Framework for Optimizing Space Layout Problem Using Agent-Based Building Occupancy Modeling

By

Dalia Hassen Taher Dorrah

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfilment of the
Requirements for the Degree of
MASTER OF SCIENCE
In
Integrated Engineering Design in Construction Projects

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Under the supervision of

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Title of Thesis:

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Key Words:
Agent-based Modeling; Queuing theory; Space Layout Problem; Multi-Objective Optimization; Modularity Approach.

Summary:
Space layout problem in buildings is a problem of allocating activities to building spaces. And with the trend occurring in the construction industry regarding incorporating sustainability measures in buildings, it has become a necessity to consider these measures in all the building requirements including the planning and design of its layouts. Applying this will enhance the efficient use of buildings, improve its performance, and offer more satisfying experience of its users. This research proposes a framework that optimizes the space planning problem in multi-purpose buildings. The framework is designed to augment both Agent-based modeling and Discrete-Event simulation techniques so as to model the building occupancies. And through the use of modularity approach and queuing theory, the modeling and simulation procedures of the various building activities are simplified but realistically studied. After the modeling stage, optimization is carried out to optimally solve the space layout problem under the different occupancy patterns modeled. Moreover, the performance assessment in the proposed framework is based on the energy consumption, flow patterns, and satisfaction of the building occupants, whereas the optimization problem is represented in the form of the multi-objective Linear Assignment minimization problem. Pairwise Pareto optimality testing is carried out for investigating the sensitivity of the optimization problem. This integrated framework is generic and can be effectively incorporated as a multi-objective decision support tool for solving large-scale space layout problems with versatile activities during the design, operation, or renovation phases.

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Dalia Hassen Dorrah

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