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Creating stimuli for the study of biological-motion perception

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In the perception of biological motion, the stimulus information is confined to a small number of lights attached to the major joints of a moving person. Despite this drastic degradation of the stimulus information, the human visual apparatus organizes the swarm of moving dots into a vivid percept of a moving biological creature. Several techniques have been proposed to create point-light stimuli: placing dots at strategic locations on photographs or films, video recording a person with markers attached to the body, computer animation based on artificial synthesis, and computer animation based on motion-capture data. A description is given of the technique we are currently using in our laboratory to produce animated point-light figures. The technique is based on a combination of motion capture and three-dimensional animation software (Character Studio, Autodesk, Inc., 1998). Some of the advantages of our approach are that the same actions can be shown from any viewpoint, that point-light versions, as well as versions with a full-fleshed character, can be created of the same actions, and that point lights can indicate the center of a joint (thereby eliminating several disadvantages associated with other techniques).

Johansson (1973) discovered that a few bright moving spots under the appropriate conditions can elicit vivid and apparently effortless perceptions of a moving person involved in readily identified activities. This phenomenon is known as the perception of biological motion. Johansson initially created these stimuli by attaching small light bulbs as markers to the main joints of an actor and then video recording the moving actor in a darkened room (an educational film, made at Johansson's lab, shows examples of these stimuli; Maas, Johansson, Jansson, & Runeson, 1971). Stills from the resulting movies do not elicit impressions of a human figure. However, when the movie is played, the impression of a moving person is compelling. It has been shown that untrained viewers can recover information about the actor's personal identity, gender, emotions, or personality characteristics from a point-light stimulus. Verfaillie (2000) provides a brief overview of the history of the study of biological-motion perception.

Several techniques have been proposed to create point-light stimuli. Each time a new technique was introduced, new possibilities were offered, but new problems were created as well. An overview of these features will allow us to evaluate the technique we present in this article. The technique is based on a combination of motion capture and three-dimensional (3-D) animation software.

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OVERVIEW OF POINT-LIGHT TECHNIQUES

Starting From Photographs or Films

One possible strategy to create biological-motion stimuli is to start from a series of photographs or films and to place dots at strategic locations on the body on a frame-by-frame basis. For instance, Mather and West (1993) used this technique with the well-known sequences of high-speed photographs of moving humans and animals, which Eadweard Muybridge made in the second half of the 19th century (Muybridge, 1955). One disadvantage of this technique is that it gives only a two-dimensional (2-D) version of a point-light action. Moreover, and this is the technique's main disadvantage, stimulus construction is extremely labor intensive. The next technique suffers less from this problem.

Video Recording

For his first recordings, Johansson (1973) used a technique that can be traced back at least to Marey (1894), who used it for chronophotography. Johansson used light bulbs to mark ankle, wrist, knee, elbow, hip, and shoulder joints of an actor dressed in black and filmed him or her with a video camera in a darkened room. When the movie was shown to participants in an experiment, the contrast was turned to near maximum and the brightness to near minimum, resulting in a display consisting of a dark background and bright dots. The main advantage of this technique is that it produces very natural point-light animations; the richness and complexity of real-life animate kinematics are preserved.

This method shares the disadvantage associated with the previous technique, in that it produces only 2-D point-light animations. Moreover, it has another drawback. When the actor's depth orientation changes with respect to the camera, the light bulbs are sometimes occluded by the joints that they mark.[1] In this case, the light bulb is no longer visible, even though the joint itself is not occluded by any other body part. For instance, suppose an actor has a light bulb attached to the outside of the right knee. When the actor is in a sagittal orientation facing to the right with respect to the camera, this knee will be marked by a visible point light. However, when the actor is facing to the left with respect to the camera, no point light on the right knee will be visible, because the knee will hide the marker's light. To make the point light on the right knee visible in a leftward orientation, a point light has to be attached to the knee's inside. Consequently, the orientation of the actor with respect to the camera cannot change within one take. For different actor orientations, different marker configurations have to be used.

The classic solution for this problem (Johansson, 1973) is the use of retroreflective material in the form of a ribbon or tape. This material is wound around the joint or, in the case of hips or shoulders, is attached as a large patch to cover the side of the body part as well as the front and back. With this marker configuration, orientation can vary during one scene. Although this method has been quite popular (e.g., Cutting & Kozlowski, 1977), it has one important inconvenience: The projected size of a marker continuously changes, depending on the camera's angle and the actor's orientation.

The video-based technique (and to some extent the technique based on photographs as well) involves direct recordings of natural events. Original films or photographs are subjected to subtractive manipulations: Everything except for lights attached to the main joints of the actor are made invisible. As an experimenter, one has direct control only over the distal event (the actor and the actions in the world) and less over the proximal event (the point lights on the computer screen). Following Runeson (1994), these techniques can therefore be described as the *distal* approach. In a *proximal* approach, in contrast, biological-motion displays are synthesized from elemental motions. Here, the experimenter has less direct control over the distal event. The next technique exemplifies the proximal approach.

Computer Animation Based on Artificial Synthesis

Cutting (1978b) was the first to describe an algorithm for simulating a point-light walker on a computer display. When displayed with appropriate timing, the algorithm produces a natural-looking version of a human figure, in a sagittal view, walking through a complete step cycle. Verfaillie, De Troy, and Van Rensbergen (1994) adapted Cutting's algorithm to simulate a point-light walker seen from different angles.

Cutting's (1978b) original algorithm became very popular in research on biological-motion perception, since it has obvious advantages over the use of a real actor. Cutting made the full code available in the literature, so that it is relatively easy to set up an experiment without having to go through the effort of frame-by-frame image manipulations or video recording. The algorithm affords the possibility of changing the body proportions of the displayed walkers, which has proven to be interesting for studying gender recognition from biological-motion stimuli (Cutting, 1978a, 1981). Moreover, the algorithm can be adapted relatively easily to change other aspects of the displayed stimulus. For instance, the contrast of the point lights can be controlled (e.g., Mather, Radford, & West, 1992). Other manipulations of the algorithm result in a change in the temporal coordination of the limbs (Bertenthal, 1993) or the position of the point lights on the joints (Cutting, 1981; Verfaillie, 1993). More recent models are far more sophisticated than Cutting's (1978b) algorithm and generate realistic animations featuring full-fleshed characters, as well as stick and point-light figures (e.g., Hodgins, O'Brien, & Tumblin, 1998).

One obvious disadvantage of computer animation of biological motion on the basis of artificial synthesis is that another algorithm is necessary for each new action. Moreover, a lot of the naturalness that is preserved in video recording of real actions is lost in artificial synthesis (Runeson, 1994).

Computer Animation Based on Motion-Capture Data

A wide variety of techniques is available for electronic registration of human motion, known as *motion capture* (e.g., Mulder, 1994). One technique traces the markers on an actor's body with video processors connected to cameras that capture the infrared signals emitted or reflected by the markers. Other motion-capture systems are not visually based but, instead, create a large magnetic field and then track the movements of markers within the field. The result of such an opto-electronic or magnetic motion-capture session is a sequence of marker coordinates in 3-D, which can be used to represent the point lights.

The technique of computer animation of motion-capture data has been used before in psychological experiments on the perception of biological motion (e.g., Ahlström, Blake, & Ahlström, 1997; Bonda, Petrides, Ostry, & Evans, 1996; Hoenkamp, 1978; Nilsson, Olofsson, & Nyberg, 1992). To some degree, this procedure combines the advantages of the distal technique of video recording of natural events with the advantages of the proximal techniques of computer animation on the basis of artificial synthesis. First, real motion data are captured, affording the rich naturalness of stimuli created with the distal approach. In addition, in comparison with procedures in which an algorithm has to be developed for each action, motion capture obviously is more efficient. Moreover, the technique shares with some algorithmic approaches the advantage of working with the 3-D coordinates of the markers, making it possible to display the same action from any viewpoint. Fourth, most 3-D animation programs allow users to systematically manipulate or distort the point-light data (albeit that, depending on specific research needs, different levels of customization will be necessary). Finally, by means of appropriate graphics software, point-light versions, as well as fully illuminated versions of full-fleshed characters, can be produced from the same motion-capture data. The main purpose of the present article is to describe such a technique.[2]

However, apart from the necessary investment in software and hardware, motion capture still has several inconveniences. First, there is the considerable effort associated with the recording. For instance, depending on the number of available cameras, an opto-electronic motion-capture session requires a thorough study of the to-be-captured action to avoid marker occlusion by the actor's body for too many cameras, since this would lead to whole sequences of missing data. A second problem is that the data often contain a large amount of very small errors, producing "jumpy" animations. Although motion editors can be used to smooth the registered marker paths and even to estimate missing data, this problem obviously mortgages the natural appearance of the resulting animations. Third, captured motion data of a moving human are not easily adapted to generate similar movements. For instance, a point-light display showing a person running at 4 m/sec cannot simply be accelerated to show a person running at 5 m/sec, without spoiling the naturalness of the action. This contrasts with some algorithmic approaches. For instance, with software that simulates runners, the animation can be speeded up in a realistic manner (Hodgins, 1998). A fourth problem is that, in contrast to data acquired with a video-based technique, captured motion data lack information concerning occlusion of markers by other parts of the body. The trace of every marker is recorded continuously during motion capture. Therefore, a point light will never disappear from the display, and the number of point lights remains constant over one take, as if the point-light figure was transparent. The present paper will describe an attempt to deal with this problem. The importance of adequate occlusion in the perception of biological motion has been described, both in adult (e.g., Proffitt, Bertenthal, & Roberts, 1984) and infant (Bertenthal, Proffitt, Spetner, & Thomas, 1985) research. Fifth, during motion capture, most of the time, the markers indicate the side of the joint that faces the cameras. Consequently, the acquired motion data mark the position of one particular side of the joint's skin area, rather than the joint itself. For instance, when a marker is attached to the outer side of the right knee, the point light does not exactly mark the position of the joint, but rather a location beside the joint (except when the actor is viewed in a rightward sagittal orientation). This problem also exists for the video-based approach. One of the assets of the approach described in the present paper is that point lights can indicate the center of a joint, even though, during the motion-capture session itself, it is obviously impossible to attach a marker to the center of the joint.

PRODUCING POINT-LIGHT STIMULI WITH CHARACTER STUDIO

Today, professional animators create stunning movies using advanced 3-D animation packages that allow for realistic animations featuring all kinds of full-fleshed characters. In the remainder of the article, we will discuss our experiences in producing animated point-light figures with Character Studio (Autodesk, Inc., 1998) as an example of such an animation package.

Character Studio is a software package that was created for use with 3D Studio MAX (Autodesk, Inc., 1997), an industry standard for affordable and high-quality 3-D computer animation. Character Studio is equipped with all the tools necessary for animating any type of two-legged character, and it exists in the form of two plug-ins for 3D Studio MAX: Biped and Physique. A biped is a human-like skeleton made up of linked boxes (e.g., Figure 1C). The skeleton structure is a classic hierarchy of linked body parts (e.g., the head is linked to the neck, which is linked to the spine, etc.). The pelvis is the root of all the objects. Physique is a modifier that uses a linked structure, such as a biped or a MAX bones system, to deform a character's skin or any other type of surface. It supports advanced features, such as weighted blending, skin sliding, muscle bulging, and tendon effects. In the present article, we will discuss our experiences with Character Studio 2.0 for 3D Studio Max 2.5. Lankes (1998a, 1998b) gives a review of the software. For training, we recommend software documentation for advanced users, such as that available from the vendor and videos by Forsburg (1998a, 1998b).

Two important properties of every object in a 3D Studio scene are its position and its orientation. Changing this information over time causes an object to move. Because a Character Studio biped is made of such objects—and is in itself an object—it is the same succession of position and orientation data that causes this biped to move around in a scene and to move its trunk, head, and limbs. To differentiate between the information that describes the motion of the biped and its parts and the information that describes the paths of a set of markers, we refer to the first kind as BIP data (which is the file name extension for biped motion data saved in Character Studio) and to the second kind as CSM data. BIP data can be constructed in four ways: (1) The biped structure is manipulated by the animator by hand (*freehand* mode), (2) the biped is manipulated by using a geometrical model of human gait (*footstep* mode), (3) the biped is manipulated by combining several BIP data sets (*motion flow* mode), or (4) the BIP data can be derived from captured motion data and subsequently edited in one of the previous modes. Because we have primarily used this last method, we will discuss it in more detail in the next section.

Capturing the Motions

To obtain captured motion data, we make use of a Qualisys MacReflex motion-capture system for use with a PC (Qualisys, Gothenburg, Sweden), including six position

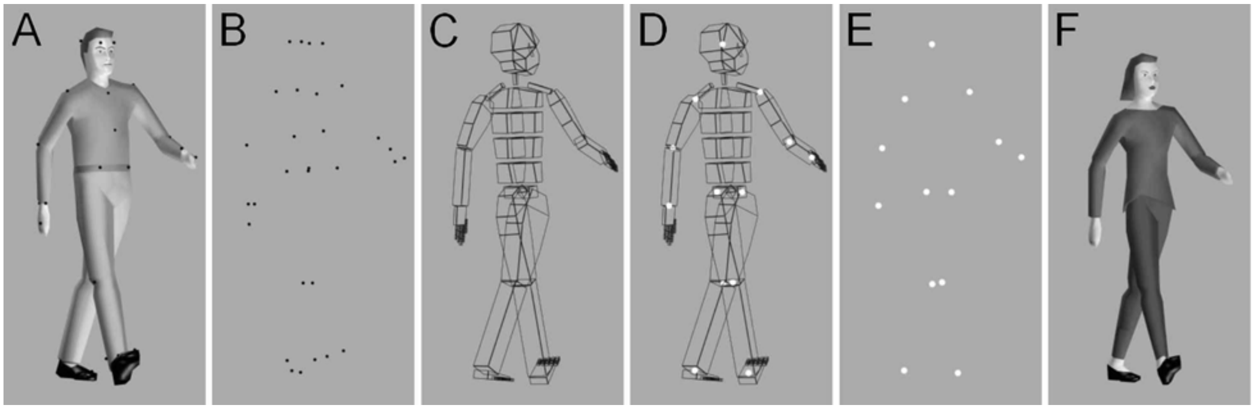

Figure 1. Illustration of the different steps in our procedure for creating point-light stimuli. (A) A schematic drawing of an actor with the visible markers attached to the body. (B) The location of the 30 markers during a motion-capture session. (C) The biped we use in Character Studio. (D) The location of the point lights on the biped (the locations are the same in the two described methods for creating point-light stimuli). (E) The resulting point-light stimulus. (F) Animation of a full-fleshed character, based on captured motion data from the person in panel A.

units (a camera and its video processor).[3] We use retroreflective markers, which are illuminated by infrared light emitted in the form of short pulses produced by an integrated LED array in the cameras. The light is then reflected back to the cameras by the markers, appearing as bright light spots. The light spots are analyzed with one video processor per camera, and their position and size are calculated every 17 msec. After the capture session, the 2-D data from all the position units are processed off line to calculate the 3-D coordinates of the markers used in the session. Whereas classic motion-capture recordings for point-light stimuli or video recording typically involve 10–12 markers (cf. Johansson, 1973), character animation software such as Character Studio requires measurements with at least 30 markers for import of raw motion data. As a result, marker placement for character animation significantly differs from marker placement in these other techniques. Usually, we place the 30 markers on anatomical locations specified in Vicon's Body-Builder 3.5 Manual (Oxford Metrics Ltd, 1997). The list of marker locations can be found in Appendix A. Figure 1A shows a computer reconstruction of an actor with the visible markers. In Figure 1B, all 30 markers are shown. The final result of a capture session is a file containing the 3-D coordinates of the 30 markers. Because this file is in a format specific to the MacReflex system (CME), we wrote software to convert the data to CSM format, which is the format for motion capture data used by Character Studio (Appendix B).

To derive BIP information from motion-capture data, the raw data are imported in Character Studio and position and 3-D angle are estimated for every box making up the biped. The biped we are currently using is shown in Figure 1C. The estimation of position and angle information is based on a biomechanical model of the character, the relative position of the markers, and the angles formed by the markers. The accuracy of this procedure depends not only on the model used for the character, but also on the algorithm for joint angle computation, the proper placement of markers on the body, and the accuracy of the captured motion data. Character Studio has its own algorithms for import of raw motion data but also allows for import of partially preprocessed motion data (BioVision's BVH format).

Obtaining motion-capture data for character animation demands more effort than simple video recording or even classic motion-capture recording for point-light stimuli (i.e., when the point-light localizations directly correspond to the marker localizations during the capture session). However, as we will point out later, Character Studio can use the resulting BIP data to animate any possible bipedal character, giving it considerable advantages over more classic techniques. Furthermore, Character Studio comes with a large number of ready-to-use BIP files based on motion-capture data, and there is a fast-growing market for character motion data, including BIP and BVH formats (e.g., http://charactermotion.com). An interesting project in that respect is a BIP library inspired by the work of Muybridge (available in Muybridge, 1955) on human motion (Pepper's Ghost Productions, 1999). Although these libraries might be too general in nature for some research purposes, they do offer the possibility of taking full advantage of the animation techniques without having to perform the actual motion capture itself.

In the next section, we will discuss how to configure the biped to produce the corresponding biological-motion stimuli.

Animating a Point-Light Character

At our lab, we developed two methods for producing point-light stimuli with Character Studio. The first method is most similar to the distal motion-capture techniques mentioned in previous paragraphs. As has already been mentioned, point lights in Character Studio can indicate the center of a joint, even on the basis of a series of coordinates obtained from motion capture. For this purpose, arbitrary objects are attached as tags in the center of the biped's head and to the pivot points of the major limbs (i.e., where the limb objects of the biped meet). For instance, to indicate the character's elbow, a tag is placed at the pivot point of the lower arm. The location of the tags on the biped is shown in Figure 1D. The tags' coordinates will change over time when the character moves around in the scene. These coordinates can then be exported to an ordinary ASCII text file by means of a script in the MaxScript macro language. The script is listed in Appendix C. Consequently, a series of coordinates in 3-D space is obtained for every joint's center. These 3-D coordinates can then be mathematically projected onto a hypothetical 2-D surface, and this projection can be used to simulate point-light motion on a computer screen.

A second method was developed for producing images or movies with the render function of 3D Studio. One important asset of 3-D animation software is its feasibility for creating an infinite number of movies from one scene by varying the camera's position in space. To produce point-light stimuli within 3D Studio, one has to devise suitable markers for attachment to the character's skin or biped skeleton. To keep the shape of a point light constant under these conditions, we use a marker with the shape of a small ball. The marker's material can be any white material configured as follows:

self-illumination	100
shininess	0
shininess strength	0
opacity	100

We attach these markers to the center of the biped's "joints" and the head. This is illustrated in Figure 1D. The biped itself is made invisible with the "hide" function. Other lights in the scene are best omitted or directed away from all objects, to avoid reflections by other material in the scene. The resulting scene can be rendered with a virtual camera or from one of the viewports to create an animation. An example of a static frame is depicted in Figure 1E.

As has already been mentioned, it is hard to mimic occlusion in the point-light stimulus, but we designed one method that gives satisfying results. We devised a double-sided material to apply to the character's skin. The material reflects the properties of a one-way screen. It is configured as follows:

translucency	100
facing material	
color	black
shininess	0
shininess strength	0
opacity	100
back material	
color	black
shininess	0
shininess strength	0
opacity	0

This material does not allow light to pass through the facing side of the skin but does allow light to pass through the back side. As a result, a virtual marker can emit light from the center of a joint to all directions straight through the character's skin, but any limb positioned in between the camera and the marker hides the light emitted by this marker. The occlusion thus acquired resembles real occlusion, as obtained with Johansson's (1973) technique. However, certain camera positions fail to produce occlusion where they would definitely lead to occlusion with Johansson's technique. For example, in a sagittal view of the character, both markers indicating the hips are visible (except when a limb moves in front of the hip light), whereas only one marker would be visible with Johansson's technique.

One advantage of this technique is that point lights can indicate the center of a joint. Light is emitted from the inside of the body, contrary to the light emitted or reflected from a marker attached to the outside of the body. Because the character's skin is nothing more than an empty shell, all the point lights emit light freely from the inside of a single volume. There is no human tissue occluding the markers inside the body. Because a point light can indicate the center of a joint, several disadvantages associated with the video recording technique—especially when the depth orientation of the moving character changes—can be avoided.

Another advantage is that the same BIP data can be used to animate any kind of rendering of a human action. Indeed, Johansson's (1973) technique can be simulated with Character Studio, attaching virtual retroreflective patches to the character's skin and illuminating the figure with virtual spotlights. Furthermore, with the same package, one can animate more than just point-light figures—for example, a full-fleshed character from any age or gender (as illustrated in Figure 1F), a stick figure, a silhouette, and so on (e.g., Verfaillie & Daems, 2002). Infinite stimulus variations are possible with one set of BIP data, and most of them take no more then a few mouse clicks from a beginning user. An important feature of Character Studio is its ability to keep the character's center of gravity fixed in one position in the horizontal plane. This gives full control of the character's position on the display during playback, which is hard to achieve with a video technique and with classic motion-capture techniques for point-light production.

CONCLUSION

With Character Studio, human motion can be simulated on the basis of models of human gait, freehand manipulation, import of motion-capture data, and combination of several motion data sets. As motion data for a large number of human actions become widely available, Character Studio can be highly useful, both for professional animators and for researchers interested in visual perception of animate actions. Animators can use both captured motion data of their own and data from many other motion-capture labs in the world. Researchers can produce animations by using several sorts of marker configurations, as well as movies based on a large number of characters, varying from point-light figures to realistic persons—all based on the same motion data. With 3D Studio and Character Studio being sold for academic purposes at prices lower than the price of an average video camera, we consider these packages to be a viable and powerful new alternative for the production of high-quality point-light stimuli, offering experimenters more control than ever before.

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NOTES

1. Although they both are types of occlusion, there is a fundamental difference between this type of "self-occlusion" and the occlusion that occurs when another part of the body moves in front of the point light (e.g., an arm in front of the hip).

2. Very recently, Thomas and Jordan (2001) described a technique for producing point-light and fully illuminated versions from identical recordings. However, because the technique is still based on video recording, it shares most of the disadvantages associated with classical video recording techniques. For instance, only 2-D point-light animations can be produced.

3. The technical specifications of our MacReflex configurations are a maximum frame rate of 60 Hz, a resolution of 1:30000 of the camera's field of view, a maximum of 50 markers (usually 30), cameras with 6-mm lenses, and video processors of the MacReflex VP II type.

APPENDIX A
Standard Full-Body Marker Placement According to Vicon's BodyBuilder 3.5

Root segment markers
- Left front waist (on the hip bone prominence)
- Right front waist (on the hip bone prominence)
- Left back waist (to the side of the back dimples)
- Right back waist (to the side of the back dimples)

Leg markers
- Left knee (on the outside of the knee joint)
- Right knee (on the outside of the knee joint)
- Left ankle (on the ankle bone)
- Right ankle (on the ankle bone)
- Left 5th metatarsal (at the base of the 4th and 5th toes)
- Right 5th metatarsal (at the base of the 4th and 5th toes)
- Left toe (big toe nail)
- Right toe (big toe nail)

Thorax and head markers
- 7th cervical vertebra (prominent neck bone)
- 10th thoracic vertebra (middle of the back)
- Breastbone (midchest)
- Clavicle (on the collarbone, centrally)
- Left front head (above left temple)
- Right front head (above right temple)
- Left back head (opposite front head)
- Right back head (opposite front head)

Arm markers
- Left shoulder (top of left shoulder)
- Right shoulder (top of right shoulder)
- Left elbow (outside of elbow joint)
- Right elbow (outside of elbow joint)
- Two markers on an extender attached to the left wrist (on a stick, just above wristwatch face position)
- Two markers on an extender attached to the right wrist (on a stick, just above wristwatch face position)
- Left fingers (on the middle finger)
- Right fingers (on the middle finger)

APPENDIX B
Program to Convert Data in CME Format to CSM Format (Script Written in Perl)

```
#CONVERT.PL
#      Perl script to convert Qtrack CME files to CSM files for use with
#      Character Studio parameters: a CME file, a CSM file and an actor
#      name, e.g. “perl convert walk.cme walk.csm Jimmy_B”
#      the program expects a VM file in the same directory as the CME
#      file, with the same name, e.g. “walk.vm”

#initialise
($cme, $csm, $actor) = @ARGV;
$vm = $cme;
$vm =~ s/.cme/.vm/;
$/=”\n”;

#open files
open CSM, “>$csm” or die “Can't append to $csm : $!”;
open CME, “$cme” or die “Can't open $cme :$!”;
open VM, “$vm” or die “Can't open $vm :$!”;
#write $Filename, $actor, $Comments
print CSM “\$Filename $csm\n”;
```

APPENDIX B (Continued)

```
print CSM "\$Actor $actor\n\n";
print CSM "\$Comments\n";
print CSM "3D Studio MAX motion capture data converted from $cme using $vm\n\n";
#write $Rate
$_ = <CME>;
$frames = $1 if /frames = (.*?) /;
$rate = $1 if /Hz = (.*)/;
print CSM "\$Rate $rate\n\n";

#write $Order
foreach $i (1..2) {$_ = <VM>;}
$markers = $1 if /MARKERS (.*)/;
print CSM "\$Order\n";
$_ = <VM>;
foreach $i (1..$markers)
            {
            $_ = <VM>;
            print CSM "$1 " if /$i (.*?) $i/;
            }
print CSM "\n\n";

#write $Points
print CSM "\$Points";
foreach $f (1..$frames)
            {
            print CSM "\n$f  ";
            foreach $m (1..$markers)
                 {
                 $_ = <CME>;
                 print CSM $1 if /(.*?)\n/;
                 print CSM "  ";
                 }
            }

#close files
close CSM;
close CME;
close VM;
```

APPENDIX C
Program to Export the Coordinates of a Set of Markers to an ASCII File
(Script Written in the MaxScript Macro Language)

```
Ball = #($Ball_Head, $Ball_L_Shoulder, $Ball_R_Shoulder, $Ball_L_Elbow,
$Ball_R_Elbow, $Ball_L_Hand, $Ball_R_Hand, $Ball_L_Hip, $Ball_R_Hip,
$Ball_L_Knee, $Ball_R_Knee, $Ball_L_Heel, $Ball_R_Heel)

global v
global vv

f = createfile "10.txt"
for t in 0 to 29 do at time t
      (
      for b in 1 to Ball.count do format " %" Ball[b].pos to:f
      format "\n" to:f
      )
flush f
close f
edit "10.txt"
```

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