ABSTRACT

Genetic algorithms (GAs) have found many applications in various fields such as physics, signal processing, artificial intelligence and recently construction engineering management. For a long time, GAs are usually criticized to be time-consuming, making it unpractical for real-time applications. This paper presents a new technique which can be used: (1) to automate construction activities, and (2) to improve building information modeling which has become an attractive research topic around the world. Different from the generic GA techniques employed in the literature, this paper proposes a new GA using hardware with field-programmable gate arrays. The proposed technique is shown to improve speed and lessen computational power. Hardware implementation of GA using static random access memory-based field-programmable gate arrays with synthesizable very high-speed integrated circuit hardware description language coding is introduced. Detailed analyses on the field-programmable gate arrays are given which show that it is suitable for real-time applications. As a result, GA is modified so that it can be implemented in series and parallel which can greatly improve computational hardware performance. Configuration of parallelization is available with a peripheral component interconnect interface, which further helps to form a fast optimization tool for real-time applications. The ultimate goal of this paper is thus to design an effective GA technique which can be employed to support building information modeling and to effectively automate critical processes in construction projects.

Keywords: Building Information Modeling, Field Programmable Gate Arrays, Genetic Algorithm (GA), Parallel Architecture, Speed Gain, Very High Speed Integrated Circuit (VHSIC), VHSIC Hardware Description Language (VHDL)

DOI: 10.4018/ijitpm.2014100102
1. INTRODUCTION

GA is a robust optimization method (Holland, 1975), operating on a population of solutions rather than a single point, thus increases the chance of escaping from a false local optimum point. However, GA can be slow for complex problems and is criticized to be unsuitable for real-time applications. The use of GA in solving demanding complex problems is likely to overwhelm central processing units using software methods. Thus a hardware GA processor is a direct solution to improve the GA computational speeds. Frequent simple operations such as crossover and mutation can be easily implemented on hardware parallel and pipelined architectures (Man, Tang, & Kwong, 2000).

GA has found many useful and practical applications in the field of project management. As advanced technologies evolve, complicated tasks demanding skilled operations and precise execution such as effective resource allocation, automation of parallel processes and estimation of cost, present major difficulties for project managers. Automation as one aspect of building information modeling thus plays a major role in project progressing the construction industry forward into the future. One of the attractive techniques is that GAs have been employed in other fields such as artificial intelligence and signal processing. GA technique was employed to search for an optimal form-making in (Yi, & Malkawi, 2009)’s study. In (Isaac, & Navon, 2009)’s study, GA was used as part of a stochastic model to estimate adaptive cost of several projects.

Major project management issues related to the use of GAs in construction are solving and optimizing cost and time effectiveness. Scheduling repetitive construction projects were performed using a GA to minimize project running cost (Long and Ohsato, 2009). A multi-objective financial decision support model was successfully based on a fuzzy-GA in Chinese state-owned construction firms (Lam, Ning, & Gao, 2009). The GA was effectively used in three modules: (1) roulette wheel selection, (2) stochastic universal sampling with multi-point crossover and single-point mutation, and (3) stochastic universal sampling with adaptive crossover and mutation. A GA was used as an optimizer in an evolutionary fuzzy neural inference model. The optimizer was successfully employed to minimize project running cost using a web-based conceptual technique (Cheng, & Wu, 2009). New support vector machine inference system for construction management using GA was successfully proposed in (Cheng, & Wu, 2009)’s study in which a fast messy GA approach was also employed. GA chromosome, fitness function, and model architecture were designed.

A general overview on how to possibly link construction industry and construction academics to improve automation in the construction field was comprehensively given in (Succar, 2009). Detailed design processes using GA, object-based modeling and other relevant algorithms were also discussed. Project objectives such as cost, time and productivity were shown to be optimized using a GA in employing a multi-objective design model (Gonzalez, Alarcon, & Molenaar, 2009). A hybrid strategy developed using GAs, simulated annealing and quantum simulated annealing techniques for the discrete time-cost trade-off problem (Sonmez, & Bettemir,
Tusting Computers Through Trusting Humans: Software Verification in a Safety-Critical Information System
www.igi-global.com/chapter/trusting-computers-through-trusting-humans/22893?camid=4v1a

Social Networking and Personal Learning Environment
www.igi-global.com/chapter/social-networking-personal-learning-environment/13426?camid=4v1a