Procedural floor plan generation from building sketches

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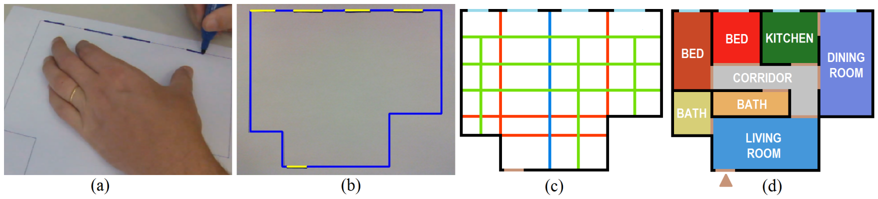

Figure 1: *The input is either a hand-drawn sketch of a building, an architectural blueprint or a real estate flyer (a). Segmentation and morphological operations are used to recover exterior walls and openings (b). The interior is subdivided according to the exterior features (c), and the resulting partition is used in the procedural room placement and expansion process to generate a floor plan (d).*

1 Introduction and Motivation

Computer graphics applications require models which are crafted by hand, requiring skill and time. In architectural applications an automated system that converts 2D floor plan images into 3D building models can be used to lower the modeling cost, and in video games procedural algorithms can be used to generate content, including cities, buildings and floor plans. One motivation to generate floor plans for predetermined building exteriors is that building generators often create only a façade without the interior. Another motivation is in planning real-world layouts, often tackled as an optimization problem (e.g. [Merrell et al. 2010] and [Peng et al. 2014]). The state of the art in [Merrell et al. 2010] uses machine learning and stochastic optimization to generate realistic layouts. However, it is unsuitable in our case because the exterior appears as a result of the layout. Our approach generates floor plans using both the building exterior and user requisites as constraints. The proposed method [Camozzato et al. 2015] handles a variety of image styles and building shapes, and the run time remains low (around 1 ms versus a 30 s optimization reported by [Merrell et al. 2010]).

2 Our Approach

We use image processing to recover exterior walls and openings. There are three distinct steps. First, the lines which encase the building are recovered, using watershed segmentation and an erosion operation to obtain the borderline, and the Harris detector to find the corners in the borderline. Second, we identify subsegments using the Sobel edge detector upon the lines encasing the building. Finally, we use K-means clustering according to mean pixel value to differentiate subsegments for walls and openings. The procedural step uses walls, openings and a list of user requisites defining desired rooms and their characteristics. First, we perform a partition of the interior by extending all exterior lines meeting at reflex angles (see Fig. 1(c), red), to separate openings (blue) and according to a wall length threshold (green), forming an irregular axis-aligned grid following the building's features. Then, rooms are placed occupying a single cell in the grid. To place a room, each eligible cell is scored according to the room's requisite, and a cell is selected with probability equal to its score. Finally, each room is iteratively expanded, first to occupy its minimum size, and then to occupy the remaining space. Connectivity is maintained during expansion, creating transition areas. Internal doors are placed considering each two rooms' adjacency and whether a connection may exist.

To evaluate the method we used 50 images obtained on the internet. For each we created a ground truth, for a total 1169 walls and 437 openings. Our method successfully identified the outline in 98.75% and differentiated openings in 94.27% of the cases. Further, the procedural step can generate different layouts with approximately the same topology to the plan created by an architect (see Fig. 2).

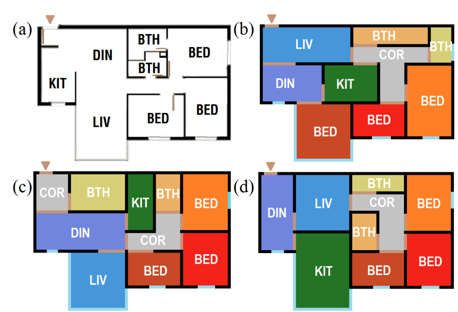

Figure 2: *A floor plan generated by an architect (a) and three procedural floor plans created from a similar architectural plan (b-d).*

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