REAL-TIME INTERACTIVE EXTERNAL LABELING FOR DYNAMIC VISUALIZATIONS

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ABSTRACT

This paper presents a real-time interactive external labeling algorithm for automatically placing labels on moderately complex 3D models. The proposed approach considers a set of constraints for the label placement, adjusts the label density on the projected screen, and designs two essential adjustment actions and a two-level label placement strategy based on the sort-and-sweep method to implement the contour-based adaptive external labeling and optimize it as the uniformly distributed label arrangement. The experimental results show that the proposed method produces high-quality label placement and compares favorably to the state-of-the-art labeling technique, thus providing practical utility for various interactive applications and having great potential for future Virtual Reality and Augmented Reality applications.

Keywords: External labeling; interactive scene; visualization; label placement.

1 INTRODUCTION

Illustrating complex objects composed of distinct parts is essential in many application fields, such as technical illustrations, anatomy drawings, and maps. Labeling the short textual annotations that connect the visual and verbal information plays a critical role in efficiently understanding the objects. One of two main labeling methods, external labeling, has been studied in computer science from a theoretical and practical point of view over the last twenty years [1]. However, most researchers focus on studying the labeling problem from a fixed viewing specification or restrict labeling objects [2, 3]. This paper presents a general real-time external labeling algorithm to place labels automatically with visual constraints.

2 PROBLEM STATEMENT

Labels represent textual or symbolic descriptions of the model's parts. An illustration with external labeling consists of a projected model, labels outside the model, and their corresponding leader lines connecting the labels with the corresponding model parts. Only straight-line segments are used in this paper. One endpoint of the leader line is restricted to the center point of the annotated model part. The other endpoint of the leader line is a point on the boundary of the label, which is restricted to one corner or the midpoint of one particular edge of the label.

The rules adapted to the needs of dynamic external labeling point features are as follows. The label should be placed outside the point feature with a small leader line length. The number of leader crossings should be minimized. There is no label overlapping. The labels are distributed evenly.

3 INTERACTIVE LABELING METHOD

The proposed method is a screen-space technique operating in a view plane where the 3D models are projected. The method adjusts the labels' positions at every frame to satisfy rules in a dynamic environment.

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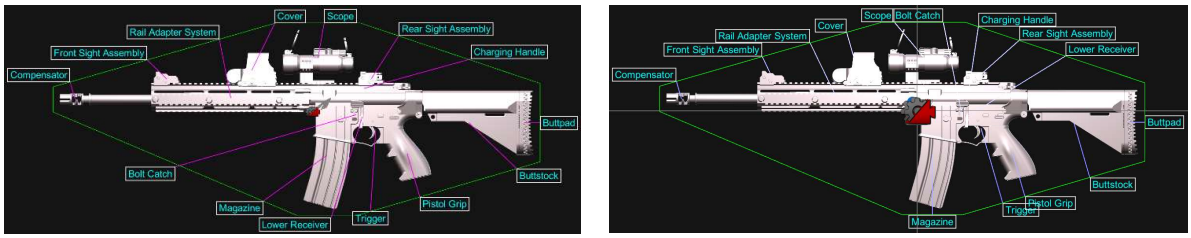
Firstly, the screen is divided into four regions, and the anchor points of the model are placed into these four regions accordingly. Then, the number of anchor points in each zone is adjusted to make the density of each area consistent. Next, the initial value of the reference point is calculated, and the initial value corresponds to the coordinate value of the label. After that, the annotations in each partition are checked for intersection or overlap, and if so, they are adjusted. Following this, a global list of labels is maintained to detect intersections or overlaps, and overlapped labels or intersecting leader lines are adjusted.

4 EXPERIMENTAL RESULTS

The proposed approach is implemented in the Unity game engine to demonstrate its unique ability to place labels automatically when the viewpoint changes and compared with the method of Ali et al. [1], shown in Figure 1.



(a) (b)

Figure 1. Label placement of the 3D Rifle model. (a) The label layout for the Rifle model using the proposed method. (b) The label layout for the Rifle model using the method of Ali et al. [1].

5 CONCLUSIONS

This paper proposed an interactive annotation placement algorithm for automatically placing external labels for 3D models and has experimented with it in several objects. This approach fulfills the desired objectives of labeling algorithms and behaves consistently over time during viewpoint changes. Compared with the forced-based method, this method is competitive in accuracy, label distribution, or temporally coherence. The proposed method has excellent potential for future Virtual Reality and Augmented Reality applications that require interactive annotations.

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