Recognition of partially occluded 3-D targets from computationally reconstructed integral images

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Abstract
In this paper, a novel approach for robust recognition of partially occluded 3-D target objects from computationally reconstructed integral images is proposed. The occluding object noises are selectively removed from the picked-up elemental images and performance of the proposed integral imaging-based 3-D target recognition system can be improved.

1. Proposed method

Correlation-based detection of depth and location data of 3-D objects in space has been actively studied in the field of 3-D object recognition[1-2]. The occluding object noises are inappropriately removed from the picked-up elemental images by use of conventional method. Fig 1. shows the overall flow-chart of the proposed method, which are largely consisted of four processes such as pickup of the elemental images, depth extraction of the occluding object, spatial filtering of the picked-up elemental images, CIIR-based reconstruction of the spatial-filtered elemental images and target recognition. Here, the target and occluding objects are assumed to be located at $z=L_{tar}$ and L_{occ} from the lenslet array, which means there exists a gap distance of $d=L_{tar} - L_{occ}$ between them as shown in Fig. 1. As shown in Fig. 1, the occluding object of 'wire-net' acts as a foreground noise to the target object of 'car'. First, intensity and directional information of the rays coming from the target and occluding objects are picked up through the lenslet array as a form of 2-D elemental images representing different perspectives of the objects. From these picked-up elemental images, a set of the plane object images (POIs) of the objects are reconstructed along the output plane by using the CIIR technique. Here we assume a target object of 'car' located behind the occluding object of 'wire-net' is under the surveillance. Then the occluding object image of the 'wire-net' can be picked up in advance and its depth data, $z=L_{occ}$ can be extracted through correlation operations between the reference occluding object image and the computationally reconstructed POIs of the occluding object. With the extracted output distance of $z= L_{occ}$ where the occluding object of 'wire-net' is originally located, the magnification factor of the picked-up elemental images at this output plane can be calculated with a relationship of $M=L_{occ}/g$. Here the occluding object image of 'wire-net' is likely to be extracted from the reconstructed POI, but it is impossible to separate the occluding object information from the reconstructed POI because the POI is a mixture of the target and occluding object images. Therefore, as a new approach for selective removal of the occluding object image from the reconstructed POI. In the proposed scheme, the occluding object information mixed in each picked-up elemental image can be spatially and selectively extracted from its magnified version on the output plane of $z= L_{occ}$ by comparing with that of the reference occluding object image. Then by de-magnifying these elemental images, a newly synthesized EIA can be obtained, in which image data of the occluding object has been totally eliminated. With this newly synthesized EIA, only the target object image of 'car' can be reconstructed without a noise affect caused by the defocused occluding object image of 'wire-net' and as a result a significant performance enhancement in recognition of the partially occluded target object can be expected.

2. Experiments and results

here we use a 3-D test object consisted of two 2-D objects, a 'wire-net' as the occluding object, a 'car' as the target object, which are located at z = 9mm and 12mm in front of the lenslet array, respectively. The distance between the lenslet array and the pickup plane is assumed to be g=3 mm. The resolution of the picked-up elemental images is given by 1050 by 750 because it is assumed that the lenslet array is consisted of 35 by 25 lenslets and the resolution of each lenslet is 30 by 30 pixels. Moreover the resolution of each 2-D test object is given by 1050 by 750 pixels. Figure 2 (a) shows the newly synthesized EIA with the proposed method. Hence, from EIA of Fig. 2 (a) their POI can be reconstructed by using the CIIR technique. That is, as the reconstructed output plane is differently taken by increasing the distance from the lenslet array with a small incremental step of 3mm a set of POIs can be reconstructed. Fig 2 (b) shows POI computationally reconstructed from EIA of fig. 2 (a). As you can see in Fig. 2(b), the occluding object image has been totally removed in the reconstructed POI. Fig 2 (c) shows the correlation result between the target object image and the POI of Fig. 2(b) reconstructed from the newly synthesized EIA.

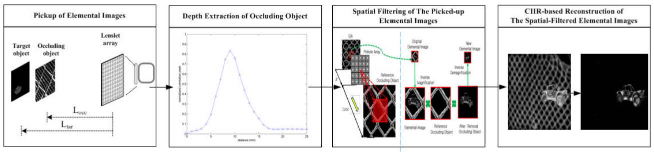
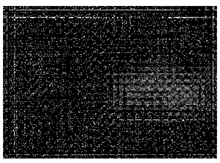
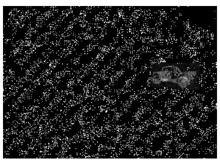


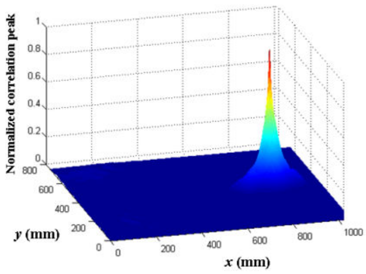
Fig. 1. Overall block-diagram of the proposed method



(a)



(b)



(c)

Fig. 2. (a) Newly synthesized EIA (b) reconstructed POI (c) Correlation results

3. Conclusion

In this paper, a novel approach to effectively recognize the partially occluded 3-D objects from computationally reconstructed integral images has been proposed. That is, the occluding object information has been removed from the picked-up EIA by using the proposed technique and then, from this newly synthesized EIA the occluded target object has been effectively recognized. Some good experimental results finally confirmed the feasibility of the proposed method.

4. Acknowledgements

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5. References

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