HUMAN BODY MEASUREMENT NEWSLETTER

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NEWSLETTER

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Editorial

Human Body Measurement Newsletter

"You press the button - we do the rest"

by the Editor Nicola D'Apuzzo, Hometrica Consulting.

I am glad to introduce and present the fifth issue of the Human Body Measurement Newsletter. More than a year has passed from the publication of the last issue and the interest in human body measurement techniques has continuously increased. The market of this specific sector has become larger and the manufacturer of 3D scanning systems have reacted accordingly, introducing new solutions and lowering the prices of their products. Some of these new accomplishments will be discussed in this newsletter.

The contents of this editorial is focused on the automation of the 3D scanning process. In fact, as the title expresses in a citation of George Eastman (1854-1932) "*You press the button - we do the rest*", the user of any technical equipment wishes to perform the minimal amount of operations in order to get the final result, by simply pressing a button.

The equipment, in our case a 3D scanning system, hopefully would perform fully automatically all the required operations in order to obtain as final result the 3D surface model of the scanned human body part. Indeed, full automation is in many applications a strongly wished requirement. In addition, full automation can reduce relevantly the operational costs, by limiting or suppressing completely the needed work of technically qualified manpower.

A typical example that shows practically the advantages of full automated scanning systems is given by the 3D dental scanners. In fact, in the last couple of years a marked increment of the availability of such products could be noted. More than 15 manufacturer of 3D scanning systems propose nowadays dedicated solutions for this specific field of application and they all report the commercial success of these devices.

The dental scanners works completely autonomously scanning entire dental cast impressions, bridges preparations, dies, stumps, etc.. They are composed of single or multiple 3D sensors and moving/rotating platforms where the dental cast is placed. During the scanning process, multiple 3D scans of the object are acquired from various directions and all the data is merged automatically into a single and complete 3D surface model. Typical scanning times range from a couple to 15 minutes, depending on the complexity of the dental cast. The relatively long total scanning time is less relevant, since the full automation of the process gives the operator freedom to perform other tasks during the scanning process. In addition, no specific technical know-how in 3D scanning is required to perform the process. All this combined with the numerous practical advantages resulting by employ such 3D scanners in dental practices and dental laboratories, made their commercial success.

Hoping to see in the near future new developments of human body measurement technologies in all the possible sectors of application, I wish you pleasant moments by reading the present issue of the Human Body Measurement Newsletter.

3D Full Body Scanning

One-Step System

Innovation in tailored clothing production

Source:
Human-Solutions (Germany), www.human-solutions.com

Odermark, a market leader in customized clothing production, started at the beginning of 2009 with a completely new system for the mass production of tailored clothing. In a joint project, the tailored clothing production specialists from Goslar (Germany) and Human-Solutions, a market leader in 3D body scanning, developed the *One-Step System*. In a seamless process that is completely computer supported, Odermark uses this system that employs the dimensions taken directly from the 3D body scanner to produce made-to-measure suits without the need for slip-on items.

The data acquired by 3D full body scanner is processed in order to extract the required measurement for the manufacture of the item of clothing in question. In a fully automatic procedure, 48 body dimension are extracted in few seconds. The system also recognizes the customer's posture. The body dimensions are then converted by the software into cut measurements relevant for the production of the desired item of clothing.

The advantage of this new process is plain to see: flanked by a dedicated software solution, the sales person guides the customer through the ordering procedure. The sales assistant and the customer decide together on the PC monitor how the future suit should look. This includes the selection of fabric and details like buttons, buttonholes, AMF lapels and the customer's own wearing preferences. Additional dimensions (measurement variances) no longer have to be taken. The final order is then sent, with just one push of a button, to the Odermark production facility in Goslar.

With the *One-Step System* the time spent by the salesman in advising and helping customers is drastically reduced. The system is also extremely user-friendly and is practically error-free, since the tailor in Goslar always has access to the scan and consequently to the customer, who is thus always available. Additionally, the manufacturer's catalogs are integrated and automatically updated.

The purchasing process is also considerably made much easier for the end user: he doesn't have to try on anything on and his measurements are taken in seconds in a contact-free and fully automated process. "The One-Step System ushers in a new era in the computer-supported mass production of tailored clothing, providing customers with suits of the best possible quality, both for fit and exclusive style. Together we have succeeded in creating an innovation which is unequaled on the market today", said Wolfgang Seebauer, Managing Director of Odermark.

Figure 1: Made-to-measure by 3D full body scanning: 3D scanning, extraction of body dimensions, selection of fabric, electronic ordering process, suit is produced accordingly.

3D Full Body Scanning

Avatars from 3D body scans

Full automatic scanning solution from [TC]²

by Nicola D'Apuzzo,
Hometrica Consulting (Switzerland).
Source:
[TC]² (USA), www.tc2.com

[TC]², the world's leading supplier of 3D whole body scanners, recently introduced its new *ImageTwin™* or *"Avatar from 3D body scan data"* feature which is offered as part of its 3D body scan processing software integrated in the complete 3D full body scanning solution *NX-16*.

Figure 2: Full automatic scanning solution from [TC]².

Creation of high fidelity, realistic, 3D Avatars (digital replicas of humans) is perhaps the most critical aspect enabling virtual applications, such as virtual words or virtual-try-on systems, to achieve a high level of realism. The Avatars are usually composed of a simplified 3D surface model representing very approximately the real person's body and internal skeleton and joint structures used to animate and move the Avatar. The strong limitation of the current Avatars is the poor representation of the real person's body shape. For example, the Avatars employed on the most popular virtual world *Second Life* have only about 4000 vertices, whereas by using a high resolution 3D body scan, over a 100X improvement in Avatar detail could be possible. In fact, a typical 3D full body scan may contain from 100'000 to over one million points of data defining the surface of the subject, catching every detail of the person's size, shape and 3D appearance.
On the other hand, the data resulting from a full body scanner is usually in form of a 3D body model representing uniquely the surface of the scanned person. The main disadvantages of this representation form are the large amount of data required (several MB) and the impossibility to change the pose and posture of the body model; thus, limiting the possibility to use original 3D scan data for on-line applications and in application where the 3D model is animated. For these reasons, the ideal solution is to generate personalized Avatars from original 3D scan data of persons.
The ability to create Avatars using 3D body scans is not new; however, manual data processing or automated processing of 3D scans took previously hours of work.

The key to [TC]²'s new functionality is the generation of the Avatar fully automatically in only a few seconds, capturing the full 3D detail present in the original 3D body scan. The [TC]² process utilizes a reference 3D template of the Avatar and morphs its shape to match the 3D body scan data, by identifying a number of reference points (see next figure).

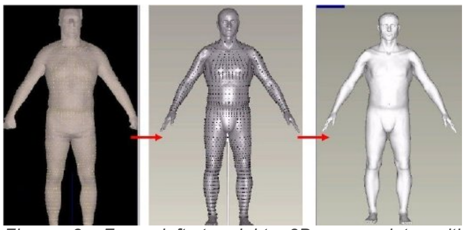

Figure 3: From left to right: 3D scan data with identification of reference points; modification of the reference mesh according to the scan data; resulting personalized Avatar.

Any reference template of any polygon count resolution may be selected. Avatar templates with a resolution of 4'000 up to 100'000 vertices are possible, thus allowing different grades of approximation of the real person's body shape. Additionally, internal joint rigging locations are included in the Avatar for animation, allowing its easy accommodation in any existing virtual world or in any software application which utilizes animated human body models. Unlike parametric computer generated human models, the output of the [TC]²'s Avatar engine is much more realistic and human-like.

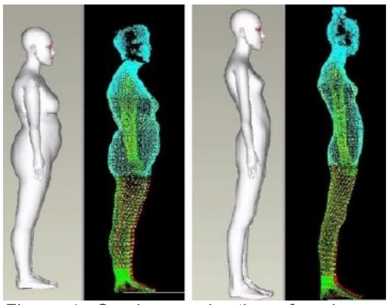

Figure 4: Good approximation of real person's body shape is achieved.

[TC]² is working with more than ten commercial reference templates to enable various applications with its Avatar, including human models from Daz3D, Poser by Smith Micro and numerous apparel industry software application models.

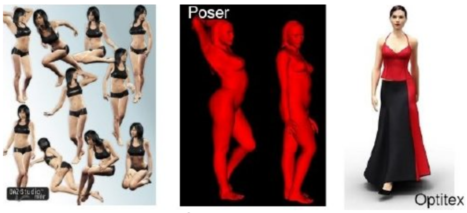

Figure 5: Example of human models compatible with [TC]²'s Avatar: Daz3D, Poser, Optitex.

With the integration of the new feature *ImageTwin™*, [TC]²'s 3D full body scanner *NX-16* can be considered the world's most complete, full autonomous and full automatic 3D full body scanning solution. In fact, automation in the data processing is also accompanied by the advancements in the scanning process. The entire scanning procedure and data processing of the *NX-16* are fully automatic and autonomous. For this reason, there is no need of a technical operator to control the scanning process.

The person operates alone the scanner and trig the scanning process by pressing a button located on holding levers inside the scanning cabin (see red circle in next figure). Recorded messages inside the cabin give additional information and instructions to the person. The scanning cabin with a small foot print may be equipped with changing room.

Figure 6: Autonomous full body scanning solution NX-16 of [TC]²: the scanning cabin and inside the scanner.

The 3D scanner is based on fringe projection technology, by employing 16 independent sensors. The resulting 3D point cloud has a typical resolution of 600'000-1'000'000 points with a point's density of 2mm and an accuracy of about 1mm.
The obtained 3D data is then processed fully automatically to extract body measures (see next figure). The 3D point cloud is firstly segmented into main body parts and the main body landmark points are automatically localized, allowing the determination of main body measures. In the following steps all the other body landmarks and body measures are extracted and stored for further applications. Typical uses of the extracted measures are cloth size fitting and made-to-measure applications.

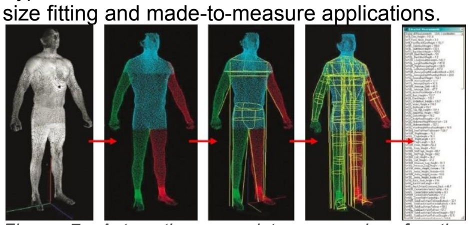

Figure 7: Automatic scan data processing for the extraction of body measures.

For more information about [TC]²'s 3D full body scanning solutions please refer to the following website: www.tc2.com.
For detailed product descriptions and quotes from Germany, Italy, Austria and Switzerland, please contact:
Hometrica Consulting: www.hometrica.ch.

3D Full Body Scanning

Measurement Campaigns

Extended 3D scanning of large groups of persons

by Nicola D'Apuzzo, Hometrica Consulting, Switzerland.
Sources: listed in the text

Measurement campaigns consider the detailed recording of human body measures of large group of persons. Two different types of measurement campaigns have to be differentiated: the large scale national and international measurement campaigns and the measurement campaigns focused on specific target groups of persons. The first case aims at the collection of general statistical information about the shape of the human body in large geographical regions or of large ethnic groups. Whereas the second case aims at the direct exploitation of the acquired data to a specific target group. Modern 3D full body scanning technologies are since various years used in both cases. Recent examples are given later in this article.

Large national measurement campaigns with the use of 3D body scanners have already been conducted in the past. Two typical cases are the campaigns of UK and USA, named *SizeUK* and *SizeUSA*, both with more than 10'000 subjects scanned and more than 120 surveyed body measures. Recently, similar campaigns were conducted also in Sweden, Germany, Brazil, China, Thailand, France, Spain and Italy.

The standard posture used in all surveys features the legs and arms slightly apart from the human body, elbows and hand joints slightly bent (see next figure). This to allow an automatic determination of the important anthropometric measures of the human body (according to norms, ISO7250). The recent size surveys have added additional sitting and standing postures and others also the measurement of hands and feet.

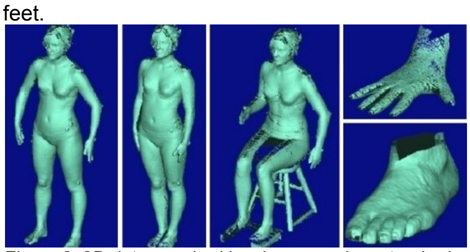

Figure 8: 3D data acquired by size surveying: standard, standing and sitting postures, foot, hand.

In the last years, such large human body measurement campaigns have become a complete necessity. All institution and companies working on ergonomics are expecting information for practical immediate exploitation. In fact, anthropometric data can improve the quality of product design and usability, workstation and work place planning, and even laborer safety in certain environment.

n the fashion industry, the gained statistical information can be used to tailor the size and shape of cloth items to stature and body form of the actual population.

The data can be analyzed and studied on the basis of different parameters, as for example sex, age, geographical provenience, ethnic group, work, etc. and provides very useful information for various applications, as for example, for helping in the definition of the new European norm on sizes (*EN-13402*), for updating the cloth sizing charts, or for the definition of correct shapes of anthropometric dummies (see next figure).

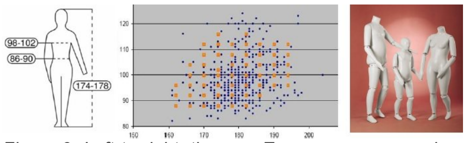

Figure 9: Left to right: the new European norm on sizes EN-13402; representation of a sizing table (in orange are displayed the cloth sizes and in blue the surveyed population); anthropometric dummies (CAD Modelling, Italy).

Three recent national measurement campaigns and a specific measurement campaigns are shortly described in the following paragraphs.

sizeGERMANY

Under the name *sizeGERMANY* was recently conducted a general measurement campaign in Germany. The campaign employed 3D full body scanners placed in key locations, as well as a mobile scanning station. The measurement phase lasted more than one and half year and was terminated in December 2008, with a total number of 13'362 recorded persons, composed of men, women and children, from 6 to 87 years old. The very large amount of data has been processed for statistical analysis for the two main application sectors: fashion and ergonomics. Typical statistical products are body sizes charts and market distribution tables. This information may, for example, be exploited by the fashion industry as basis for the definition of optimal cloth sizes or by the automotive industry for the optimal ergonomic design of seat and cockpit instrumentation.

More information about *sizeGERMANY* can be found at the website: www.sizegermany.de.

Shape GB

Shape GB is a UK government sponsored collaborative project between three major retailers, three universities and a number of companies and organizations that specialize in retail sizing. The first part of the project project launched in March 2009 consists of a national childrenswear survey. A series of other sizing surveys are planned for the following few years.

The national childrenswear survey is the first large-scale project to measure children across the UK using 3D full body scanners and aims at the recording of 6000 children, boys and girls, aged 4 to 17. The data gathered will provide a more sophisticated means of measuring and analyzing children's measurements and will identify the differences in height and body shape between children of different ages.

Most UK based retailers are still working to British standard measurements for children's clothing from 1990, so the project will provide a much clearer idea of what their customers look like and how sizes need to be changed to create better fitting clothes for children.

More information about *Shape GB* project can be found at the website: www.shapegb.org.

Mensuration Senior

Similarly to the children national measurement campaign, described int he previous paragraph, but with the opposite group of age, in France was recently conducted a national measurement campaign of seniors, i.e. of people aged over 70 years. The national senior survey was managed by the *Institut français du textile et de l'habillement (IFTH)*. The survey aimed at the study and the determination of the changes in the morphologies of aged people, that are to time not well known, and at the integration of this information in the conception of clothes for this specific group of people.

This measurement campaign had the goal to satisfy a need of equipment for aged persons by proposing them clothes better adapted, that fit them well, that have good comfort, that look nice and that can easily be worn.

The data resulting from the measurement campaign, i.e. detailed description of the body shapes and their changes for aged persons, can also be exploited for ameliorating the life conditions of this specific group of persons, by intervening in the ergonomic design of public transportation, habitation (seating, kitchen working plans, bathrooms, etc.) and medical equipment related to persons (wheel chairs, etc.).

More information about the French national senior survey can be found at the website of IFTH: www.ifth.org.

Swimmers survey

The U.S. Olympic swimming trials of summer 2008 have resulted in several swim records being shattered. Product development using 3D body scanned humans and computational fluid dynamics simulation is being considered a key element in this success.

Speedo's Aqualab R&D team has developed the *LZR RACER* swimsuit, incorporating an ultralightweight, low drag, water repellant, fast-drying fabric, with panels of an ultra-powerful polyurethane membrane bonded onto the woven material to help reduce drag in specific locations on the body .

[TC]²'s 3D body scanning technology was used to scan over 400 athletes at the 2006 spring Olympic trials in USA and UK as the initial step for the research project. From scan data that was acquired, custom 3D male and female human models were created by [TC]² from multiple scan data sets to be able to represent the swimmers in the guide position, which were subsequently used to test fabrics and suit designs in simulations. Water flume and wind tunnel tests were conducted to simulate a swimmer’s movements, followed by time trials with swimmers wearing the new suit and standard training wear. Speedo continued the research to reduce drag by adding tensile properties to the material to compress key body areas.

Figure 10: Body model of swimmer in the glide position and flow analysis and simulation with the LZR RACER swimsuit.

More information about this application of 3D scanning technology can be found in the newsletter of [TC]²: www.tc2.com.

New Frontiers in 3D Scanning

Hand-Held Scanning Systems

Ultra portable 3D scanners

by Nicola D'Apuzzo, Hometrica Consulting, Switzerland.
Sources: listed in the text

In the last two years, the interest in hand-held scanning system increased strongly. The manufacturers of 3D equipment reacted accordingly by launching in the market, during this period, more than ten new hand-held 3D scanners and by ameliorating existing products. The next figure depicts four examples (from left to right): *MobilCam3D* of ViALUX, based on ultra-fast fringe projection and with automatic alignment of multiple acquisition by using coded targets; *ERGOscan* from Creaform, auto-positioning hand-held laser scanner with special lasers for the measurement of human body parts; *PRIMOSpico* of GFMesstechnik, an extremely small hand-held 3D surface scanner based on ultra-fast fringe projection technique; *OptiNum* of Noomeo, a new company with a hand-held scanner based on fringe projection and capable to acquire also texture images.

Figure 11: Examples of new hand-held 3D scanners.

Such fervent activity is not to be noted in any other segment related to 3D scanning equipment. For this reason, the different technologies and approaches employed are shortly described in the following paragraphs.

The first hand-held scanning system

The company Polhemus (USA) was manufacturing already in 2003 hand-held laser scanning systems. These first systems were based on electro-magnetic tracking technology, which is usually employed for motion tracking. The basic motion tracking system is composed of one or multiple receptors and one or multiple markers. The system deliver in real time the 6DF (six degrees of freedom, i.e. position and orientation in space) of every markers relative to the connected receptor.

Polhemus hand-held scanning method consists of combining a laser profiler with a motion tracking system: a 6DF marker is integrated in the hand-held scanning sensor and the receptor placed in a fix location that defines the coordinate system. In this way, the 3D profiles acquired in real time by the laser scanner can be transferred into the reference system defined by the receptor. The scanning process is therefore very simple and intuitive: the operator move, completely freely, the hand-held scanner over the object, while the acquired 3D profiles are shown in real-time on the monitor.

The next figure shows two examples of acquisition by using a two different scanning systems: *FastSCAN Cobra* composed of a laser light and a single camera, and *FastSCAN Scorpion* with two cameras; the receptors are marked with red circles.

The scanners of Polhemus are unique in this genre among the available hand-held scanning systems. The different technologies and methods used by hand-held scanners are described in the next paragraphs.

Figure 12: FastSCAN Cobra and Scorption in use.

Methods and technologies

The hand-held scanning systems can be divided into four distinguished groups:

1. hand-held laser profilers tracked by photogrammetric systems,
2. hand-held laser profilers tracked by laser tracking systems,
3. hand-held auto-positioning laser scanners,
4. hand-held ultra-fast white light scanners.

The first two groups, as well as the Polhemus scanning systems, are very similar. In fact, they all are composed of a laser profiler and a tracking system that serves for the determination in real time of the position and orientation of the sensor (i.e. its 6DF). They differ uniquely in the employed tracking method: electro-magnetic, photogrammetry, laser tracking. The target sector of the first two groups is clearly industrial measurement, for this reason, such systems are very accurate and the price ranges are accordingly very high. Hand-held scanners of the other two groups are more affordable and find applications also for the 3D measurement of the human body.

Hand-held auto-positioning laser scanners

This group of hand-held scanners consists practically only of the products of the Canadian company Creaform. The hand-held scanner is in this case a very compact sensor with two cameras, illumination and laser projection. The method that is on the base for Creaform's hand-held laser scanners requires to place on the object to scan, a number of signalized targets. These targets are used by the hand-held scanner in order to determine in real-time its 6DF in the space. This process, called "auto-positioning", applies classical photogrammetric techniques on the images acquired by the two cameras. A projected double laser line (forming a cross) serves, at the same time, to determine 3D profiles. The scanning process is very simple, the scanner is moved over the object and the acquired 3D profiles can be visualized in real-time on the monitor.

The major advantage compared to other hand-held scanning systems, is that complete freedom is guaranteed, since no need persists for the sensor to continuously be in the field of view of an external tracking device. The important limitation of Creaform's hand-held scanners is the need to place signalized points on the surface to be scanned. Creaform produces various versions of hand-held scanners, the next figure show two of them by typical configurations by the scanning process; note the signalized points on the object.

Figure 13: REVscan and ERGOscan in use.

Hand-held ultra-fast white light scanners

This group of hand-held scanners showed in the last years not only a large increase of available systems, but also a great amelioration in performance, as well as a strong reduction of their size, making these hand-held 3D scanners portable as video-cameras. The two examples in the next figure, *PRIMOSpico* of GFMesstechnik and *OptiNum* of Noomeo, show how small these scanning system can be.

Figure 14: Small hand-held scanners.

The method used by these scanning systems is the same employed by standard white light scanners, i.e. the projection of fringe patterns. The differences in the case of hand-held systems are the following: (i) the acquisition time is reduced to a minimum (10-50 msec); thus allowing to hold the scanner by hand; (ii) the size of the entire system is reduced to a minimum, so that ultra-portable scanning systems may be realized; (iii) in some cases, a single pattern is projected, instead of a sequence of patterns, thus reducing the lateral resolution; (iv) the alignment and merging of the different points clouds acquired by different directions is, in mostly cases, being performed semi-automatically with some manual intervention.

In the past, the development of hand-held 3D white-light scanners was difficult especially for the first two points (i,ii). However, in the last years, the technology used for digital projection ameliorated so strongly that nowadays these issues can be easily solved. The method used by new hand-held scanning systems is based on the DLP technology developed by Texas Instruments (USA). A DLP projection system can operate with frequencies of several kHz. In addition, DLP technology offer the possibility to miniaturize projection systems. In the following years, it is therefore to expect an increase of scanning system based on DLP technology.

Special case: intra-oral dental scanner

For the completeness of this short overview on hand-held scanning systems, a short description has to be included also on intra-oral dental scanners. In fact, intra-oral scanner are miniaturized hand-held scanning system specifically designed to be inserted in the mouth of patients for the 3D scanning of teeth. The employed technology in these systems is mainly structured light projection, however variations in the light source and in the patterns are present in the different products available in the market.

The next figure shows an example of intra-oral scanner: the *Cerec AC* of Sirona Dental Systems, which uses blue light LEDs to project fringe patterns on the teeth. Since the surface of the teeth is highly reflective, the teeth have to be coated by using a special powder spray before the 3D acquisition.

Figure 15: Examples of intra-oral dental scanner.

For detailed information about hand-held scanners, please consider the services offered by Hometrica Consulting, www.hometrica.ch.

New Frontiers in 3D Scanning

4D Scanning Systems

Applications in cinematography

by Nicola D'Apuzzo, Hometrica Consulting, Switzerland
Sources:
MOVA (USA), www.mova.com
Paramount Pictures (USA), www.paramountmovies.com

The movie industry is employing since more than 20 years 3D scanning technologies for its visual effects. One of the representative example is the movie *The Abyss*, produced in 1989 by 20th Century Fox. For its visual effects, one of the first 3D laser scanner (from Cyberware Inc., USA) was used to digitize the faces of two actors. *The Abyss* was awarded in 1990 with the Oscar for best visual effects. Nineteen years later, on February 2009, the movie *The Curious Case of Benjamin Button*, produced by Paramount/Warner Bros, was also awarded by the Oscar for best visual effects. Again, 3D scanning technologies were behind this success. In the latter case, a new factor was present or, better said, an additional dimension. In fact, together with other technologies as 3D scanning, motion capture, computer graphics and animation, a 4D scanning system was employed in order to scan and track the face of the main actor Brad Pitt.

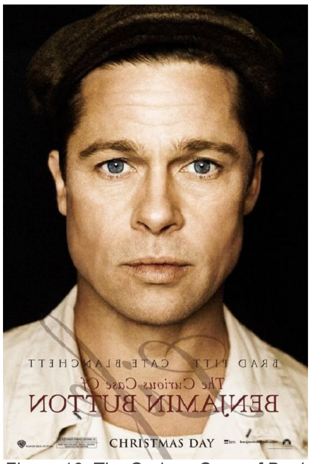

Figure 16: The Curious Case of Benjamin Button.

The entire process of generating the backwards-aging character of Benjamin Button can be summarized in the following steps (note: unfortunately, images of the single steps may not be included in this article because of copyright reasons).

Step 1: Static face model at different ages
Makeup artists created a life cast molded from Mr. Pitt's head and on its basis they manually sculpted different versions of him at different ages (80, 70, 60, ...). The sculptures were then scanned and computer graphic models of them generated. These face models featured all the minimal details and looked perfectly as truth life.

Step 2: Facial expressions database
Using a tracking and scanning system, Brad Pitt's face was recorded as he cycled through more than 120 different expressions. The result was a database of all possible movements and expressions of his face. These could be applied directly into the computer graphic models of his face at different ages.

Step 3: Motion capture of head movement
A body actor played the scenes by wearing a special headgear: a blue hood with tracking markers. Classical motion capture methods were employed to track in 3D the head of the body actor. This information would be used in order to insert correctly the computer graphic generated head into the sequence.

Step 4: Facial expression tracking
For particular scenes, Brad Pitt performed specifically in front of the facial tracking and scanning systems. The recorded facial movements were then applied to the computer graphic model of his face at the specific age.

Step 5: Insertion of computer graphic face
The head of the body actor (wearing the blue hood) was then electronically changed with the animated computer graphic face of Brad Pitt. In the resulting scene, the spectator would recognize Brad Pitt's expressions on a computer graphic generated aged face of him, on a body of an other performing actor.

Beside all the classical 3D technologies used for the visual effects for *The Curious Case of Benjamin Button*, the facial tracking/scanning system, *Contour* of MOVA, is of particular interest. In fact, the system can be considered both a dynamic 3D face scanner and a facial expression 3D tracking system, combining both approaches into a unique product.
Classical marker-based motion capture systems employ markers (typically, retro-reflective markers or painted dots) which are placed on the face of the person. An array of cameras surrounding the person acquire multiple image sequences and photogrammetric methods are then used in order to measure and track the markers. Since only a small number of markers can be practically placed on a human face (typically 30-120 markers), the result from this process is a sparse representation of the occurred facial movements.
On the other side, dynamic 3D face scanners employs photogrammetric or ultra-fast fringe projection methods to scan the surface of a human face in movement. The result is a set 3D point clouds or 3D surface models representing the face in all its details at each time step. However, no tracking information is available.
The tracking and scanning system *Contour* combines both approaches and is capable of capturing an entire scene of vertex-continuous 3D surface in motion without use of markers. *Contour* uses an array of synchronized cameras placed around the capture volume (see figure 17). The acquired image sequences from all the cameras are processed in order to measure a dense set of points onto the moving face and at the same time to track the same dense set of points through the entire time frame. The result is a complete 3D surface model, measured and tracked during the scene. In addition, also visual images of the face are recorded, so that photorealistic visualization of the 3D surface model can be generated by texture mapping.

Figure 17: Camera array in front of the person.

A very smart and interesting method is on the base of the very nice results achieved by *Contour*: the application on the person's face of a special phosphorescent make-up and the use of a high-speed synchronized illumination system. The phosphorescent make-up is not visible with normal illumination, whereas it appears as a dirt coat on the face when the lights are switched off (see figure 18).

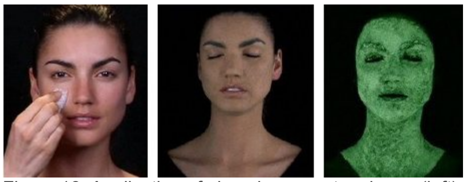

Figure 18: Application of phosphorescent make-up (left). Image acquired with lights on (center) and off (right).

The high-speed illumination system is synchronized with the image acquisition system so that rapid alternating images are acquired with and without lights. The set of images acquired without illumination are used for the measurement and tracking process, whereas the set of images acquired with illumination are used for the generation of photorealistic results. The images acquired in the dark are rich of additional features and therefore can be processed by photogrammetric and image correlation methods in order to measure and track a dense set of 3D points onto the face. A minimum of 2 cameras, up to 256 cameras may be used (an example with 7 images is shown in figure 19).

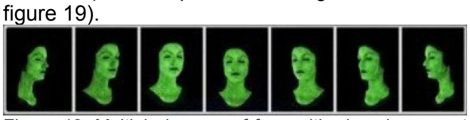

Figure 19: Multiple images of face with phosphorescent make-up.

Practically, the phosphorescent make-up replaces the retro-reflecting markers placed on the face in a common motion capture system, with the difference of an augmented density of the measured and tracked 3D points. The results are shown in figure 20: a 3D surface model of the face is measured for each time step and a dense 3D mesh is tracked during the time frame. The acquired visual images of the face can then be mapped onto the 3D face model resulting in a photorealistic result.

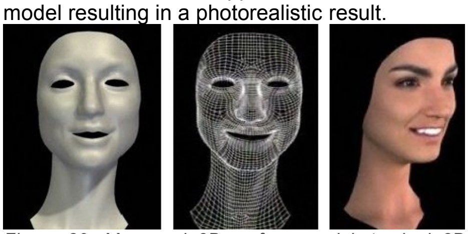

Figure 20: Measured 3D surface model, tracked 3D mesh and photorealistic result.

The main application of the facial tracking and scanning system of MOVA regards visual effects and more specifically the so called "digital makeup". Digital makeup refers to capturing the human face in 3D, and then manipulating the face, while still retaining the performance of the actor. An actor can be aged, made to look younger, changed to look like a historical figure, or even transformed into a fantasy character, while keeping his subtle personal facial expressions. So, just as actors today use their voices to add life to animated characters, with *Contour*, actors can use their faces to bring life to computer-generated characters, while still retaining the subtleties of their performance (an example is shown in figure 21).

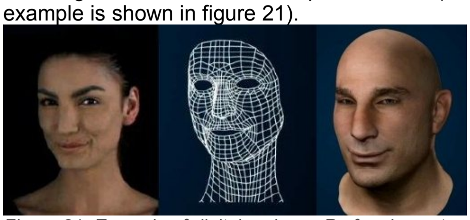

Figure 21: Example of digital makeup. Performing actor, tracked 3D mesh and computer-generated character.

New Frontiers in 3D Scanning

3D Cameras for Game Consoles

Increased interaction man-machine

Sources:
Microsoft Xbox (USA), www.xbox.com
Ubisoft (France), www.ubi.com

The E3 Expo (Electronic Entertainment Exposition) in Los Angeles of June 2009 was rich of new developments around video games. Key new features of this year were the announced 3D sensing tools for game consoles that would allow an augmented interaction between the user and the machine, completely freely without the need to hold or wear special equipment. In other words, these systems use no controller and solely rely on movements of the human body. In the next paragraphs are given the two examples for the game consoles *Microsoft Xbox 360* and *Nintendo Wii*. Other consoles also announced similar features.

Microsoft's new innovation, grouped under the name *Project Natal*, consists of a 3D camera that will be instantly compatible with the game console *Xbox360*. No details on the specification have been revealed yet; however, the camera provides at the same time and at video frame rate, synchronized color video and depth information. The new device will enable consumers to control video games through intuitive body gestures and immerse themselves with virtual reality. Microsoft underlines that *Natal* will completely change the way consumers interact and play with their game consoles. The camera takes an approximative 3D scan of the player's body; this is then broken down into 48 joints, which are tracked in real time. Depending on the game or application, particular joints are tracked. By monitoring their direction and acceleration the consumers become the controller for the game. Additionally, the camera will also perform facial tracking and face expression recognition in order to use this information for augmented interaction between the consumer and the console.

Figure 22: Microsoft's Project Natal, Xbox360 and 3D camera (left), consumer playing a fighting game (right).

The second example of the use of 3D sensing technologies for game consoles is the application *Your Shape* from the French software company Ubisoft for the Nintendo *Wii* game console. *Your Shape* is a new fitness game with augmented interaction and personalization with the help of 3D sensing and tracking technologies. A new camera device for the game console is included with the software application. Featuring Ubisoft's proprietary body tracking technology, the game enables players to scan their bodies and then projects their images onto the monitor, creating a personalized and interactive workout. Based on the player's specific body shape analysis, fitness level and personal goals, *Your Shape* is able to recommend the workout program that is best suited for them. Specific of this application, analogue to Microsoft's Project *Natal*, is that *Your Shape* allows the consumer to play without holding a controller.

Figure 23: Ninento Wii and Your Shape application.

Conferences and Fairs

IMB 2009

Trade fair on textile processing

by Nicola D'Apuzzo, Hometrica Consulting, Switzerland
Source: IMB, www.imb.de

The European largest trade fair on textile processing, IMB 2009, was held in Cologne (Germany) during four days in April 2009. This article in the Human Body Measurement Newsletter reports shortly about the trade fair, since 3D body scanning technologies are gaining importance in the specific sectors related to textile industry.

IMB, which is held every three years in Cologne, is considered one of the world's top event for textile processing. This year, more than 500 companies from 34 countries were presenting their products at IMB 2009. All the major world's leading companies in the sector were present. The trade fair was attended from about 20'000 visitors from more than 100 different countries. As expected, because of the global economic crisis, a slightly decrease of visitors from America and Asia was noted; however, the number of visitors from Europe remained stable. The majority of the exhibitors reported, at the end of the four days, that the established contacts during IMB were very high qualitative and they consider their overall achievements during the trade fair very positive and successful.

The spectrum of products and services at this year's IMB ranged from textile machines and facilities, through software and IT-solutions, to services, for all stages of the textile value chain, from product development, through the various production processes, to the distribution of the final products. In addition, IMB presented a broad range of processing techniques for technical textiles, textile machines, textile finishing, and logistics.

Figure 24: Highlights of IMB 2009: 3D full body scanning and 2D pattern design software.

In the specific product range related to human body 3D measurement, only three booths were presenting and demonstrating 3D scanning systems. Even though this limited presence, very large was the interest of the visitors to this technology. On the other hand, at IMB 2009, examples of exploitation of this technology in the textile sector were numerous, from made-to-measure garment production, through virtual-try-on systems, to anthropometric mannequins built on the basis of data gained by measurement campaigns. In addition, various Universities presented their interesting research works related mainly with processing of data acquired by 3D scanners and with software for 3D simulation of garments.

Summarizing, it can be concluded that 3D body scanning technologies have succeeded to found their market segment in the sector of textile processing and hopefully this will increase continuously in the near future. The next IMB will take place in May 2012 and the next IMB Forum, a smaller version of the trade fair, will be held in May 2010, both in Cologne, Germany.

Note: for detailed reports related to 3D body scanning for textile processing, consider the services offered by Hometrica Consulting: www.hometrica.ch.

Conferences and Fairs

Vision2008, EuroMold2008, Control2009

3D equipment from industrial trade fairs

by Nicola D'Apuzzo, Hometrica Consulting, Switzerland
Sources:
Vision, www.messe-stuttgart.de/vision
EuroMold, www.euromold.com
Control, www.control-messe.de

The three industrial international trade fairs Vision, EuroMold and Control are held yearly in Germany. Vision, held in autumn in Stuttgart, is the most important platform for machine vision and identification technologies in Europe. EuroMold, held in winter in Frankfurt, is the world leading trade fair for moldmaking and tooling, design and application development. Control, held in spring in Stuttgart, is the world leading trade fair for quality assurance. Essential topics as optical and non-contact 3D measurement are largely present at the three trade fairs. For this reason, Vision, EuroMold and Control together cover largely the sector of industrial 3D measurement. New developments and tendencies in this sector are relevant also for the specific solutions and products related to 3D human body measurement. For this reason, in this article, are shortly reported the main tendencies that could be identified from the wide range of products presented at the three industrial trade fairs Vision2008, EuroMold2008 and Control 2009.
The main tendencies are summarized in the following paragraphs and presented with typical examples.

1. Consolidation of the mostly employed non-contact 3D measurement systems in the industrial sector into four distinguished groups:

(a) 3D sensing heads (e.g. laser profilers) mounted on CMMs,
(b) fringe projection 3D scanning systems,
(c) hand-operated surface scanners (e.g. laser profiler on mechanical arm),
(d) hand-held surface scanners.

The next figure shows some typical examples of the four main groups of non-contact 3D measurement systems.

Figure 25: Left up to bottom right: fringe projection system ATOS by GOM mbH, laser profiler XC50-LS mounted on CMM by Metris, hand-operated laser profiler on mechanical arm Laser Scan Arm V3 by FARO, hand-held scanner EXAscan by Creaform.

2. Strong increment of portable and/or hand-held 3D scanners.
The marked increase of interest in such scanning systems started already two years ago. Since then, the manufacturers of 3D equipment continuously increased the offer of products falling in this group. A complete article is dedicated in this newsletter to this type of scanners (see at page 4).

3. Increment of the integration and combination of different technologies/methods into complete 3D scanning systems.
A typical example is the product *naviSCAN3D* of Breuckmann GmbH, which is composed of a fringe projection 3D surface scanner and a photogrammetric tracking system that is used to determine the external orientation and position of the scanner (see next figure). In this specific case, reference markers, tracked by the photogrammetric system, are fixed to the 3D scanner. The combined use of the two technologies allows to achieve a full automatic 3D scanning of large objects with high accuracy.

Figure 26: Combined system naviSCAN3D. Left: setup, stereoSCAN3D with reference cage and photogrammetric measurement system. Right: naviSCAN3D mounted on a robot.

4. Increment of systems capable of dynamic 3D scanning and/or 3D tracking.
Two different examples are shown in the next figures. The first example is the high-speed tracking system *Wheel-Watch* of AICON 3D Systems GmbH. The system performs, by photogrammetry, a dynamic measurement of the wheel of a car and it determines 6-DOF (degrees of freedom) data of the wheel with reference to the car body. Coded targets are used both for the reference points as well as for the measured points.

Figure 27: Wheel-Watch system during test driving (left), coded marks on the car body and on the wheel (right).

The second example shown in figure 28 regards the 3D scanning and tracking system *Vic-3D* of Limess Messtechnik & Software. The system, based on stereo photogrammetry and image correlation, allows the 3D surface measurement of dynamic events. Typical applications are deformation and strain analysis of industrial parts. The specific parts have to be painted/sprayed with a random pattern texture (visible in the figure), in order to allow the determination of image correlations.
Note: the facial tracking system of MOVA described in the article on page 5 of this newsletter, uses the same technology with the difference that instead painting the face of a person with a random pattern texture, is applied a phosphorescent make-up (which results in the dark as a random pattern).

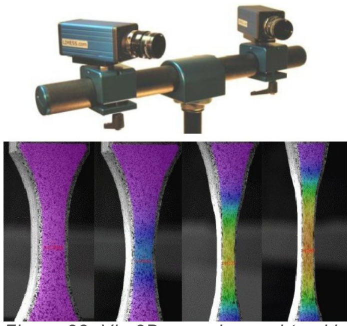

Figure 28: Vic-3D scanning and tracking system and some frames of a sequence of a deformation analysis (strain values are coded in colors).

5. Interfacing between 3D measurement systems and 3D processing software
A very important and relevant part of the tasks that have to be performed for a complete 3D scanning project regards the processing of the data obtained from the scanner. Typical tasks that follow the 3D data acquisition are: alignment/merging of the multiple 3D data, removal of outliers, decimation, smoothing, 3D modeling, fine 3D editing, texture mapping, as well as analysis and inspection tools. Software packages are available since many years for these tasks and have become standard in the sector of industrial 3D scanning. Such software packages are, from one side, ameliorated continuously and become every year more sophisticated; and from the other side, they are integrated or closely interfaced with more and more 3D scanning systems, in order to obtain complete scanning and processing solutions.

6. Strong increment of 3D measurement and/or scanning solutions developed for specific tasks
Very often the final user of 3D scanning equipment is not interested in a product that can be used in different situations but instead he is looking for a 3D scanner tuned for his tasks. In addition, he also wish a specific software solution. The manufacturers react to this trend to one side by offering customized solutions upon request from the users and on the other side by offering complete 3D scanning solutions (hardware and software) for various recurrent specific tasks. A typical example of the latter case is given by dental scanners.
Dental scanners are designed specifically to digitize and generate accurate digital models of full dental casts, single dies/stump, inlay preparations, bridge preparation, etc.. As discussed in the editorial of this newsletter, dental scanners have shown a strong increase and a relevant commercial success in the last couple of years. The next figure shows a typical example from the company 3Shape A/S.

Figure 29: 3D dental scanner D640 of 3Shape and examples of acquired 3D data.

Note: for detailed reports related to 3D measurements in the industrial sector, please considers the services offered by Hometrica Consulting, www.hometrica.ch.