論文の要旨

題目　Change Detection of 3D Scene with 3D and 2D Information for Environment Checking

(3 次元と 2 次元の情報を用いた環境検査のための 3 次元変化検出手法)

氏名　林宝尉

Recent surveillance technology developments motivate a regular observation of places such as coast, slopes and highways, where disasters and accidents can happen with high probability. Hence, any obvious change must be alerted. However, this is not practical for a wide area. Therefore, an automatic detection of unusual change seems to be useful and important.

In this thesis, we describe some methods which divided into online and offline approaches to detect temporal change. The online step is a 3D-2D detection using a 3D scene geometry at time A (reference) and the image of the same scene at time B (query or test). The offline step is a 3D-3D registration of 3D scenes for different times which could provide more accurate results.

To quickly detect changes and visualize the change taking place for operators at regular observation, our online step method uses the combination of 3D-2D and 2D-2D matching. We assume that a 3D scene geometry is given but only at time A as a reference 3D scene, hence no 3D range finder is necessary. At time B (query), a hand-held camera is used to take images of the same place, and the reference 3D geometry is used for 3D-2D matching for camera pose estimation. To find a region of change in the query images, first, the nearest image of a query image is selected from the training images. Then, the matching between the query image and the nearest images is computed for finding a set of non-matching points as a region of change. These change regions are visualized by projecting 3D points back only to those regions. Experimental results show that our method can detect change areas correctly.

In order to perform 3D-2D matching for camera pose estimation, we represent the 3D keypoints by their corresponding 2D keypoints. A 3D keypoint is assumed to have corresponding 2D keypoints in two or more of the training images. These 2D keypoints have 2D feature descriptors that can be used to characterize the 3D keypoints. Therefore, we use the 2D feature descriptors as a feature descriptor of the corresponding 3D keypoint. After detecting the 3D keypoints, we perform feature

matching and register the newly taken query images. Experimental results with 3D point clouds of indoor and outdoor scenes show that the extracted 3D keypoints can be used for matching with 2D keypoints in query images.

Once we find the change areas from the 3D-2D method, what we need to do is to improve the accuracy of the detection result. We propose a method to register 3D point clouds offline. The alignment result could provide the users much better result than just using image based rough detection result. Our offline method is divided into two methods. The first method estimates the scale of each point cloud separately: each point cloud has its own scale that is something like the size of a scene. We call it a keyscale, which is a representative scale and is defined for a given 3D point cloud as the minimum of the cumulative contribution rates of PCA of descriptors over different scales. Our second method directly estimates the ratio of scales (scale ratio) of two point clouds. Instead of finding the minimum, this approach registers the two sets of curves of the cumulative contribution rate of PCA by assuming that those differ only in scale. Experimental results with simulated and real scene point clouds demonstrate that the scale alignment of 3D point clouds can be effectively accomplished by our scale ratio estimation.