Computer Vision Based Room Interior Design

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ABSTRACT

This paper introduces a new application of computer vision. To the best of the author's knowledge, it is the first attempt to incorporate computer vision techniques into room interior designing. The computer vision based interior designing is achieved in two steps: object identification and color assignment. The image segmentation approach is used for the identification of the objects in the room and different color schemes are used for color assignment to these objects. The proposed approach is applied to simple as well as complex images from online sources. The proposed approach not only accelerated the process of interior designing but also made it very efficient by giving multiple alternatives.

Keywords: Interior Designing, Image Segmentation, Color Schemes, SRM, Room Designing.

1. INTRODUCTION

Computer vision is concerned with the analysis, processing and automated extraction of information from images. Its applications cover almost every field of daily life, such as medical sciences [1], surveillance [2], biometric identification [3] [4], and optical character recognition for reading postal codes. Apart from these applications, computer vision has revolutionized traffic management through gathering traffic flow statistics and providing access to car parks [5], [6] [7]. This paper introduces another application of computer vision i.e. interior designing and identifies its potential market and possibilities of research.

Room interior design is the process of shaping the interior of a room, considering the psychological, environmental, architectural and traditional aspects to establish a common style and theme in the room. The Color scheme and object positioning play a very important role in creating a common theme in room interior design. A well-considered selection of color scheme can help to unify the space collection, and develop a desired atmosphere in a room and can change one's perception about the room (e.g. certain colors can make a room feel warm, cooler), and even it can affect the room's appearance i.e. makes a room feel smaller or larger (dark colors give intimate appearance while lighter colors make a room feel larger). Although the color scheme is often a personal opinion but every color has a psychological value and therefore, there are certain colors that are more relaxing and influencing on one's mood and thoughts and therefore are better suited for sleeping places, dining rooms and living rooms [8].

Selection of a color scheme for a room is not an easy task, rather a number of factors have to be considered to pick a proper combination of colors for a specific type of room that can create balance and harmony in the interior spaces. According to Kathryn Marsh [9], 8 factors including: personal color preferences, light source, room orientation, fixed and furnished elements, surfaces, nuances of color, paint finishes (includes flat, gloss and semi-gloss), place of color and personal mood must be considered in the selection of color for an interior space. Repetition of color pattern, progression, transition and contrast are some other ways of developing a theme in room interior space through color selection[1]. Due to such diverse considerations, interior designing is a time consuming, tedious and challenging process. Generally, Computer Aided Design (CAD) softwares are used for the interior designing as a simulation and visualization tool before the actual design (implementation). A number of CAD-based tools are available e.g. AutoCAD LT 2014 for PC [10], Autodesk 3Ds Max [11], TurboCAD[2] and Room Planner SEMA[3]. In CAD based room interior design, the designer

[1] http://www.interior-design-it-yourself.com/
[2] http://www.turbocad.com/

generally uses the color wheel in selection of color scheme for room interior design. However; CAD-based approaches provide a limited number of options in color selection and is also an expensive way of interior design [12]. Room interior designing can be accelerated and made more efficient by utilizing computer vision based approaches. This paper presents such an approach for the automatic selection of color scheme for an interior space. The two main tasks involved in interior design are object positioning and color assignment. In computer vision based interior design the fundamental problem is the identification of objects in the image on which further operations are performed. The other two challenges are color assignment and object positioning. The main contributions of this paper are effective object identification through efficient image segmentation and object classification algorithms, the development of color assignment schemes for different types of room and also a Graphical User Interface (GUI) control to facilitate the user in defining the color schemes and creation of new color combinations.

The rest of the paper is organized as follows. Section 2 presents the technical description of the techniques and approaches used in the proposed work while a detailed description of the dataset used for the evaluation of this work is provided in section 3. Section 4 provides the results and analysis, while section 5 draws the conclusions and identifies the potential for further work in this area.

2. TECHNIQUES AND APPROACHES

The working of computer vision based room interior design is depicted in Figure 1. The process can be carried out mainly in two steps. The first step is the identification of different objects contained in an image while in the second step colors are assigned to these identified objects. For object identification, image segmentation algorithms are used while for color assignment different color schemes are used for a better color combination among the objects in a room. Post-processing phase aims to further refine the output of the color assignment phase. These three steps are described in greater details in the following sub sections.

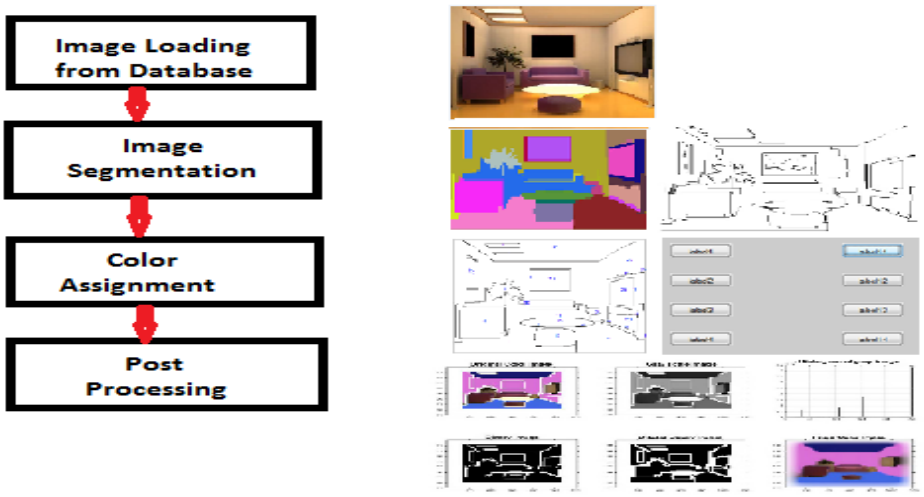


Figure 1. Block Diagram of proposed approach

2.1 Image Segmentation

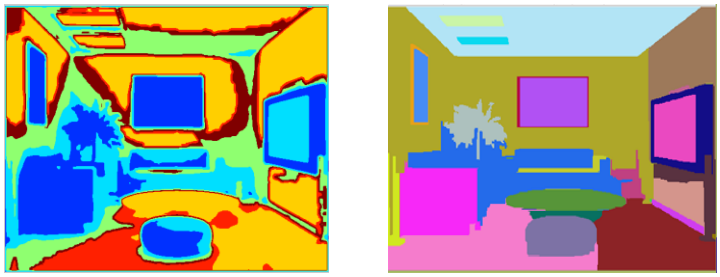
Image segmentation is used in a number of computer vision and image processing applications, such as object recognition and image compression. In room interior design image segmentation is utilized to identify or annotate various objects in the image of the room representing the regions of interest to which color are to be assigned. The various Image segmentation algorithms used in literature can be classified into three categories; data clustering based approaches, region based approaches and edge based approaches [13].

Among the various options available for the image segmentation is K-means clustering [14], edge based approaches such as the one presented by Jianping et al. [15] and some region based approaches, such as [16]. These segmentation

[3] http://www.archiexpo.com/prod/sema/interior-design-software-cad-3369-962552.html

algorithms are suitable for some specific applications, however for room interior design such an algorithm is needed which not only correctly identify all the objects in the room's image, but also to group similar objects, such as all the walls of the room and assign the same label to them. This makes it a more challenging task than ordinary image segmentation tasks. Keeping in mind the demanding requirements of the room interior design application, in this work two different segmentation algorithms have been used. One is the K-means clustering [14] and the second is the Statistical Region Merging algorithm [17]. Both of these image segmentation algorithms provide a flexibility to vary the estimated number of regions according to the complexity of the room's image.

K-means clustering algorithm originally developed for signal processing, clusters the data on the basis of distance among the data points while the SRM algorithm utilizes the intensity and color features for the segmentation. Figure 2 shows the image segmentation results of SRM and K-means clustering algorithm on a room image. From the Figure 2 it is clear that SRM has comparatively better performance than its competitor K-means clustering. In Figure 2 it can be noticed that K-means algorithm has divided the walls into different regions and same is the case with the roof while the SRM algorithm has identified all the walls as the same region (same object). The main strength of SRM algorithm that makes it a better choice for the room interior design application is its capability of merging similar objects (regions) into one region on the basis of color ranges, min and max size of a region and the number of platelets [17].



(a) (b)

Figure 2. (a) Segmentation using k-Means clustering (b) Segmentation using SRM Algorithm

Another factor favoring the use of SRM algorithm for the segmentation in this application is the adjustable threshold value "Q" representing the estimated number of regions in an image. The value for Q can be adjusted on the basis of image's complexity i.e. number of objects in the image. Similar case is with K-means clustering algorithm; variation in the value for k affects the segmentation performance.

2.2 Color Assignment

Another crucial part of the computer vision based interior room design is the selection of soothing colors. The centroid information can be utilized in assigning colors to different objects (regions) identified in segmentation phase. These objects can be labeled in two ways: firstly through blob analysis centroid of each labeled region in the segmented image is found as shown in Figure 3. The region label can also be obtained through the mouse cursor. Figure 4 shows the objects with their labels. Once the object label is obtained any color operation can be performed on it. In Figure 4, colors have been assigned to all objects in the room. Just selecting the labels can reassign the colors of any objects.

Although room color selection depends on personal choice but there are some colors that are more relaxing, serene attractive and sophisticated, therefore are best suited for certain rooms. For example, red color is more suitable for living and dining rooms, yellow color is most suited for the kitchens, dining room and bathroom, and blue color is better option for bedrooms and bathrooms. Therefore, the proposed application also selects these colors by default depending on the nature of the room. For color assignment we have two schemes. One is to assign pre-selected colors to different regions identified in the room by utilizing different properties of regions e.g. length, width and area etc. through regionprops function. If one is interested to make its own color combination he/she can access the objects to assign them colors of their own choice.

A Graphical User Interface (GUI) has been developed to provide user interface to access different objects in the image and to perform color assignment operations on these objects. Buttons are used for accessing the objects and selection of color to be assigned to the selected object. In Figure 5 (a), label 11 is selected to assign a new color to it. Once the label is selected, a new window will open with a number of options of colors to be assigned to selected object (represented by the selected label). Figure 5 (b) shows the window representing the sample colors, from possible options of colors that can be assigned to the selected object.

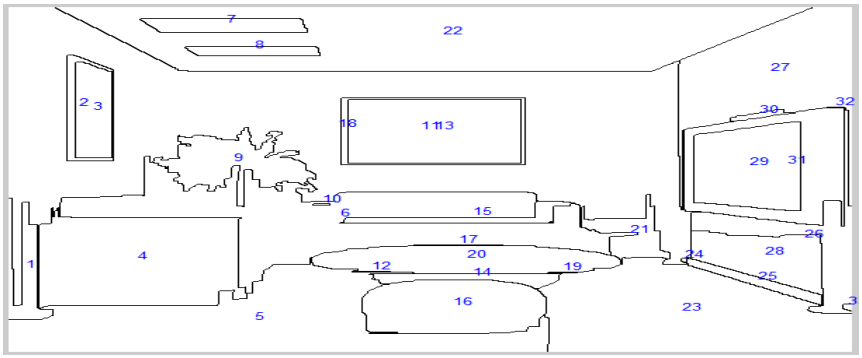
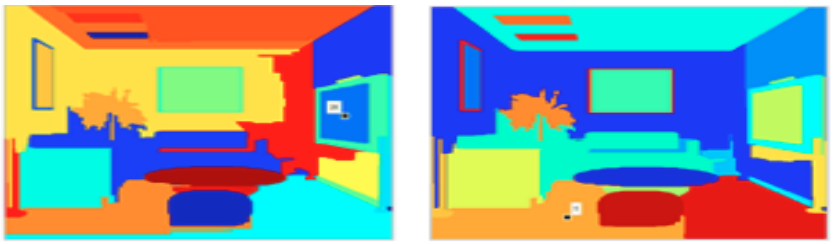
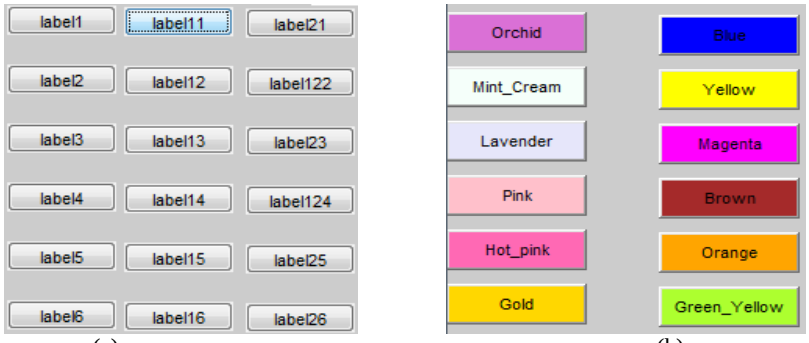


Figure 3. Segmentation output image with labels and centroid of each object



(a) (b)

Figure 4. (a) Television's label is displayed (b) floor's label



(a) (b)

Figure 5. (a) Lebels's GUI for objet's selection for assigning color: Label 11 being selected (b) GUI for color selection

2.3 Post-Processing

The post-processing phase aims to enhance the resultant images of the color assignment phase. In Figure 7 (b), there is some overlapping as well as some small regions due to the limitations of image segmentation algorithms. In this phase image dilation approach is used as post-processing step to wrap-up the unwanted regions. The resultant image of color assignment phase is first converted to binary image and then dilated to identify the pixels that need to be used to fill in holes. After dilation, the red, green and blue color channels are extracted and combined to-gather to get the true color RGB image back. Results of this phase are shown in Figure 12 in following section 3.

3. DATA SET

The dataset used for the evaluation of the proposed approach for room interior designing is composed of images of different categories including images of bed rooms, living rooms, dining rooms, study rooms and kitchen, thus covering most of the common application of interior design. To the best of author's knowledge computer vision based room interior design has never been carried out before and no standard dataset exist for this application, therefore, the images in the data set used for the evaluation of proposed work are taken from online sources. The complexity of the images varies according to the nature of the room. There are images with large number of objects as well as room's images with less number of objects. Figure 6 shows a few sample images from the dataset.

Figure 6. Sample images from the data set

4. RESULTS

The proposed approach relies on the image segmentation algorithms for the identification of different objects in a room's image. The segmentation results are shown in the figure 2 and figure 3 of section 2.1 and 2.2, respectively. As far as the results of the color assignment phase are concerned, the resultant GUI for color assignment phase and the resultant room's image with new color combination are shown in figure 7 (a) and 10 (b), respectively.

(a) (b)

Figure 7 (a) Graphical User Interface for color selection (b) Resultant room's image with new colors

In post-processing phase, the resultant images of phase 2 are passed through a number of steps to cover the unwanted small regions (e.g. the wavy white regions in above Figure 7 (b) among the different regions of interest. Figure 8 shows the results of post-processing phase.

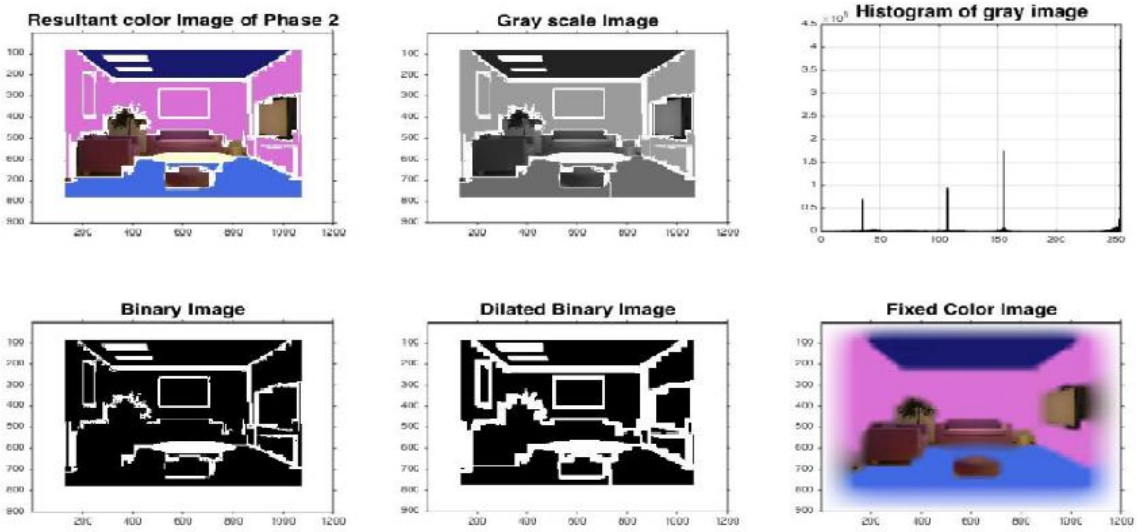


Figure 8. Results of post-processing phase

5. CONCLUSION

The two main tasks involved in room interior design are the color assignment to the objects in the room and the positioning of the objects. The research work presented in this paper automates the color assignment task through the automatic identification of objects in the image of the room and the color assignment to these objects. To the best author's knowledge this is the first attempt on the use of the computer vision for this application. The traditional CAD based room interior designing approaches are less efficient and time consuming. The introduction of computer vision based approaches can potentially make the room interior designing fast and accurate. In the future, this work can be extended to include the object positioning.

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