



Temporally Stable Boundary Labeling for Interactive and Non-Interactive Dynamic Scenes: Supplementary Material

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ARTICLE INFO

Article history:

Received 28th August 2020

Keywords: boundary labeling, label layout, temporal coherence, stability, interaction, dynamic scene, visualization

ABSTRACT

We propose two novel temporally stable screen-space labeling methods for dynamic scenes. The first one is suitable for offline processing of the entire interaction or the video in advance. The second method is designed for interactive applications. The main idea of our proposed methods is to minimize the vertical and horizontal movement of the labels during the interaction with the scene (*e.g.*, zooming or translating the camera). According to the results of quantitative evaluation, our labeling is more stable during the interaction than labeling produced by the current state of the art. Moreover, participants of a comprehensive user study declared that the labeling produced by the proposed methods allows them to follow moving labels significantly more accurately, and it is significantly more pleasing than with previously published methods. Furthermore, the proposed methods can be extended by the prominence of the features and easily parameterized to fit different requirements to the label layout.

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1. Introduction

This document is a supplementary material to the *Temporally Stable Boundary Labeling for Interactive and Non-Interactive Dynamic Scenes* paper. We present a detailed description of the tasks that participants fulfilled during the user study. We expect that the reader has already read the paper and will look into the paper while reading the supplementary material.

2. Detailed Description of the Accuracy Experiments

In this section, we present a detailed description of the tasks evaluated in the Accuracy Experiments. To see all the three described tasks being fulfilled, please look at the supplement-

ary video.¹ Please note that the participants tried each task on a demo scene to get familiar with the task before they started fulfilling the task.

2.1. Task 1: Assign Label to Highlighted Anchor

The first task was to find the label associated with a highlighted anchor. An image with a labeled scene was presented to the participant. After one second, one of the anchors was highlighted. The participant had to find the label associated with the highlighted anchor and press the space-bar. Then only the labels (without text) remained visible on the screen, and the participant had to click on the associated label. The participant was instructed to click on free space between labels if s/he was not able to find the associated label. We measured the reaction *time*, measured as the time between highlighting the anchor and pressing the space-bar, and the *error rate*, measured as the

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¹Supplementary material is available at the project page <http://cphoto.fit.vutbr.cz/interactive-labeling/>

number of wrongly selected labels relative to all selected labels. When the participant could not decide which label belonged to the highlighted anchor, we counted this as an error. The whole process was repeated 30 times (10 different labels in 3 different scenes). After each scene, we have presented to the participant three statements:

1. It was easy to select the correct labels.
2. I was able to find the correct labels fast.
3. I was confident that I was selecting the correct labels.

The participants indicated their subjective agreement or disagreement with each statement on Likert scale from 1 to 5.

2.2. Task 2: Assign Anchor to Highlighted Label

The second task was to find the anchor associated with a highlighted label. The task was similar to task 1. An image with a labeled scene was presented to the participant. After one second, one of the labels was highlighted. The participant had to find the anchor associated with the highlighted label and press the space-bar. Then only small boxes around each anchor remained visible on the screen, and the participant had to click on the associated anchor. The participant was instructed to click on free space between the boxes if s/he was not able to find the associated anchor. Similarly, as in task 1 the reaction *time* and the *error rate*. The whole process was repeated 30 times (10 different labels in 3 different scenes). After each scene, we have presented to the participant three statements:

1. It was easy to select the correct anchors.
2. I was able to find the correct anchors fast.
3. I was confident that I was selecting the correct anchors.

The participants indicated their subjective agreement or disagreement with each statement on Likert scale from 1 to 5.

2.3. Task 3: Follow the Moving Label

The third task was to follow a certain label moving in time and then select the label. The task was similar to tasks 1 and 2. An image with a labeled scene was presented to the participant. After one second, one of the labels was highlighted. The participant pressed the space-bar, then the highlight of the label disappeared, and the animation started playing with the speed of 10 frames per second. The participant had to follow the movement of the initially highlighted label. After two seconds, the animation stopped, and only the labels (without text) were displayed on the screen. The participant should have clicked the label that s/he was following. The participant was instructed to click on free space between the boxes if s/he was not able to find the correct label. In this task, we measured the *error rate* only. Again, the whole process was repeated 30 times (10 different labels in 3 different scenes). After each scene, we have presented to the participant two statements:

1. The label layout made it easy to follow the labels.
2. I didn't have to focus hard to be able to follow the labels.

The participants indicated their subjective agreement or disagreement with each statement on Likert scale from 1 to 5.

3. Detailed Description of the Preference Experiments

In this section, we present the detailed description of the tasks evaluated in non-interactive and interactive environments. To see all the three described tasks being fulfilled, please look at the supplementary video¹.

3.1. Non-Interactive Environment

The stimuli were represented by three different video sequences presented in a web browser, and we evenly distributed them among the participants. Each participant was sequentially stimulated by a pair of videos produced by the tested labeling methods.

At the beginning of the experiment, participants were familiarized with the experimental procedure by the written instructions:

1. When the test starts, you will be able to play two animations, please play both of them.
2. During each playback, try to focus on your personal feeling about the visual presentation of labels (label layout).
3. Afterward, you will be asked if you prefer the first or second label layout.

During the experiment, participants were able to play the assigned sequence as many times as they wanted. The names of the methods were transcoded with numbers.

3.2. Interactive Environment

The stimuli were represented by an interactive visualization of mountain terrain presented at resolution 1200x900, where the independent variable was the labeling method. During the experiment, participants were guided along the same predefined path above mountain peaks. Each participant was familiarized with the experimental procedure by the written instructions:

1. This study aims to assess four interactive labeling techniques for dynamic scenes. The estimated time to complete the study is approximately 20 minutes.
2. The presented scene is set in the Alps where you can:
 - fly above mountain tops following the predefined path by holding the Up key (forward) or the Down key (backward),
 - stop whenever you want to by lifting your finger from the Up or Down key,
 - rotate the camera by pressing the left mouse button and moving,
 - zoom in and out by mouse wheel, and
 - return to the beginning of the path by pressing the Z key.
3. Your goal is to rank the four methods "1", "2", "3", "4" from the most preferred to the least preferred method. You can use prepared cards to establish the ranking continuously during the study.

4. Please focus predominantly on the assessment of the label placement and the movement of the labels in the time.
5. Throughout the study, you can change the method any time by pressing the corresponding numerical key. The name of the selected method is available in the top left corner of the application window. You can change the method as many times as you want.
6. Please let the supervisor know whenever you are satisfied with the final ranking of the methods or when you need assistance.

At the end of the experiment, participants were asked to describe their decision process and to justify their ranking.