Cross-ratio Based Natural View Object Recognition for Mobile AR

Hyejin Kim, Sang-Goog Lee and Woontack Woo

I. Introduction

In upcoming ubiquitous computing environment, the number of smart objects will increase and various services will be hosted by these smart objects. Therefore, it is necessary to show the information and services of smart objects in order to aid users for an easy access. As a part of this purpose, the vision-based AR (Augmented Reality) has played an important role in the visual communication between smart environment and users.

In this paper, we propose a method to recognize smart objects based on invariant cross-ratios for indoor mobile AR. This method supports natural view recognition, longer distance (2m~3m) recognition and improving running speed without marker compared with fiducial marker based or local feature based method.

II. Cross-ratio based Natural View Object Recognition

A. The Overall Procedures

Figure 1 shows the overall procedures of cross-ratio based natural view object recognition. It consists of input images, off-line steps, on-line steps and output information-id and other information of the objects. Like input images, in home environment, we can observe many rectangular shaped objects such as TV, windows, audio and shelves. For this reason, we re-define and use rectangular shapes of objects as natural view.

The function of other steps is like following.

1) Detection: We extract features which are quadrangle shape similar to marker based method. At this time, we also can take partial quadrangle shape in order to use three or four points for cross-ratio calculation.

2) Description: All quadrangle objects consist of the top and bottom row line and the left and right column line. Therefore, we make use of these straight lines from objects. Then, we check the vanishing point or intersection of row lines in order to know whether the view is on one-side or two-side wall. Next, we calculate cross-ratio by using intersections of straight lines.

3) The Off-line steps for Save as DB: We acquire cross-ratio values for selected object and save it with direction and name information into database.

4) The On-line steps for Matching: If the view is one-side wall, then we calculate cross-ratio values for each object just as show the method in description step. However, if it is two-side wall, we set the basis as boundary of wall and calculate cross-ratio values between objects at each wall.

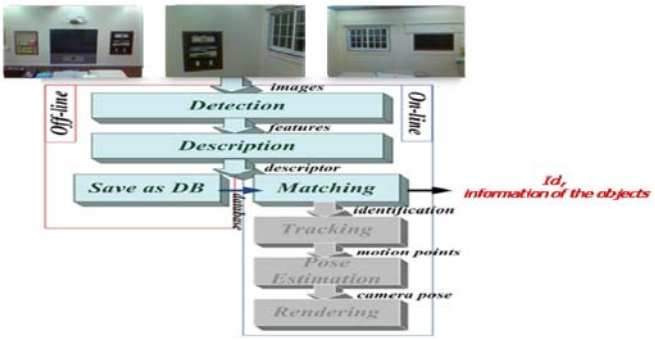

Figure 1 The overall procedures of the proposed method.

B. Cross-ratio

Cross-ratio means ratio of ratio of lengths which make up of four sets of collinear points. And it is invariant under projective geometry [1]. If four points-x1, x2, x3, x4- are given in order, the cross-ratio is defined as equation (1). Also, if one of the points has a zero entity, it lies at infinity and simply cancels the terms containing the point. For instance, if the second point have a zero entry, then $\overline{x_{23}} = \overline{x_{24}} = \infty$. Thus, it cancels each other and a result of cross-ratio is defined as equation (2).

$$Cross(\overline{x_1}, \overline{x_2}, \overline{x_3}, \overline{x_4}) = \frac{\left|\overline{x_1 x_3}\right|\left|\overline{x_2 x_4}\right|}{\left|\overline{x_1 x_4}\right|\left|\overline{x_2 x_3}\right|} \quad (1)$$

$$Cross(\overline{x_1}, \overline{x_2}, \overline{x_3}, \overline{x_4}) = \frac{\left|\overline{x_1 x_3}\right|}{\left|\overline{x_1 x_4}\right|} \quad (2)$$

References

[1] R. Hartley and A. Zisserman, *Multiple view geometry in computer vision*. Cambridge University Press, 2003.

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Hyejin Kim is with the Gwangju Institute of Science and Technology, Gwangju 500-712, S.Korea (corresponding author to provide phone: +82-62-970-2279; fax: +92-62-970-2204; e-mail: hjinkim@gist.ac.kr).

Sang-Goog Lee is with the Catholic University of Korea, Bucheon-si, Gyeonggi-do 420-743, S. Korea (e-mail: sg.lee@catholic.ac.kr).

Woontack Woo is with the Gwangju Institute of Science and Technology, Gwangju 500-712, S.Korea (e-mail: wwoo@gist.ac.kr).