Retexturing under Self-Occlusion using Hierarchical Markers

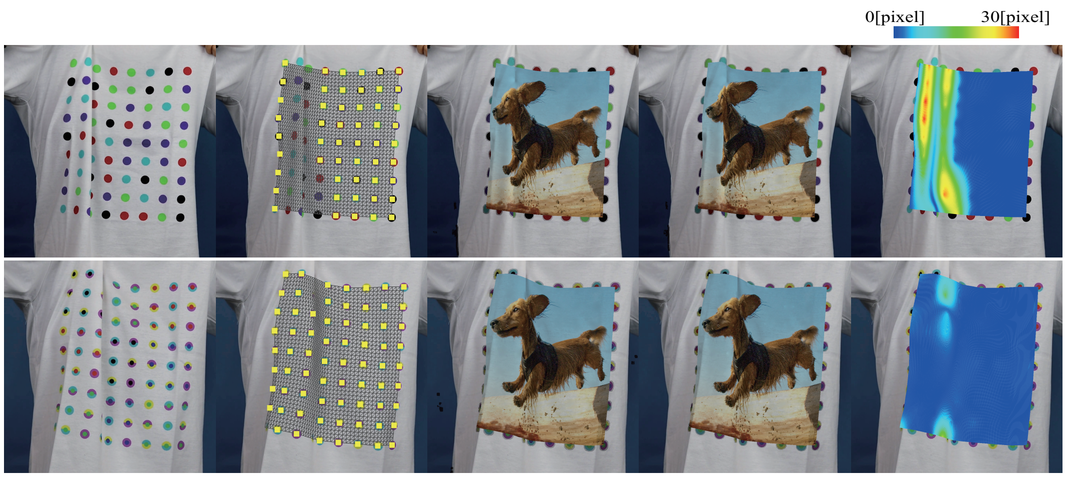
Shoki Miyagawa
Waseda University

Yoshihiro Fukuhara
Waseda University

Fumiya Narita
Waseda University

Norihiro Ogata
Seiren Co.,Ltd.

Shigeo Morishima
Waseda Research Institute for Science and Engineering



(a) Input image (b) Mesh image (c) Retextured image (d) Ground Truth (e) Error map

Figure 1: Results of retexturing under self-occlusion (Above: Scholz et al., Below: Our method)

CCS CONCEPTS

• **Computing methodologies → Computer vision problems**; *Mixed / augmented reality*; • **Human-centered computing →** Mixed / augmented reality;

KEYWORDS

Retexturing, self-occlusion, hierarchical marker

ACM Reference format:
Shoki Miyagawa, Yoshihiro Fukuhara, Fumiya Narita, Norihiro Ogata, and Shigeo Morishima. 2017. Retexturing under Self-Occlusion using Hierarchical Markers. In *Proceedings of SIGGRAPH '17 Posters, Los Angeles, CA, USA, July 30 - August 03, 2017,* 2 pages.
DOI: 10.1145/3102163.3102247

1 INTRODUCTION

Marker-based retexturing is to superimpose the texture on a target object by detecting and identifying markers from within the captured image. We propose a new marker that can be identified under a large deformation that involves self-occlusion, which was not taken into consideration in the following markers. Bradley et al. [Bradley et al. 2009] designed the independent markers, but it is difficult to recognize them under complicated occlusion. Scholz et al.[Scholz and Magnor 2006] created a circular marker with a single color selected from multiple colors. They created ID corresponding to the alignment of colors by one marker and the markers around it and identified by placing the marker so that the ID would be unique. However, when some markers are covered by self-occlusion, the positional relationship of the markers appears to be different from the original, so markers near the self-occlusion are failed to identify. Narita et al. [Narita et al. 2017] considered self-occlusion by improving the identification algorithm. They succeeded in improving the accuracy of identification by creating triangle meshes whose vertices are the center of gravity of markers and assuming that they are close to a right isosceles triangle. However, since outliers are removed using angles, identification of markers may fail in the case of the object that is likely to be deformed in the shear direction like a cloth. Therefore, we considered self-occlusion by designing hierarchical markers so that they can be referred to in a global scope. We designed a color based marker for easy recognition even at low resolution.

SIGGRAPH '17 Posters, Los Angeles, CA, USA

978-1-4503-5015-0/17/07…$15.00
DOI: 10.1145/3102163.3102247

2 OUR APPROACH

2.1 Structure of a hierarchical marker

We designed hierarchical markers with internally and externally separated structures. Each marker can be classified into blocks composed of $N^2 (N \geq 2)$ markers. The proposed marker when $N = 3$ is shown in Figure 2 (left). The inside color is selected from four

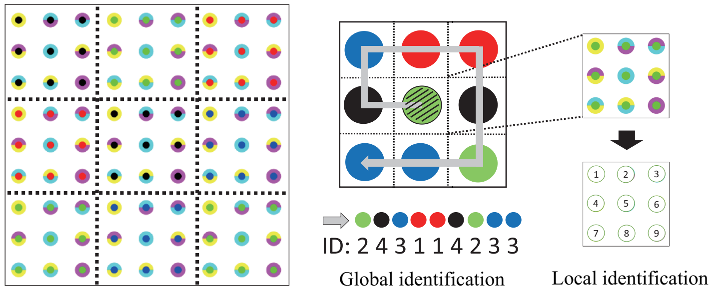


Figure 2: Hierarchical markers (left) and identification method (right)

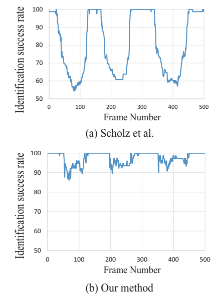


Figure 3: Changes in the identification success rate

colors (red, green, blue and black), all markers in the block show the same color. The choice of the internal color in each block is the same the Scholz et al.'s method. That is, when ID corresponding to the arrangement of colors of a certain block and surrounding blocks are created, colors are determined so that all IDs are unique. The outside is divided into two parts, upper and lower, and N colors are assigned. The colors are arranged so that the color arrangement on the outside of each marker in the same block is different. In this case, since there are N^2 combinations, each pattern is assigned to N^2 markers in the block. However, it is necessary to assign the color arrangement to each block in common.

2.2 Identification of hierarchical markers

The inside and the outside of the marker have different roles. Since the block and the marker are in a tree structure relation, identification is performed hierarchically as shown in Figure 2 (right). We identiry blocks at first. This is accomplished in three steps. First, we look at the inside color of the marker as the representative color of the block. Second, we acquire the color of the surrounding block like Scholz et al. [Scholz and Magnor 2006] and create a ID. Finally, we search ID from the database and get the texture coordinate. Next, we distinguish each marker in the block (Local identification). Since there are nine patterns of external color arragement in the block, it is determined as to which order of color arrangement each marker matches as shown in the figure. When hierarchical identification succeeds, it is possible to acquire the texture coordinates previously associated with the marker. Actually, before the identification, each marker is grouped and a block is created. Blocks are created based on the internal color type of the marker and the external color arrangement. However, since the proposed method assumes that some markers in the block are visible, there is a limit to the magnitude of deformation that can be dealt with. Therefore, it is necessary to adjust the size of blocks according to the degree of deformation of the object.

3 RESULT AND CONCLUSION

We carried out an experiment to check the success rate of identification by placing 81 markers on the T-shirt and causing self-occlusion that hide 1 row of markers. We used a Canon EOS 80D camera and set the resolution to 1080 × 1080. The results of the retexturing performed by Schol et al.z[Scholz and Magnor 2006]

Table 1: Average and standard deviation of identification success rate

	[Scholz and Magnor 2006]	Our method
Average	74.19(%)	95.60(%)
Standard deviation	14.10(%)	2.82(%)

and the proposed method are shown in Figure 1. In the mesh image, markers which succeeded in identification are represented by yellow dots. The identification success rate is defined as the ratio of the number of markers successfully identified to the number of detected markers. For the peaks in the graph due to self-occlusion, the average and standard deviation of the identification success rate are shown in Table 1. Ground truth is the result of manually identifying the marker, and the error map shows that the accuracy has improved compared to the conventional method. From the above, it was confirmed the effectiveness of the proposed method. Futhermore, since the upper limit number of markers that can be arranged is increased by about nine times compared with Narita et al., it can be applied to a larger range. However, since the hierarchical marker has a complicated structure compared to Scholz et al., there are multiple small peaks in Figure 3. Therefore, it is a problem to devise a marker that has a hierarchical structure and is more easily detectable. In conclusion, we proposed a new hierarchically structured marker and a method to distinguish it in a global range. As a result, we realized retexturing robust against self-occlusion. For future work, we would like to make a comparison by simulation in order to examine the effectiveness of the proposed method more precisely.

4 ACKNOWLEDGMENT

This work was supported by JST ACCEL Grant Number JPMJAC1602, Japan.

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