Marker-less Motion Capture using Dense Human-body Shape Scanning System

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Abstract

In this paper, we propose a new marker-less motion capturing system using our original dense and high-frame-rate shape capturing system. The technique is useful for CG and movie production. In terms of 3D shape capturing system, we have developed a high fps and dense shape capturing technique with projector camera system. Here, we propose the system consisting of multiple sets of them to capture entire shape of human body and its useful applications, i.e. marker-less motion capture. The system mainly have three contributions. First, dense entire shape capture of human body wearing cloth is actually constructed, second, subtle and fast motion of muscle and facial expression can be captured, and third, marker-less motion capture with small number of cameras are realized. Marker-less motion capture is strongly required and Visual Hull based technique was proposed as a realistic solution so far. With our system, the number of camera can be drastically reduced to achieve the same quality.

1. Introduction

In this paper, we propose a new marker-less motion capturing system using our original dense and high-frame-rate shape capturing system. The technique is useful for CG and movie production. In terms of 3D shape capturing system, we have developed a high fps and dense shape capturing technique with projector camera system. Note that the system can realize capturing the bursting balloon in our previous paper[2]. Here, we propose the system consisting of multiple sets of them to capture the entire shape of human body and its useful applications, such as marker-less motion capture. The system mainly have three contributions as follows.

1. **Dense entire shape capture of human body**

   Such system is strongly required and researched, however, most of them are silhouette or stereo based using a number of cameras and no active system has been presented. With our system, i) the number of cameras can by drastically reduced and ii) human wearing textureless cloth can be reconstructed.

2. **Accurate capturing of fast motion of muscle and human face**

   When realistic muscle rendering is required (e.g. movie “HULK”), physical simulation is usually applied and it needs a special skill and work load.With our system, subtle motion of muscle can be directly captured and utilized.

3. **Marker-less motion capture with small number of cameras**

   Marker-less mo-cap is strongly required and Visual Hull based technique was proposed as a realistic solution[4]. With our system, the number of camera can be drastically reduced to achieve the same quality.

2. Overview of Entire Shape Capturing System

The proposed system uses multiple projectors and cameras, combining multiple sets of [2]. Since it is based on oneshot-scanning (i.e. the projected patterns are static and not changed), extremely fast motions can be captured. In the current setup, cameras and projectors are configured to encircle human and entire-shape of human body can be captured with only 6 cameras. For the 3D reconstruction, a method that combines active scanning and multi-view stereo is used. In the method, intersection points between observed patterns are used to reconstruct connected pattens simultaneously, and, by matching information from multiple cameras, efficient and precise 3D reconstruction is achieved.

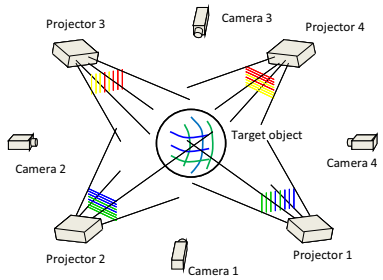


Figure 1. Entire shape capturing system configuration.

3. Applications

3.1. Dense and High-speed Shape Capture

Capturing human body with a high-speed camera enables to measure the detailed change of muscles or facial expression. While dense line pattern is required to capture the detail, dense pattern is difficult to detect. Therefore, we propose a method to interpolate between lines by using a Gabor filter. Since the neighboring lines are encoded by a periodic color code based on the de Bruijn sequence, the adjacency information is obtained. If neighboring lines are adjacent also in projected pattern, it can be correctly interpolated and dense shapes are estimated consequently.

3.2. Marker-less Motion Capture

There have been many attempts to capture human motion wearing tight clothes from multi-view video sequences[3, 1] In contrast, the proposed system enables motion capture of a person even wearing loose clothes by extending the work[4]. In the proposed motion capture method, an articulated deformable body model is roughly aligned to visual hull, then it is aligned to dense reconstruction result to achieve better accuracy by the ICP based forward/backward hierarchical estimation method. Robust motion estimation against a variety of the shape of clothes is realized by evaluating the distance between body and cloth.

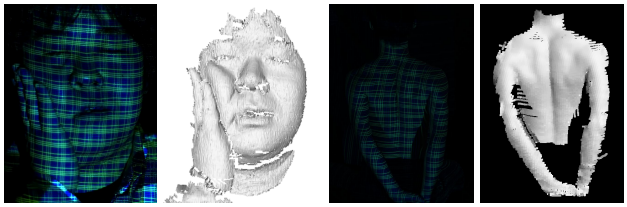
4. Experimental Results

First, results of dense shape capture with high-speed camera are shown in fig.2. We used 600fps with this case. We can confirm that the detailed shapes are captured with our system.

Next, results of dense entire shape capture and motion estimation using the entire shape scanning system are shown in fig. 3. We used six cameras with 30 fps. We can see that the motion is successfully estimated even if the target person wears clothes.

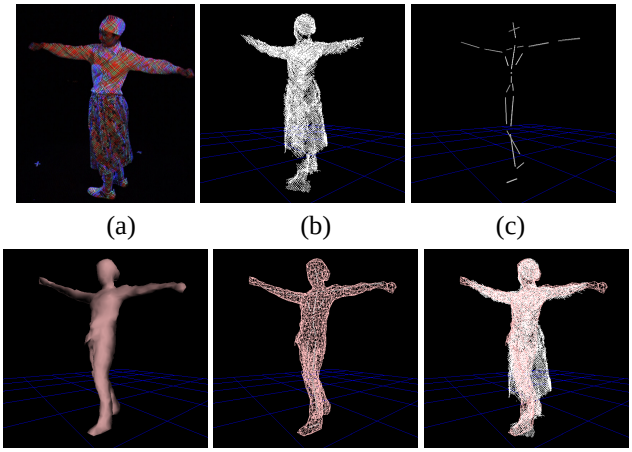
5. Conclusion

Dense and entire shape capturing system which can achieve marker-less motion capture is actually constructed and demonstrated. From the results, we can confirm that the system can provide a practical solution to realize realistic human body animation without special knowledge or skills.



(a) (b) (c) (d)

Figure 2. (a)(c) captured image, and (b)(d) reconstruction results.



(a) (b) (c)

(d) (e) (f)

Figure 3. Marker-less motion capture results: (a) a captured image out of six cameras, (b) dense shape reconstruction result, (c) estimated bone, (d) mesh model using the bone, (e) wire-frame of (d) and (f) dense shape and mesh model are overlapped.

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