. INTRODUCTION

The term Artificial Intelligence was used in a conference held at Dartmouth College in 1965.It is a complex discipline involving computer science, cybernetics, psychology, neurophysiology, linguistics, information theory. It involves the research and development, design and application of intelligent systems.

Artificial Intelligent systems aims to carryout human brain functions by select algorithms and codes. This paper lists out the previously published papers and their research field to apply artificial intelligence in civil engineering and construction works. This paper may complement already published literary survey articles that (1) may provide foundation or play major role for the improvement of AI systems (2) would put forth the levels of development and areas of development in artificial intelligence systems (3) would help future researchers for improvement. This article explains intelligent optimization methods that can be applied in civil engineering using Artificial Intelligence systems.

II. METHODS OF INTELLIGENT OPTIMIZATION IN CIVIL ENGINEERING

In the field on civil engineering especially in design, construction management and decision making were influenced not only by using mathematics, physics and structural behaviour but also on the decision making capabilities which involve experience of practitioner. This experience may include illogical, imprecise and incomplete data. This cannot be handled using traditional procedures. However Artificial Intelligent systems have advantage of solving and decision making by imitating experts using past known data.

Adam and Smith[5] presented progress in adaptive civil engineering structures. For an active tensegrity structure in a controlled framework, multi objective shape control, self-diagnosis and reinforcement learning were implemented. Among the available artificial intelligence based computational techniques, adaptive neuro fuzzy systems are most suitable one for analysing the model systems with known input and output data. Such type of fuzy systems are efficient to model non-linear, complex and ambiguous behaviour of materials based on cement undergoing single, dual and multiple damage factors in various forms of civil engineering. The durability properties of self-consolidating concrete for various sodium sulphate exposure regimes were calculated using Fuzzy logic by Bassuoni and Nehdi[6]. An artificial neural network (ANN) system was employed by Prasad et al[7] to predict the 28th day compressive strength of self-compacting concrete (SCC) and high performance concrete (HPC) with high volume of fly ash. Lee et al[8] using back propagation neural networks, an artificial intelligence technique, carried out the slope failure assessment. Numerical research technique was employed to evaluate the effectiveness of artificial intelligent techniques to evaluate the slope failure potential. Shaheen et al[9] proposed a system to extract information from experts that can be used to develop rules of fuzzy system. To illustrate the features of this system, a tunneling case study was used. To predict the maximum dry density (MDD) and to predict the unconfined compressive strength of cement stabilized soil a set of two artificial intelligent systems was described by Das et al[10].

A. Genetic Algorithm

Genetic algorithms (GAs)[11] is a famous algorithm using principle of evolution by Darwin and his theory of Survival of the fittest in optimization. It can be extensively used in the field of civil engineering and construction techniques but have to be extensively evaluated in order to show future developments.

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Now a days, the developments in genetic algorithms has introduced various mathematical tools and has found its extensive use in civil engineering design and models. We can look forward to the development in civil engineering design, optimization and construction techniques along with growth in computer technologies. To schedule linear construction projects, Senouci and Al-Derham [12] presented multi-objective optimization model based on genetic algorithms. This can be used by planners to evaluate optimal or close to optimal construction plans that minimise both time and cost.

B. Genetic Programming

The model of computer programming that uses the idea of evolution of biological organisms to solve complex evaluation problems is known as genetic programming[13]. Hybrid method integrating genetic programming (GP) and simulated annealing (SA), called GP/SA was used in estimating the base shear of plane steel structures which are subjected to earthquake loading by empirical model produced by Aminien et al[14]. Hsie et al[15] integrated two optimization techniques called the Levenberg Marquardt(LM) Method and the genetic operation tree (GOT) and proposed a new approach called LMGOT. To generate optimization tress(OT) that represent the structures of the formulas , LOT adapts genetic algorithm which is famous to solve discrete optimization problems. The results obtained showed a formula to determine the length of pavement transverse cracking, and also proved that LMGOT was way more efficient to build an accurate crack model. Plate strength formulations that can be applied to metals that possess the property of non-linear stress strain curve such as aluminium and stainless steel alloys was obtained by genetic algorithms and neural networks by the work of Cevik and Guzelbey[16]. The buckling strength in terms of Ramberg-Osgood parameters of rectangular plates can be determined by the proposed formulations.

C. Swarm Intelligence

Metaheuristics in view of swarm insight, which recreates a populace of straightforward people developing their answers by associating with each other and with the environment, have indicated promising execution on numerous troublesome issues and have turned into an extremely dynamic research region lately.

1) Particle Swarm Optimization

Another population based optimization that empowers various number of solutions, known as particles to move through hyper dimensional search space to search and find ideal is known as Particle Swarm Optimization (PSO). Each particle has a position and velocity vector that are adjusted during every iteration by learning from a local best by the particle on its own and globel best from the whole complete swarm. When modelling a system where multiple solutions of a candidate exists and collaborates simultaneously, PSO applies embed method of solving problems in a social network and they are suitable for optimization of very high complex systems. The previously mentioned technique is also being successfully applied.

The application of particle swarm optimization to design and optimize the parameters of tuned mass damper control scheme to achieve the best results in reducing the response of a building subjected to earthquake excitations was given by Shayeghi et al[17]. The results of analysis showed that the TMD control designed by PSO has excellent capacity to reduce the seismically excited example building. In order to mitigate the vibration buildings using magnetorheological dampers, ideal fuzzy logic control was expressed by Ali and Ramaswamy[18]. The FLC parameters were optimized by micro-genetic algorithm and Particle swarm optimization. Improved vibration control for the structures subjected to earthquake vibrations was provided by this approach.

2) Ant Colony Optimization

Ants living in colonies communicate with each other by pheromones to accomplish complex tasks such as establishing the shortest route from nest to food source. Ant colony optimization tries to mimics this behaviour. Ant colony optimization for constrained engineering design problems was presented by Kaveh and Talatahari[19]. They also applied ACO to ideally design different engineering problems. To solve portfolio section problems Kaveh and Talatahari[19] introduced Pareto Ant colony optimization, a specialized meta-heuristic approach. He to compare its performance with other heuristic approaches also used computational experiments with random experiments.

D. Neural Networks

A more efficient approach for estimating the friction coefficient using neural networks was introduced by Bilgil and Altun[21]. Neural network is one of the most promising computational tool that can be used in civil engineering. The arrived friction coefficient values were substituted in Manning equation to predict the flow in open channel so as to compare proposed neural networks based method and conventional method. The arrived results showed that the proposed neural networks were in good agreement with experimental results than conventional method. An adaptive neural network composed of Gaussian radial function was proposed by Laflamme and Connor[22] to map the behaviour of structures controlled by magneto rheological dampers. The proposed control is stimulated using three types of earth quakes.

The cost estimation of highway engineering was analysed by a model designed by Wang et al[23]. BP neural network showed promising perspective but at the cost of increased construction rates. Beams structure containing multiple traverse cracks were analysed using Neural Network controller by Parhi and Dash[24]. The results obtained from neural networks was compared with theoretical data and finite element analysis. By evaluating the performance of Neural network, it is observed that the development method can be a active diagnosition tool.

To analyse and solve complex problems (espc. In non-linear problems) neural networks is an important tool. The neural network is very much use of information technology and engineering technology by researchers. It can be widely considered in civil and

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construction engineering disciplines. The Neural network is still a cross science and may take to time to be perfected. The improvement of research in neural network in this field is in progress. And in application studies of neural networks there are still problems like the combination method of the neural network, fuzzy logic genetic algorithm, and expert system are to be rectified.

III. CONCLUSION

This paper summarizes the use of intelligent optimization systems in civil engineering and the researchers conducted in the field. On the basis of above research the optimization in civil engineering is discussed. Inexperienced people can solve engineering problems, and the efficiency of experienced user increases with respect to time. Artificial intelligence may develop and develop day-by-day as computer application is used in large numbers. Counterfeit consciousness advances step by step, as the framework in connected to an ever increasing extent and its degree in structural designing will widen.

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