Hybrid Skeletal-Surface Motion Graphs for Character Animation from 4D Performance Capture

Supplemental Images

Peng Huang
Margara Tejera
John Collomosse
and Adrian Hilton

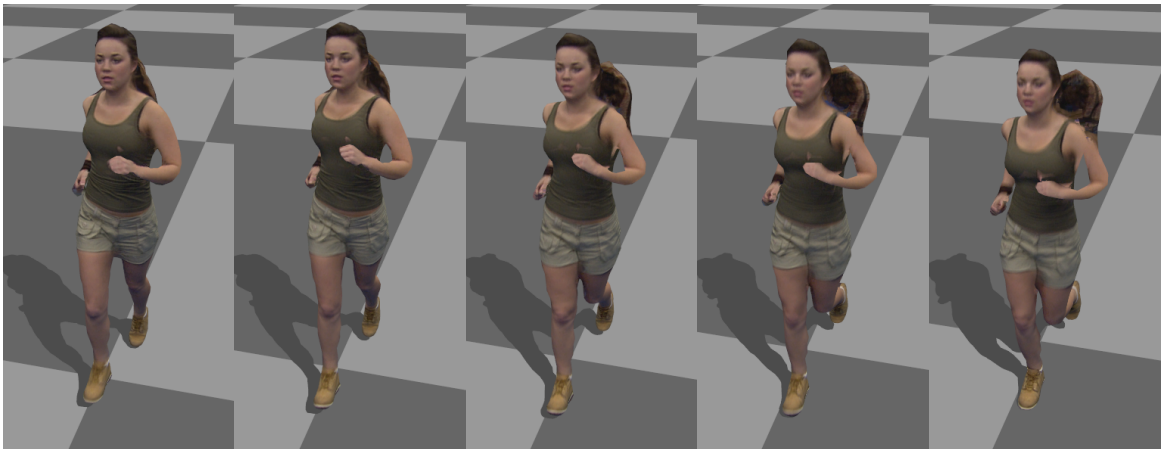
CVSSP, University of Surrey

Contents

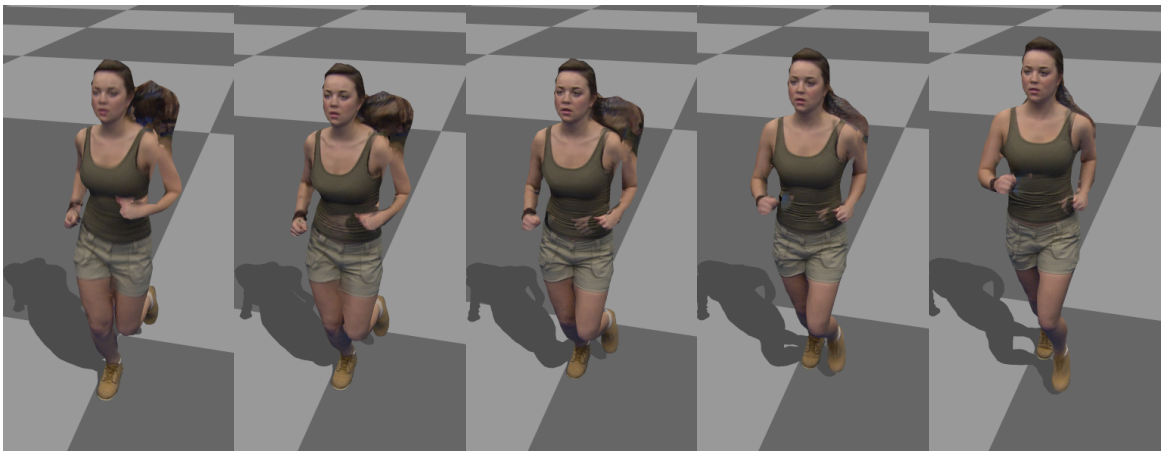
1 Visual Benefits

1.1 Dynamic Details

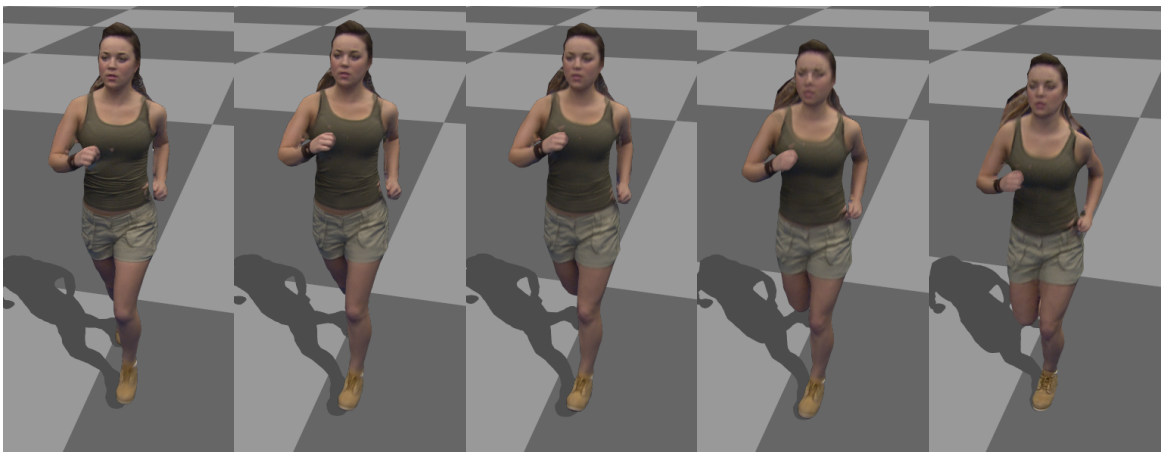
1.1.1 Dynamic Details A



(a) Frame t (b) Frame t+1 (c) Frame t+2 (d) Frame t+3 (e) Frame t+4



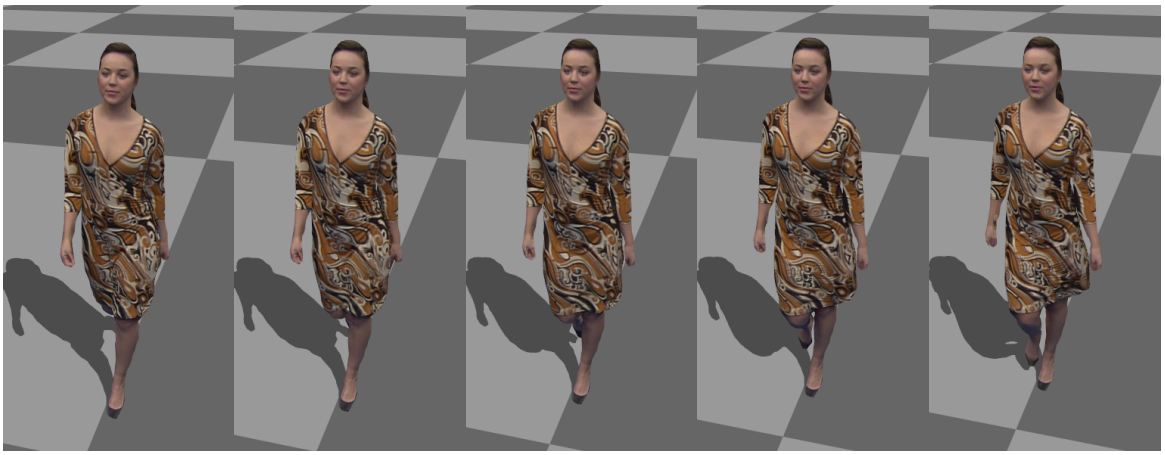
(f) Frame t+5 (g) Frame t+6 (h) Frame t+7 (i) Frame t+8 (j) Frame t+9



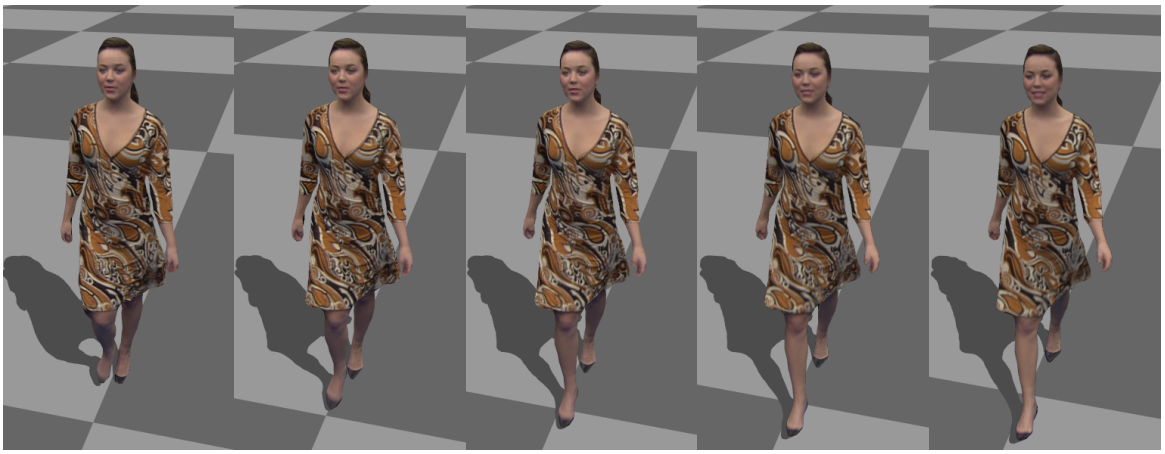
(k) Frame t+10 (l) Frame t+11 (m) Frame t+12 (n) Frame t+13 (o) Frame t+14

Rendered Frames: Character1 Animation Stand1→Hit45 Jogging
Benefit: Realistic bounce of ponytail which will be very difficult to reproduce
Notes: The bounce of ponytail looks natural and if matted properly (probably with some additional manual works) will have a more realistic looking. The proposed approach holds the potential to bring back dynamic details of a vivid performance to the synthesised Character Animation.

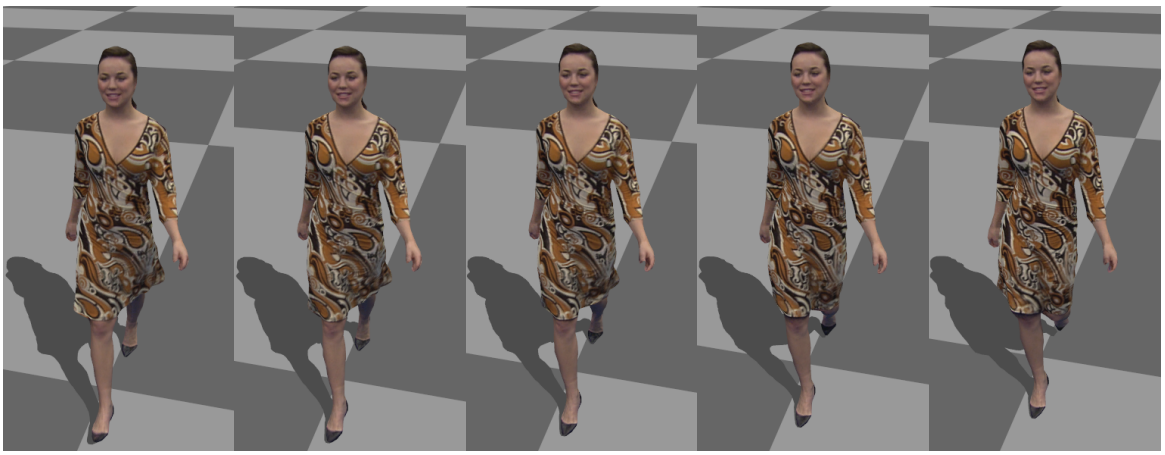
1.1.2 Dynamic Details B



(a) Frame t (b) Frame t+1 (c) Frame t+2 (d) Frame t+3 (e) Frame t+4



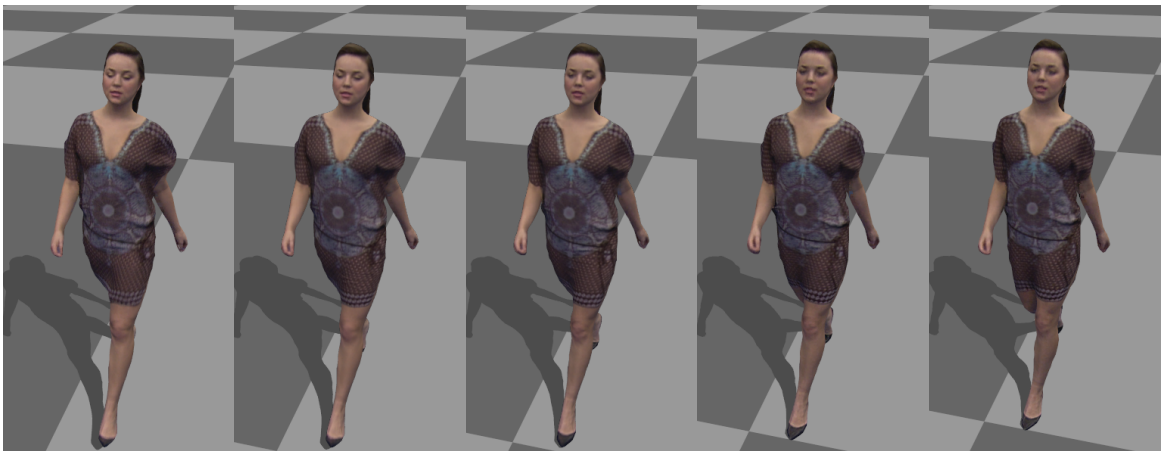
(f) Frame t+5 (g) Frame t+6 (h) Frame t+7 (i) Frame t+8 (j) Frame t+9



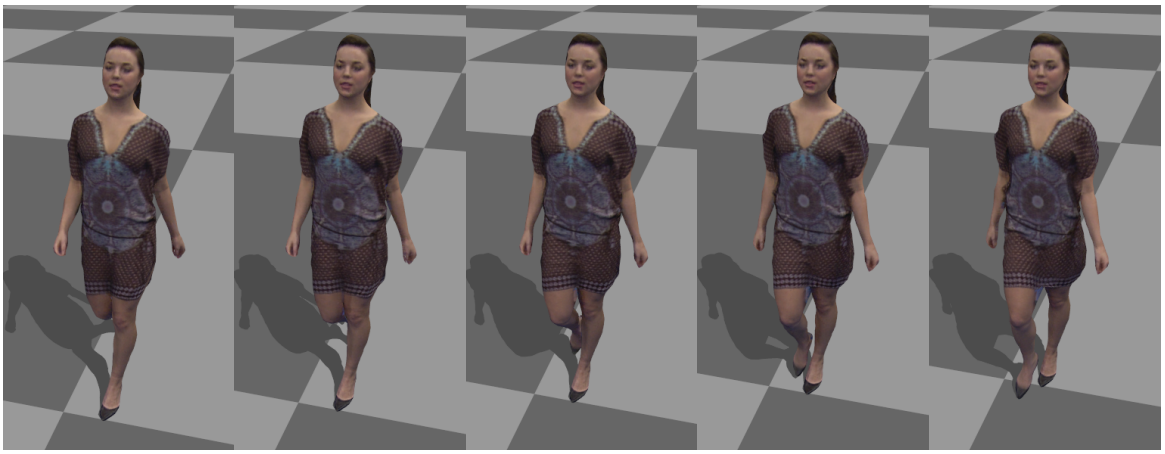
(k) Frame t+10 (l) Frame t+11 (m) Frame t+12 (n) Frame t+13 (o) Frame t+14

Rendered Frames: Fashion1 Animation Pose1→Twirl85 Walking
Benefit: Realistic looking of moving loose dressing and nice face
Notes: The movement of loose dressing along with the walking looks natural and bring back dynamic details to the synthesised animation. In addition, the projected texture compensates the inaccuracy of the reconstructed/aligned geometry, e.g. the face looks nice but actually no details in geometry.

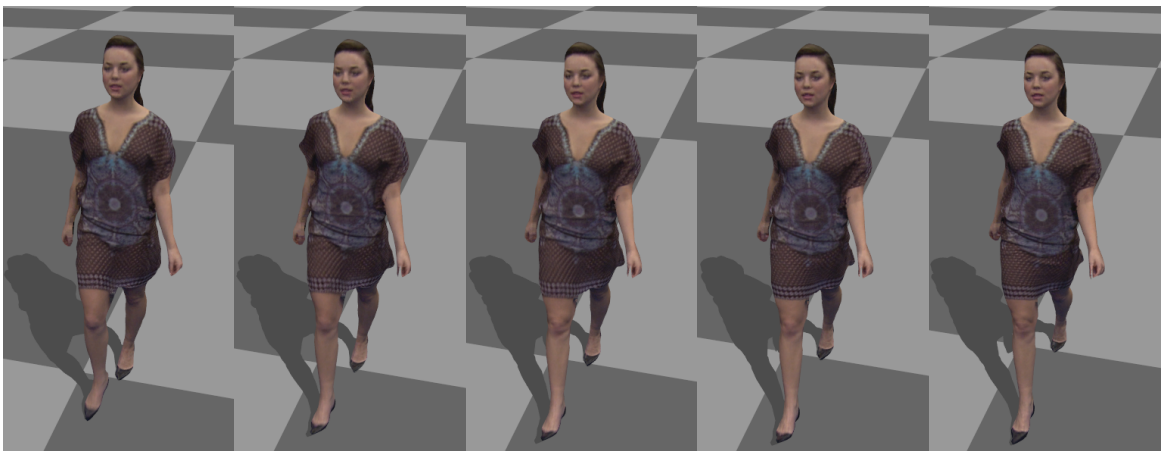
1.1.3 Dynamic Details C



(a) Frame t (b) Frame t+1 (c) Frame t+2 (d) Frame t+3 (e) Frame t+4



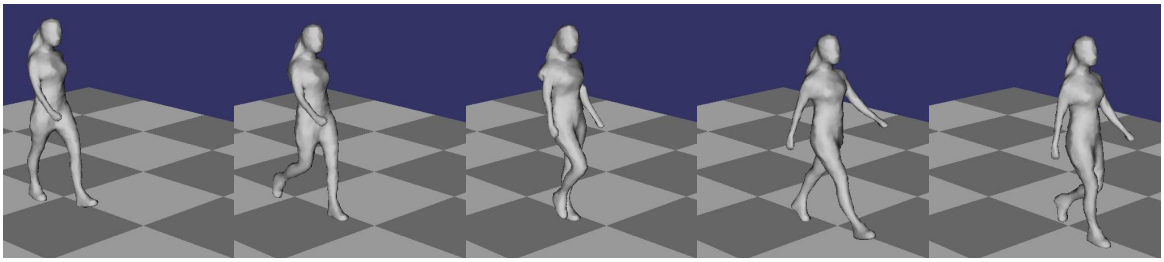
(f) Frame t+5 (g) Frame t+6 (h) Frame t+7 (i) Frame t+8 (j) Frame t+9



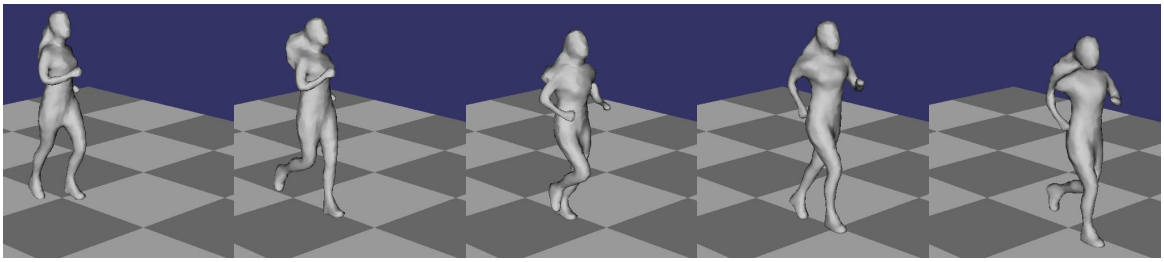
(k) Frame t+10 (l) Frame t+11 (m) Frame t+12 (n) Frame t+13 (o) Frame t+14

Rendered Frames: Fashion2 Animation Pose1→Twirl100 Walking
Benefit: Realistic looking of wrinkles on loose dressing and nice face
Notes: The wrinkles on loose dressing looks natural but the geometry may not be there. The proposed approach demonstrates a relatively cheap way to reproduce a decent level of dynamic details without fully reconstructed/aligned detailed geometry, such as wrinkles.

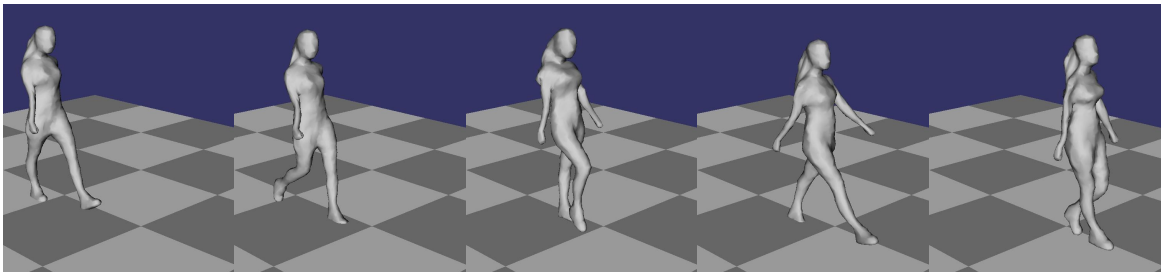
1.2 Comparison with Parametric Motion Control



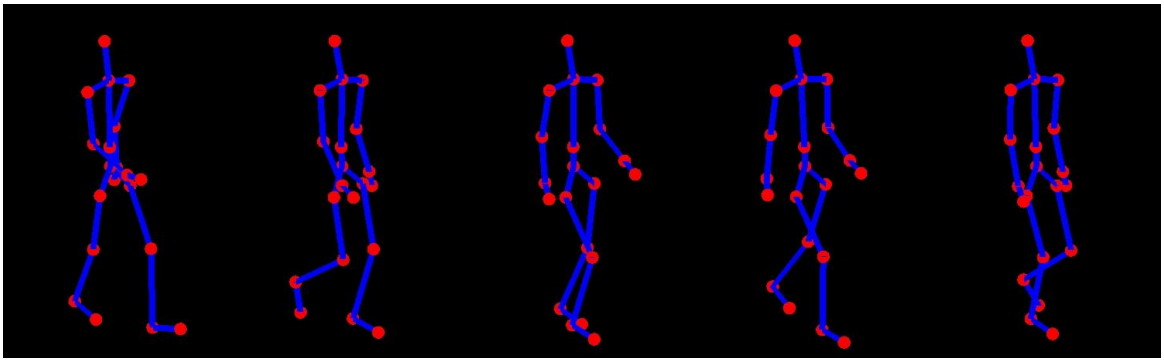
(a) Source Frame 0 (b) Source Frame 5 (c) Source Frame 9 (d) Source Frame 14 (e) Source Frame 18



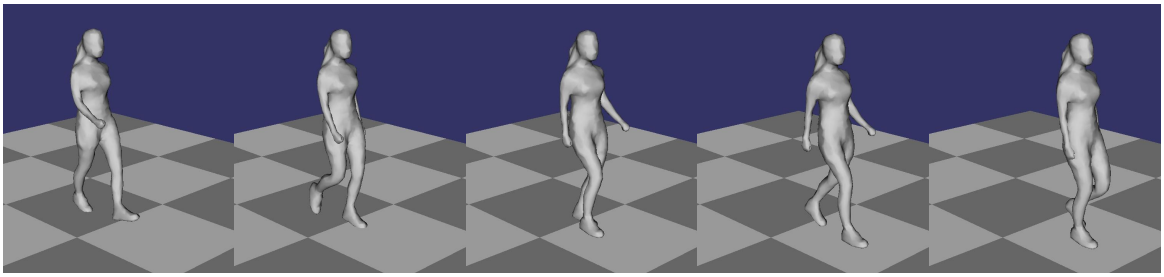
(f) Target Frame 0 (g) Target Frame 4 (h) Target Frame 8 (i) Target Frame 11 (j) Target Frame 15



(k) Parametric Motion Frame 0 (l) Parametric Motion Frame 5 (m) Parametric Motion Frame 10 (n) Parametric Motion Frame 15 (o) Parametric Motion Frame 20



(p) Skeleton Frame 0 (q) Skeleton Frame 5 (r) Skeleton Frame 10 (s) Skeleton Frame 15 (t) Skeleton Frame 20



(u) Hybrid Skeletal-Surface Frame 0 (v) Hybrid Skeletal-Surface Frame 5 (w) Hybrid Skeletal-Surface Frame 10 (x) Hybrid Skeletal-Surface Frame 15 (y) Hybrid Skeletal-Surface Frame 20

Source sequence: Character1 Walk
Target sequence: Character1 Jog
Parametric Motion result: Motion extrapolation using [Casas et al. 2013]
Skeletal MoCap query sequence: CMU MoCap sequence 02_01
Hybrid Skeleton-Surface Motion result: Motion synthesis using proposed approach
Blending function: $(1-\alpha) \times Source + \alpha \times Target$, where $\alpha = -0.5$
Benefit: Slow-down walking synthesised by Hybrid Skeleton-Surface Motion Graphs looks natural
Notes: Given a walking and a jogging sequence as inputs, Parametric Motion result is created by using direct extension of parametric motion interpolation [Casas et al. 2013] for extrapolation and Hybrid Skeleton-Surface Motion result is created by proposed approach with additional input of a skeletal MoCap sequence as query. The extrapolation parameter α is set as -0.5 for both methods to generate a slow-down walking animation respectively. Without a skeletal MoCap sequence as guide, Parametric Motion Extrapolation cannot produce a natural looking slow-down walking animation. In terms of poses: (a) and (f) extrapolates (k) in which the model's right arm is bending in a unnatural way. The same happens to other corresponding blending pairs (b)(g)→(l), (c)(h)→(m), (d)(i)→(n) and (e)(j)→(o). In figure (m) and (o), due to the lack of proper guide of skeletal motion, odd movement are introduced to the head by directly extrapolation of input motions. In terms of motion: the width of step of Parametric Motion result does not change to be smaller as expected for a slow-down walking, although the total number of frames generated for a walking phase is the same, the Parametric Motion result fails to create a truely slow-down walking. The proposed approach successfully produces a natural looking slow-down walking with smaller steps.

2 Visual Artefacts

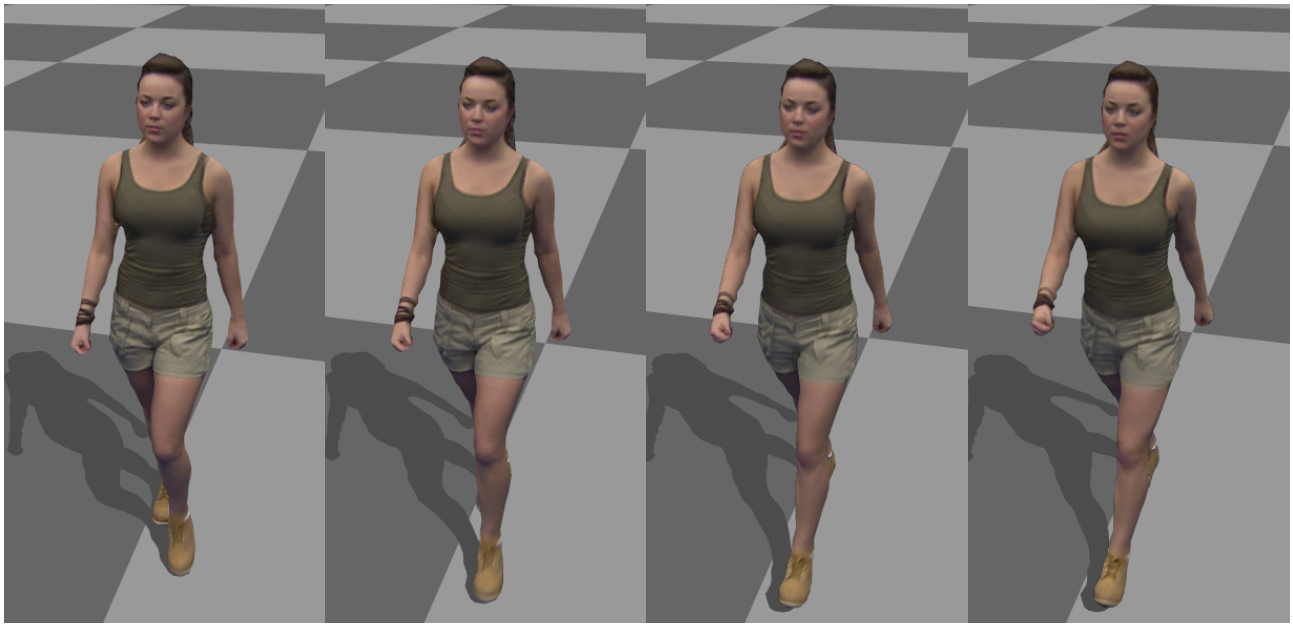
2.1 Reconstruction/Alignment Error

(a) Rendered Frame (b) Rendered Frame (from a different angle) (c) Frame Mesh (d) Frame Mesh (e) Frame Mesh (unaligned)

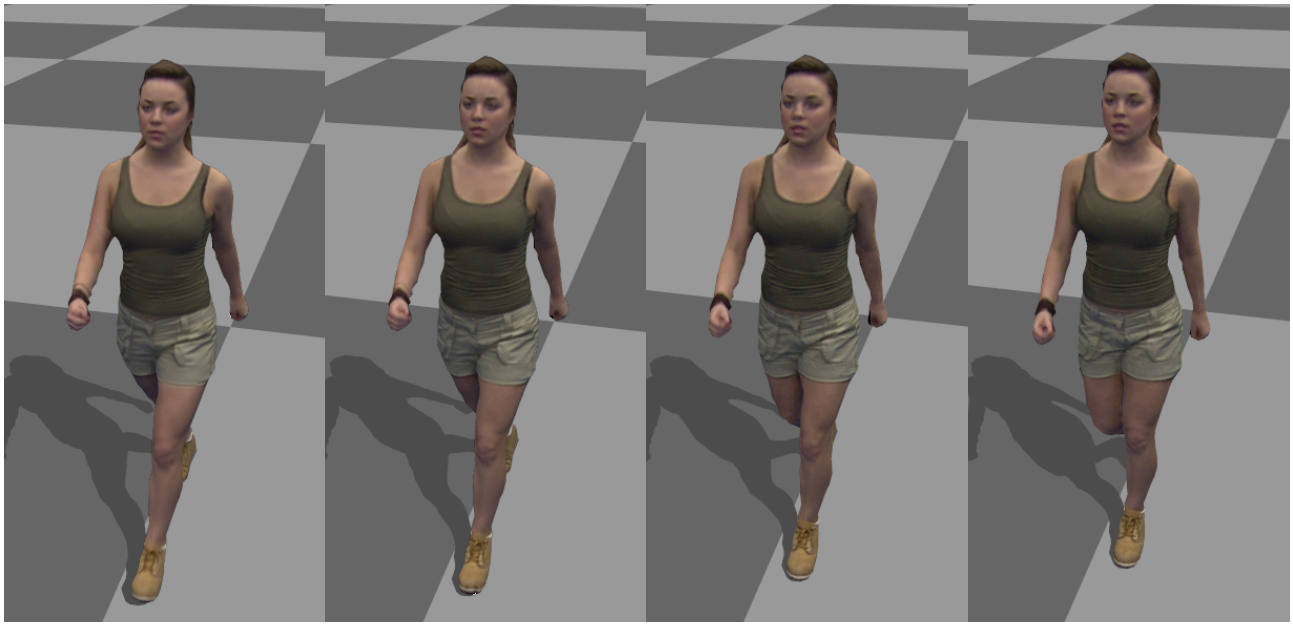
Rendered frame: Character1 Jog 63
Problem: Hand texture leaped to the body/T-shirt (red circle) and bad geometry of left arm (yellow circle)
Notes: In the rendered frame (a), the artefact indicated in a red circle is caused by inaccuracy of multi-view 3D reconstruction – (e) shows a raw 3D reconstruction where the left hand/fingers are missing – view-dependent rendering projects back texture to the mesh but the geometry of hand/fingers is missing which results in hand/fingers texture leap and appear on the body/T-shirt. The other artefact in yellow circle is due to poor temporal alignment – a template mesh with hair attached to body has been used for alignment which causes the hair movement stretching left arm over time and ends to a distorted left arm mesh in (c). This could be solved by choosing a better template mesh with hair unattached to the body, e.g. choosing the mesh in (e).

2.2 Rendering/Texture Error

2.2.1 Baked-in Illumination



(a) Frame t (b) Frame t+1 (c) Frame t+2 (d) Frame t+3



(e) Frame t+4 (f) Frame t+5 (g) Frame t+6 (h) Frame t+7

Rendering sequence: Character1 Walk Cycle
Problem: Character's face and chest appears noticeable darker in (h) than in (a)
Notes: Artefacts shown here are visible change of appearance of face at transitions of each walk cycle (this will be more visible when playing back the walking animation) – face illumination is lighter at the beginning of each walk cycle and darker at the end – this is caused by baked-in illumination when capturing original multiple-view video in the studio. This could be resolved by introducing relighting to 4DPC model, however, it is out of the scope of this paper.

2.2.2 Blurring Texture

(a) Rendered Frame (b) Multiple-View Images captured by 8 HD cameras

Rendering Frame: Character1 Jog 51
Problem: Blurred frame, especially at character's face
Notes: Blurring artefacts shown in (a) are caused by blurring when capturing multiple-view video in the studio (b) – this is a fast moving motion, jogging, and blurring sometimes happens when camera recording.

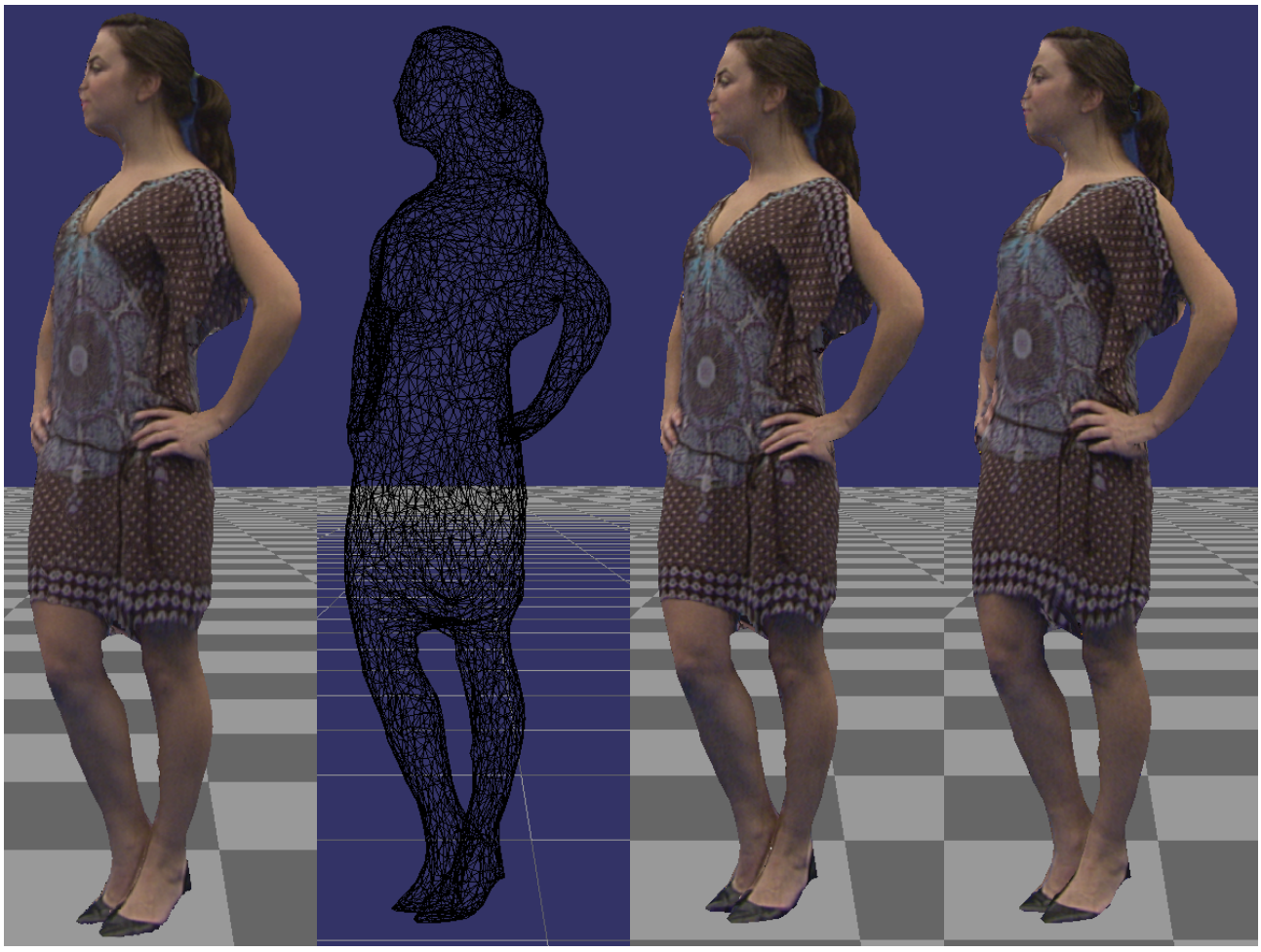
2.2.3 Shimmering Contours

(a) Frame t (b) Frame t texture (zoom-in) (c) Frame t mesh (zoom-in) (d) Frame t+1 texture (zoom-in) (e) Frame t+1 mesh (zoom-in)

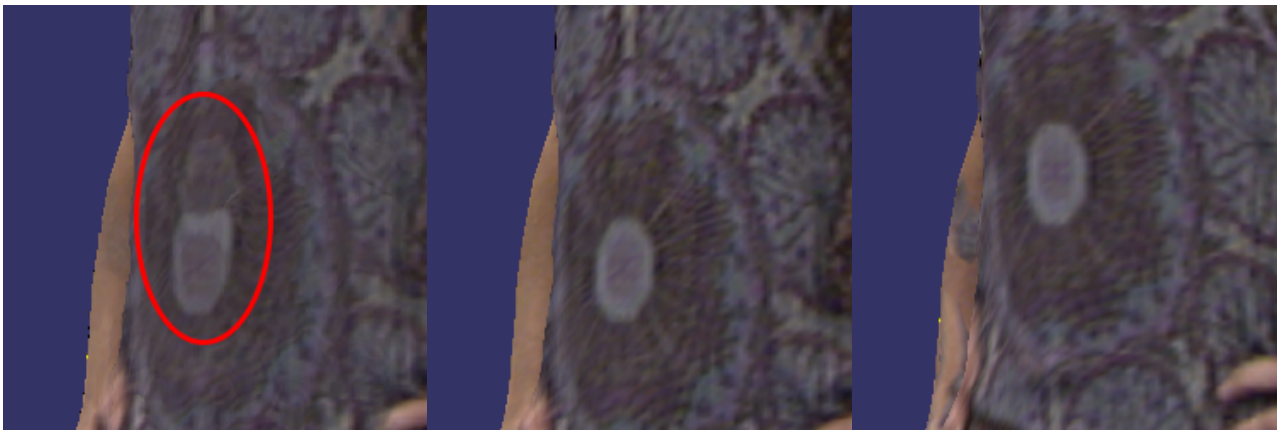
(f) Frame t+2 texture (zoom-in) (g) Frame t+2 mesh (zoom-in) (h) Frame t+3 texture (zoom-in) (i) Frame t+3 mesh (zoom-in) (j) Frame t+3

Rendered Sequence: Fashion1 Pose
Problem: The contour of the model, particularly around her left arm, shimmers over time
Notes: Artefacts are caused by inaccuracy of reconstruction/alignment. (b)~(i) show a zoom-in focus on left armpit where the gap between arm and body moving up and down over time even for a static pose (this will be more visible when playing back the animation).

2.2.4 Ghosting Textures



(a) Blended Mesh with Warped Texture (b) Blended Mesh (c) Blended Mesh with Source Texture (d) Blended Mesh with Target Texture



(e) Blended Texture (zoom-in) (f) Source Texture (zoom-in) (g) Target Texture (zoom-in)

Source Frame: Fashion2 Walk2Stand 82
Target Frame: Fashion2 Twirl 8
Rendered Frame: $(1-\alpha) \times Source + \alpha \times Target$, where $\alpha = 0.33$
Problem: Ghosting texture indicated by a red circle
Notes: Artefacts are caused by failure of optical flow computation then misalignment of source texture and target texture. View-dependent rendering is first performed on the blended geometry/mesh (b), with source multi-view images and target multi-view images resulting (c) and (d) respectively. (a) is obtained by optical flow guided blending of (c) and (d) [Casas et al. 2014]. In this case, optical flow computation is failed and the blending produces ghosting artefacts in (a) and (e).