Real Catcher View Image Generation Method For Baseball Contents

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***Abstract*— Pitching trajectories in the scene of the catcher view are represented by computer graphics in many baseball contents. The catcher view scene that is generated with computer graphics cannot provide extremely realistic scene to viewers. To address this issue, this paper proposes a method that a real catcher view is generated by using an image which is acquired from a camera at the stand of a baseball stadium. Our experiments have demonstrated that transformed catcher view image is highly similar to a ground truth image of the catcher view. We acquired image data in a real baseball stadium.**

Keywords— Baseball contents; Baseball broadcasting; Pitching trajectories; Catcher view; Homography matrix

I. INTRODUCTION

Recently, various baseball contents are provided to users as software and hardware are developed [1]. For example, position of players in a baseball field is represented in screens of baseball broadcasts and 360° scenes at the moment of batting are provide by integrating the images of several cameras [2]. In addition, the speed and direction of batting trajectories are shown in TV screen. Also, several pitching trajectories are represented in TV screen during Major League Baseball broadcasts because the trajectories are highly important information for pitchers and batters [3]. 3D data of trajectories which are provided from Trackman [4] are projected onto images of baseball broadcasts during Major League Baseball game. This can give viewers visual information of pitching and increase immersion about baseball broadcasting. If pitching trajectories are represented at the catcher viewpoint, realistic baseball contents could be provided to viewers or baseball contents users. However, there are no cases that the real pitching images at the catcher viewpoint are offered in baseball contents. This is because a camera cannot be equipped at the point of catcher's eyes in real baseball game. For this reason, many baseball contents offer the pitching images and ball trajectories of the catcher viewpoint by using computer graphics. The images based on computer graphics cannot provide the sense of reality. Therefore, it is necessary that pitching images at the catcher viewpoint are generated with real pitching images at the other viewpoint and ball trajectories are represented on the catcher view images. As mentioned above, there is a problem that a camera cannot be equipped at position of catcher's eye during real baseball games. To solve the problem, method in this paper proposes that real images from cameras at the stand before a catcher are transformed to catcher view images.

A flow chart of the proposed method is represented in Fig. 1. An original image is acquired from a camera at the stand. When the image is transformed to the catcher view image, the degree of parallax is large in ground region and small in background region. In this reason, the original image is split into two parts for efficient image transformation. One part is ground and another part is background. The background is defined as region which is the rest part except ground region. To transform the ground region of the original image to that of the catcher view image, homography matrix should be estimated. To acquired homgraphy matrix, position information of bases which are first, second, third and home bases is used. Homography matrix means relation of the original image and the catcher view image in ground region. The matrix can be calculated from the position of four bases in the two images which are the original images and the catcher view images. The ground region in the original image is transformed to the catcher view image by homography matrix. In case of background region, the background in the catcher view image is acquired by changing the scale of background region in the original image. Catcher view images can be generated by integrating the ground region and the background region of catcher view images. In section Ⅱ, we explain the proposed method that catcher view images are generated. Experiments and results are analyzed in the section Ⅲ. Finally, conclusion and future works are described in the section Ⅳ.

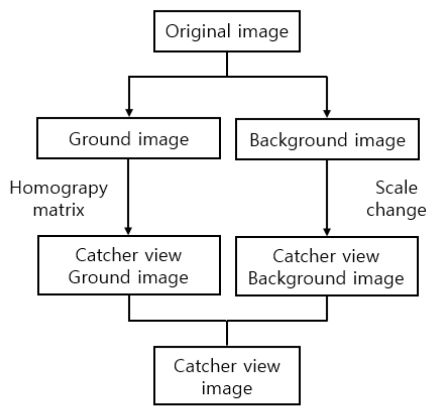
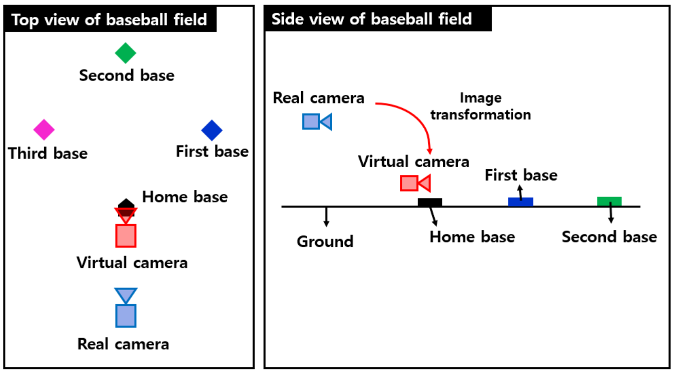


Fig. 1. Flow chart of proposed method

II. Proposed Method

A. Real catcher view image generation system

The system of proposed method is depicted in Fig. 2. A blue camera is a real camera equipped at the stand before a catcher and a red camera is a virtual camera which could be used for generating catcher view images. In the top view image of Fig. 2, blue, green and magenta diamonds are the first, second and third bases respectively. Also, black pentagon is the home base. The method in this paper proposes that images from the real camera is transformed to catcher view images of the virtual camera.



(a) (b)

Fig. 2. Proposed method system. (a) A top view image of the system. (b) A side view image of the system.

B. Image partitioning

The original image from real camera consists of ground region and background region as Fig. 3 is depicted. Blue curve is the boundary between ground and background region.

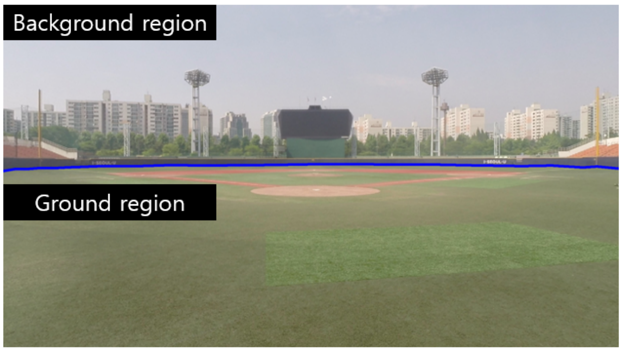


Fig. 3. Ground and background region of the original image.

The scene of ground region is changed drastically when the original image is transformed to the catcher view image. On the other hand, the background scene is changed less than ground region. This is because the ground region is nearer from the real camera than the background region. The fact is represented in Fig. 4. For this reason, the process that the ground region is transformed is different from that of the background region. Therefore, it is necessary that images are partitioned into two parts as the ground and background. Image partitioning was conducted manually.

(a) (b)

Fig. 4. Ground and background region of the original image. (a) Difference of background scene in the original image (first row) and catcher view image (second row). (b) Difference of ground scene in the original image and catcher view image.

C. Catcher view image generation

In order to transform the original ground image to the catcher view image, homography matrix [5], as relation between the original image and the catcher view image should be acquired. To have homography matrix, corresponding points of the original image and the catcher view image should be known. In this paper, bases are used as corresponding points in the ground region. We acquired first, second, third and home bases in original images manually. Also, the position of bases in the catcher view images should be acquired as corresponding points. Finding the position of bases in the catcher view image is the uncomplicated process because catcher view images cannot be acquired before generating catcher view images from the original images. Therefore, we cannot get the position of bases in the catcher view image manually. We know the relative position of bases and virtual camera because specification of all baseball stadiums is same and we can set the position of the virtual camera. It is depicted in Fig. 5. 3D position of the bases and the virtual camera is represented at the virtual camera coordinates system and the virtual camera is origin.

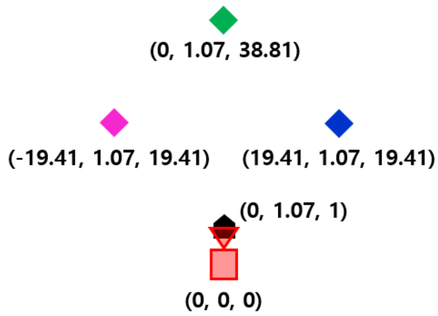
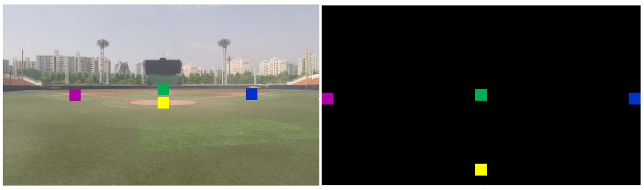


Fig. 5. Relative position of the bases and the virtual camera.

We can get the position of bases at catcher view image coordinates system when 3D position of bases is projected onto catcher view image coordinates system with intrinsic parameters of the virtual camera. It is expressed in (1). X_b, Y_b, Z_b are the position of bases at the virtual camera coordinates system. f_x, f_y are focal length of the virtual camera. c_x, c_y are x and y coordinates of a principal point. sc is skew and the value of skew is almost zero. x_b, y_b are x and y coordinates of bases in the catcher view image. n is a scale factor. The bases at catcher view image coordinates system becomes the corresponding points. In this process, we can have corresponding points of the original image and the catcher view image. In Fig. 6, the position of bases in the original image and the catcher view image is represented.



(a) (b)

Fig. 6. The position of bases in the original image and the catcher view image. (a) The position of bases in the original image. (b) The position of bases in the catcher view image

Homography matrix can be estimated with corresponding points by using SVD [6]. The relation between the ground region of the original image and the catcher view image is represented in (2).

$$\begin{bmatrix} nx_b \\ ny_b \\ n \end{bmatrix} = \begin{bmatrix} f_x & sc & c_x \\ 0 & f_y & c_y \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} X_b \\ Y_b \\ Z_b \end{bmatrix} \quad (1)$$

$$\begin{bmatrix} sx_c \\ sy_c \\ s \end{bmatrix} = \begin{bmatrix} h_1 & h_2 & h_3 \\ h_4 & h_5 & h_6 \\ h_7 & h_8 & 1 \end{bmatrix} \begin{bmatrix} x_o \\ y_o \\ 1 \end{bmatrix} \quad (2)$$

x_o, y_o are x and y coordinates of bases in the original image. x_c, y_c are x and y coordinates of bases in the catcher view image. h_1, h_2, h_3, h_4, h_5, h_6, h_7 and h_8 are elements of homography matrix. As a result, we can transform the ground region of the original image to that of the catcher view image and the result image is shown in Fig. 7.

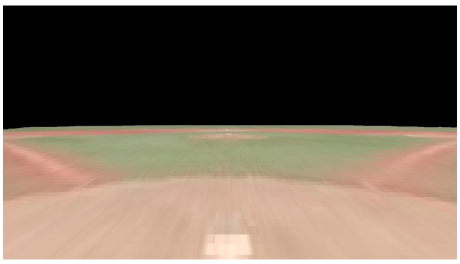


Fig. 7. The result image of the ground region.

As shown in Fig. 4, the background scene is not changed dramatically. In this reason, the background region of the original image is transformed to the background scene of the catcher view with only scale change. The result image is depicted in Fig. 8.

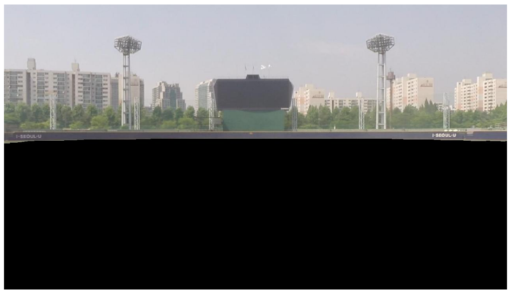


Fig. 8. The result image of the background region.

The catcher view image can be generated by integrating the ground and background parts which are transformed from the original image. Also, 3D trajectories of a ball that was pitched can be represented on the catcher view image. In Fig. 9, the catcher view image and 3D trajectories at the catcher view point are depicted

Fig. 9. The catcher view image (left) and the ball trajectory at the catcher viewpoint (right).

III. Experiments and Results

We acquired real baseball stadium images from real cameras at the stand before a catcher for generating catcher view images. All images as dataset were got at Mok-dong baseball stadium in South Korea. The data are shown in Fig. 10. The data were captured from real cameras which were placed at different position.

Fig. 10. The baseball stadium image data for generating the catcher view image.

We conducted experiments about the data and result images are represented in Fig. 11 and ground truth is represented in Fig. 12. The ground region of the real image is highly small. On the other hand, the catcher view image's ground region is large. Therefore, the ground region of the catcher view image blurs because of interpolation. To make the realistic catcher view images, the ground region image of ground truth can be stitched with the catcher view images. This is because the ground truth image can be acquired before baseball games. The result images are highly similar to the ground truth image. We evaluated the proposed method. The position of bases in ground truth image and the catcher view image is compared.

In other words, we calculated Euclidean distance between bases of the ground truth image and the catcher view image respectively. The average distance is about 30 pixels.

Fig. 11. The result image about the baseball stadium image data.

Fig. 12. The ground truth image.

IV. CONCLUSION

The method in this paper proposes that catcher view images are generated from real images. There are no previous researches according to method that the catcher view images are generated. In this method, original images are divided into ground and background region for efficient image transformation. Ground region of the original images is transformed to the catcher view image by homography matrix. In case of background, the original images are transformed by scale change. As a result, result images are similar to the ground truth image. This method can provide realistic experience to baseball contents users. In the future, we should solve the problem that the scene of ground region in the catcher view image blurs because of interpolation. Also, we could research the method that real pitcher images are added on the catcher view images for giving realistic baseball contents.

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