

# Markerless motion tracking: MS Kinect and Organic Motion OpenStage

A L Brooks<sup>1</sup>, A Czarowicz<sup>2</sup>

<sup>1</sup>AD:MT, School of ICT, Aalborg University,  
Niels Bohrs vej 8, Esbjerg, DENMARK

<sup>2</sup>VP Sales, Organic Motion, USA

<sup>1</sup>*tb@create.aau.dk*, <sup>2</sup>*alex@organicmotion.com*

<sup>1</sup>*medialogy.eu*, <sup>2</sup>*www.organicmotion.com*

## ABSTRACT

This contribution focuses on the Associated Technologies aspect of the ICDVRAT event. Two industry leading markerless motion capture systems are examined that offer advancement in the field of rehabilitation. Residing at each end of the cost continuum, technical differences such as 3D versus 360 degree capture, latency, accuracy and other issues are discussed. The plusses and minuses are presented including reflections on the evolution of the MS Kinect to be a stand-alone device for PC with a SDK to offer access for creative programmers to develop systems for disabled users. A conclusion is how the SDK enables half-torso and mirroring calibrations offering new opportunities for wheelchair users.

## 1. INTRODUCTION

Behind this brief position contribution is a mature body of research that evolved bespoke motion sensing devices to enable markerless gesture control of multimedia. Games (movement mapped to gameplay); robotics (movement control of motor-driven multimedia devices); and creative expression (e.g. movement control of digital music, robotic devices, digital painting, effects etc.) have been explored. An international patent, an independent commercial product, and a spin out company resulted from the research (Brooks and Sorensen, 2005). Upon this background two contemporary motion capture systems are explored, specifically the Kinect and the Organic Motion systems. The aim is to provoke a debate on requirements for use within rehabilitation of such technologies - both as a tool to motivate and optimize engagement as well as a means to assess use and potential end-user development. To support the emerging communities of users, i.e. trainers/educators/therapists/carers/families, who are interested in ICT applied in their work, a series of papers are being written to detail the choices that are available for communication apparatus and method in line with Brooks and Sorensen (2005). This contribution focuses on specific camera-based systems that empower control of avatars without using wearable or held equipment, i.e. markers, handsets, or other tangible artefacts that can impede in complex situations such as rehabilitation.

## 2. TECHNOLOGIES

With the advent of markerless motion control becoming commercially available to the masses at an affordable price, this paper compares two systems at each end of the price spectrum so that potential adopters may have insight upon which to consider potentials to supplement traditional rehabilitation. The first system presented is the affordable Microsoft Kinect, which is available either bundled with the MS X-Box or as a stand-alone Windows PC device with a supplied SDK and drivers. The second system, which is at the high end of the price range, is the OpenStage® V2.0 Markerless Motion Capture System by Organic Motion.

### 2.1 Kinect

The MS Kinect system is well documented as the first consumer-grade application that uses a pattern of projected infrared-points to generate a dense 3D-Image to capture information from a scene. The user's whole or upper body can be calibrated to permit limb motion control via skeletal mapping. Whilst the level of markerless data accuracy is not as high as high end marker-based systems it is impressive relying on interpretation and predictive algorithms to determine the most probably upcoming pose. The Kinect technology is overviewed in table 1. This technique predicts the most probably skeleton by building on its experience and pre-programmed kinematics models. This skeleton is then outfitted as a 3D avatar.

Limitations reported to date are of ‘blob’ detection rather than specific details of limb, e.g. fingers versus hand location. This is improved in the new Kinect for Windows SDK.

**Table 1.** *Comparatives of Kinect & Organic Motion.*

PARAMETER	KINECT (MS X-BOX)	ORGANIC MOTION
SPEED	30 fps limited tracking of fast moves	Adjustable from 30 to 120 fps to track
ACCURACY	Low – Not a real 3d mocap	High – In the mm range
FULL 3D TRACKING	No, based in predictive algorithms	Yes, provides full 3D real time data
BONE SIZING	Approximation	Accurate
FOOT TRACKING	Unknown	Yes
FINGER TRACKING	Unknown	No
HEAD TRACKING	Limited	Yes
BIOMECHANICS APPLICATIONS	No	Yes
360 DEGREE VIEW	No	Yes
LATENCY	250 millisecs	50 – 100 millisecs
RESOLUTION	640x480	8-18 cameras, 640x480
# OF PEOPLE	More than 2	More than 2
SCANNING AREA	1.2–3.5 m	Scalable, up to 5m by 5m

## 2.2 *Organic Motion*

OpenStage harnesses Organic Motion’s core computer vision technology, enabling computers to cognitively “see” people’s complex movements and generate accurate 3D tracking data in real-time. A Video Sub-System acquires lens and space calibrated video from 8 - 18 cameras and delivers these synchronized streams to the 3D Reconstruction Processor. 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. The final 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 OpenStage delivers is the X, Y and Z positions and orientation of 21 segments of this skeleton. This information is then ready to be loaded directly via plug-ins or SDK into any form of animation software, game engine, biomechanical or other processing software, all in real-time. Tracking customized objects, non-typical humans, or non-human shapes requires the modelling of new character fitting systems, which OpenStage offers as part of its new software architecture.

## 3. DISCUSSION

The Kinect sold 18 million units in 2011. Microsoft have responded to the demand of the ‘hacking’ community by launching “The Kinect Effect” informing of use of the peripheral beyond traditional games, e.g. in USA within therapy sessions with children diagnosed with autism (Lakeside Center for Autism), in UK hospitals treating Stroke patients (Royal Berkshire), in Spain within hospital operating rooms where doctors navigate MRIs and CAT scans (Tedesys) ... there is a long list. The built in biofeedback for the player’s self-monitoring advances this field.

Organic Motion sold systems in over 20 countries worldwide, and is used in both commercial and academic settings for multiple applications in various markets including: Digital Media & Arts (Animation,

Game Development, VFX); Life Sciences (Bioengineering, Physical Therapy and Rehab, Neuroscience, Sport); Training and Simulation (Military and Defence); Public Installations (Theme Parks, Museums). OpenStage interfaces with various 3D animation systems, 3D game engines and Virtual World systems and 3D immersive visuals, biofeedback and other applications. For therapeutic applications, movement 'rules' may be incorporated to encourage people to be more actively engaged in the recovery regime, thus, improving outcomes and reducing recovery times. The high accuracy of OpenStage allows clinicians and researchers to identify multi-level movement disorders, develop predictive models of pathology and gather statistical relevant data for long-term improvements. OpenStage was recently used by a research group at the Rush University Medical Center in Chicago for a study to quantify Hyperkinesia and Stereotypies in Males with Fragile X Syndrome.

#### 4. CONCLUSIONS

Evaluating a dancer's performance via Kinect-based skeleton tracking is reported in Alexiadis et al. (2011). Matthias Wölfel from the Karlsruhe University for Arts and Design provides the Kinetic Space tool (<http://kineticspace.googlecode.com>) that enables automatic recognition of customized gestures using depth images. This provides a visual feedback how well individual body parts resemble a given gesture. Similarly the Organic Motion is used across related disciplines. Markerless-motion tracking has clear impact in rehabilitation especially when the SDK enables access to adapt source, mapping and content data with real-time humanoid feedback. The half-torso and mirroring calibrations with the Windows PC Kinect are deemed to offer new opportunities for wheelchair users that will be further explored in the future research.

#### 5. REFERENCES

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