

Exploring Various Residential Layout Generation Using Conditional Generative Adversarial Networks (Case Study: Apartments In Districts 1 and 2 of Hamadan City)

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ABSTRACT: Artificial intelligence technology has become an influential and trending topic in architectural layout design. The core technology of AI, machine learning, has attracted the attention of architects as a decision-making tool. The focus of many studies that apply machine learning to layout design is using the generative adversarial network (GAN) within a given boundary. Previous research demonstrates that training a GAN with labels can help a computer understand how spatial elements relate and the logical relationship between spatial elements and boundaries. However, this paper applied conditional GAN to generate space layouts with given boundaries and supplementary conditions.

The supplementary conditions provide designers control over the generated layout plans by satisfying input boundary and user requirements. It also allows designers to generate different layout plans within the same boundary. To achieve this, a method for dividing image channels is proposed so that both given boundaries and supplementary conditions become the model's input. The dataset consists of 660 apartment plans in Hamadan. The dataset is split into a training set and a test set. The training set includes 594 images, and the test set includes 66 (10%) of the images. After training the model with the training set, the model is tested using the test set. Finally, the model outputs are evaluated based on quantitative and qualitative methods. The results show that the supplementary conditions provide further guidance to the model for space layout generation based on user preferences and reduce the image quality problems of the synthetic images.

KEYWORDS: *Spatial layout design, Machine learning, image-to-image translation, Conditional GAN.*

INTRODUCTION

Computer-aided architectural design was introduced in the 1950s and has since experienced different periods of development (Caetano et al., 2020). Space layout design is one of the research branches of computer-aided architectural design. It involves determining possible locations and dimensions for interrelated objects that adhere to all design requirements (Michalek et al., 2002). In other words, it proposes a layout following topological and geometrical constraints. Many objective and subjective factors influence these constraints. Objective factors could be defined as numerical rules such as design standards. However, subjective factors like aesthetics are based on the designers' expertise (Rahbar et al., 2019). There are two algorithmic approaches to generating design solutions. First, the rule-based method views the design process as an optimization problem and applies human-defined rules to find a solution that satisfies the requirements, such as a genetic algorithm (Zheng & Yuan, 2021). Researchers have used these algorithms to improve their design work in architectural research for many years.

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