Stage™

Markerless motion capture technology

How it works – New Possibilities for the Animation, Game Development, Visual Effects

Prepared for

Company

A MARKERLESS MOTION CAPTURE - HOW IT WORKS

Intro

Organic Motion is a computer vision technology innovator that has created a revolutionary new method to digitally capture, quantify and understand the body movements of humans.
We have developed a patent-pending technology in computer vision, creating the world's first commercially available markerless motion capture system – capable of "seeing" the complex movements of people and generating highly accurate 3-D tracking data in real-time, without using bodysuits or markers.
Up until now there were no simple ways for computers to quantify human movement without the use of elaborate body suits, special "markers" or cumbersome attached tracking devices. This has limited the use of computer based motion tracking to the domain of research and unique one-off engineering projects.

For applications, ranging from research, clinical and sport to entertainment and virtual reality, it is important to be able to measure accurately the movement of a patient, an athlete, an actor or an object.
There are many reasons for such measurements from the medical diagnosis and functional evaluation of a patient, to the monitoring of an athlete's progress, as well as the development of interactive attractions for amusement parks or gyms, and the analysis of dynamics in the industrial processes, vehicle crash tests, ergonomic design and more.

General primer on markerless technology

There is no 'gold standard' in accurately measuring human skeletal movement. Over the years optical marker based systems have become a tool of choice to measure the movements of humans. Two types of accuracy have become important here: relative accuracy and absolute accuracy. By applying a marker set to a subject, various optical technologies have become very good at tracking relative movements of the human body. These relative movements are important when testing variance in the movement of athletes even if they are inaccurate in absolute terms. Accuracy in the absolute domain has become much harder to achieve. Absolute accuracy becomes important when one wants to compare data between subjects, between multiple days or even between facilities. A methodology of "marker sets" has been developed to help add consistency to comparisons between subjects and facilities. A big factor in this process is the ability of a technician to accurately place markers on a subject using these guidelines.

The introduction of markerless motion capture systems brings with it a paradigm shift in the way researchers evaluate and think of data. The first step in evaluating this new technology is to understand some of the different ways Stage gathers data when compared to a legacy marker based system.

All data generated with Stage is “pseudo-absolute”. This means it will deliver the same real world accuracy for the same subject every time within the same facility or across facilities. This is a very positive development for researchers who collaborate: Accuracy is no longer dependant on specific marker setups or the technicians who apply them. On the negative side it means that a markerless based system will not achieve results as strong as a marker based system in the relative data domain. The relative accuracy of a markerless based system can be compared to the relative accuracy of a marker based system if the subject is re-fitted with markers between trials. We call Stage data “pseudo-absolute” because the data it generates does not necessarily correspond with the actual bone movement. Markerless systems look at the skin and make assumptions as to the bone movements underneath. Generating a mapping from flesh movement to real world bone movement is still a continuous process.

There is also a change in thinking required when setting up various tests. Marker based systems see markers. Stage sees humans. The human becomes the marker. Researchers can no longer glue a marker on an object and then simply track the object. In a markerless system specific programming is required to expand its ability to track non-biped objects or creatures. The system can not easily discriminate between a human and objects that are touching this person. Objects become part of the shape that is being tracked. This works well for shoes and tight fitting clothing. It works less well for bulky items. The system can also not focus in on special body parts since the system must always track the entire person to understand how the person is moving.

How it works

Organic Motion's technology uses multiple 2D video cameras to track the subject. The data output from each camera is fed into a vision processor which maps every pixel of information and triangulates the location of the subject by seeing where the various camera images intersect.

Monochrome cameras are integrated into the structure/frame surrounding the capture volume. Organic Motion will have cameras aiming at the volume from above, the back, sides and the floor.
The cameras have a resolution of 756 x 480 pixels and a frame rate of up to120hz.

Organic Motion uses custom made cameras that include an LED ring of lights around the lens. When these cameras point at a special retro-reflective material, the material appears to glow to the camera. We use this technique to reduce the processing required in the vision system. The process greatly simplifies subtracting the background from the subject the system is tracking. Special consideration has to be given to the reflective material used in the background. It means that the cameras must always be pointed at this reflective material. We place this material on the ground/floor, on the back, left and right side walls of the capture volume (the backdrop).

The system consists of 14 cameras suitable for a scan area of max. 16ft by 12ft.

Organic Motion's computer vision system incorporates three general components:

1. Video Sub-System

The Video Sub-System acquires lens and space calibrated video from the cameras and delivers these synchronized streams to the reconstruction processor.

2. 3D Reconstruction System

The 3D Reconstruction System turns the 2D video streams into 3D point and surface clouds by triangulating the various 2D viewpoints. In this way the 3D Reconstruction System acts much like a 3D scanner. This system generates massive amounts of data that resembles the human subjects as they appear inside the scan space.

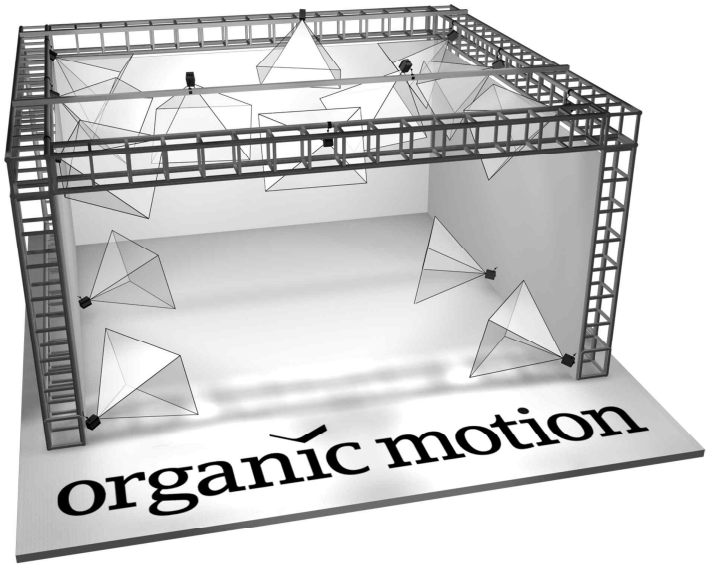
3. Character Fitting System

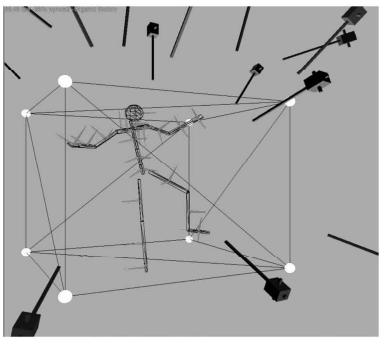
The last step involves "recognizing" the human figure in this 3D data cloud. Here Organic Motion uses a complex rules based approach which maps a 3D humanoid skeleton into the data. The output data the System delivers is the X, Y and Z positions and orientation of the segments of this skeleton. Currently this last segment is specialized to recognize and track a typical human biped.

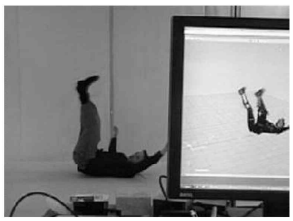
Key Features in summary

- No markers, no sensors, no suit to wear
- Auto calibration to actors body size in seconds
- Real-time capturing, tracking and processing

- 3D data output (6dof, 21 bones) in real-time
- 3D mesh output (up to 8000 polygons) in real-time
- 3D texture output in real-time
- Animation in MotionBuilder in real-time through plug-in
- No post-processing
- No expert technician to operate and maintain software and hardware
- SDK for easy integration with other solutions and applications









B SYSTEM DESCRIPTION STAGE

1. Scanning Parameters

- Scan Space, up to 5m x 4m x 2.5m
- 60-120 fps, real-time with approximately 100-25ms latency
- XYZ Positional Accuracy (arms, legs) up to 1.0mm
- Rotational Accuracy (arms, legs other than along axis) up to 1°
- Rotational Accuracy (along axis) up to 2°
- Bones: 21 bones - 6 degrees of freedom each
- Designed for indoor use in typical artificial and/or natural lighting

2. Hardware

- Vision Processor
- 14 Cameras:
- 120 fps, gray scale,
- Resolution equivalent to 2 mega pixel of marker-based system,
- Scalable Scaffolding and reflective cloth to create scan space
- All connection cables

3. Software

- Software embedded in Vision Processor
- Animation Plug-ins: Autodesk® MotionBuilder™
- Software Development Kit (SDK)

4. Calibration

- Lens Calibration: lens distortion is pre-calibrated prior to shipping
- System Calibration: On site in approximately 3 minutes via pattern board or wand
- Actor Calibration: On site in a few seconds

5. Output Format

- Supported through Plug-ins and SDK; inquire for specific formats
- 3D mesh variable from 500 to 8000 polygons
- Surface texture via video

C THE MARKERLESS ADVANTAGE

Non-intrusive markerless human tracking offers opportunities like never seen before in the industry - creating possibilities for new applications such as everyday medical use, research, sport evaluation, new forms of fully interactive and completely immersive entertainment venues.
Imagine simply walking into a mo-cap system wearing your regular street clothes and receiving a 3D representation of yourself being dynamically immersed into a 3D world or analyzed in biomechanical analysis software - all in real-time!

Organic Motion's Stage system improves the way motion capture is done and removes many constraints found in typical motion capture systems.
It makes our clients more effective by offering real-time markerless tracking that minimizes preparation, allows easy/instant access to mocap for anyone, shortens the product development cycle and allows animators, researchers, and students alike to operate the system directly while providing clean 3D motion data.

Key Benefits in summary:

- Non-intrusive – nothing to wear other than typical clothes or uniform
- Minimal setup per capture session, instant access to motion capture and real-time use
- Movements less contrived, more realistic movements in wider range of multiple scenarios
- Integrates into 3D Game engines Virtual World systems in real-time via OM's SDK
- A state-of-the-art-solution to attract students, businesses, and professionals to the University
- Expected to generate high profile publicity, which Organic Motion will help generate
- Dramatically easier to use than marker-based motion capture systems, Organic Motion systems can be operated by animators/students directly and don't require hiring a technician for set up, calibration and post-production - greatly reducing operating costs
- Increasing the number of animators/students who can work with the system in a given time
- Allows animators/students to fully concentrate on their core work.

Range of Capabilities:

- Test new ideas and try out what works and what not
- As a prototyping tool, not so much as a production tool
- As a live input tool in the process of writing the procedural story
- Develop a framework/visuals of what you want to achieve prior going into full production
- Be able to better explain to the producer how the final outcome is supposed to look at hand of prototype results

Points of difference:

	MARKERLESS	**MARKER-BASED**
Tracking Method	No markers	Requires markers, suit or other sensors
Immediate access to mocap	Yes	No
Invasive	No	Yes
Marker occlusions	None	Yes
Data output	3D data, texture, mesh	3D data
Subject prep time	None	High
Data consistency and comparability	High	Low due marker placement error
Data availability	Real-time	Some require manual post-processing
Data cleaning	None	Some require manual cleaning
System Operator required	No	Yes