

Role of Artificial Intelligence in Civil Engineering: Review

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Abstract- *Man-made reasoning is a part of software engineering, associated with the examination, plan, and utilization of savvy PC. Conventional strategies for displaying and improving complex structure frameworks require colossal measures of processing assets, and man-made brainpower based arrangements can frequently give important options to effectively tackling issues in the structural designing. This paper sums up as of late created strategies and speculations in the creating bearing for uses of man-made brain power in structural designing, including developmental calculation, neural organizations, fluffy frameworks, master framework, thinking, arrangement, and learning, just as others like disorder hypothesis, cuckoo search, firefly calculation, information based designing, and recreated tempering. The primary exploration patterns are additionally brought up eventually. The paper gives a review of the advances of computerized reasoning applied in structural designing.*

I. INTRODUCTION

The research of artificial intelligence has been developed since 1956, when the term “Artificial Intelligence, AI” was used at the meeting hold in Dartmouth College. Artificial intelligence, a comprehensive discipline, was developed based on the interaction of several kinds of disciplines, such as computer science, cybernetics, information theory, psychology, linguistics, and neurophysiology. Artificial intelligence is a branch of computer science, involved in the research, design and application of intelligent computer. The goal of this field is to explore how to imitate and execute some of the intelligent function of human brain, so that people can develop technology products and establish relevant theories. The first step: artificial intelligence’s rise and fall in the 1950s. The second step: as the expert system emerging, a new upsurge of the research of artificial intelligence appeared from the end of 1960s to the 1970s. The third step: in the 1980s, artificial intelligence made a great progress with the development of the fifth generation computer. The fourth step: in the 1990s, there is a new upsurge of the research of artificial intelligence: with the development of network technology, especially the international internet technology, artificial intelligence research by a single intelligent agent began to turn to the study

of distributed artificial intelligence based on network environment. People study not only the same goal-based distributed problem solving, but also the multiply intelligent agents problem solving, which made the artificial intelligence more practical. Additionally, a thriving scene of artificial neural network research and application emerged and it had been deep into all areas of life as the Hopfield multilayer neural network model put forward. The main theories and methods of artificial intelligence are summarized as symbolism, behaviourism, and connectionism approach. Since the appearance of artificial intelligence AI in the 1950s, a lot of hopes and dreams about it have been generated. Now we will elaborate the latest progress of artificial intelligence technology in all aspects of civil engineering and their relationship as follows. The objective of this review paper is to present highlights of references pertaining to artificial intelligence in civil engineering. Such papers will complement previously published literature survey articles that would provide the theoretical foundation or may play an important role in the development of artificial intelligence in civil engineering; would represent the levels and hotspots of current research of artificial intelligence in civil engineering; and would facilitate continued research efforts. The rest of the paper is synthesized as follows: describes artificial intelligence in civil engineering, and learning of artificial intelligence in civil engineering.

Intelligent Optimization Methods in Civil Engineering

Artificial intelligence is a science on the research and application of the law of the activities of human intelligence. It has been a far-reaching cross-frontier subject, after the 50 years’ advancement. Nowadays, this technology is applied in many fields such as expert system, knowledge base system, intelligent database system, and intelligent robot system. Expert system is the earliest and most extensive, the most active and most fruitful area, which was named as “the knowledge management and decision-making technology of the 21 century.” In the field of civil engineering, many problems, especially in engineering design, construction management, and program decision-making, were influenced by many uncertainties which could be solved not only in need of mathematics, physics, and mechanics calculations but also

depend on the experience of practitioners. This knowledge and experience are illogically incomplete and imprecise, and they cannot be handled by traditional procedures. However, artificial intelligence has its own superiority. It can solve complex problems to the levels of experts by means of imitate experts. All in all, artificial intelligence has a broad application prospects in the practice of civil engineering. Self-diagnosis, multi-objective shape control, and reinforcement-learning processes were implemented within a control framework on an active tensegrity structure. Among artificial intelligence-based computational techniques, adaptive neuro-fuzzy inference systems were particularly suitable for modelling complex systems with known input-output data sets. Such systems can be efficient in modelling nonlinear, complex, and ambiguous behaviour of cement-based materials undergoing single, dual, or multiple damage factors of different forms in civil engineering. A neuro-fuzzy based prediction of the durability of self-consolidating concrete to various sodium sulphate exposure regimes. An artificial neural network _ANN_ to predict a 28- day compressive strength of a normal and high strength self-compacting concrete _SCC_ and high performance concrete _HPC_ with high volume fly ash. An artificial intelligence technique of back-propagation neural networks to assess the slope failure. The numerical results demonstrate the effectiveness of artificial neural networks in the evaluation of slope failure potential. A methodology for extracting the information from experts to develop the fuzzy expert system rules, and a tunnelling case study was used to illustrate the features of the integrated system. Two artificial intelligence techniques for prediction of maximum dry density _MDD_ and unconfined compressive strength _UCS_ of cement stabilized soil has been found . The results of a study that incorporates computer simulations in teaching linear scheduling concepts and techniques, in a civil engineering course “Construction Planning and Scheduling.” To assess the effect of incorporating computer simulation in teaching linear scheduling, the students’ evaluations and answers to the questionnaire were statistically compared. A methodology for designing ontologybacked software applications that make the ontology possible to evolve while being exploited by one or more applications at the same time. The methodology relies on a contract between the ontology and the application that is formally expressed in terms of integrity constraints. In addition, a reference Java implementation of the methodology and the proof-of-concept application in the civil engineering domain was introduced. Due to a lot of uncertain factors, complicated influence factors in civil engineering, each project has its individual character and generality; function of expert system in the special links and cases is a notable effect. Over the past 20 years, in the civil engineering field, development and application of the expert system have made a

lot of achievements, mainly used in project evaluation, diagnosis, decision-making and prediction, building design and optimization, the project management construction technology, road and bridge health detection and some special field, and so forth.

Evolutionary Computation

Evolutionary computation EC is a subfield of artificial intelligence, which uses iterative process often inspired by biological mechanisms of evolution to evolve a population of solution to a desired end. EC has been applied to the domain of civil engineering for several decades, mainly served as an effective method for solving complex optimization problems.

Genetic Algorithms

Genetic algorithms are one of the famous evolutionary algorithms which simulate the Darwinian principle of evolution and the survival of the fittest in optimization. It has extensive application value in the civil engineering field, but in many aspects it needs to be further studied and improved. According to the research progress above the genetic algorithm in civil engineering, due to genetic algorithm developed rapidly, so there are still a lot of improvement measures not included in this paper. In general, the improvement of genetic algorithm approaches include change the genetic algorithm component or the use of technology, the hybrid genetic algorithm, the dynamic adaptive technology, using nonstandard genetic operators, and the parallel genetic algorithm. In recent years, the improvement of the genetic algorithm introduced many new mathematical tools and absorbed civil engineering as the latest achievement of applications. We can expect, along with the computer technology, the genetic algorithm in civil engineering application will be more general and more effective, a genetic-algorithm-based multiobjective optimization model for the scheduling of linear construction projects. The model allows construction planners to generate and evaluate optimal/near-optimal construction scheduling plans that minimize both project time and cost.

Artificial Immune Systems

Provoked by the theoretical immunology, observed immune functions, principles, and models artificial immune system AIS stimulates the adaptive immune system of a living creature to unravel the various complexities in real-world engineering optimization problems. In this technique, a combination of the genetic algorithm and the least-squares method was used to find feasible structures and the

appropriate constants for those structures. The new approach overcomes the shortcomings of the traditional and artificial neural network based methods presented in the literature for the analysis of civil engineering systems. According to characteristics of diversity of the immune system, a variety of immune algorithms have proposed by realization form. But since the immune system characteristics of the application exploration is still in its initial stage, the algorithm design has many aspects for improvement, such as the realization of the algorithm, parameter selection, the theory discussion, and the immune system in civil engineering application, still needing further development.

Genetic Programming

Genetic programming is a model of programming which uses the ideas of biological evolution to handle complex optimization problems. A new empirical model to estimate the base shear of plane steel structures subjected to earthquake load using a hybrid method integrating genetic programming and simulated annealing, called GP/SA. "LMGOT," that integrates two optimization techniques: the Levenberg Marquardt LM Method and the genetic operation tree GOT. The GOT borrows the concept from the genetic algorithm, a famous algorithm for solving discrete optimization problems, to generate operation trees_OTs_, which represent the structures of the formulas. Results show a concise formula for predicting the length of pavement transverse cracking and indicate that the LMGOT was an efficient approach to building an accurate crack model. The two plate strength formulations applicable to metals with nonlinear stress-strain curves, such as aluminum and stainless steel alloys, obtained by neural networks and Genetic Programming. The proposed formulations enable determination of the buckling strength of rectangular plates.

II. FUTURE SCOPE

With the ability to digitalize engineering data, generative AI expands possibilities for human decision making, allowing humans to select the solution that optimally balances scope, cost and scheduling and drastically reduces engineering cost and time. Generative AI also greatly facilitates human and computer interaction for engineering input, review and feedback, including conversation between human and digital twins. We have summarized the main bio-inspired methods for SCM system design and optimization. It is deserved to note that swarm-based methods and artificial immune systems are not yet mature and thus are expected to gain more research interests. In civil engineering field, in the present situation, the research and development of artificial intelligence is only just starting, so far failing to play its

proper role. The combination including Artificial intelligence technology and object-oriented and the Internet is the artificial intelligence technology the general trend of development. Artificial intelligence is in its development for civil engineering in the following aspects.

1. Fuzzy processing, integrated intelligent technology, intelligent emotion technology in the civil engineering.
2. To deepen the understanding of the problems of uncertainty and to seek appropriate reasoning mechanism is the primary task. To develop practical artificial intelligence technology, only to be developed in the field of artificial intelligence technology, and the knowledge to have a thorough grasp.
3. According to application requirements of civil engineering practical engineering, the research and development of artificial intelligence technology in civil engineering field were carried out continually. Many questions in civil engineering field need to use artificial intelligence technology. Due to the characteristics of civil engineering field, artificial intelligence technology was used in many areas for civil engineering field, such as civil building engineering, bridge engineering, geotechnical engineering, underground engineering, road engineering, geological exploration and structure of health detection, and so forth.
4. Hybrid intelligence system and a large civil expert system research.
5. With the development of artificial intelligence technology, some early artificial intelligence technology need enhance and improve for knowledge, reasoning mechanism and man-machine interface optimization, and so forth.
6. To some related problems, many single function of artificial intelligent system integration can carry out, integrated as a comprehensive system of artificial intelligence, and expand the artificial intelligence system to solve the question ability.
7. Artificial intelligence technology was used in the actual application, only in the practical application of artificial intelligence technology, to test the reliability and give full play to the role of the artificial intelligence technology and to make artificial intelligence technology to get evolution and commercialize. In the commercialization of artificial intelligence technology, there are many successful examples abroad, for enterprise and socially brought considerable benefit.

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