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Title: Results of Exploration Experiment on View Synthesis
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1. Introduction

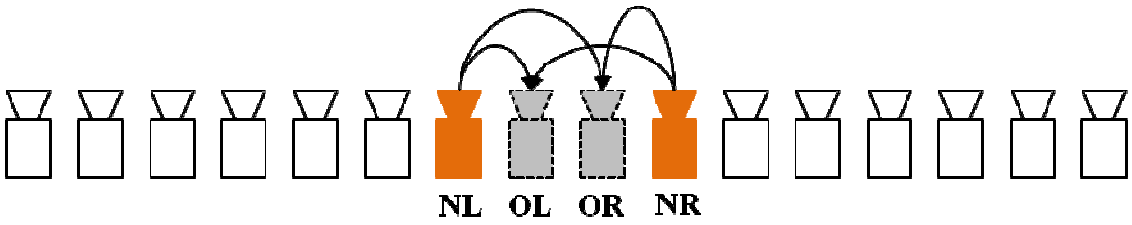
This document reports the results of exploration experiment on view synthesis for 3DV. We have synthesized intermediate views of 'book_arrival' and 'pantomime' sequences using SW that is provided by Nagoya University [1]. Since view synthesis is based on the depth map, we have estimated it using depth estimation SW. Three types of experiments have been performed: narrow, medium, and wide baselines.

2. Description of Experiment

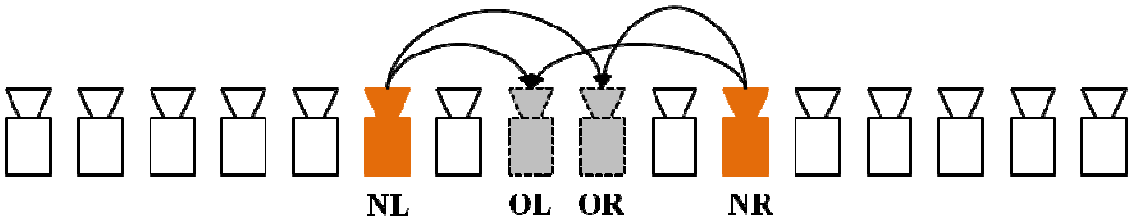
The sequences that we have assigned are 'book_arrival' of HHI and 'pantomime' of Nagoya University. As described in the previous document [2], there are three cases of baselines to synthesize intermediate view images. Table 1 contains details of the experiments. *OL* and *OR* represent the viewpoints to be synthesized using neighboring views *NL* and *NR*. Figure 1 depicts the different baselines according to the different camera distances.

Table 1. Experiments for View Synthesis

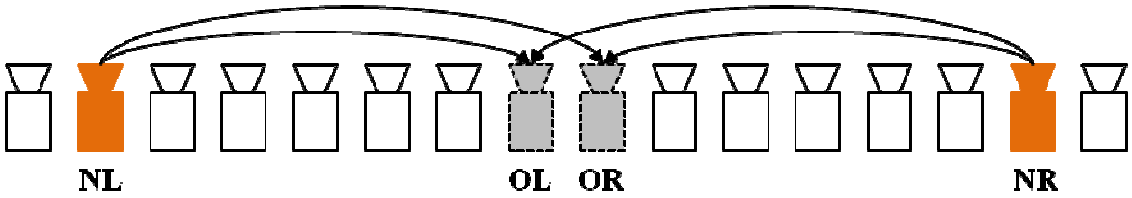
Baseline	Data Set	Seq. Provider	OL-OR	NL-NR
Narrow	pantomime	Nagoya Univ.	39-40	38-41
	book_arrival	HHI	4-5	3-6
Medium	pantomime	Nagoya Univ.	39-40	37-42
	book_arrival	HHI	4-5	2-7
Wide	pantomime	Nagoya Univ.	39-40	30-50
	book_arrival	HHI	4-5	2-15



(a) Narrow Baseline Case



(b) Medium Baseline Case

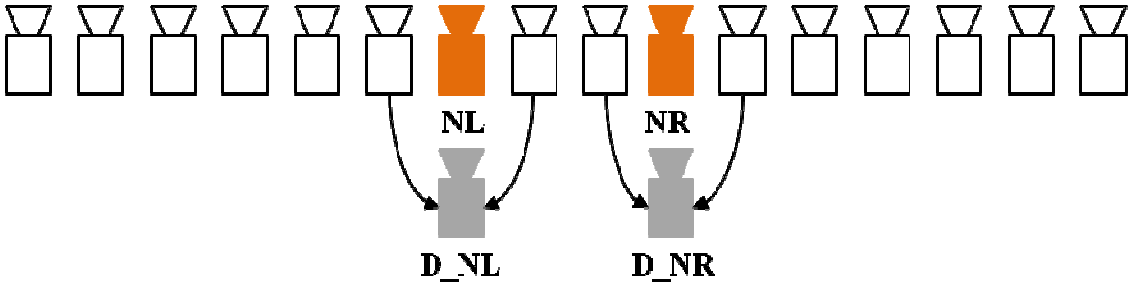


(c) Wide Baseline Case

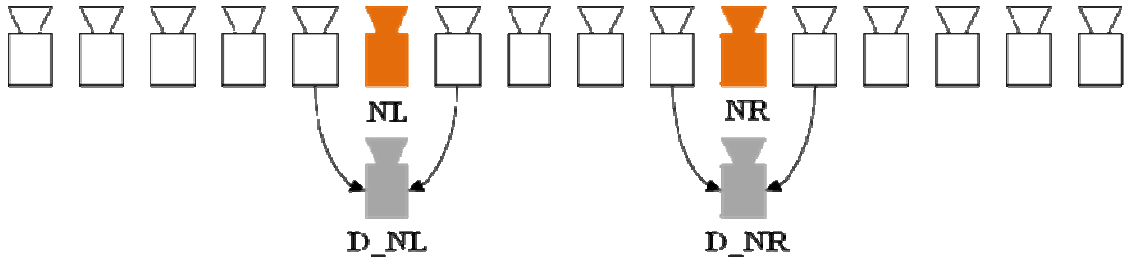
Fig. 1. Experiments on Three Baselines

2.1. Depth Map Estimation

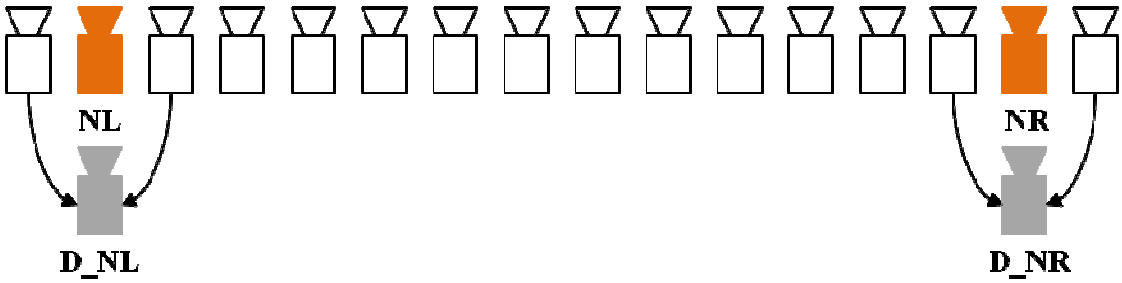
Because view synthesis SW employs 3D warping technique, the depth maps and depth video corresponding to the reference views are necessary. Hence, we used Nagoya University's depth estimation SW to obtain the corresponding depth map. Figure 2 describes how we generate a depth map. The provided SW considers two neighboring views NL and NR as reference images. Since there is no rule of selecting reference views, we select the neighboring two views as reference images.



(a) Narrow Baseline Case



(b) Medium Baseline Case



(c) Wide Baseline Case

Fig. 2. Depth Map Generation

Depth generation SW employs some parameters to describe the depth range, Z_{near} and Z_{far}. We used the following parameters as presented in Table 2. When we estimate the depth map of 'pantomime' sequence, we select 'view#i-2' and 'view#i+2' as reference views to get a depth map for 'view#i' because the maximum disparity is small. However, 'book_arrival' sequence has quiet big disparity range, so we select 'view#i-1' and 'view#i+1'.

Table 2. Parameters of Depth Map Estimation and View Synthesis

Data Set	min disparity	max disparity	Z_{near}	Z_{far}
pantomime	-2	35	2804.198	9241.909
book_arrival	16	32	25.47978	50.95956

2.2. View Synthesis

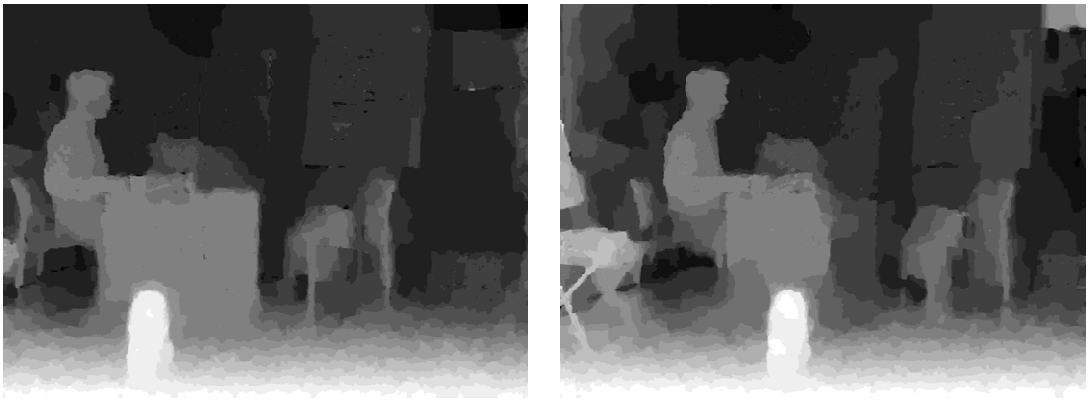
By using the generated depth maps, we have synthesized the new intermediate images. We used Z_{near} and Z_{far} as the parameters followed by Table 2. We have generated 500 frames for 'pantomine' sequence and 100 frames for 'book_arrival'. The format of input sequences is YUV 4:2:0. The version of view synthesis is 'VS2_3'.

3. Experimental Results

From the experiments, we confirmed that the synthesized image is highly dependent upon the accuracy of the depth map.

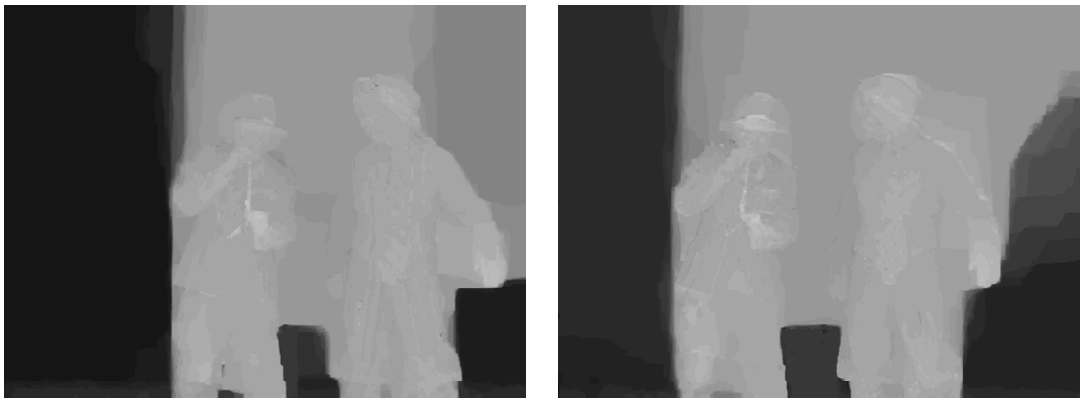
3.1. Estimated Depth Maps

We obtained depth maps for the original reference view using two neighboring viewpoint images. Figure 3 and 4 demonstrate the results of depth maps. In both sequences, the quality of depth map was good. In the case of 'pantomime', the depth of background seems to be the same with the foreground. However, it doesn't matter in view synthesis because the background is the same with black. Without this fact, the shape of two pierrots is easy to recognize.



(a) Depth Map of 'book_arrival_02' (b) Depth Map of 'book_arrival_07'

Fig. 3. Estimated Depth Map of 'book_arrival' Sequence



(a) Depth Map of 'pantomime_38' (b) Depth Map of 'pantomime_50'

Fig. 4. Estimated Depth Map of 'pantomime' Sequence

3.2. Synthesized Images

We synthesized 12 view images: 6 for 'book_arrival' and 6 for 'pantomime'. Figure 5-7 demonstrate the synthesized images. Throughout the whole experiments, the results of narrow baseline case were good. However, as the distance between cameras getting further, the quality of synthesized image is getting deteriorated.

3.2.1. Narrow Baseline Case

As showed in Fig. 5, the quality of both sequences is good. Effects of occlusion and disocclusion are hard to distinguish. The pictures of 'pantomime' in Fig. 5 are the 95th frame. As we mentioned above, the depth values errors at the background can be negligible because of the same color of background. The overall quality is quite good, but there are annoying spots around boundary.

3.2.2. Medium and Wide Baseline Case

As the distance of the cameras getting further, the quality of the synthesized images is getting poor. In 'pantomime' sequence, you can easily see a ghost phenomenon in Fig. 6-7. This is happening because of the unstable performance of depth estimation SW or estimation error. However, the image of 'book_arrival' is relatively good, but there are some noises around boundary area with spots.

(a) Synthesized Image of 'book_arrival_4' (b) Synthesized Image of 'book_arrival_5'

(a) Synthesized Image of 'pantomime_39' (b) Synthesized Image of 'pantomime_40'

Fig. 5. Synthesized Image of Sequences for Narrow Baseline Case

(a) Synthesized Image of ‘book_arrival_4’

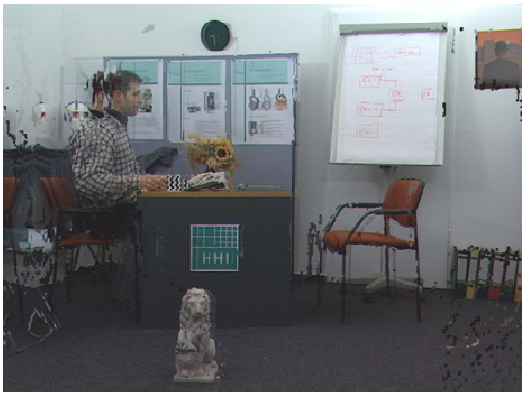
(b) Synthesized Image of ‘book_arrival_5’

(a) Synthesized Image of ‘pantomime_39’

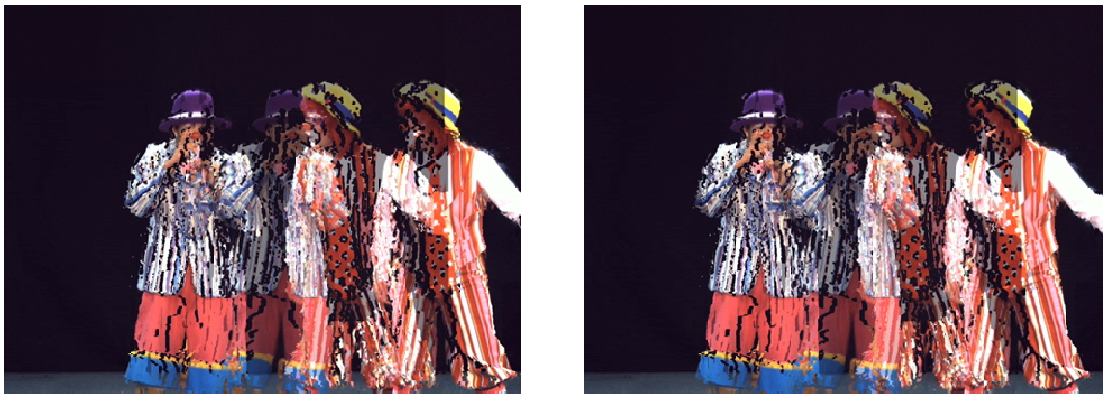
(b) Synthesized Image of ‘pantomime_40’

Fig. 6. Synthesized Image of Sequences for Medium Baseline Case

(a) Synthesized Image of ‘book_arrival_4’



(b) Synthesized Image of ‘book_arrival_5’



(a) Synthesized Image of ‘pantomime_39’ (b) Synthesized Image of ‘pantomime_40’

Fig. 7. Synthesized Image of Sequences for Wide Baseline Case

4. Conclusion

We have experimented view synthesis using a SW provided by Nagoya University with ‘book_arrival’ and ‘Pantomime’ sequences. Since we needed depth maps, we estimated them with the depth estimation SW. After estimation, we synthesized the intermediate view images for three different baseline cases. The quality of the synthesized image of both sequences was good, but the quality of synthesized images of ‘book_arrival’ was relatively better than ‘Pantomime’. As the distance between cameras is getting wide, the synthesized images are getting poor.

5. Acknowledgements

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6. References

[1] ISO/IEC JTC1/SC29/WG11 “Reference Softwares for Depth Estimation and View Synthesis,” M15377, April 2008.
[2] ISO/IEC JTC1/SC29/WG11 “Description of Exploration Experiments in 3D Video Coding,” N9783, May 2008.
[3] ISO/IEC JTC1/SC29/WG11 “Reference Software for Depth Estimation and View Synthesis,” M15377, May 2008.