Adaptive Annotation Layout in Projection-Based Mixed Reality by Considering Its Readability

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Abstract

Superimposing annotations on physical objects such as the 3-D model of a human body in projection-based mixed reality can help our understanding of the objects. For the projection-based annotation, it must be carefully considered that the readability of the annotation varies according to the shape and texture of the object's surface. In this paper, we propose a method which applies a genetic algorithm (GA) to compute the adaptive layout of superimposing annotation on an arbitrary surface so that the readability is not much degraded. This paper also shows the result of a psychophysical test which was carried out to investigate the issue.

Keywords: Projection-based mixed reality, readability, optimal layout, superimposing annotation

1 Introduction

Annotations help our understanding of objects. In recent years, much research has been studied that automatically calculates an appropriate layout [1]. For superimposing annotations for real 3-D objects, mixed reality (MR) has been used. This paper aims at superimposing annotations to the real object surface using projection-based MR. In that case, there is a problem that the readability of a projected annotation significantly degrades when the shape and texture of a projection surface spatially vary.

Therefore we propose an adaptive annotation layout technique which computes the readability of each annotation projected on a non-planar and textured surface.

2 Proposed Technique

The flow of the proposed technique is shown in Figure 1. The input is the shape and texture data of object, labeling problem (annotations and their regions) and position of projectors. An energy-minimizing optimization using the genetic algorithm then generates the adaptive layout of annotations by considering the readability of projected letter.

3 Evaluation of the Readability of Projected Letter

It is thought that distortion and the shadow of a projected character, and the contrast of a background color to a projected letter affect the readability of a projected image. So we conducted a psychophysical test to investigate the issue. In the experiment, the projected result of an alphabet on a non-planar surface was simulated. The gauss noise was added to the generated image. Examinees observed the image displayed on the screen and answered which character was projected.

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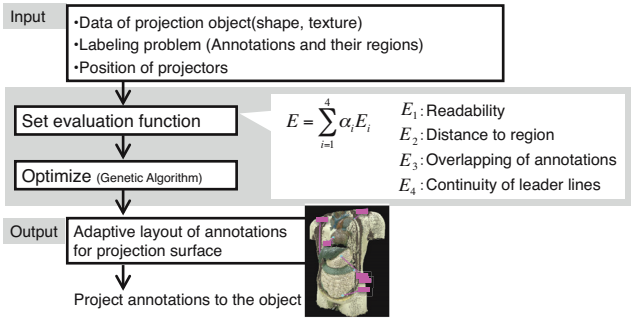

Figure 1: Flow of the proposed technique

The index of readability R is defined as the maximum quantity of the gauss noise in that the examinee could answer correctly. The result was fitted to a plane by the least-square method as follows:

$$R(D,O,C) = a_1(C) + a_2(C)D + a_3(C)O \quad (1)$$

where D is an average of the distance of each pixel of the character domain from a position in simulation image to the position in case that it is not distorted, O is a rate of the portion that is invisible from a virtual viewpoint or a virtual projector position, and C is the contrast of a background color to a projected letter. a_1, a_2, a_3 are represented by the continuous function using C as follows: $a_1(C) = 395.368 - 753.654C + 390.324C^2$, $a_2(C) = -9.11365 + 11.2027C$, $a_3(C) = -100.728 - 273.116exp(-7.259C)$.

In order to evaluate that the function R can estimate the readability of projected characters in real environments, we conducted the subject experiment. Subjects observed alphabets projected on real 3-D objects and ranked them according their readability. As a result, the correlation coefficient between the average value of the ranking which all the subjects answered and the value of readability calculated by R was -0.829. Therefore, it is thought that the readability of the projection character in real environment is computable using the proposed function R.

4 Conclusion

We proposed a technique that computes the adaptive layouts of superimposing annotation by considering the readability of projected letter. We conducted a psychophysical test to evaluate the readability of projected letter and defined the model function of the readability.

We plan to construct a layout system of annotation by using this result of the experiment.

References

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