Location Estimation from Pre-Recorded Video Taken by Omnidirectional Cameras

Yuta Nagumo
Graduate School of Systems and Information Engineering
University of Tsukuba
s1720836@u.tsukuba.ac.jp

Itaru Kitahara and Yoshinari Kameda
Center for Computational Sciences
University of Tsukuba
{kitahara,kameda}@iit.tsukuba.ac.jp

***Abstract*—We are developing a new navigation system based on a pre-recorded video of a planned route. This paper proposes a position estimation method that uses two omnidirectional cameras. Position estimation is performed by finding the most similar image in pre-recorded image database for a picture taken by a pedestrian on the route. We improve the accuracy of the image retrieval by using two omnidirectional cameras. Our preliminary camera system can cope with scenes with less features and strong light source that damages one of the cameras. We evaluate the performance of the proposed method on a route set in our campus.**

Keywords—pedestrian navigation; image retrieval; route navigation; local image feature

We propose a method to improve location estimation accuracy for pedestrians by using two omnidirectional cameras. It is based on the location estimation method for pedestrians using only a camera image proposed by Kameda et al. [1, 2].

We assume the situation that a visually impaired person is planning to walk along a planned route. In the method [1, 2], a volunteer goes along the navigation route in advance to obtain the pre-recorded video. A database is then generated from the pre-recorded video. On navigating a user on the route, the user takes a photo with the same camera system.

When estimating the position, the image taken by the camera system is treated as a query image and the most similar image in the preceding captured images are retrieved. The location on the route can be estimated from the frame number in the pre-recorded video if the walking speed of the volunteer is fixed or recorded. The image retrieval is performed by matching SIFT [3] keys. In the previously proposed approaches [1,2], single camera is oriented in the direction of travel along the route. Therefore, if there are few unique local features in the direction of travel, location estimation will not be successful.

We propose to install two omnidirectional cameras at the front and rear in the direction of travel to solve this problem. The two cameras are set with about 1 meter baseline. We adopt the same procedure of [1, 2] for computer vision part.

By omnidirectional cameras, it becomes possible to obtain feature points from objects and areas in a wider view range than an ordinary monocular camera. Another factor of lowering the accuracy of the image retrieval by the conventional method using a monocular camera is loss of detection of feature points due to highlight from a strong light source in one direction and blackout in dark places. The proposed method can solve this problem because of the 1-meter offset of the two cameras.

The images from the two cameras are simply combined into one image for each frame. Since the two cameras are installed in front of and behind the user, even if one camera is interfered by a strong light source from one direction, image retrieval can be still successful because of the remaining half of the image taken by the other camera.

Fig. 1. Synthesized image of two omnidirectional cameras

An image synthesized from two omnidirectional cameras is shown in Fig.1. The image is strongly warped by projection distortion due to the property of the omnidirectional cameras we use. However, as validated in our previous method [1, 2], it is not necessary to cancel this distortion if the preceding photographing route and the current route are close to each other.

Evaluation experiments were conducted with our preliminary system on a route in the university. It contains indoor scenes, outdoor scene, and some dark part. We found that the proposed method is more successful than the one using an ordinary monocular camera.

This work is partially supported by JST RISTEX and JSPS KAKENHI Grant Number 17H01773.

REFERENCES

[1] Y. Kameda and Y. Ohta. “Image Retrieval of First Person Vision for Pedestrian Navigation in Urban Area,” 20th International Conference on Pattern Recognition, pp.364-367, 2010.

[2] K. Kamasaka, I. Kitahara, Y. Kameda, and Y. Ohta. “Reference-Frame Selection at Walking Navigation Based on Prerecorded Video,” 1st International Workshop on Challenges and Applications of Urban Augmented Reality (in conjunction with ISMAR2015), 2015.

[3] D.G.Lowe. ”Distinctive Image Features from Scale-Invariant Keypoints”, International Journal of Computer Vision, vol.60, pp.91-110, 2004.