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Recognizing architecture styles by hierarchical sparse coding of blocklets



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ABSTRACT

In this work, we propose a novel architecture style recognition model by introducing blocklets that capture the morphological characteristics of buildings. First, we decompose a building image into a collection of blocks, each representing a basic architecture component such as a stone pillar. To exploit the spatial correlations among blocks, we obtain locklets by extracting spatially adjacent blocks, and further formulate architecture style recognition as matching between blocklets extracted from different buildings. Toward an efficient blocklet-to-blocklet matching, a hierarchical sparse coding algorithm is proposed to represent each blocklet by a linear combination of basis blocklets. On the other hand, toward an effective matching process, an LDA [25,1]-like scheme is adopted to select the blocklets with high discrimination. Finally, we carry out architecture style recognition based on the selected highly discriminative blocklets. Experimental results on our own compiled data set demonstrate that the proposed approach outperforms several state-of-the-art place/building recognition models.

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1. Introduction

Architecture style is a way of classifying buildings largely by their morphological characteristics in terms of form, techniques, materials, etc. Recognizing architecture style is useful for scene annotation and classification. It helps to accept likely scene configurations or rule out unlikely ones. For example, a successful scene annotation system should encourage the co-occurrence of a skyscraper and crowded streets while suppressing the co-occurrence of an ancient Greek temple and a commercial district.

However, it is still challenging to deal with architecture style recognition successfully due to the following three factors:

- State-of-the-art image representations fail to effectively represent the morphological characteristics of architecture styles, such as the lattice-like spatial arrangements of arches in Fig. 2.
- The occlusions and large changes in viewpoints, such as the Cologne Cathedral and the Kuantan Mosque in Fig. 1, make it difficult to achieve a robust recognition model.
- It is infeasible to recognize architecture styles by using a single type of visual feature. Different architecture styles feature in different types of visual characteristics such as color, texture, and spatial configurations. As shown in Fig. 1, the Islamic style is discriminated from the Medieval Gothic style by its dome and spatial arrangements of pillars; while the Baroque and the Rococo style are differentiated by their decorative textures.

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Cologne Cathedral (typical Medieval Gothic style)



Kuantan Mosque (typical Islamic style)



San Carlo alle Quattro Fontane (typical Baroque style)



Kaisersaal (typical Rococo style)

Fig. 1. Example of buildings with different architecture styles.

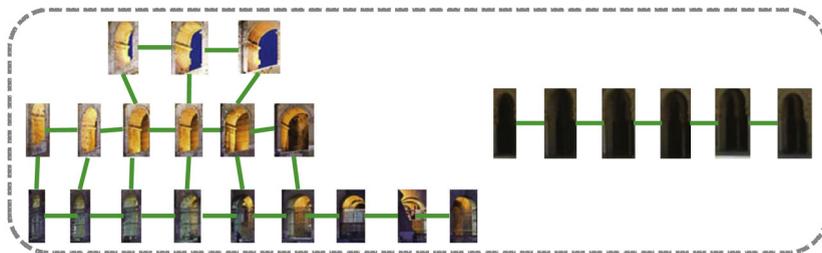


Fig. 2. Top left: Roman Colosseum with typical ancient architecture style; top right: Great Mosque of Kairouan with typical Islamic style; and bottom: the lattice-like structure captured by blocklets from the Roman Colosseum, wherein each block denotes a circular arch.

Our work closely relates to two research topics, i.e., object recognition with spatial pyramid matching (SPM) [15] and specific building/place recognition. In recent years, several approaches have been proposed in these two research topics. Such approaches can be briefly divided into three categories: global feature-based approaches, local feature-based approaches, and local-global feature-based approaches.

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