**Setting the Standard**
2010 Edition 1

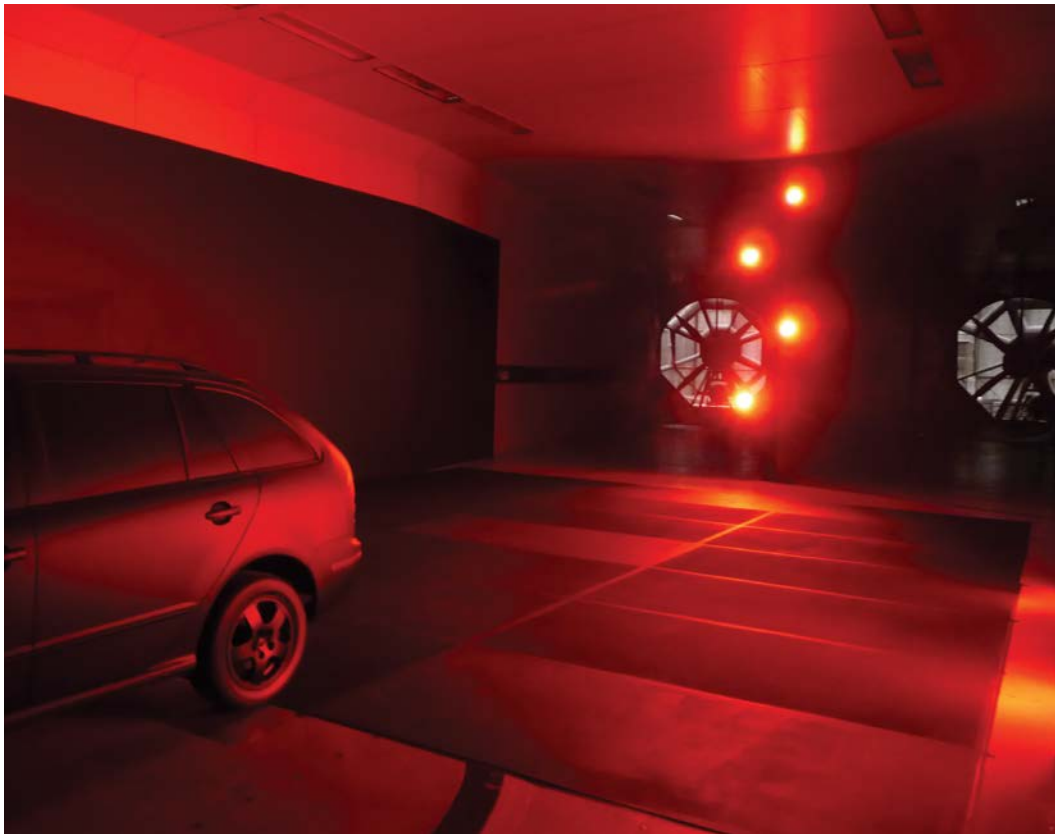
VICON

# The Standard

Vicon Engineering

## 3MM BUBBLES TRACKED WITH VICON IN AUTOMOTIVE AERODYNAMICS WIND TUNNEL

### UK's Only Full-Scale Wind Tunnel Uses Vicon for Environmentally Friendly Car Design



**For over 40 years British automotive test company, MIRA, has been recognized as a leading independent product engineering, testing consultancy and certification organization.**

MIRA strives to deliver new vehicle systems and components by integrating innovative design and simulation techniques, which are validated in over 30 major test facilities.

Operating across a range of transport technologies, MIRA provides particular expertise in vehicle safety, aerodynamics, thermal management, NVH (noise, vibration and harshness), EMC (electromagnetic compatibility) engineering, power train integration, environmental engineering and all aspects of durability.

MIRA's engineers thrive on diverse and technically challenging projects, offering an innovative approach or solution for its customers. It's customer base includes major vehicle manufacturers, systems and component suppliers and other independent consultancies throughout most of the vehicle-producing world.

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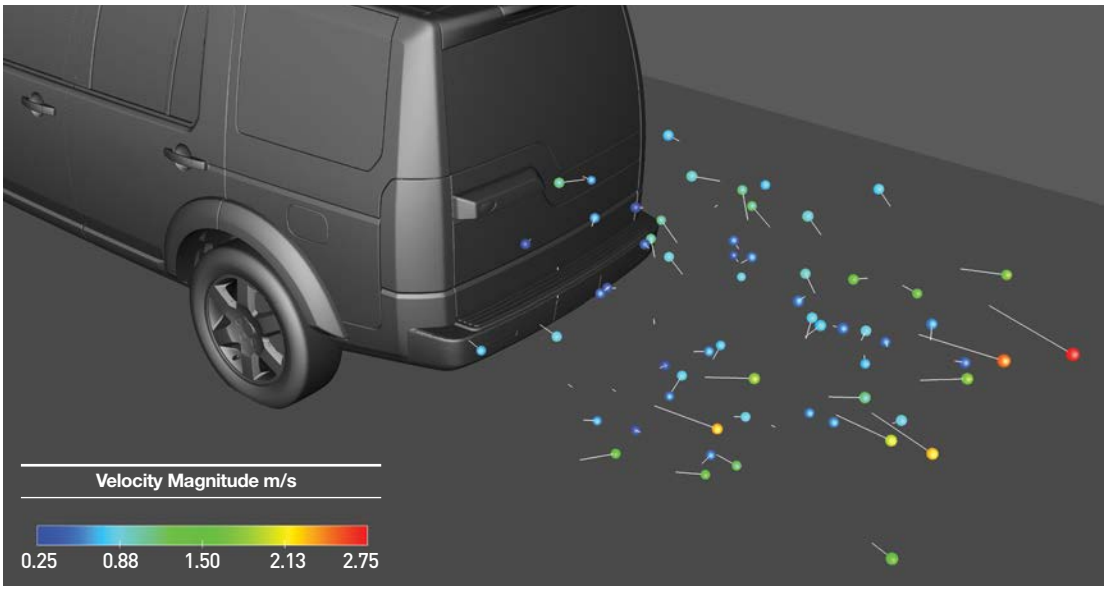



**Credit**
MIRA

## The Challenge

Car manufacturers increasingly look for ways to improve the efficiency of their vehicles. Making a car or truck more aerodynamic has many benefits. For example, it improves fuel efficiency, making the vehicle greener, and it will enable the car to travel faster; particularly useful if you're a Formula 1 driver!

Angus Lock, head of Aerodynamics at MIRA said, "Fuel efficiency is now more important than ever. Our customers are leading the way, ahead of the 2012 EU guidelines requiring all new cars to reduce $CO^2$ emissions to 130g/KM. The problem is, the current analysis methods either don't offer us enough detail or they take months to complete."

Always looking for a challenge, the engineers at MIRA set themselves the task of looking for a way to improve the efficiency of current airflow visualization – a technique used to improve the aerodynamics of a vehicle by monitoring the airflow around it. However, drag reduction techniques are notoriously slow and time consuming: the most common methods include Particle Image Velocimetry (PIV), which is limited to a single plane, tomographic PIV or Particle Tracking Velocimetry (PTV), which is limited to academia and small volumes.

However, in 2005 MIRA started to look into a new visualization method called bubble tracking using 3mm helium filled bubbles. These bubbles are pumped around the rear of a vehicle in a full-scale automotive aerodynamics wind tunnel to give an accurate display of air flow. Previously, this was a manual process, limited by very small capture volumes and the labor intensive task of processing the data.

Lock hoped to track the bubbles using technology more commonly found in a gait lab. He realized, because of the near transparent nature of the bubbles, the speed and seemingly random way they moved, he needed a highly accurate system. Every bubble needed to be tracked in the 3mx2mx2m wind tunnel, to give Lock the accurate and precise airflow data.

## The Solution

MIRA worked with Vicon to win funding for the project from the Department of Trade and Industry (DTI). The two companies conducted preliminary research to prove that a Vicon motion capture system could see and track a soap bubble.

The first hurdle encountered during the project was to ensure the bubbles would be visible to the cameras.

Andy Ray, EMEA Sales Manager at Vicon said, "Angus came to Oxford with the bubble machine and we tested it in our studio. Our first attempt was successful! It was fantastic to see, in real time, the bubbles being tracked and moving across the screen. We didn't even need to chemically alter the soap solution."

Seeing the successful results of the project, the DTI awarded MIRA funding to complete its bubble flow visualization technique, including the purchase of a 12 camera T40 motion capture system.

Lock explained, "MIRA chose to work with Vicon's T-Series cameras because of its unique mix of high resolution, fast capture rates and proven motion tracking abilities.

With our Vicon mocap system, we can tell where flows originate, what the flow is doing at any one moment in time and how it evolves in time.

Data that used to take us months to gather and analyze, now takes an afternoon."

## The Result

Several high profile car manufacturers and two Formula 1 teams have successfully used the

Continued

"MIRA chose to work with Vicon's T-Series cameras because of its unique mix of high resolution, fast capture rates and proven motion tracking abilities."

**For more information on Vicon T-Series visit**
www.vicon.com

innovative airflow visualization technique. Lock continued, "Measuring the precise location of hundreds, even thousands of helium filled bubbles gives our clients valuable velocity information, and they're able to build up a picture of what the flow is doing around the car."

"The continual technical support from Vicon helps us exploit the T-Series' class leading technology in a completely new application area, as well as rapidly getting to grips with the capabilities of the system. Our technical partnership with Vicon means we can continue to deliver a truly world class aerodynamic flow visualization technique." ■

## The Standard

**Welcome to the latest edition of The Standard. This issue is our most diverse to date and aims to introduce you to the interesting and innovative work of all our customers. As well as our traditional Life Science articles, by popular request, we've also featured articles on Virtual Reality, Film, Engineering, Games, Education, Rehabilitation and Sport Science. We hope you enjoy reading about the wide range of applications out there.**

Editorial team:
Tara Valgoi, Emma Wixey
Hayley Roberts, Lindsay Gerber

Contributions:
Karen Raz

# CEO NOTE

**Douglas Reinke**
**CEO & President**

Last year saw some unusual applications emerge for motion capture from tracking 3mm bubbles to develop environmentally friendly cars to helping soldiers deal with Post Traumatic Stress Disorder. One system was even used to demonstrate to children with Neonatal Diabetes how a new drug can save them from having daily insulin injections.

Motion capture has come a long way. 10 years ago I had to explain what motion capture was and how it helped - these days' people already know. Its growing popularity is getting it into the hands of more and more people. Recent evidence of this was at the 2010 Consumer Electronics Show; Intel's keynote speech covered a range of new technologies including how Vicon helped bring the Magic Mirror to life in Broadway's Shrek the Musical. Sponsors of the 2010 World Cup, Adidas, held a World Media Day to demonstrate how motion capture can help soccer players improve their game as well as prevent injuries. In addition, 3D home viewing will become more and more common. For the first time ever this year's World Cup and the 2011 Sony open for Golf and BCS National Championship Game will be available to watch in 3D.

Looking forward, 2010 continues to be about listening to what our customers need to enable them to carry out their important work.

At JEGM in Miami, we will be making a series of announcements showing our dedication to a group of core customers. This joint meeting of GCMAS and ESMAC is going to be a great conference and I look forward to seeing you all there.

Finally, myself and our valued Vicon employees would like to thank all our customers for carrying out such life changing work. The difference you make never ceases to amaze us. ■

Vicon Profiles

# CARNEGIE MELLON UNIVERSITY PITTSBURGH

Jessica Hodgins, Professor in Computing Science and Robotics and Moshe Mahler, Animation Designer at Carnegie Mellon spoke to The Standard about the successful research projects they have been working on with their Vicon motion capture system.

**To see a video of this story** please visit our YouTube channel www.youtube.com/vicon100

**Credit** Mahler, Bancroft and Slyper

**Carnegie Mellon University is a global research facility recognized for its world-class arts and technology programs, collaboration across disciplines and innovative leadership in education.**


The university began as a small technical school and evolved into what it is today under the guidance of exceptional leadership teams. The world-renowned faculty members are practicing professionals who bring extensive knowledge and experience into the classroom.

The university has been a Vicon customer for ten years and its current set up includes twelve MX 40's and four T160's that have been used for various research projects. Her current project involves trying to understand the skin and muscle deformations in the shoulder complex as it moves.

Hodgins explains, "The project we're best known for wasn't actually a research project but a community service project. We captured six hours of motion capture data and put it all out on the web for people to use. There have been more than fifty papers published by authors who have nothing to do with our lab using this data. It's had a big impact on the research community.

"Right now we're trying to update that database by making it specific to particular activities that occur in the kitchen. We're doing experiments with cutting and stirring and cooking and things like that, to look at tasks for assistive technology, which would allow the elderly to stay in their homes for longer."

This project involves trying to understand how the skin and muscle deforms when the shoulder moves. To achieve a higher quality of data, small markers are densely placed on the shoulders and cameras are moved closer together.

Hodgins continues, "For this capture we drew a grid on the patient's shoulder and put markers at the intersections of each of the gridlines to make sure the markers are roughly uniformly spaced. Then we cluster together groups of markers and figure out from the motion of those clusters how the skin and muscle should deform in an actual capture.

"What we hope to accomplish with projects like this, when we're measuring the surface of the skin instead of measuring the skeleton as you do traditional motion capture, is to allow people to create much more realistic animations of figures. You can either do the skeletal motion capture and then in the skinning process try and put back the level of detail that's lost, or just capture it and try and use it directly from the system."

The inclusion of new T160's into the lab has opened up other research possibilities for Hodgins. She explains, "We just did a big capture of facial animation data using these new T160 cameras. We're going to try and use that data to understand how we might be able to build better rigs for facial animation. We had 300-400 markers just on the face and we had the cameras all moved in. We hired a number of actors to give us emotionally expressive sentences to capture their emotion."

Moshe Mahler has worked in the motion capture lab at Carnegie Mellon for 6 years and has conducted various research projects. He's also created a few art pieces, one of which is called 'Walk N' Say' implementing a classic 1983 'See N' Say'. This is a circular toy with various animals pictured around the dial, connected to a screen. The user not only hears the animal sound from the toy but also sees the animation change on the screen.

Continued

Mahler said, "We had an actor come in and portray their interpretation of each of the animals. We then took this data and printed it out and used a classic rotoscoping technique to get the motion capture data onto a nostalgic crayon drawing representation of each one of the animals.

We use a rugged rotary potentiometer to help us tell where the dial is pointing. Then we have that hooked up to an arduino, which sends a radio signal to a hidden laptop which is running the projector. When someone pulls the string it changes the animation on the screen."

**Info**

Times Higher Education ranked Carnegie Mellon 27th overall and 9th in technology in it's 'Top 200 World Universities in 2009'

## Vicon Entertainment

**Credit**
WET
Playstation 3


# HOUSE OF MOVES ANIMATES FINAL BOSS FIGHT BATTLE SEQUENCE FOR "WET"

**LA based animation studio, Vicon House of Moves (HOM), was involved in creating the animation and providing motion capture services for the recently released highly cinematic video game, WET.**

WET, developed by Artificial Mind and Movement (A2M), is a highly-stylized third person shooter that seamlessly blends gun play, sword kills and over-the-top acrobatics to create the ultimate interactive action experience. The game allows the player to shoot anywhere, anytime, all while running, sliding down ladders and across the floor, or performing any number of acrobatic moves. Featuring an ironic mix of humor and violence, unique retro film visual treatment, and original 70's inspired music, WET is an experience unlike any other.

HOM was engaged by A2M to animate a final climactic battle, and contribute to other fight sequences. The cinematic-like sequence allows the player to make decisions that guide the course, and ultimately the success or failure of the battle.

HOM completed multiple days on the motion capture stage shooting several performers, including a weapons specialist to perform complex sword fighting moves.

A2M selected the moves that would make it into the game and the HOM animation team tracked and retargeted the capture data onto 3D character and weapon models. HOM executed the character animation by utilizing a motion capture base, and adding dynamic poses, speed adjustments, weight, timing and other sweetening elements as well as key-framing facial and secondary animation. The final animation was delivered to A2M in Autodesk Maya for integration into the game engine.

**Info**

WET was released on September 15, 2009. The game stars a heroine named Rubi Malone voiced by Hollywood actress Eliza Dushku.


We're always excited to hear about the interesting and diverse applications customers are using their Vicon systems. If you have work you'd like featured in the next edition of The Standard please contact us at **editorial@viconstandard.org**

**The Standard**

**Credit**
Andrew Glennerster

Vicon Engineering

# USING IMMERSIVE VIRTUAL REALITY TO DISCOVER HOW THE BRAIN REPRESENTS 3D SPACE

Info

Andrew and a group of researchers have set up an immersive virtual reality laboratory to study spatial perception and motor control in freely-moving observers.

Andrew Glennerster, School of Psychology and Clinical Language Sciences, University of Reading

**My colleagues and I use a Vicon MX3 system and Tracker software to track the head movements of participants in the immersive virtual reality laboratory. The experiments aim to improve our understanding of how people see a stable 3D world despite the fact that they move their head and eyes continually, which is one of the key challenges in neuroscience today.**

The majority of studies on human three-dimensional vision have, historically, focused on binocular stereopsis – the ability to perceive depth from a static head position using two eyes. Yet, studying human 3D vision in moving observers is fundamental to understanding how we see in depth. Humans, along with many other animals, use movement to help them find out about the depth structure of

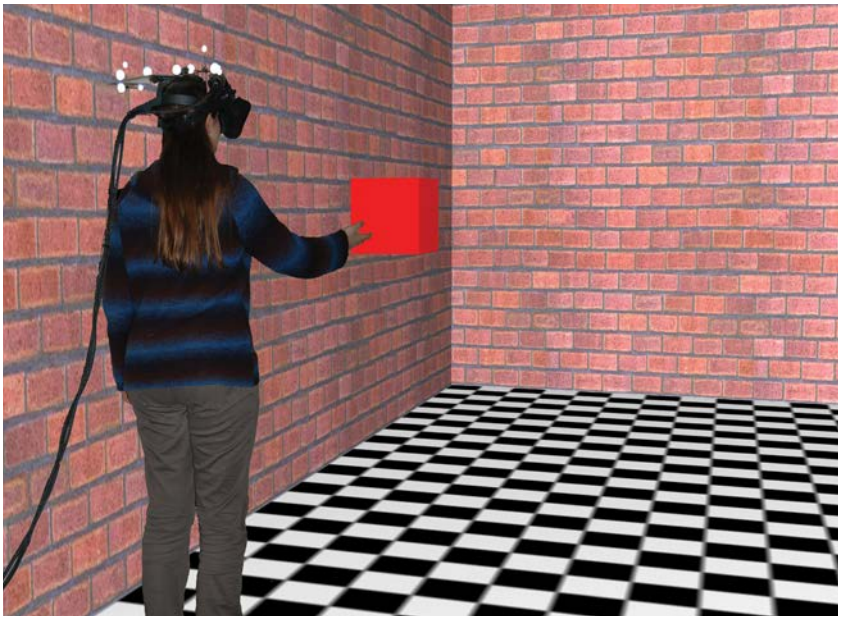
**Virtual Reality Research Group University Laboratory of Physiology, Oxford**
http://virtualreality.physiol.ox.ac.uk

the scene around them. It's thought binocular stereopsis only evolved to allow hunting animals to remain still and avoid being seen by their prey.

The reason for the relative neglect of 3D vision in freely moving observers has largely been a technological one. In general, vision scientists must manipulate the images the observer sees in order to find out what are the critical aspects determining their perception. If the observer is free to move, this is difficult to do in a controlled way without using virtual reality. One of the keys to a convincing virtual simulation of a 3D scene is fast and accurate measurement of the observer's head position and orientation. This is provided in the lab by our Vicon MX3 tracking system, which represents a great improvement in accuracy and latency over earlier head trackers.

The purpose of our experiments is to discover how the brain interprets the information from moving images to form a representation of the 3D world. We use virtual reality because it enables us to create scenes that would be impossible to reproduce in the real world. For example, in one of our experiments, as an observer moves from one side of the room to the other, the whole room expands by a factor of 4. Crucially, the point of expansion is always half way between the observer's eyes, even when they are moving. So objects move further away and also get larger along the observer's line of sight, meaning that the images that fall onto the retina are the same irrespective of the expansion of the room. This means that any single image the observer sees could have come from either a small room or a larger room. However, by comparing two images (e.g. the images seen by the left and right eyes, or images seen from two viewpoints that are a meter apart), the brain should, in theory, be able to compute the location and size of objects in the room. Fig 1. shows the expansion of the virtual room and an example of the images the observer sees.

"Studying human 3D vision in moving observers is fundamental to understanding how we see in depth."

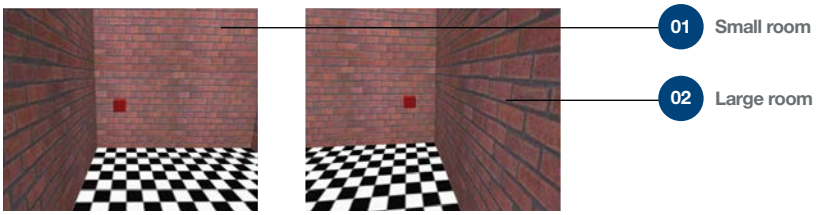


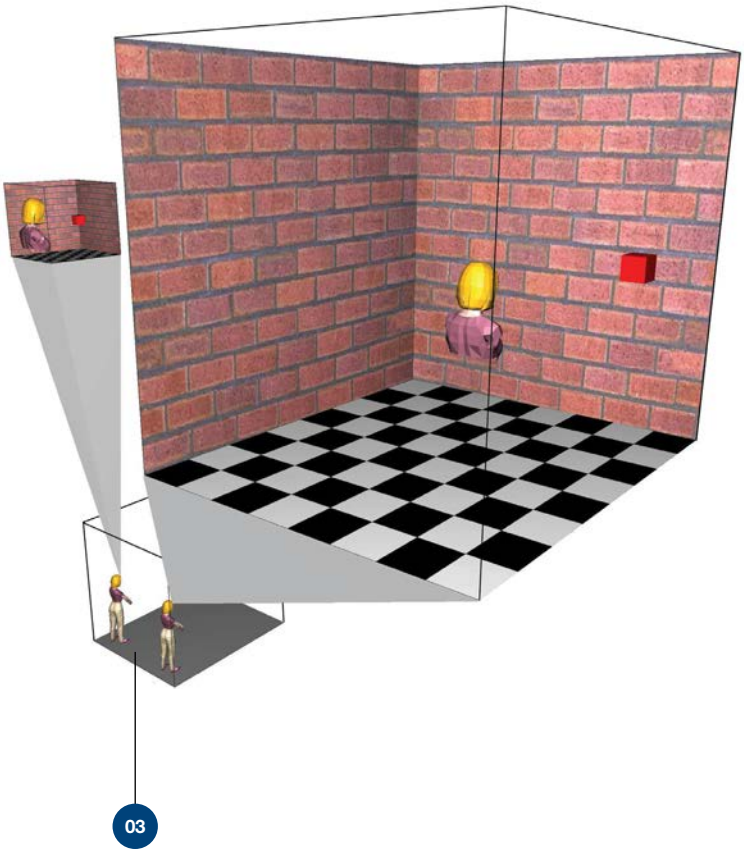
The main result is, remarkably, people are quite unaware of the fact that the room around them is expanding. It means that, at least for conscious awareness, the information from binocular stereopsis (seeing depth with two eyes) and from motion parallax (the information about depth that comes from moving around) is ignored, despite this information signaling a four-fold change in size of the virtual room. We carried out a series of experiments that show the information is used in some tasks and is combined in efficient ways with other sources of information about the size and depth of objects. Thus, it is not that the information about the scale of the scene is lost entirely but, just as in other experiments on 'change blindness', the fact that nothing obvious changes as the observer moves across the virtual room gives them a powerful sense that the room has remained the same size, over-riding their 3D cues.

This peculiar room, which changes size but appears to stay the same, raises challenging questions about the way humans represent 3D space. Our current experiments explore some of the contradictions that people's perceptions of space in this room seem to imply, if they represent the room as something like a 3D model. Instead, we are testing the hypothesis that their representation is more like the type of view-based models that have recently become popular in computer vision.

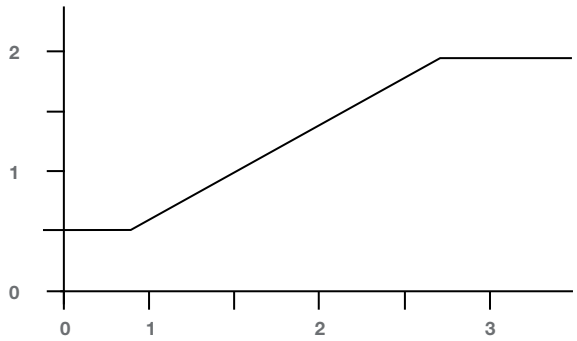
Continued

Fig 1.




**Room scale**




**Distance**

**Credit**
Reproduced with permission, from Glennerster et al., 2006, (c) Elsevier.

The question of how visual information is integrated by observers as they move their head and eyes is central to achieving progress in neuroscience today. Information from a continually changing retinal image must contribute to a stable representation of the scene but we have little idea, as yet, what form that representation takes. There is considerable interest in the computer vision community in implementing human-like visual representation. Once we have identified and described them with adequate precision, many commercial and medical applications are likely to follow. One of the most exciting long term prospects may be the possibility of helping the blind build up a 'visual' representation of a scene using the information from cameras under their control.

There is no necessity for visual information to arrive at the brain through the optic nerve – touch may prove to be just as effective – and, despite all the current interest in retinal implants, cameras that saccade and fixate like the eyes may prove to be a more flexible source of images for a blind person than the signals from a retinal implant. One reason that cameras and touch may be preferable to retinal implants is that the input images could be pre-processed in various ways, with a negligible delay, before the person 'feels' them. ■

## Other members of the VR lab:

**Dr. Stuart Gilson**
Department of Physiology, Anatomy and Genetics, University of Oxford

**Ms. Ellen Svarverud**
School of Psychology and CLS, University of Reading

**Dr. Lyndsey Pickup**
School of Psychology and CLS, University of Reading

Vicon Entertainment

**Credit**
Copy courtesy of ICG Magazine November 2009 issue.

**For more details on Vicon's involvement in 'A Christmas Carol'**
Visit http://www.icgmagazine.com/wordpress/2009/10/30/ghosts-in-the-machine/

# VICON AT THE CINEMA

**We've been involved with several high profile films in the past 12 months, including Angels and Demons, Harry Potter and The Curious Case of Benjamin Button. The most recent and arguably the biggest of those is Robert Zemeckis' A Christmas Carol, which was released in December 2009.**

Doug Peter /EMPICS Entertainment


ICG, the magazine that represents the International Cinematographers Guild, published an article on the film last year. Reporter, Carolyn Giardina, quotes Zemeckis on the benefits of performance capture in film making:

"Performance capture is a beautiful process," Zemeckis said last summer during a press conference at Los Angeles' Union Station to kick off a promotional train tour that travelled from Los Angeles to New York.

"We don't have to do things out of continuity, (or) break things up for coverage. The cast does the scene from beginning to end, just like they are doing theater. So the pacing of a scene is all up to the actors. I don't have to worry about the cinema technique. I can concentrate on what the characters are doing."

Vicon Life Sciences

# NEW GAIT LAB IN KOREA

**In October 2009, a new gait lab opened in the department of Rehabilitation Medicine at Chungnam National University, Korea.**

The Laboratory is equipped with eight MX T20 cameras, 4 AMTI OR6-7 force platforms, Tekscan F-Scan with ConforMat System and a Delsys 8-channel Trigno EMG system.

Faculty members directly involved in the new lab are Dr. Bong-Ok Kim, Dr. Min- Kyun Sohn, Dr. Kang-Hee and Dr. Sung-Joo Ji.

Planned Projects for the lab include developing a Rehabilitation Robot for patients with spinal cord injury and the rehabilitation of stroke and elderly patients.

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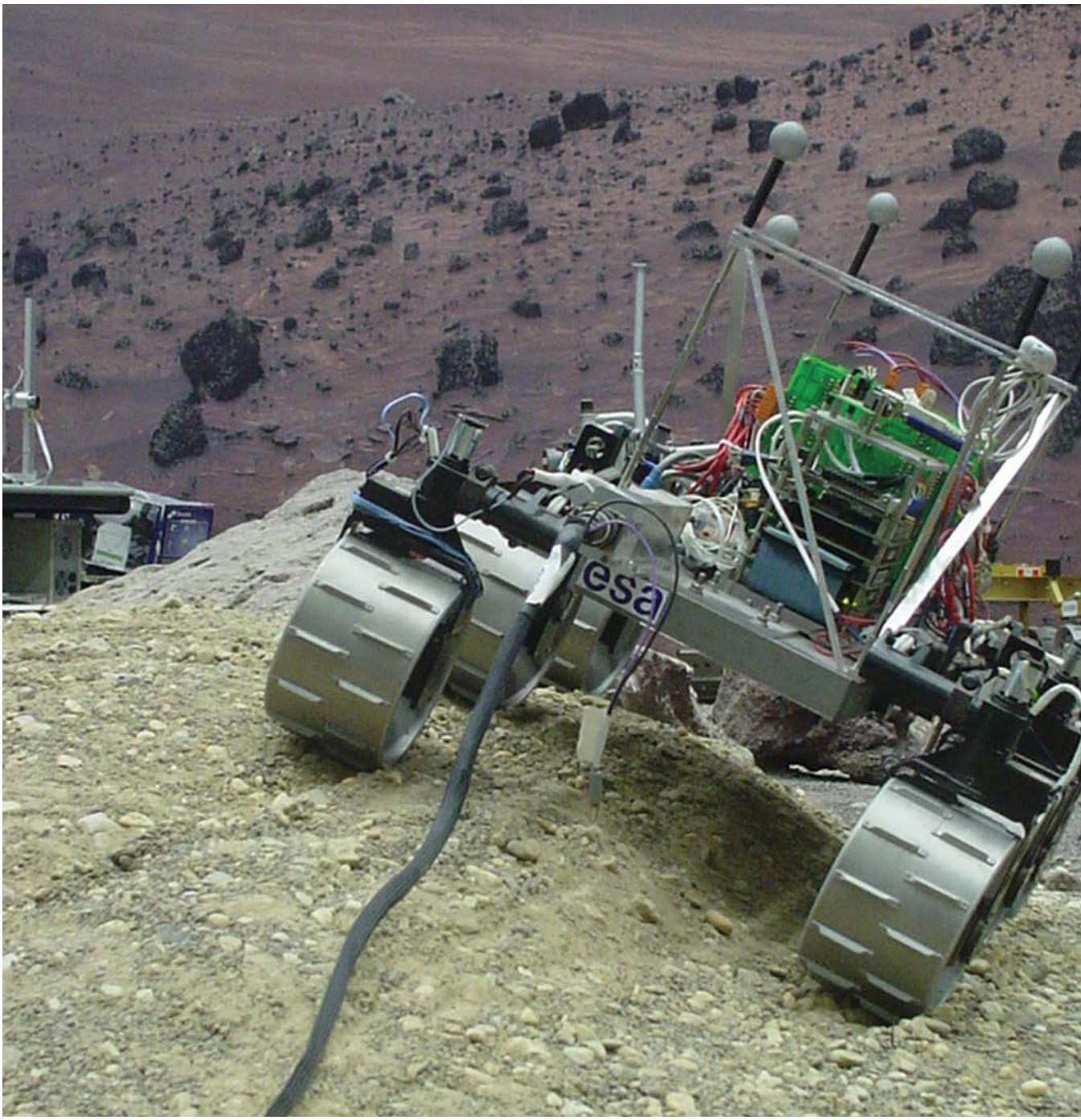
Q&A

Vicon Engineering

# PLANETARY SURFACE OPERATIONS
## AIDED BY MOTION CAPTURE AT EUROPEAN SPACE AGENCY'S AUTOMATION & ROBOTICS LABORATORY (ESA ARL)

**Credit**
ESA - Automation + Robotics Laboratory



"The ESA ARL is now working with an eight camera Vicon motion capture system to track the movements of the rovers aimed for planetary surface exploration."

**The European Space Agency was established in 1975 and is an intergovernmental organization dedicated to space research, technology and exploration.**

Its Automation & Robotics Laboratory (ARL) is currently conducting tests, which will enable them to accurately program the movements of autonomous robots for planetary exploration, such as Mars and Moon rovers.

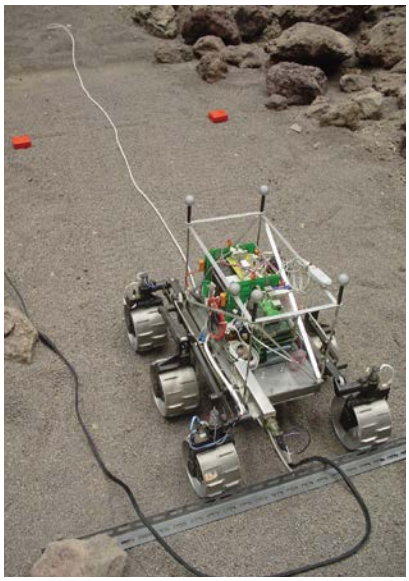
Pantelis Poulakis, a robotics systems engineer at the ESA ARL said, "The rovers are either tele-operated or they execute autonomous navigation algorithms onboard. The latter is necessary for a Mars mission scenario due to the long time it takes for signals to travel between Earth and Mars and the limited availability of communication windows."

Being able to accurately predict the movement of the rover in space is extremely important to the ESA ARL. It required a motion tracking system that can give instantaneous feedback and provide an excellent quality of data. The ESA ARL is now working with an eight camera Vicon motion capture system to track the movements of the rovers aimed for planetary surface exploration. The Vicon system is installed in an 80m$^2$ planetary terrain simulation ground called the Planetary Utilisation Testbed (PUTB), which mimics some tricky planetary surfaces such as boulder fields, sandy dunes and gravel patches.

The Vicon system allows the ARL to test algorithms and make alterations to the programme which is vital in the planning for the next Mars mission in 2018.

"In order to 'know' its position on the surface of the planet and to close the loop with the navigation algorithms, the rovers are equipped with a set of sensors called a 'localization' scheme," Poulakis explained.

"It's a continuous learning curve for us. The Vicon system tracks the rover's navigation trajectories, thus providing an external localization reference. We then analyze that data, in order to validate the navigation algorithms and test our onboard localization scheme. In a nutshell, we're narrowing the difference between how we expect the rover to move and what it actually does." ■



**Info** Headquartered in Paris, ESA has a staff of more than 2,000.

Info

Based on Microsoft Research SenseCam technology, Vicon Revue is a tool aimed at medical researchers as an aid for people with memory loss.

**For more information on Vicon Revue visit**
www.viconrevue.com

**For more information on research that has taken place with SenseCam visit**
http://research.microsoft.com/en-us/um/cambridge/projects/sensecam/

Vicon Revue

# MEMORIES FOR LIFE

**Estimates suggest that dementia will affect 700,000* people in the UK and 5,000,000* people in the US, which is why Vicon were so pleased Microsoft granted us a license to develop their exciting SenseCam technology. We aim to help memory loss sufferers with Vicon Revue.**

Microsoft Research Based on Microsoft Research SenseCam Technology

Preliminary results from SenseCam have produced remarkable results. By wearing the camera and repeatedly reviewing the images at regular intervals, patients' ability to recapture memories of events recorded is massively improved. Incredibly, some have found that they are eventually able to retrieve the memories themselves, without visual prompting. However, it has never been available to purchase.

Vicon Revue will be available for medical researchers as an aid for people with severe memory impairment including sufferers from Alzheimer's disease. Clinical Neuropsychologist Dr. Emma Berry, who has been involved in the research from the beginning says, "We have a lot more research to do, but the preliminary results are compelling.

There's something uniquely powerful about the images SenseCam technology produces that seems to stimulate recall in our patients, enabling them to remember thoughts and feelings not depicted by the images."


*http://alzheimers.org.uk/
*http://www.alzinfo.org/

Vicon Entertainment

# HOUSE OF MOVES CAPTURES DANCERS FOR BLACK EYED PEAS' 'BOOM BOOM POW'

## Production Studio Motion Theory Taps House of Moves for Music Video Mocap

**To see the Black Eyed Peas music Video: Boom Boom Pow**
visit our YouTube channel www.youtube.com/vicon100

**LA based studio, Vicon House of Moves, provided motion capture services for the Black Eyed Peas' high impact 'Boom Boom Pow' music video.**

Directed by Motion Theory's Mathew Cullen and Mark Kudsi, the promo features a troupe of perfectly synchronized CG dancers that were animated based on performances captured on the newly constructed Vicon House of Moves (HOM) soundstage.

"Working at HOM was a fairly intuitive and a very streamlined process. We had instant feedback after every take, which made it very easy to direct and make adjustments," said Kudsi. "HOM also provided us with footage from the capture session that proved to be extremely helpful throughout the editorial process. We were able to incorporate placeholders of our session the very next day into our edit."

The video embodies the supersonic energy of the track with rapid-fire cuts of dancers and of the hip hop group as they transform into their digital doppelgangers. Several sequences feature transformer-like shapes that pulsate to the beat as they multiply, divide and morph into groups of CG dancers.

"Since the dancers acted as catalysts for change, it was important for us to have total control of how they looked and transformed in the video. They needed to have a human feel so it was important to capture the details of their movement in a realistic manner," explained Kudsi.

"The use of mocap for this project was necessary in accomplishing our creative vision. Mocap also gave us the flexibility to quickly try several different iterations of choreography that we wouldn't have had the time for, had we done everything by hand."

Motion Theory spent one day shooting two dancers on the newest of House of Moves' two custom designed motion capture stages. The new stage features soundproof walls and a scalable truss system that can allow for facial, body and finger or full-performance capture. The stage is also equipped to record professional-quality audio during capture into a single time code synced performance. ■

Vicon Awards

# RECOGNITION FOR THE T-SERIES


**Vicon was extremely proud to receive the award in November 2009 for Best New Product Developed in the UK at the BCS & Computing Awards 2009 for our T-Series camera range.**

In an event held at the famous Battersea Park Events Arena in the UK, the award recognizes significant achievement in business technology product development by UK IT professionals. With 10 finalists in the category, Vicon T-Series wowed the judges by demonstrating the impressive measurable benefit for customers.

**Info** Vicon T-Series - the world's first 16 megapixel motion capture camera

Vicon Life Sciences

# Q&A
# DENVER CHILDREN'S HOSPITAL

**Credit**
Gait lab at Denver Children's Hospital

**The Standard profiled the Children's Hospital in Denver 10 years ago. We caught up with James Carollo and his team for a quick update on how things have progressed since installing their first Vicon system a decade ago.**

**How has your Vicon system changed over the last 10 years?**
The original Children's Hospital Denver laboratory was built in 1999, so the current technology at the time was Vicon 512, Workstation, and BodyBuilder. We started with six analog progressive cameras, and expanded it to eight cameras before retiring the system in 2007.

We also had sufficient analog data channels to support four Kistler force platforms and 16 EMG channels. The Motion Lab System's MA-300 from the original installation is still being used today, although for routine clinical use we have added a wireless EMG telemetry system (ZeroWire). The original Vicon 512 system is on loan to one of our academic partners at University of Colorado and is helping to support faculty research and student training today.

Our current motion capture environment was built in 2007, to accommodate the move of our entire hospital to the campus of the University of Colorado. It consists of two separate Vicon MX systems to service our principle measurement areas, one for over-ground recording and one associated with our Bertec split-belt force measuring treadmill. Upper extremity recordings can be made in either measurement area.

In 2007 the most recent camera technology was the MX F40 cameras; we currently use 13 in the main lab and 7 in the treadmill room. We designed the facility with a common "control room" so the same technical staff can manage motion capture in both rooms simultaneously. We also laid out the facility with extra camera and control cables so we can move cameras from one measurement area to the other quickly to accommodate specific motion capture protocols. With this setup, we can utilize a calibrated measurement volume of approximately 9.0m x 1.5m x 2.5m in the main lab, and 2.5m x 1.5m x 2.5m in the treadmill room using 14mm markers for a full-body motion capture. We have now completely transferred over to Nexus v1.4 for motion capture and processing, and use BodyBuilder, PECS, and Polygon.

At the time of the original laboratory design, we were early adopters of Polygon; beginning with v0.9. Our team in Denver continues to utilize the weekly multispecialty review of clinical data, and Polygon facilitates this review allowing us to easily locate and display our video, kinematic, kinetic, and EMG data together for all the conditions and comparisons we need to make to arrive at a clinical recommendation. We hope that this product continues to evolve, so that we can integrate our radiographic, HD video and plantar pressure recordings directly into this multimedia tool.

Continued

### Has the level of detail you can capture changed?

The improved resolution of the F-Series cameras was a significant step forward for us given our original analog cameras had effectively a 0.6 megapixel resolution. Increased spatial and grayscale resolution is a great advantage in optical motion capture especially in larger volumes and more complex models. It helps to improve the accuracy of the marker centroid calculation and reduce tracking errors when targets come close to each other. We routinely use no larger than 14mm markers for all experiments and clinical motion captures, and can use smaller markers for specialized models that need more markers per segment or a more densely packed configuration. While we rarely capture faster than 120Hz over-ground, treadmill captures during higher walking or running speeds benefit from the higher frame rates available.

### Has your relationship with Vicon been important over the years?

I have been pleased with the support we have received from Vicon over the years, especially since the Vicon office opened in Colorado. We view our relationship with Vicon as a two-way partnership, benefiting both parties and learning from each other. The transition from a mature Workstation product to an early Nexus environment was harder than we anticipated, especially with our laboratory's level of complexity. Working together, we have found a stable configuration of hardware and software that is flexible enough for the different experiments and measurement systems we use, allowing us to efficiently conduct our work and support our patients.

### Does your current system allow you to conduct research projects you couldn't previously?

We were satisfied with our old system for routine clinical gait analysis; it was stable and could satisfy all of our fundamental measurement requirements. Where the new system gives us more options is for those experiments that need higher frame rates and more complicated marker sets. We have been interested in better understanding the implications of spinal fusion on gait performance in our patients with neuromuscular scoliosis, and our new system allows us to measure full-body movement more easily and over a larger distance than before. The addition of the force measuring treadmill integrated into our motion capture environment also gives us many more options for our growing adolescent sports program. ■

Vicon Sponsors

# IMECHE AWARD

**Vicon sponsored the IMechE MED Student Project award for the second year running. The Vicon sponsored award, Best Project involving the Design or Development of a Medical Device, was awarded to Simon Crowther from the University of Bristol for the development of a Precise Flow Delivery System for Biomedical Applications.**

Tom Shannon, Founder and Director at Vicon said, "Vicon believes it has a social responsibility to attract bright, lateral thinkers to pursue biomedical engineering as a worthwhile and fulfilling career. We're very pleased and proud to be given the opportunity to sponsor this prize and to be able to judge three fascinating and innovative entries this year.

"All three entries were of a very high standard, each demonstrating a very clear understanding of the science and of the engineering required. Simon Crowther's work on the development of a device to precisely mimic flow patterns found in human vessels will have great practical application as will the work of the two runners-up, Wael Dandachli and Perrin Metzger."

Crowther is currently studying Mechanical Engineering at the University of Bristol. Having enjoyed fluid mechanics and design and manufacture units in his first and second year he was given the opportunity to take on a project in these areas in the third year. After meeting with Dr Stephen White, a research fellow of the University, a brief for a flow delivery system to look at how endothelial cells respond to shear stresses was conceived. Throughout the third year of Simon's degree the flow apparatus was designed and built.

Crowther comments, "I am honored to have won the Vicon Prize in the 2009 Student Project Competition. Having worked so hard throughout the year, it is great to receive recognition from the IMechE for what I have done. Presenting my work to such a distinguished audience was also a privilege. I would like to thank everyone who was involved with, and helped out with the project. I would also like to thank Tom Shannon from Vicon and Professor Peter Brett from Aston University for judging the category." ■

# 2010 CONFERENCES

## North America

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### JEGM
Gait and Clinical Movement Analysis Society and the European Society of Movement Analysis in Adults and Children
May 12 – 15, 2010
Miami, FL
**www.jegm.org**
Vicon exhibiting booth #25 and annual user group meeting

### ACSM
American College of Sports Medicine
June 2 – 5, 2010
Baltimore, MD
**www.acsm.org/AM/Template.cfm?Section=Annual_Meeting2**

### SEM
Society for Experiential Mechanics
June 7 - 9, 2010
Indianapolis, Indiana
**www.sem.org/CONF-AC-TOP.asp**

### CSB
Canadian Society for Biomechanics Conference
June 9 – 12, 2010
Kingston, ONT, CA
**www.csb-scb-2010.ca**
Vicon exhibiting booth #7

### ISBS
International Society of Biomechanics in Sports
July 19 – 23, 2010
Marquette, MI
**www.nmu.edu/isbs**
Vicon exhibiting

### CGVR
The 2010 International Conference on Computer Graphics and Virtual Reality
July 12 - 15, 2010
Las Vegas, NV
**www.world-academy-of-science.org**

### GDC - Austin
Games Developers Conference
October 5 - 8, 2010
Austin, TX
**www.gdcaustin.com**

### ICAD
Alzheimer's Association International Conference on Alzheimer's Disease 2010
July 10 - 15, 2010
Honolulu, HI
**www.alz.org/icad**

### 3DMA
Eleventh International Symposium on the 3-D Analysis of Human Movement
July 14 – 16, 2010
San Francisco, CA
**www.3dma-10.org**

### SIGGRAPH
Special Interest Group on Computer Graphics and Interactive Techniques
July 25 - 29, 2010
Los Angeles, CA
**www.siggraph.org/s2010**
Vicon exhibiting booth #1047

### ASB
American Society of Biomechanics
August 18 - 21, 2010
Providence, RI
**www.asbweb.org**
Vicon exhibiting

### i-Fab
2nd Congress of the International Foot and Ankle Biomechanics Community
September 16 - 18, 2010
Seattle, WA
**www.i-fab2010.org**

## Rest of the World

### ICCB
International Conference on
Computational Biology
May 26 - 28, 2010
Tokyo, Japan
**www.waset.org/conferences/2010/tokyo/iccb**

### ICMS
The Third International Conference
on Modeling and Simulation
June 4 - 6, 2010
Wuxi, China
**www.wjms.org.uk/icms2010**

### WCE
World Congress on Engineering
June 30 – July 2, 2010
London, United Kingdom
**www.iaeng.org/wce2010**

### OBCAS
International Conference on
Orthopaedic Surgery,
Biomechanics and Clinical
June 6 - 9, 2010
London, UK
**www.brunel.ac.uk/about/acad/sed/conf/obcas**

### ESB
17th Congress of the ESB
July 5 - 8, 2010
Edinburgh, UK
**www.lifelong.ed.ac.uk/esb2010**

### ECSS
European College of Sport Sciences
July 6 – 9, 2010
Antalya, Turkey
**www.ecss-congress.eu**

### ISEA
8th Conference of the International
Sports Engineering Association
July 12 – 16, 2010
Vienna, Austria
**http://isea2010.technikum-wien.at**

### DEVELOP
July 13 – 15, 2010
Brighton, UK
**www.develop-conference.com**

### WCB
The 6th World Congress on
Biomechanics
August 1 – 6, 2010
Singapore
**www.wcb2010.net**
Vicon exhibiting

### GDC - Europe
Games Developers Conference
August 16 - 18, 2010
Cologne, Germany
**www.gdceurope.com**

### BASES
The British Association of Sport
and Exercise Sciences
September 6 – 8, 2010
Glasgow, UK
**www.gla.ac.uk/bases**

### MEDICA
International Trade Fair with World
Forum for Medicine
November 17 – 20, 2010
Düsseldorf, Germany
**www.medica.de**

Info

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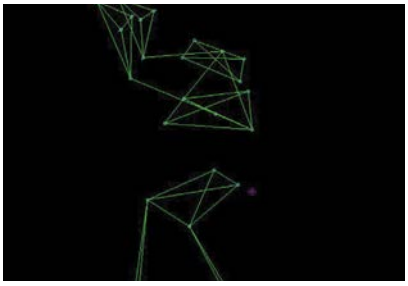
Vicon Life Science

# LITERATURE UPDATE THE STANDARD

Ed Biden

In reading articles for this review, I have been intrigued by a number of motion capture and analysis reports which are sports oriented and which have been done at more or less full scale within laboratory settings.



**Screenshot**
Vicon BodyBuilder

The first of these is **Chin A, Elliott B, Alderson J, Lloyd D, Foster D. 'The off-break and "doosra": kinematic variations of elite and sub-elite bowlers in creating ball spin in cricket bowling', Sports Biomechanics. 2009 Sep 8: 3, 187-98**. The details of the cricket will be of interest to those who follow the sport, but the technology will be of interest to almost everyone. Starting with a 12 camera Vicon system running at 250 hz and a lab big enough to incorporate a "full length cricket pitch ... primarily housed within the biomechanics laboratory" the authors describe a 62 marker, full body marker set built up of three marker rigid marker holders. This is a very complex set-up which they describe in great detail. Nonetheless, the most interesting part for me was that they attached markers to the cricket ball being thrown. They acknowledge that they had to adjust the marker locations for each person tested so as not to interfere with the grip on the ball. Three markers allow them to develop a coordinate system and give enough information to be able to measure ball speed as well as rotation just after the ball is released. Their modeling is done using BodyBuilder.

The paper goes on to describe the comparisons between the "elite" and "high performance" bowlers and the measurements from the ball show significant differences in ball speed and angular velocity at the time of release. They don't say what happens to the markers when the ball bounces. When comparing the "doosra" to more conventional "off-break" throws stride length and lower release height were observed.

My limited knowledge of cricket didn't change much from this paper but the experimental setup and careful description will make this a paper which is a valuable resource for anyone developing motion analysis techniques for fast moving, large volume applications where you want to track things that are thrown.

Sometimes when reading papers one wishes that two groups could get together and share facilities. **Spratford, W., Mellifont, R., Burkett, B. 'The influence of dive direction on the movement characteristics for elite football goalkeepers', Sports Biomechanics. 2009 8: 3, 235 – 244** describe another in lab set up which has a large volume. They want to assess dives by soccer goal keepers. To do this they have an arrangement where the goal keeper is in the "net" with soccer balls suspended to simulate high, low and in between shots on both sides. The goal keeper being tested observes a video which is at a distance from them. They see someone making a shot which would correspond to one of the balls suspended on either their dominant or non-dominant sides and they then launch off a force platform and block the static ball. The virtual kicks are randomized so the goal

**High performance**
Ball speed and angular velocity analysis

keeper cannot anticipate in which direction they will need to move. The system to record this is a Vicon 612 with 8 cameras running at 120 hz and a Kistler force platform. The experiment used 37 markers and the "Plug in Gait" marker set developed by Vicon.

The experiment showed significant differences between the dominant or preferred side and many of these differences were in three dimensional motions such as pelvic and torso rotation which would be very difficult to assess without 3D motion tracking. The authors conclude that there are sufficient differences between sides that knowing which is a goal keepers preferred side would likely make a difference in scoring.

The other paper which addressed a related issue is **Schmitt KU, Schlittler M, Boesiger P., Biomechanical loading of the hip during side jumps by soccer goalkeepers.", J Sports Sci. 2009 Dec 2, 1-7** in which they measure the impact loads on the hip when one hits the ground after diving to block a shot on goal. They acknowledge that their single camera 2D measurements are inadequate to assess fully the kinematics of a dive and actually recommend a system such as the one above. The experiment had soccer goal keepers' dive onto an array of three Kistler force plates which measured the impact with the floor. Both the height and length of the dives influenced the peak forces as did whether or not the person diving rolled on impact. In perhaps the most dramatic measurement, the act of rolling reduced the maximum force by nearly half from over 7000N to just about 4000N, still a significant multiple of body weight. The authors repeat the experiments in the field using a portable force sensor and find similar results. The experiment is very nicely done. The in lab and in the field component make it a good example of how to conduct laboratory experiments and verify them using additional data from more real life setting.

Going in a rather different direction is the paper by **Wang F, Stone E, Dai W, Skubic M, Keller J., "Gait analysis and validation using voxel data.", Conf Proc IEEE Eng Med Biol Soc. 2009 1:61, 27-30.** They are seeking a method to do very low tech gait analysis for the sort of surveillance that might be appropriate in tracking elderly people to assess whether they are likely to suffer a fall. Their approach includes validating the system using a GAITRite mat and a Vicon system.

The authors are seeking to develop a two camera system which can detect someone walking and can then calculate some basic measures of walking speed, step length and so forth. They do this by using a pair of webcams which have a slow frame rate but reasonably high resolution. Their claim is that they can measure video elements (VOXELS) of about 25mm on a side. The ultimate objective is to be able to track a person, for example, someone walking in a nursing facility and make measures which assess their risk of falls.

There is a very interesting discussion in the paper about required frame rates for what they propose to measure since their video is only 5 frames per second. They demonstrate that they can detect steps which seem to be at the very limits of the frequency which could be tracked with a 5 hz system. Their method of detecting the person walking is of interest as well since they use a fairly conventional approach of taking an image of the empty frame and then subtracting it from the image with the person in it and then trying to detect the outline of the person. The unique part of their work is in combining camera views to get 3D. The results of this rather interesting system are verified as being reasonably accurate using a 7 camera Vicon MX system.

This is one of those papers which will really challenge you to think about what the minimum requirements are to make measurements and would make a good teaching case. ■

"The unique part of their work is in combining camera views to get 3D. The results of this rather interesting system are verified using a 7 camera Vicon MX system."

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