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NEWSLETTER

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Editorial

Human Body Measurement Newsletter

Special theme issue "Medical Applications"

by the Editor Nicola D'Apuzzo, Hometrica Consulting (Switzerland).

I am glad to introduce and present the fourth issue of the *Human Body Measurement Newsletter*. The first three numbers, published in years 2005 and 2006, had a very positive success with more than 5000 downloads. I hope the number of readers of the newsletter will continue to increase also in the next years and I hope the newsletter will continue to provoke interest and discussion about human body digitization techniques and their applications in various domains.

The contents of this issue are focused on medical applications of human body measurement technologies. As many of the readers of this newsletter are for sure aware of, the medical field represents an established group of users of human body measurement techniques. In this regard, various applications can be found in biomechanics, plastic surgery, orthopedics, prosthetics, orthodontics, forensic medicine, dermatology, etc.. In the following pages, some example of recent applications are shortly described. They represent uniquely a small part of possible exploitations. Nevertheless, they serve to illustrate the potentials of 3D measurement techniques applied in medicine.
Hoping the next years will reserve to human body measurement technologies greater exploitations in the medical as well as in other domains, I wish you pleasant moments by reading the present issue of the *Human Body Measurement Newsletter*.

Introduction

3D Measurement Techniques for Medicine

Human body surface scanning

by Nicola D'Apuzzo, Hometrica Consulting (Switzerland).

Laser scanning and structured light projection represent the optical measurement technologies mostly employed for the three-dimensional digitalization of the surface of the human body.
They are both based on the same rule, namely triangulation, in the way that light structures (normally in form of stripes) are projected onto the human body, whereas light sensors acquire the scene; by known geometry of the set-up, 3D information can then be drawn from the imaged data.
The difference between the two method resides in the way the light structure is projected and imaged. By laser scanning, laser light sources are used to project on the human body one or multiple thin and sharp stripes (see figure 1), whereas by structured light projection systems, light patterns (usually in form of a bundle of stripes) is projected onto the entire interested area of the human body (see figure 2).

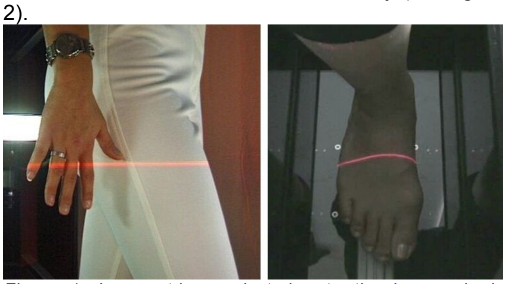

Figure 1. Laser stripe projected onto the human body (images from Vitronic GmbH, I-Ware Laboratories Co.Ltd.).

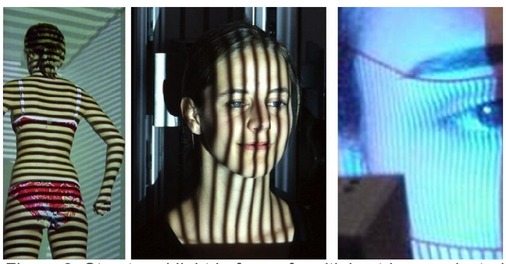

Figure 2. Structured light in form of multiple stripes projected onto the human body (images from Telmat Industrie, 3D-Shape GmbH, Breuckmann GmbH).

Both systems are entirely inoffensive for the human body, since by laser scanning only eye-safe lasers are employed and by structured light projection systems normal white light projectors are employed. Both methods are also similar in terms of accuracy and resolution, however they differ consistently in the construction and in the way specific measurement tasks are solved.
Which of the two technologies should be more adequately employed, depends on the measurement task to be performed. This fact is also demonstrated by the multitude of commercial measurement systems available nowadays and based on different methods and technologies. Among them, four groups can be identified as the mainly used systems in the medical field: (1) modular structured light projection systems (multiple units can be combined into a complete system) - for a fast digitization of body areas; (2) desktop solutions with multi-axial moving platform - for the automatic measurement of small objects (e.g. dental impressions, ear impressions); (3) hand-operated or hand-held laser profilers - for a complete freedom during the acquisition; (4) dedicated systems designed for a specific measurement tasks - as for example face scanner, foot scanner, full body scanner. The next figure shows examples for the four groups. Examples of their use in the medical field will follow in the next pages.

Figure 3. Examples of surface measurement systems employed in medicine: InSpeck surface digitizer Mega Capturor II (mounted on a vertical bar), Breuckmann skin digitizer dermaTOP, Laserdenta desktop dental cast scanner, Polhemus hand-held surface digitizer FastSCAN Cobra, IVB-Jena face scanner gscan.

Medical Applications

Plastic Surgery

Face scanning for design and production of epitheses

Sources:
InSpeck Inc. (Canada).
Stelzer S. et al., Utilisation of 3D Face Scanner in Medical Faculty. Proc. of 3D Modelling 2006, Paris.

Even though, at first sight, plastic surgery will be thought as an ideal field of application of human surface measurement techniques, practically this is not yet the case. Commercial systems dedicated to the measurement of various parts of the human body and especially developed for surgical applications are available. An example is shown in the next figure: the breast and face digitizer of InSpeck with a dedicated software.

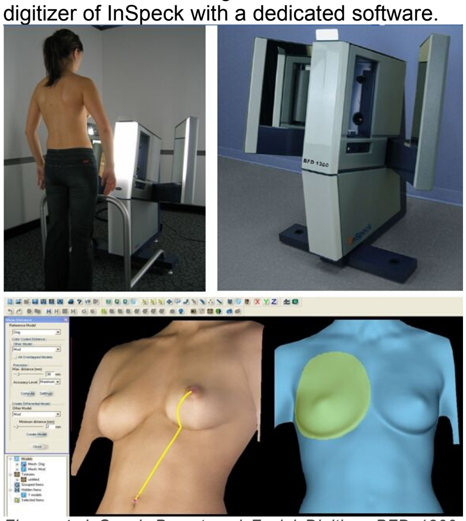

Figure 4. InSpeck Breast and Facial Digitizer BFD 1300 and analysis software EM-Measurement.

Advantages of using such systems in combination with analysis and measurement software could be manifolds, e.g. for the planning of surgical interventions, for the comparison between pre- and post-operative shape, or for a better interface between patient and surgeon. Other software solutions go even further by simulating the effects of surgical interventions in a virtual environment. Regardless all these available solutions, resistances are still present from the surgeons for their use in real practice. Nevertheless, interest begin to arise, especially if advantages can be demonstrated, as it is the case of the following example.

In the cases where patient have lost part of their faces (as eyes, ears or nose), plastic surgery commonly uses the method of generating an artificial replacement (called “epithesis”) for the missing part. 3D scanning technologies can be very useful in these situations. A project at the Institute of Production Engineering of the Technical University of Dresden (Germany) aims at the use of face scanning and rapid prototyping technologies for the design and production of epitheses.

A face scanner based on white light projection, *gscan* of IVB-Jena, is used to measure three dimensionally the face of patients. Modeling software are then employed to virtually design and model in 3D the replacement of the missing part. In the cases where the missing parts are still present on the face of the patient as mirrored parts (as eye or ear), the missing part can be modeled by mirroring the existing part. In the case of a missing nose, the artificial replacement can be chosen among an extensive 3D database of virtual noses and visualized in 3D over the digitized face.

The accurate 3D modeling of the artificial replacement is completely performed in a virtual environment by using commercial modeling software. The obtained CAD model is then converted into a physical model with rapid prototyping techniques. The model is firstly generated on 3D printers in a polymer material and then used as master for the production of the final epithesis from silicone. The next figure shows the employed scanner, an example of 3D scan data and the modeled epithesis (to protect the privacy of the patient, uniquely a 3D point cloud of the face is shown; in the real situations fully textured surface models are visualized).

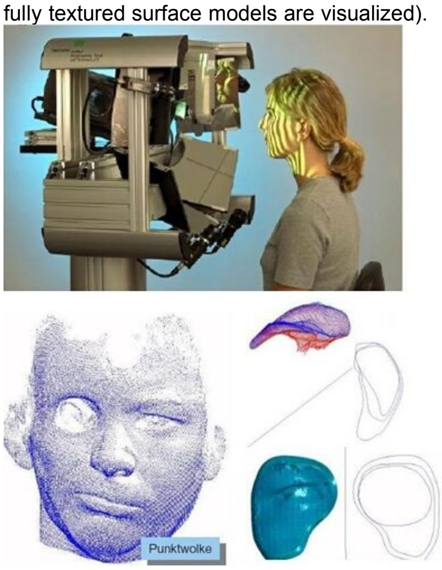

Figure 5. Human face scanner gscan (left), 3D point cloud of patient with missing eye (centre), digital design of the missing part (right).

Surgical Navigation Systems

Computer aided knee replacement surgery

Sources:
Axios 3D Services GmbH (Germany).
BrainLAB AG (Germany).

Optical measurement systems are an established facet of surgical procedures using computer aided assistance. The importance of these systems has grown with the increasing popularity of minimally invasive procedures, which are associated with a reduction in operative field visibility. These measurement systems are mostly based on stereo photogrammetry and are usually composed of a stereo camera acquisition unit and surgical instrumentations marked with signalized targets points. The next image shows a typical example: the infra-red photogrammetric system *Cambar* of the company Axios 3D Services.

Figure 6. Axios3D Cambar photogrammetric measurement system and surgical instrumentation with signalized targets.

The stereo photogrammetric measurement system is uniquely a component of the surgical navigation system. In fact, complete solutions for computer assisted surgery include also real-time navigation and real-time computer assisting software solutions. Moreover, medical imaging data acquired pre-operatively (as for example by CT or MRI) has also to be integrated into the navigation system. This is required both for planning and for executing the surgical intervention.

Various solutions are available commercially and dedicated solutions have been implemented for typical interventions, as for example knee replacement or spinal surgery. The next figure shows snapshots of different parts of a complete navigation system for total knee replacement: *VectorVision Knee* of BrainLAB AG. The complete navigation solution enables knee replacement surgery with great precision and control.

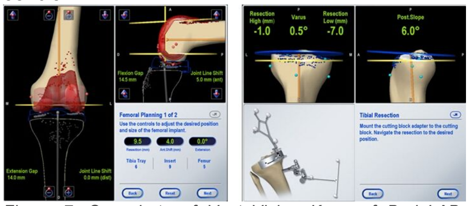

Figure 7. Snapshots of VectoVision Knee of BrainLAB. Initial planning and alignement of the implant position (left), real-time bone cut navigation and verification (right).

The system helps, in real time and with a on-screen information, the surgeon for the different phases during the intervention, from the bone cuts execution to the precise insertion of the knee replacement components in the bone.

The surgeon has also the option to make individual modifications of the treatment plan, including the size, position, and orientation of the implant.

Surgical instruments are continuously tracked by the navigation system to judge their precise position and alignment relatively to the operated parts and in accordance to the planned and executed treatment. This provides the surgeon with comprehensive real-time information, which allows him to make decisions for greater control over the surgical outcomes.

Medical Applications

Forensic Medicine

Virtual autopsy

Source:
Naether S. et al., Virtopsy - Scientific 3D Documentation of Human Bodies in Forensic Medicine: with High Resolution Surface Scanning and Radiological MSCT/MRI Scanning. Optical 3-D Measurement Techniques VIII, 2007, Zurich.

Documentation of morphological findings on and in living and deceased is essential in forensic medicine. Nowadays, most of the documentation of forensic relevant medical findings is limited mainly to traditional 2D photography, 2D radiographs, sketches and verbal descriptions. More and more forensic institutes begin however to employs modern 3D acquisition techniques, as photogrammetry, laser scanning, surface scanning, for the documentation and analysis processes. Among them, the Institute of Forensic Medicine at the University of Bern (Switzerland) represents a pioneer. Within the research project *Virtopsy* (also reported on the Human Body Measurement Newsletter Vol.1 No.2), 3D optical surface digitizing and cross-sectional radiological modalities were introduced for documentation and reconstruction of the internal and external body morphology of living or deceased persons, as well as of objects involved in the case.

For the digitization of the external body morphology, the forensic institute is using the structured light based surface scanning system *ATOS III* and the photogrammetric measurement system *TRITOP*, both of GOM mbH (Germany). The combined *TRITOP/ATOS III* system has the advantage that it can be used for surface documentation ranging from fine detailed structures, as skin lesion or fine instrument structures, to overview documentation, as whole body or entire vehicles.

Additionally, with the precise 3D measurement of markers placed on the corpse, 3D data acquired optically can be aligned and merged with the internal body morphology digitally documented using medical imaging systems as computed tomography and magnetic resonance imaging.

The next figure shows the employed computer tomograph and the optical acquisition system *GOM ATOS III*.

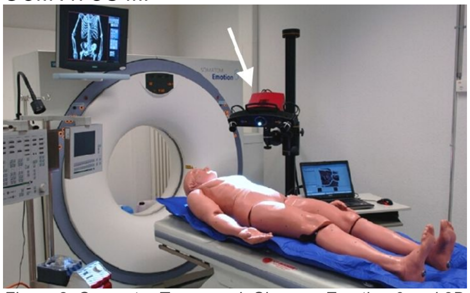

Figure 8. Computer Tomograph Siemens Emotion 6 and 3D surface scanner GOM ATOS III (arrow).

The integration of the radiological data and the 3D body surface data allows for a complete and detailed analysis of injuries. Moreover, the documented geometric findings (on and in the body, and involved objects) can be animated step by step or even by movie clips. Using data merging methods and animation, it is possible to answer reconstructive questions of the dynamic development of patterned injuries (i.e. morphologic imprints).

Modern technologies of three-dimensional documentation can open new possibilities for forensic reconstruction by bringing added values and a real quality improvements into forensic science. Additionally, they enable real data based 3D reconstructions at any time, without the need of storage of the bodies, vehicles and instruments.

By bringing the body into a virtual 3D accident or crime scene, further information about the course of events can be delivered than in the conventional way.

The next figure shows two examples. On the top, the virtual reconstruction of the impact situation in a traffic accident case where a person was struck by a reversing car. A computer model, adapted to the body data of the victim, can be moved anatomically correctly. With the comparison of the damage of the car and injuries of the body, the collision position could be determined. The second example considers the analysis of patterned injury on a face deriving from the sole of a shoe. The injury was documented with photogrammetry. The shoes of the presumable offenders were digitized with the 3D scanning system and accurate 3D match analysis of patterned injury and the suspected injury-causing shoe was performed by matching the areas of the shoe sole pattern and the skin lesion.

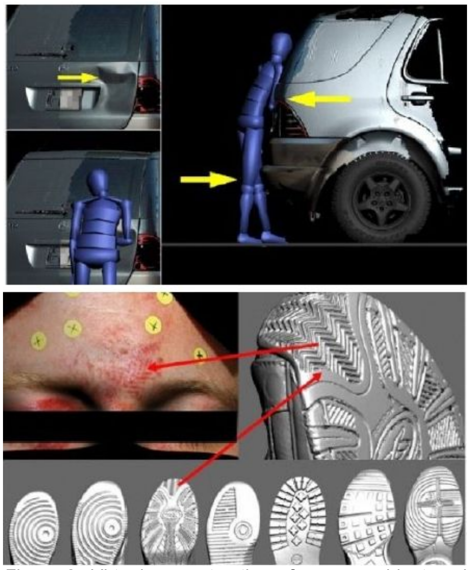

Figure 9. Virtual reconstruction of a car accident and matching of patterned injury on a face from a shoe sole.

Orthodontics, Dentistry

CAD/CAM dental solutions, Intra-oral scanners

Sources:
Laserdenta AG (Switzerland).
D4D Technologies L.P. (USA).

In dentistry and orthodontics the advantages of employing optical 3D digitization techniques can be as straight forward as by orthopedics and prosthetics (see page 4). However, because of a lack of comprehension from the parties active in the dental domain (i.e. dentists and dental laboratories), the 3D technologies have reached nowadays only a penetration of 5% in the specific market. This is far below the real potential. In fact, already available since many years are CAD/CAM solutions for the 3D scanning of dental cast impressions for archiving and for a simplified design of orthodontical restoration, as well as, dedicated intra-oral 3D scanners for a direct 3D measurement of teeth without the need of dental impressions.

Various complete solutions are available in both cases. A typical example of solutions for modern design and production of dental restorations starting from 3D scans of dental cast impressions is the given by the products of the company Laserdenta AG (Switzerland), which cover all the process steps: 3D scanning, 3D processing, 3D visualization, 3D virtual planning of restorations (see figure 10). For this purpose, a desktop laser scanning solution was especially designed and developed to automatically scan dental impressions with a complete automatism and with high accuracy. The data resulting from the scanning process can then be used by dentist and/or dental laboratories to directly plan and design dental restorations in a virtual environment (e.g. bridges, ceramic inlays, crones, etc.). The virtually designed components of a restoration can then be produced in a fast and accurate way by modern rapid prototyping technologies. Both metals as well as ceramics parts can be to time produced automatically by CAM solution starting from CAD data.

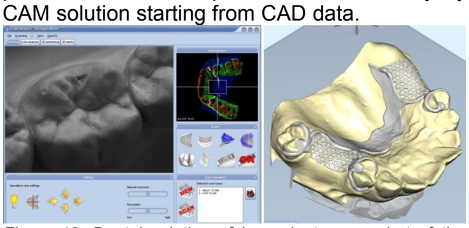

Figure 10. Dental solution of Laserdenta: snapshot of the scanning control software (left), virtual planning of a complex dental restoration (right).

The employment of 3D scanning technologies and modern CAD/CAM solutions in the dental domain can increase the efficiency and at the same time reduce the costs of the design and production of the different parts (in ceramic and/or metal) required by a dental restoration. For this reason, these technologies have a great potential of expansion in the dental domain.

A step further to simplify the entire process for the design and production of dental restorations is given by intra-oral scanners. Various companies offer to time solutions for a direct scanning of teeth inside the oral cavity. The next figure show an example of such device from the company D4D Technologies. The hand-held 3D scanning system is so miniaturized that it can be placed inside the mouth of a patient to accurately record the 3D shape of the teeth.

Figure 11. The intra-oral scanner E4D Dentist of D4D Technologies: the hand held miniaturized scanner (left), surface scanning by multiple lines projection (right).

The main advantage resulting from the use of intra-oral scanners is the immediate generation of a 3D surface model of teeth. Thus, allowing an immediate and direct design and planning of dental restorations in a virtual environment. In some simple cases (e.g. ceramic inlays) the entire procedure can be performed during the same session, i.e. without the need of having the patient leave. In fact, 3D intra-oral scanning systems are usually accompanied with virtual restoration planing software, as well as with small milling machines for the production of ceramic parts directly from the generated 3D data.

Medical Applications

Prosthetics, Orthopedics

Lower limb prostheses, Orthopedic shoes

Sources:
Bonacini D. et al., 3D Digital Model Reconstruction: Residual Limb Analysis to Improve Prosthesis Design. Optical 3-D Measurement Techniques VIII, 2007, Zurich.
Vorum Research Corporation (Canada).
pedcad Orthopaedieprodukte GmbH (Germany).

The peculiarity of orthopedics and prosthetics is that measurements of the interested body part are always required. In a large part of the cases, in order to build best fit ortheses or prostheses, negatives of the human body part are required; these are usually obtained by casting. For these reasons, 3D scanning technologies have the best presuppositions to become replacements of classical methods.

A good example of how 3D surface scanning can be successfully employed in the field of prosthetics is well described by the work of Bonacini et al. (also presented in the Human Body Measurement Newsletter Vol2. No.1) and regards the design process of lower limb prostheses. An important aspect concerns the reconstruction of the 3D digital model of the stump, which replaces plaster cast.

The work of Bonacini et al. go even further by combining optical 3D measurement techniques for the external surface of the limb and computer tomography (CT) and magnetic resonance imaging (MRI) for the inner structure (bone structure, muscle tissue, soft tissue and dermis).

The obtained 3D model of the stump can then be used for the design and production of a customized socket in a CAD/CAM environment. A proof of the utility of this modern process is given by the presence in the market of commercial CAD/CAM solutions dedicated especially for the design of lower limb socket, based on 3D scan models of the stump. An example is shown in the next figure, the *CANFIT-PLUS P&O* system from the Canadian company Vorum Research Corporation. In this specific case, an hand-help laser scanner is employed for the 3D acquisition of the external surface. Dedicated software tools are then employed for the accurate modeling of prostheses on the base of the scanned data.

Figure 12. Lower limb socket design system CANFIT PLUS: hand-held laser scanner and snapshots of CAD/CAM software.

The second example of application of 3D scanning technologies in the orthopedic field regards the design and production of customized orthopedic soles. The classical method consists in this case to first get an imprint of the foot (i.e. a negative of the foot plantar) and then to build the shoe sole according to it. The advantages of using modern 3D scanning technologies to acquire the shape of the foot are manifold compared to the classic imprint method.

The design of customized shoe soles can in fact be completely performed in CAD/CAM solutions starting from 3D scan data of the plantar of the feet of a person.

Various commercial systems have been developed especially for this purpose. Inexpensive scanning solutions are available, since the measurement task is relatively simple. Thus, making this application commercially more interesting.

A typical example of a complete solution is given by the German manufacturer pedcad Orthopaedieprodukte (see figure 13). The scanning system is based on structured light projection method and acquires the shape of the plantar of the foot in very short time. The integrated software solution allows for the analysis of the scan data and for the complete design process of customized orthopedic shoe soles in a CAD/CAM environment. The generated data can be directly sent to milling machines for the production. Also in this case, the integration of 3D scanning systems with CAD/CAM solutions serves for a smoother and simplified design and production.

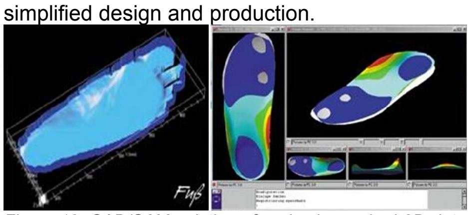

Figure 13. CAD/CAM solution of pedcad: acquired 3D data from scanning system (left), design and analysis of the sole.

3D Bedding Analysis System

Mattress and bed customized to individual body measures

Source: Custom8 NV (Belgium).

We spend approximately one third of our lives in bed, while our inactive body depends on the sleeping system we are lying and relying on, i.e. mattress, supporting structure and head cushion. Biomechanical research points out that the mechanical characteristics of mattresses and slatted bases have a major influence on the position of the spine in both a lateral and a supine sleeping position. For this reason, a thorougher selection of adequate sleeping systems is strongly recommended and conscious customers are increasingly aware of the importance of the quality of sleeping systems for their welfare and well-being.

The Belgian company Custom8 (linked to the Division of Biomechanics and Engineering Design and the University Hospitals of the Katholieke Universiteit Leuven) has exploited biomechanical and 3D human body measurement techniques to develop modern tools for the analysis and definition of personalized bedding systems. In fact, through numerical simulations and experiments, the influence of individual body dimensions and sleeping system characteristics on the position and the shape of the spine during sleeping can be determined. Moreover, statistical methods can be used to put a link between anthropometrical characteristics and standardized mattress properties.

Custom8 is offering combined hardware-software solutions to integrate the information on optimal body support in personalized advice regarding sleeping systems or in personalized sleeping system design.

The product *Ikélo*, shown in figure 14, serves for a customization of mattress and bed, based on individual body measures.

A relatively simple optical 3D measurement device is employed to measure the individual physical characteristics of a person, including body dimensions, the shape of the spine, and body weight distribution. The easy-to-use software solution combines these measured values with personal preferences in order to select the optimal mattress, bed base and pillow.

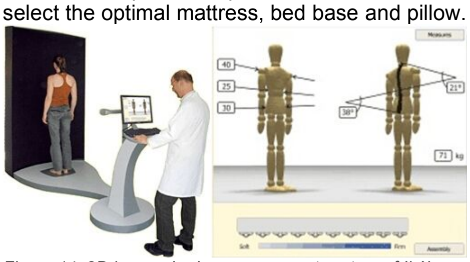

Figure 14. 3D human body measurement system of Ikélo.

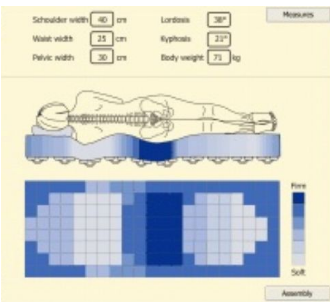

Figure 15. Customization of mattress from the obtained measures.

For further ergonomic optimization of high-quality bedding system, the company also offer the solution named *3D Backprint* which is able to monitor and to steer a multitude of sleeping parameters.

The system (shown in figure 16) is based on a bidirectional multi-sensor matrix which allows for an automatic registration of personal characteristics during the sleep.

The easy-to-use software solution helps for: (i) the assessment of spine support quality, through indentation measurements; (ii) the assessment of comfort quality, through pressure distribution measurements; and (iii) the assessment of climate, through temperature and humidity measurements.

The system can additionally serves for bedding companies to provide the information they need to gain a clear insight into added value product customization, a consequent automated production and intelligent marketing of complete bedding systems.

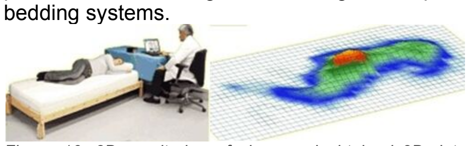

Figure 16. 3D monitoring of sleep and obtained 3D data from the bidirectional multi-sensor matrix.

Medical Research

Quantification of Brainshift

3D photogrammetric tracking system

Source:
D'Apuzzo N. and Verius M., Dynamic monitoring of the intraoperative brainshift by multi image photogrammetry. Optical 3-D Measurement Techniques VIII, 2007, Zurich.

A previous section treated surgical navigation systems: in order to perform real-time 3D tracking of both surgical instrumentations and the interested human body parts, signalized targets points were needed. Alignment of preoperative data (such as CT or MRI scan data) with the intra-operative situations can also be achieved by special markers (e.g. lead shots) or by the employment of touch probes. These procedures could however pose problems in surgical intervention regarding soft tissues or in the special case of brain surgery.
In fact, by neurosurgical interventions with craniotomy (opening of the skull in order to access the brain for surgical repair), the cerebral structures will show a displacement from the original position. This effect is called “brainshift” and its causes are mainly the changes of pressure and loss of cerebrospinal liquid.

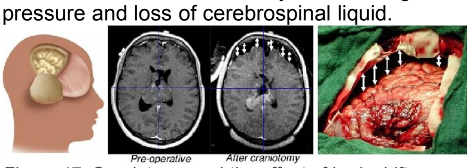

Figure 17. Craniotomy and the effect of brainshift.

The planning and execution of neurosurgical intervention can be negatively influenced by the phenomenon of brainshift. A typical example is the removal of intracranial tumor. In these cases, the neurosurgical interventions are preceded by an MRI scan, which provides a detailed 3D volumetric data of the brain.

This serves the surgeon to determine the location of the intracranial tumor, as well as, to plan the precise location for bone removal and the appropriate angle of access to the interested brain areas. Navigation systems are very attractive tools in surgical planning and execution. However, after craniotomy, the brainshift causes also changes of tumor location and size; thus, limiting the accuracy and usefulness of neuronavigation that is based on pre-operatively acquired datasets.
To solve this problem, an innovative approach is studied by a research project at the Clinic of Neuroradiology and Neurosurgery of the Medical University of Innsbruck (Austria), which aims at the quantification of the intraoperative brainshift by means of photogrammetry. Preliminary studies on a multi-image photogrammetric system and the first measurement results on a brain phantom were achieved in collaboration with Hometrica Consulting (Switzerland).
The employed method consists on the automatic 3D measurement and tracking of selected points on the surface of the brain by image based matching algorithms. The natural texture of the brain surface allows the matching algorithm to perform robustly without the need of any markers (as can be seen in the next figure).

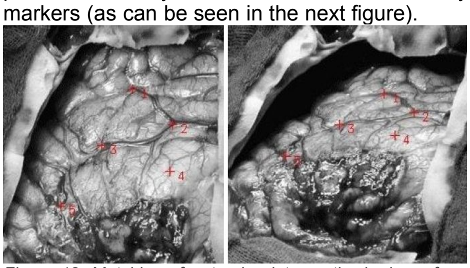

Figure 18. Matching of natural points on the brain surface (no markers are needed).

A multi-image acquisition system was developed for the acquisition of triplets of images of the brain surface: three synchronized cameras acquires image sequences.

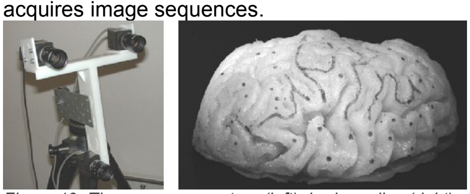

Figure 19. Three-camera system (left), brain replica (right).

Before starting with real clinical experiments, the equipment and algorithms were tested by mean of a silicon replica of the brain (figure 19, right). The brain replica was deformed simulating a compression of cerebral structures whereas the multi-camera acquisition system was recording synchronized image sequences. The next image shows the results achieved by the 3D tracking algorithm. These can be seen as 3D trajectories that represent the movement of selected points on the surface of the brain.

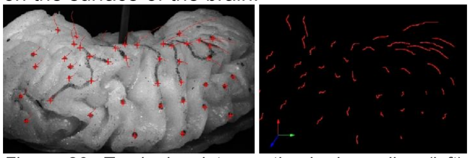

Figure 20. Tracked points on the brain replica (left), computed 3D trajectories (right).

Clinical tests of the prototype multi-acquisition system and the developed tracking algorithms during real neurosurgical interventions and the analysis of the obtained 3D measurements will provide data to determine the real possibilities for a precise and reliable quasi-real-time monitoring of the brainshift effect by means of multi-image photogrammetry.

TMJ Tracking System

Research in tempomandibular disorders

Source:
Clinic for Masticatory Disorders, University of Zurich (Switzerland).

Over the years, the Experimental Laboratory of the Clinic for Masticatory Disorders of the University of Zurich (EL-KFS) has gained considerable expertise in the field of biomechanics of the masticatory system. In this regard, EL-KFS has developed a method that combines a three-dimensional software reconstruction of mandibular anatomy with jaw movement data, obtained by means of optoelectronic tracking with six degrees-of-freedom (dynamic stereometry).
The tracking system consists of three linear cameras with fixed geometry, which record the position of markers (light emitting diodes, LEDs) in a space of at least 200×200×200mm. Each camera has an accuracy of 5μm and a data acquisition rate of 200Hz for each LED.

Figure 21. Three linear camera system.

Three LEDs are required for the maxilla and the mandible in order to detect their spatial position and orientation.

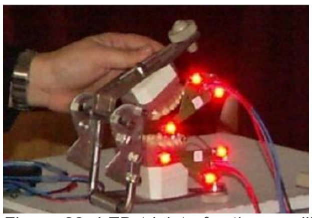

Figure 22. LED triplets for the maxilla and the mandible.

The LED triplets are rigidly connected to the upper and lower dental arches by means of very light splints and attachments that not interfere with occlusion. Thus, the subject can perform all sorts of mandibular movements. Mathematical transformations provide a complete recording of mandibular motion relative to the maxilla; and it is not necessary to immobilize the head.

Figure 23. LED triplets connected to the upper and lower dental arches.

A special face bow allows the transfer of anatomical data recorded in a tomography system (in general MRI) to the jaw tracking environment.

Figure 24. TMJ tracking system in operation.

Anatomic data are reconstructed to computer models of the head or only the temporo-mandibular joint (TMJ). These computer models are animated by means of jaw tracking data, thus providing a dynamic craniomandibular model. These animated models can then be analyzed by different techniques, e.g. by assessing compression areas in the soft tissues (stress-fields).
The EL-KFS (Experimental Laboratory of the Clinic for Masticatiory Disorders of the University of Zurich) is proposing to organize a research network with other world centers working in the field of temporomandibular disorders (TMDs). The goals of the research network are: (i) to establish data acquisition and analysis standards, (ii) to exchange experience in research on TMDs, (iii) to promote cooperation among the centers, (iv) to share acquired data to use for individual studies, (v) to guarantee each center's independence and peculiar interests, (vi) to enhance the critical mass of world wide TMD research.

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MAIN ACTIVITIES AND EXPERTISES

Consulting on Technologies for 3D Human Body Measurement

- Laser Scanning
- White Light Projection
- Visual Hull, Silhouette Extraction
- Optical Measurement Systems
- Contact Measurement Systems
- 3D Modeling, 3D Data Processing
- Full Body, Face and Foot Scanners
- 4D Dynamic Measurement Systems

Fields of Applications

- Medical and Forensic Sciences
- Textile, Apparel, Fashion
- Beauty, Cosmetics
- Ergonomics, Anthropology
- Sport, Fitness
- Biometry, Security
- Computer Graphics, Animation
- Arts, Sculpture
- Communications

Products and Services

- Feasibility, recommendation and evaluation reports
- Survey of the market
- Technology information
- Project planning and management
- Business development
- Business intermediary
- Network of business contacts with private companies and research institutions
- Lists of companies and products for 3D human body measurement

ADDITIONAL FIELDS OF EXPERTISE

3D Surface Digitization

- Industrial Measurement Systems
- Technologies for 3D Scanning
- Survey of European Market
- Network of Business Contacts

Data Processing

- 3D Processing and Visualization
- 3D Printing, Rapid Prototyping
- Machine Vision, Photogrammetry
- Image Processing

Related to Human Body

- MOCAP Motion Capture Systems
- Virtual-Try-On Solutions
- Biometric Solutions
- Medical Imaging

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SOME REFERENCES

Manufacturers of Scanners, Solutions and Equipment

TOPCON Corp. (Japan)
Project management, Product development
Technology consulting, Market surveying

Breuckmann GmbH (Germany)
Market surveying, Publication

Sirona Dental Systems GmbH (Germany)
Technology consulting

InSpeck Inc. (Canada)
Market surveying

Human Solutions of N. America Inc. (USA)
Market surveying

[TC]² (USA)
Advertisement

Telmat Industrie (France)
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Hamamatsu Photonics K.K. (Japan)
Advertisement

Polygon Technology GmbH (Germany)
Market surveying

TSI Inc. (USA)
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Scansystems s.r.l. (Italy)
Advertisement

GFaI e.V. (Germany)
Advertisement

3D Scanworks GmbH (Germany)
Advertisement

corpus.e AG (Germany)
Advertisement, Publication

Hamano Eng, Co. Ltd. (Japan)
Advertisement

SMARTTECH Sp. zo.o. (Poland)
Advertisement

Medical Sciences, Ergonomics

ZZMK University of Zurich (Switzerland)
Business intermediary
Product recommendation

Medical University Innsbruck (Austria)
Technology consulting
Product development

MEDLIBRE Forschungsgesellschaft mbH (Germany)
Feasibility study, Market surveying

Centre Laser Dermatologique (France)
Technology consulting
Product recommendation

Fig. Corp. LLC (USA)
Market surveying

Ortopedia Gualerzi s.r.l. (Italy)
Market surveying

Fashion, Apparel, Beauty

IFTH (France)
Product recommendation

Promiles-Decathlon Production (France)
Extended survey

TNO (The Netherlands)
Market surveying

CAD Modelling Ergonomics Srl (Italy)
Technology consulting

PosFit Inc. (South Korea)
Market surveying

adidas-Salomon AG (Germany)
Market surveying

I.T., Finance, Consulting

Zürcher Kantonalbank ZBK (Switzerland)
Technology evaluation

Hermos AG (Germany)
Feasibility study

Emory University (USA)
Product recommendation

QinetiQ (UK)
Market surveying

Geomatics, Measurements

DIIAR Politecnico Milano (Italy)
Measurement services

ISPRS WG V/6 (International)
Board membership

IGP ETH Zurich (Switzerland)
Scientific review

ASPRS (USA)
Scientific review

Computer Graphics, Animation

Animazoo Europe SARL (France)
Market surveying

XYZ RGB Inc. (Canada)
Technology consulting

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