

## (d) ELENCO DELLE PUBBLICAZIONI DEL CANDIDATO

ai sensi degli artt. 1 e 4 del bando rep. 266-2018 prot.54509 del 8/02/2018

ANDREA SCORZA

### (A) Pubblicazioni scientifiche

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|------|---|
| c.01 | Sassaroli, E., Scorza, A., Crake, C., Sciuto, S.A., Park, M.-A.<br><i>Breast ultrasound technology and performance evaluation of ultrasound equipment B-mode</i><br>(2017) IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control. 64 (1), art. no. 7731138, pp. 192-205.<br>DOCUMENT TYPE: Article  |
| c.02 | Scorza, A., Orsini, F., Andrea Sciuto, S.<br><i>Use of phantoms and test objects for local dynamic range evaluation in medical ultrasounds: A preliminary study</i><br>(2017) I2MTC 2017 - 2017 IEEE International Instrumentation and Measurement Technology Conference, Proceedings, art. no. 7969844 .<br>DOCUMENT TYPE: Conference Paper  |
| c.03 | Battista, L., Scorza, A., Botta, F., Sciuto, S.A.<br><i>A novel fiber-optic measurement system for the evaluation of performances of neonatal pulmonary ventilators</i><br>(2016) Measurement Science and Technology, 27 (2), art. no. 025704,<br>DOCUMENT TYPE: Article  |
| c.04 | Massaroni, C., Schena, E., Bastianini, F., Scorza, A., Saccomandi, P., Lupi, G., Botta, F., Sciuto, S.A., Silvestri, S.<br><i>Development of a bio-inspired mechatronic chest wall simulator for evaluating the performances of opto-electronic plethysmography</i><br>(2014) Open Biomedical Engineering Journal, 8, pp. 120-130.<br>DOCUMENT TYPE: Article                                  |
| c.05 | Scorza, A., Conforto, S., D'Anna, C., Sciuto, S.A.<br><i>A comparative study on the influence of probe placement on quality assurance measurements in B-mode ultrasound by means of ultrasound phantoms</i><br>(2015) Open Biomedical Engineering Journal. 9, pp. 164-178.<br>DOCUMENT TYPE: Article  |
| c.06 | Scorza, A., Lupi, G., Sciuto, S.A., Bini, F., Marinozzi, F.<br><i>A novel approach to a phantom based method for maximum depth of penetration measurement in diagnostic ultrasound: A preliminary study</i><br>(2015) 2015 IEEE International Symposium on Medical Measurements and Applications, MeMeA 2015 - Proceedings, art. no. 7145230, pp. 369-374.<br>DOCUMENT TYPE: Conference Paper |
| c.07 | Battista, L., Scorza, A., Sciuto, S.A.<br><i>Fiber-optic flow sensor for the measurement of inspiratory efforts in mechanical neonatal ventilation</i><br>(2014) Lecture Notes in Electrical Engineering. 268 LNEE, pp. 453-457.<br>DOCUMENT TYPE: Book Chapter   |
| c.08 | Scorza, A., Battista, L., Silvestri, S., Sciuto, S.A.<br><i>Design and development of a rheometer for biological fluids of limited availability</i><br>(2014) Review of Scientific Instruments. 85 (10), art. no. 105105.<br>DOCUMENT TYPE: Article   |
| c.09 | Battista, L., Sciuto, S.A., Scorza, A.<br><i>An air flow sensor for neonatal mechanical ventilation applications based on a novel fiber-optic sensing technique</i><br>(2013) Review of Scientific Instruments, 84 (3), art. no. 035005.<br>DOCUMENT TYPE: Article  |

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- c.10    Branca, F.P., Sciuto, S.A., Scorza, A.  
*Comparative evaluation of ultrasound scanner accuracy in distance measurement*  
 (2012) Review of Scientific Instruments, 83 (10), art. no. 105103.  
 DOCUMENT TYPE: Article
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- c.11    Marinozzi, F., Branca, F.P., Bini, F., Scorza, A.  
*Calibration procedure for performance evaluation of clinical Pulsed Doppler Systems*  
 (2012) Measurement: Journal of the International Measurement Confederation, 45 (5), pp. 1334-1342.  
 DOCUMENT TYPE: Article
- 
- c.12    Scorza, A.  
*A novel method for automatic evaluation of the effective dynamic range of medical ultrasound scanners*  
 (2008) IFMBE Proceedings, 22, pp. 1607-1611.  
 DOCUMENT TYPE: Conference Paper
- 
- c.#    Scorza A. ,  
*Qualità d'immagine negli apparati diagnostici ad ultrasuoni: studio e realizzazione di un banco di prova per la valutazione delle prestazioni di apparati ecografici d'uso clinico,*  
 tesi di dottorato, Università degli Studi di Padova, 2005
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(B) Abstract delle pubblicazioni scientifiche

- c.01 Sassaroli, E., Scorza, A., Crake, C., Sciuto, S.A., Park, M.-A.  
*Breast ultrasound technology and performance evaluation of ultrasound equipment: B-mode*  
 (2017) IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control, 64 (1), art. no. 7731138, pp. 192-205.

DOCUMENT TYPE: Article

ABSTRACT: Ultrasound (US) has become increasingly important in imaging and image-guided interventional procedures. In order to ensure that the imaging equipment performs to the highest level achievable and thus provides reliable clinical results, a number of quality control (QC) methods have been developed. Such QC is increasingly required by accrediting agencies and professional organizations; however, these requirements typically do not include detailed procedures for how the tests should be performed. In this paper, a detailed overview of QC methods for general and breast US imaging using computer-based objective methods is described. The application of QC is then discussed within the context of a common clinical application (US-guided needle biopsy) as well as for research applications, where QC may not be mandated, and thus is rarely discussed. The implementation of these methods will help in finding early stage equipment faults and in optimizing image quality, which could lead to better detection and classification of suspicious findings in clinical applications, as well as improving the robustness of research studies. © 1986-2012 IEEE.

AUTHOR KEYWORDS: B-mode; image quality; needle-guided biopsy; quality control (QC)

SOURCE: Scopus

<https://www.scopus.com/inward/record.uri?eid=2-s2.0-85015157168&doi=10.1109%2FTUFFC.2016.2619622&partnerID=40&md5=82015d1259aeb273a400ca9fb744c599>

DOI: 10.1109/TUFFC.2016.2619622

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- c.02 Scorza, A., Orsini, F., Andrea Sciuto, S.  
*Use of phantoms and test objects for local dynamic range evaluation in medical ultrasounds: A preliminary study*  
 (2017) I2MTC 2017 - 2017 IEEE International Instrumentation and Measurement Technology Conference, Proceedings, art. no. 7969844.

DOCUMENT TYPE: Conference Paper

ABSTRACT: In the ultrasound image the relationship between echo amplitudes and gray levels is expressed by means of the Grayscale Mapping Function (GMF), that is the grayscale transfer function associated with the echo displayed. The GMF allows the determination of some image quality parameters and quantities, among which the Local Dynamic Range (LDR) is relevant, since it is defined as the  $20 \cdot \log_{10}$  of the ratio of the minimum echo amplitude that yields the maximum gray level in the digitized image to that of the echo that yields the lowest gray level at the same location in the image and the same settings. This study reports the implementation of a method for the automatic determination of the LDR on medical ultrasound scanners and its application by means of a commercial grayscale ultrasound phantom, nevertheless it can be used also with general purpose phantoms: the LDR is obtained from the estimation of the GMF, based on processing of a sequence of uncompressed bidimensional ultrasound images provided by the scanner. In the manuscript, some theoretical considerations have been done to determine the GMF and its fitting model, as well as the LDR values, after that an experimental setup is described and some results are shown for an ultrasound system equipped with two different probes. © 2017 IEEE.

AUTHOR KEYWORDS: Diagnostic ultrasound; Local dynamic range; Measurement

SOURCE: Scopus

<https://www.scopus.com/inward/record.uri?eid=2-s2.0-85026736175&doi=10.1109%2FJ2MTC.2017.7969844&partnerID=40&md5=311c3bfd911f52cfdeb00ba37d084cf0>

DOI: 10.1109/J2MTC.2017.7969844

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- c.03 Battista, L., Scorza, A., Botta, F., Sciuto, S.A.  
*A novel fiber-optic measurement system for the evaluation of performances of neonatal pulmonary ventilators*  
 (2016) Measurement Science and Technology, 27 (2), art. no. 025704.

DOCUMENT TYPE: Article

**ABSTRACT:** Published standards for the performance evaluation of pulmonary ventilators are mainly directed to manufacturers rather than to end-users and often considered inadequate or not comprehensive. In order to contribute to overcome the problems above, a novel measurement system was proposed and tested with waveforms of mechanical ventilation by means of experimental trials carried out with infant ventilators typically used in neonatal intensive care units: the main quantities of mechanical ventilation in newborns are monitored, i.e. air flow rate, differential pressure and volume from infant ventilator are measured by means of two novel fiber-optic sensors (OFSs) developed and characterized by the authors, while temperature and relative humidity of air mass are obtained by two commercial transducers. The proposed fiber-optic sensors (flow sensor Q-OFS, pressure sensor P-OFS) showed measurement ranges of air flow and pressure typically encountered in neonatal mechanical ventilation, i.e. the air flow rate  $Q$  ranged from 3 l min<sup>-1</sup> to 18 l min<sup>-1</sup> (inspiratory) and from -3 l min<sup>-1</sup> to -18 l min<sup>-1</sup> (expiratory), the differential pressure  $\Delta P$  ranged from -15 cmH<sub>2</sub>O to 15 cmH<sub>2</sub>O. In each experimental trial carried out with different settings of the ventilator, outputs of the OFSs are compared with data from two reference sensors (reference flow sensor RF, reference pressure sensor RP) and results are found consistent: flow rate  $Q$  showed a maximum error between Q-OFS and RF up to 13 percent, with an output ratio  $Q_{RF}/Q_{OFS}$  of not more than  $1.06 \pm 0.09$  (least square estimation, 95 percent confidence level,  $R^2$  between 0.9822 and 0.9931). On the other hand the maximum error between P-OFS and RP on differential pressure  $\Delta P$  was lower than 10 percent, with an output ratio  $\Delta P_{RP}/\Delta P_{OFS}$  between  $0.977 \pm 0.022$  and  $1.0 \pm 0.8$  (least square estimation, 95 percent confidence level,  $R^2$  between 0.9864 and 0.9876). Despite the possible improvements, results were encouraging and suggested the proposed measurement system can be considered suitable for performances evaluation of neonatal ventilators and useful for both end-users and manufacturers. © 2016 IOP Publishing Ltd.

**AUTHOR KEYWORDS:** biomedical instrumentation; flow measurement; optical fiber sensor; pressure measurement; pulmonary ventilation

**SOURCE:** Scopus

<https://www.scopus.com/inward/record.uri?eid=2-s2.0-84955441820&doi=10.1088%2F0957-0233%2F27%2F2%2F025704&partnerID=40&md5=d177113005443c765f30d6ef5260161f>

DOI: 10.1088/0957-0233/27/2/025704

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- c.04 Massaroni, C., Schena, E., Bastianini, F., Scorza, A., Saccomandi, P., Lupi, G., Botta, F., Sciuto, S.A., Silvestri, S.  
*Development of a bio-inspired mechatronic chest wall simulator for evaluating the performances of optoelectronic plethysmography*  
 (2014) Open Biomedical Engineering Journal, 8, pp. 120-130.

DOCUMENT TYPE: Article

**ABSTRACT:** Instrumented gait analysis based on optoelectronic systems is an expensive technique used to objectively measure the human movement features and it is generally considered as the gold standard. Optoelectronic plethysmography (OEP) is a particular motion analysis system able to: (i) determine chest wall kinematic via the evaluation of marker displacements placed on the thorax and (ii) compute respiratory volumes during breathing. The aim of this work is to describe the performances of a custom made, bio-inspired, mechatronic chest wall simulator (CWS), specifically designed to assess the metrological performances of the OEP system. The design of the simulator is based on the chest wall kinematic analysis of three healthy subjects previously determined. Two sets of experiments were carried out: (i) to investigate the CWS dynamic response using different target displacements (1 - 12 mm), and (ii) to assess the CWS accuracy and precision in simulating quiet breathing, covering the physiological range of respiratory frequency and



tidal volume. Results show that the CWS allows simulating respiratory frequency up to ~ 60 bpm. The difference between the actual displacement and the set one is always  $< 9 \mu\text{m}$ . The precision error, expressed as the ratio between measurement uncertainty and the actual displacement, is lower than 0.32%. The observed good performances permit to consider the CWS prototype feasible to be employed for assessing the performances of OEP system in periodical validation routines. © Massaroni et al.

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[84920764731&partnerID=40&md5=cc2e3d3c5af7c97769c4b001a04a4be9](https://www.scopus.com/inward/record.uri?eid=2-s2.0-84920764731&partnerID=40&md5=cc2e3d3c5af7c97769c4b001a04a4be9)

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c.05 Scorza, A., Conforto, S., D'Anna, C., Sciuto, S.A.

*A comparative study on the influence of probe placement on quality assurance measurements in B-mode ultrasound by means of ultrasound phantoms*

(2015) Open Biomedical Engineering Journal, 9, pp. 164-178.

DOCUMENT TYPE: Article

ABSTRACT: To check or to prevent failures in ultrasound medical systems, some tests should be scheduled for both clinical suitability and technical functionality evaluation; among them, image quality assurance tests performed by technicians through ultrasound phantoms are widespread today and their results depend on issues related to scanner settings as well as phantom features and operator experience. In the present study variations on some features of the B-mode image were measured when the ultrasound probe is handled by the technician in a routine image quality test: ultrasound phantom images from two array transducers are processed to evaluate measurement dispersion in distance accuracy, high contrast spatial resolution and penetration depth when probe is handled by the operator. All measurements are done by means of an in-house image analysis software that minimizes errors due to operator's visual acuity and subjective judgment while influences of ultrasound transducer position on quality assurance test results are estimated as expanded uncertainties on parameters above (measurement reproducibility at 95 percent confidence level): depending on the probe model, they ranged from  $\pm 0.1$  to  $\pm 1.9 \text{ mm}$  in high contrast spatial resolution, from  $\pm 0.1$  to  $\pm 5.5$  percent in distance measurements error and from  $\pm 1$  to  $\pm 10 \text{ mm}$  in maximum depth of signal visualization. Although numerical results are limited to the two examined probes, they confirm some predictions based on general working principles of diagnostic ultrasound systems: (a) measurements strongly depend on settings as well on phantoms features, probes and parameters investigated; (b) relative uncertainty due to probe manipulation on spatial resolution can be very high, i.e. from 10 to more than 30 percent; (c) Field of View settings must be taken into account for measurement reproducibility as well as Dynamic Range compression and phantom attenuation. © Scorza et al.

AUTHOR KEYWORDS: Distance measurements; Image quality; Maximum depth; Spatial resolution; Transducer manipulation; Ultrasound; Ultrasound phantom

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[84947915012&partnerID=40&md5=d19210b6992e7237cb136f85bb31f78b](https://www.scopus.com/inward/record.uri?eid=2-s2.0-84947915012&partnerID=40&md5=d19210b6992e7237cb136f85bb31f78b)

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c.06 Scorza, A., Lupi, G., Sciuto, S.A., Bini, F., Marinozzi, F.

*A novel approach to a phantom based method for maximum depth of penetration measurement in diagnostic ultrasound: A preliminary study*

(2015) 2015 IEEE International Symposium on Medical Measurements and Applications, MeMeA 2015 - Proceedings, art. no. 7145230, pp. 369-374.

DOCUMENT TYPE: Conference Paper

ABSTRACT: In the present work a new approach for maximum depth of ultrasound signal visualization has been proposed by means of a tissue mimicking phantoms: the novel method is based on a threshold on the tangent applied to the mean depth profile that is drawn by averaging adjacent columns in the diagnostic image. It has been implemented and preliminary tested on three different diagnostic systems equipped with linear array probes under similar settings: results have been compared with the mean judgment of 5 observer and with output from another method, based on a threshold of the mean depth profile above the noise level, as

suggested in literature. Even though a not negligible difference among some results is observed, due likely to the high electronic noise level displayed in the ultrasound image, the tangent method seems to agree with observer judgment and be more sensitive to echo signal than the other one, even at higher noise levels. Nevertheless other test are going to be performed in the next future for a more detailed characterization of the method. © 2015 IEEE.

AUTHOR KEYWORDS: depth of signal visualization; Diagnostic Ultrasound; noise; quality assurance; ultrasound phantom

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[84939560962&doi=10.1109%2fMeMeA.2015.7145230&partnerID=40&md5=c3b89ab0726966e5a6fb2472602bfe03](https://www.scopus.com/inward/record.uri?eid=2-s2.0-84939560962&doi=10.1109%2fMeMeA.2015.7145230&partnerID=40&md5=c3b89ab0726966e5a6fb2472602bfe03)

DOI: 10.1109/MeMeA.2015.7145230

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Department of Mechanical and Aerospace Engineering, Sapienza University of Rome, Rome, Italy

c.07 Battista, L., Scorza, A., Sciuto, S.A.

*Fiber-optic flow sensor for the measurement of inspiratory efforts in mechanical neonatal ventilation*

(2014) Lecture Notes in Electrical Engineering, 268 LNEE, pp. 455-457

DOCUMENT TYPE: Book Chapter

ABSTRACT: A novel fiber-optic flow sensor has been developed for monitoring inspiratory efforts during neonatal mechanical ventilation. The considered sensor is based on fiber-optic sensing techniques, allowing the reduction of the effects due to electromagnetic interferences and a possible improvement of the electrical safety conditions. In the arrangement described here, the fiber-optic sensor is able to measure, with an accuracy of 5 %, flow variations in the range between 0.5 l/min and 5 l/min that are the typical flow variations due to infants' inspiratory attempts and typical flow trigger levels set during assist-control ventilation (ACV). Moreover, a good agreement ( $r^2 = 0.998$ ) between experimental data and the parabolic theoretical model can be deduced. The metrological characteristics confirm that the novel proposed configuration for the optical fiber air flow sensor is suitable for monitoring flow variations due to infants' inspiratory attempts. © 2014 Springer International Publishing Switzerland.

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[0\\_87&partnerID=40&md5=24f708c3653cadf321c51d4459b8b294](https://www.scopus.com/inward/record.uri?eid=2-s2.0-84893200788&doi=10.1007%2f978-3-319-00684-0_87&partnerID=40&md5=24f708c3653cadf321c51d4459b8b294)

DOI: 10.1007/978-3-319-00684-0\_87

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c.08 Scorza, A., Battista, L., Silvestri, S., Sciuto, S.A.

*Design and development of a rheometer for biological fluids of limited availability*

(2014) Review of Scientific Instruments, 85 (10), art. no. 105105.

DOCUMENT TYPE: Article

ABSTRACT: From studies on the dynamic characterization of human bones, it is noticed that reference data on the viscous behavior of the bone marrow are quite poor. Dependently from marrow limited availability and its opacity, we have not been able to retrieve a tool of appropriate characteristics able to measure bone marrow viscosity. Therefore, principal techniques for the viscosity measurement have been preliminarily examined, and a device suitable for viscosity measurements of biological fluids has been realized. In particular, a rotational rheometer has been developed: it is a coaxial cylinders system, where the fluid flows dragged by the inner cylinder. The device is an absolute rheometer, that is, particularly useful as nowadays it is not known the classification of the bone as far as it concerns its viscous behavior. In this work a preliminary evaluation of the metrological characteristics of the measurement system has been carried out and its main metrological performances have been evaluated. © 2014 AIP Publishing LLC.

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[84907971382&doi=10.1063%2f1.4897490&partnerID=40&md5=45adi7c7e4bd62bb4558589eb6b7f793](https://www.scopus.com/inward/record.uri?eid=2-s2.0-84907971382&doi=10.1063%2f1.4897490&partnerID=40&md5=45adi7c7e4bd62bb4558589eb6b7f793)

DOI: 10.1063/1.4897490

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- c.09 Battista, L., Sciuto, S.A., Scorza, A.  
*An air flow sensor for neonatal mechanical ventilation applications based on a novel fiber-optic sensing technique*  
 (2013) Review of Scientific Instruments, 84 (3), art. no. 035005.

DOCUMENT TYPE: Article

ABSTRACT: In this work, a simple and low-cost air flow sensor, based on a novel fiber-optic sensing technique has been developed for monitoring air flows rates supplied by a neonatal ventilator to support infants in intensive care units. The device is based on a fiber optic sensing technique allowing (a) the immunity to light intensity variations independent by measurand and (b) the reduction of typical shortcomings affecting all biomedical fields (electromagnetic interference and patient electrical safety). The sensing principle is based on the measurement of transversal displacement of an emitting fiber-optic cantilever due to action of air flow acting on it; the fiber tip displacement is measured by means of a photodiode linear array, placed in front of the entrance face of the emitting optical fiber in order to detect its light intensity profile. As the measurement system is based on a detection of the illumination pattern, and not on an intensity modulation technique, it results less sensitive to light intensity fluctuation independent by measurand than intensity-based sensors. The considered technique is here adopted in order to develop two different configurations for an air flow sensor suitable for the measurement of air flow rates typically occurring during mechanical ventilation of newborns: a mono-directional and a bi-directional transducer have been proposed. A mathematical model for the air flow sensor is here proposed and a static calibration of two different arrangements has been performed: a measurement range up to  $3.00 \times 10^{-4}$  m/s ( $18.0$  l/min) for the mono-directional sensor and a measurement range of  $\pm 3.00 \times 10^{-4}$  m/s ( $\pm 18.0$  l/min) for the bi-directional sensor are experimentally evaluated, according to the air flow rates normally encountered during tidal breathing of infants with a mass lower than 10 kg. Experimental data of static calibration result in accordance with the proposed theoretical model: for the mono-directional configuration, the coefficient of determination  $r^2$  is equal to 0.997; for the bi-directional configuration, the coefficient of determination  $r^2$  is equal to 0.990 for positive flows (inspiration) and 0.988 for negative flows (expiration). Measurement uncertainty  $\delta Q$  of air flow rate has been evaluated by means of the propagation of distributions and the percentage error in the arrangement of bi-directional sensor ranges from a minimum of about 0.5% at  $-18.0$  l/min to a maximum of about 9% at  $-12.0$  l/min. © 2013 American Institute of Physics.

SOURCE: Scopus

[https://www.scopus.com/inward/record.uri?eid=2-s2.0-](https://www.scopus.com/inward/record.uri?eid=2-s2.0-84875903324&doi=10.1063%2F1.4798298&partnerID=40&md5=4c3ee4eb27ed070ef9f9be20f81c21327)

84875903324&amp;doi=10.1063%2F1.4798298&amp;partnerID=40&amp;md5=4c3ee4eb27ed070ef9f9be20f81c21327

DOI: 10.1063/1.4798298

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- c.10 Branca, F.P., Sciuto, S.A., Scorza, A.  
*Comparative evaluation of ultrasound scanner accuracy in distance measurement*  
 (2012) Review of Scientific Instruments, 83 (10), art. no. 105103,

DOCUMENT TYPE: Article

ABSTRACT: The aim of the present study is to develop and compare two different automatic methods for accuracy evaluation in ultrasound phantom measurements on B-mode images: both of them give as a result the relative error  $\epsilon$  between measured distances, performed by 14 brand new ultrasound medical scanners, and nominal distances, among nylon wires embedded in a reference test object. The first method is based on a least squares estimation, while the second one applies the mean value of the same distance evaluated at different locations in ultrasound image (same distance method). Results for both of them are proposed and explained. © 2012 American Institute of Physics.

SOURCE: Scopus



<https://www.scopus.com/inward/record.uri?eid=2-s2.0-84868355176&doi=10.1063%2F1.4755811&partnerID=40&md5=491966979a3249a5f217ee3578f503a>  
DOI: 10.1063/1.4755811  
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- c.11 Marinozzi, F., Branca, F.P., Bini, F., Scorza, A.  
*Calibration procedure for performance evaluation of clinical Pulsed Doppler Systems*  
(2012) Measurement: Journal of the International Measurement Confederation, 45 (5), pp. 1334-1342.

DOCUMENT TYPE: Article

ABSTRACT: This paper describes the analysis of an experimental setup for the performances evaluation of Pulsed Doppler feature in clinical ultrasound scanners. The equipment basically consist on a commercial flow phantom made by a straight tube having a known and constant cross sectional area in which a blood mimicking fluid is forced to flow at laminar conditions. Given the accuracy declared by the manufacturer ( $\pm 0.7$  cm/s), unsatisfactory for low flow rates, we calibrated the phantom using the gravimetric method. From the digitized images of the Pulsed Doppler spectra over time, the mean velocities have been computed with the software package developed by the authors. Moreover, to test the calibration procedure in effective conditions, we carried out performance test on five different ultrasound platforms, equipped with phased array and convex array probes with a nominal mean velocity of the blood mimicking fluid ranging from 1.1 cm/s to 12.7 cm/s. The pooled data showed an overestimation of the mean velocity, from over 200% down to about 50%, depending on nominal flow rate and ultrasound equipment. The same data, corrected via the calibration curve, showed a sensible recovery of the estimated accuracy of the tested platforms at low flow rates ( $< 3$  cm/s). © 2012 Elsevier Ltd. All rights reserved.

AUTHOR KEYWORDS: Clinical ultrasound scanners; Doppler velocity measurement; Performance testing  
SOURCE: Scopus

<https://www.scopus.com/inward/record.uri?eid=2-s2.0-84859163224&doi=10.1016%2Fj.measurement.2012.01.052&partnerID=40&md5=a8346100b3c5c535e9de8d2a40ae790f>  
DOI: 10.1016/j.measurement.2012.01.052

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- c.12 Scorza, A.  
*A novel method for automatic evaluation of the effective dynamic range of medical ultrasound scanners*  
(2008) IFMBE Proceedings, 22, pp. 1607-1611.

DOCUMENT TYPE: Conference Paper

ABSTRACT: Quality of imaging in medical ultrasound system can be described by means of parameters such as spatial resolution, accuracy in distance measurements and depth of penetration: despite of their importance, it must be pointed out that the information which can be obtained from an ultrasound image is determined also by the dynamic range of signal levels displayed (gray scale characteristic) and by the minimum detectable changes in echo signal amplitude. Moreover, the knowledge the relationship between echo amplitude and gray level on the image (Gray Scale Mapping Function or GSMF) allows to evaluate the other parameters, like low contrast spatial resolution and depth of penetration, referring to the echo strength and so to the sensitivity of the diagnostic system. If system control settings are carefully selected, the echo range between lower and upper saturation of the GSMF determines the effective dynamic Range (EDR), that is the echo range (in dB) that corresponds to the "useful" gray levels spanned on the image: also EDR can be used as a performance indicator of ultrasound systems. Tissue equivalent test objects (ultrasound phantoms) are today available for direct determination of the gray scale characteristic and minimum detectable echo signal changes: they are usually embedded with large targets of different size and image contrast (contrast target in a background matrix). Contrast target provide a gray scale reference with uncertainty on echo level difference with respect to the background usually over  $\pm 1$  dB and a few points of contrast; moreover they are very expensive. The aim of the present study is the implementation of a novel and less expensive method for the automatic determination of the GSMF and EDR on medical ultrasound scanners: by means of a general purpose



ultrasound phantom, the method allows the evaluation of the GSMF by a least squares estimation on the results of the analysis and processing of a series of uncompressed bi-dimensional ultrasound images directly produced by the scanner. Finally EDR has been investigated on 3 medical ultrasound scanners of different technologies and results are proposed and explained. © 2009 Springer Berlin Heidelberg.

AUTHOR KEYWORDS: Dynamic Range; Measurement; Ultrasound Scanner

SOURCE: Scopus

[https://www.scopus.com/inward/record.uri?eid=2-s2.0-70350633810&doi=10.1007%2F978-3-540-89208-3\\_382&partnerID=40&md5=491995500c5de8115a352b21e5f1ba6e](https://www.scopus.com/inward/record.uri?eid=2-s2.0-70350633810&doi=10.1007%2F978-3-540-89208-3_382&partnerID=40&md5=491995500c5de8115a352b21e5f1ba6e)

DOI: 10.1007/978-3-540-89208-3\_382

AFFILIATIONS: Department of Mechanical and Industrial Engineering, University of Rome ROMA TRE, Rome, Italy

c.# Scorza A.,

*Qualità d'immagine negli apparati diagnostici ad ultrasuoni: studio e realizzazione di un banco di prova per la valutazione delle prestazioni di apparati ecografici d'uso clinico.*  
tesi di dottorato, Università degli Studi di Padova, 2005

ABSTRACT: Durante lo svolgimento del presente lavoro particolare attenzione è stata rivolta ai caratteri dell'immagine ecografica, ossia a quel particolarissimo tipo di rappresentazione bidimensionale, che si avvale dei fenomeni di propagazione degli ultrasuoni all'interno dei distretti anatomici per fornire una raffigurazione la cui utilità diagnostica è non solo indiscussa ma sempre più indispensabile per la Medicina moderna: in particolare, lo studio descritto si è occupato della fisica degli ultrasuoni e delle caratteristiche delle immagini ecografiche bidimensionali al fine di allestire e caratterizzare un banco di prova per la valutazione degli ecotomografi clinici. A tal scopo è stata dapprima affrontata la fenomenologia alla base della formazione dell'immagine ecografica, coinvolgendo sia gli aspetti più propriamente fisici di propagazione e, più in generale, d'interazione degli ultrasuoni con la materia sia le applicazioni tecnologiche legate all'elaborazione del segnale ecografico all'interno degli ecotomografi. Successivamente l'attenzione è stata rivolta all'insieme delle grandezze che definiscono la qualità dell'immagine ecografica, illustrando e giustificando non solo alcune delle metodologie più o meno note nel settore ma anche proponendone di nuove e sviluppando "ad hoc" un insieme di procedure informatiche atte al loro calcolo e valutazione. Inoltre è stata offerta una breve panoramica di quei fenomeni che causano un'incorretta rappresentazione delle strutture osservate o del loro moto e vengono indicati con il nome di artefatti. In seguito sono stati illustrati i tipi di sistemi commerciali più comunemente impiegati per valutare la qualità delle apparecchiature diagnostiche ad ultrasuoni (*fantocci per ultrasuoni*), fornendo anche un esempio del loro impiego in un *Image Quality Test*, basato su alcune delle metodologie informatiche di analisi dell'immagine ecografica anzidette. I costi elevati e la scarsa disponibilità di tali strumenti hanno portato all'ideazione di un prototipo di fantoccio ad ultrasuoni a basso costo per la valutazione della sensibilità al contrasto degli ecotomografi. Pertanto sono state descritte le fasi di progettazione e realizzazione di otto campioni di contrasto per imaging ad ultrasuoni e la loro caratterizzazione, ottenuta conducendo una campagna di misura volta alla determinazione di grandezze come la velocità di propagazione del suono  $c$ , l'impedenza acustica  $Z$ , il coefficiente di attenuazione  $\alpha$  ed il coefficiente di backscattering  $\sigma$ . Ciascun campione è stato prodotto ponendovi all'interno una distribuzione di particelle diffuse, provenienti da due differenti popolazioni (polvere di grafite ed allumina) e la cui concentrazione è stata variata da un provino all'altro per ottenere diversi livelli di contrasto. Le misure suddette hanno fatto da base per la successiva costruzione del fantoccio "*low cost*", costituito da un blocco di Resina Epossidica (Araldite LY554), con speckle simile a quello di alcuni tessuti biologici, all'interno del quale sono stati immersi sette gruppi di target a diverso contrasto, ciascuno dei quali comprendente nove oggetti di dimensioni variabili tra i 2 ed i 10 mm di diametro. È stato inoltre sviluppato un metodo per valutare "in situ" il coefficiente di backscattering relativo  $\sigma_r$  dei test object a partire dall'immagine da essi prodotta su ecotomografi d'uso corrente in ospedale. Come risultato finale sono stati ottenuti i dB acustici di contrasto rispetto al background di ciascuna serie di target (rispettivamente 2,8dB, 3,8dB, 5,2dB, 7,2dB, 9,0dB, 12,4 dB e 13,5dB) mostrando un andamento quasi lineare di tale grandezza da un gruppo all'altro. Infine è stato mostrato un esempio di impiego dell'apparecchio, con il tracciamento delle curve Contrasto-Dettaglio per due diverse sonde ecografiche.

Autorizzo il trattamento dei miei dati personali ai sensi del D. Lgs. 196/2003

Roma, 01 marzo 2018

Andrea Scorza, Ph.D

9/9

Allegato B

se Verbale n. 2 del 16/05/2018

Curriculum dell'attività professionale, scientifica e didattica di Andrea Scorza

## **CURRICULUM DELL'ATTIVITÀ PROFESSIONALE, SCIENTIFICA E DIDATTICA**

di *Andrea Scorza*

8 marzo 2018

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## GENERALITÀ

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 Servizio militare:

- Giugno 1994: Diploma di maturità scientifica, conseguita presso l'Istituto "A. Meucci" di Aprilia (LT), con la votazione di 56/60.
- Febbraio 2000: Laurea in ingegneria meccanica indirizzo "tecnologie e strumentazioni biomediche", conseguita presso l'università di Roma "La Sapienza" il 16 Febbraio 2000 con votazione di 105/110. Argomento della tesi: *"Progetto ed analisi sperimentale di un illuminatore da banco ottico per il controllo e la verifica dello stato di efficienza dei fibroscopi clinici"*, svolta presso il laboratorio di Misure Meccaniche dell'università (dipartimento di Meccanica e Aeronautica) ed il Servizio di Ingegneria Clinica dell'istituto di ricovero e cura O.B.G. Roma, sotto la supervisione del prof. ing. F.P. Branca.
- Luglio 2000: Abilitazione alla professione di ingegnere conseguita il 3 Luglio 2000 con votazione 100/120
- Gennaio 2001: Iscrizione all'albo degli ingegneri di Roma con numero di matricola 21642.
- Marzo 2001: Attestato di Diploma di Elaboratore C. E. D. , rilasciato dal Ministero della Difesa
- Aprile 2005: Dottorato di Ricerca in Misure Meccaniche per l'Ingegneria, conseguito il 7 Aprile 2005 presso l'Università degli Studi di Padova.
- Aprile 2005: Tesi discussa *"Qualità d'immagine negli apparati diagnostici ad ultrasuoni: studio e realizzazione di un banco di prova per la valutazione delle prestazioni di apparati ecografici d'uso clinico"* sotto la supervisione del prof. ing. F.P. Branca, Coordinatore prof. ing. F. Angrilli
- Marzo 2009: Corso di perfezionamento per Responsabili e Addetti del Servizio di Prevenzione e Protezione - modulo A.
- Da Aprile 2009 a Luglio 2009: Corso di formazione "Qualità in Sanità" per verificatori della certificazione di qualità nelle strutture ospedaliere (organizzato da CNIM, ANPO, ANMDO)
- Febbraio 2010: Corso di perfezionamento per Responsabili e Addetti del Servizio di Prevenzione e Protezione - modulo B (macrosettore 8).
- Marzo 2010: Corso di perfezionamento per Responsabili e Addetti del Servizio di Prevenzione e Protezione - Rischio Amianto.
- Aprile 2010: Corso di perfezionamento per Responsabili e Addetti del Servizio di Prevenzione e Protezione - Rischio Chimico.
- Dicembre 2011: Corso di perfezionamento per Responsabili e Addetti del Servizio di Prevenzione e Protezione - DVR e DUVRI nel D.lgs. 81/08, obblighi e responsabilità, redazione pratica dei documenti.
- Da Febbraio 2012 a Maggio 2012: Corso di perfezionamento per Coordinatore Sicurezza Cantieri
- Giugno 2013: Corso di formazione per la Sicurezza degli ambienti di Lavoro: radiazioni ottiche artificiali negli ambienti di lavoro - Valutazione dei rischi e protezione dei lavoratori esposti
- Marzo 2014: Corso di formazione "La verifica dei Progetti ai fini della Validazione (D.P.R. 207/2010)

– Artt. 44 - 55)”

Settembre 2014 Corso di formazione National Instruments : Labview Core1, Labview Core 2

Marzo 2017 Conseguimento dell'Abilitazione Scientifica Nazionale per professore di II fascia nel settore concorsuale 09/E4 MISURE (bando D.D. 1532/2016).

### ESPERIENZE PROFESSIONALI E DI RICERCA

Febbraio 2000: È collaboratore esterno alla ricerca ed alla didattica nel settore delle Misure Meccaniche e Termiche sotto la direzione del prof. ing. Francesco Paolo Branca, ordinario della cattedra di Misure Meccaniche, Termiche e Collaudi presso la Facoltà d'Ingegneria dell'Università degli Studi di Roma “La Sapienza”, nonché fondatore del corso di Ingegneria Clinica presso la medesima Facoltà.

Da Marzo 2000 a Settembre 2004: Svolge attività di collaborazione esterna presso il Servizio di Ingegneria Clinica dell'Ospedale Pediatrico Bambino Gesù di Roma.

Aprile 2000: Svolge attività di ricerca finalizzata allo sviluppo di una catena di misura per la valutazione dello stato d'efficienza dei fibroscopi clinici a partire dall'analisi e l'elaborazione di immagini diagnostiche prodotte con l'ausilio di mire ottiche.

Marzo 2001: Svolge attività di ricerca con obiettivo la valutazione delle caratteristiche e delle prestazioni degli apparati diagnostici ad ultrasuoni d'uso corrente in ambito ospedaliero.

Maggio 2001: Vincitore di borsa di studio Siemens S. p. a., per attività di ricerca nel settore delle Misure per la Diagnostica clinica

Novembre 2001: Vincitore della borsa di Dottorato in Misure Meccaniche per l'Ingegneria, con sede amministrativa presso l'università degli Studi di Padova. Termina nel 2004 l'ultimo anno di tale Dottorato presso le strutture dell'università degli Studi di Roma “La Sapienza” (Facoltà d'Ingegneria Meccanica), sotto la direzione del prof. ing. F. P. Branca.

Da Gennaio 2002 a Dicembre 2004 Svolge attività didattica e di ricerca come Dottorando di Ricerca in Misure Meccaniche per l'Ingegneria (XVII ciclo), presso il Dipartimento di Meccanica ed Aeronautica dell'Università degli Studi di Roma La Sapienza.

Svolge attività didattica e di ricerca come collaboratore esterno, presso il Dipartimento di Ingegneria Meccanica ed Industriale dell'Università degli Studi ROMA TRE (referente prof. S.A. Sciuto).

Partecipa come cultore della materia ed in qualità di membro di commissione per i seguenti corsi:

Da Febbraio 2002 a Dicembre 2008:

- Fondamenti di Misure Meccaniche e Termiche (9 CFU, primo anno della Laurea Magistrale in Ingegneria Meccanica)
- Misure Meccaniche (5 CFU, terzo anno della Laurea Triennale in Ingegneria Meccanica)
- Complementi di Misure Meccaniche, Termiche e Collaudi (5 CFU, Lauree magistrali in Ingegneria Meccanica-Costruzione, Ingegneria Meccanica-Produzione e Ingegneria Meccanica-Energia)
- Misure Meccaniche, Termiche e Collaudi (vecchio ordinamento);
- Sistemi di Elaborazione di Misure di Grandezze Dinamiche (vecchio ordinamento).

Febbraio 2002 ad oggi: Svolge attività di ricerca nell'ambito delle misure per la diagnostica clinica, con scopo la valutazione dei limiti che pregiudicano le prestazioni di apparati ecotomografici, a partire dall'analisi dell'immagine su di essi ottenuta con l'ausilio di fantocci per ultrasuoni.



Aprile 2003:	È consulente per Siemens S.p.A. nel settore delle apparecchiature e strumentazioni ecotomografiche.
Da Settembre 2004 a Gennaio 2005:	Partecipa con il prof. ing. F.P. Branca alla commissione tecnica di collaudo delle apparecchiature biomedicali offerte nella gara a procedura aperta per la fornitura di 3 lotti di ecotomografi destinati all'Azienda Policlinico Umberto I di Roma (gara "G", pubblicata sul foglio delle inserzioni della Gazzetta Ufficiale n. 175 del 28/07/2004).
Da Gennaio 2005 a Maggio 2005:	Svolge attività di collaborazione esterna presso la cattedra di Misure Meccaniche della Facoltà d'Ingegneria dell'Università di Roma TRE con incarico di "Svolgimento sistematico di prove volte alla caratterizzazione del circuito paziente" nell'ambito della ventilazione polmonare assistita.
Da Luglio 2005 a Marzo 2006:	Assistente C.T.U. per la Procura della Repubblica presso il Tribunale di Taranto nell'ambito della verifica di contraffazione di dispositivi medici.
Da Settembre 2005 a Novembre 2005:	Partecipa in qualità di assistente alla verifica dei collaudi degli impianti tecnologici e strumentazione biomedicale per il nuovo ospedale F. Miulli di Acquaviva delle Fonti (BA).
Da Settembre 2005 a Maggio 2006:	Collabora al progetto di ricerca di Facoltà presso la Facoltà di ingegneria dell'Università di Roma La Sapienza, dal titolo "Progetto e realizzazione di un fantoccio prototipo per la verifica delle prestazioni della Tecnica Doppler Tessutale".
Da Ottobre 2005 a Novembre 2005:	Svolge attività di collaborazione esterna presso il Dipartimento di Meccanica ed Aeronautica della Facoltà di Ingegneria dell'Università degli Studi di Roma "La Sapienza" nell'ambito del progetto MIUR 40% - cofinanziamento 2004 con incarico di "Analisi delle prestazioni di sensori di pressione per ventilatori polmonari".
Da Ottobre 2006 a Gennaio 2009	Svolge attività di collaborazione esterna presso la cattedra di Misure Meccaniche della Facoltà d'Ingegneria dell'Università di Roma TRE con incarico volto allo studio e sviluppo di metodologie atte alla misura e controllo da remoto di grandezze meccaniche legate allo stato patologico ed alle prescrizioni diagnostico-terapeutiche per pazienti in assistenza domiciliare.
Da Febbraio 2007 a Ottobre 2009	Svolge attività di collaborazione per il Comitato Nazionale Italiano per la Manutenzione (CNIM srl), curando l'impostazione e l'implementazione degli schemi di certificazione di sistemi di gestione e di prodotto in ambito sanitario.
	Svolge attività di collaborazione per il Comitato Nazionale Italiano per la Manutenzione (CNIM srl) nell'ambito di studi mirati allo sviluppo di procedure volte all'analisi del Mercato Nazionale della Manutenzione nel settore della Sanità e alla valutazione della qualità e dei costi dei servizi di manutenzione nelle Aziende Sanitarie.
Da Ottobre 2007 a Settembre 2008	È assegnista di ricerca nell'ambito del progetto PRIN 2006 su "Sistemi per la misura remota di grandezze meccaniche per il recupero della salute dell'uomo".
Da Ottobre 2008 a Novembre 2011	Consulente Tecnico di Ufficio della Procura della Repubblica presso il Tribunale di Roma nell'ambito della strumentazione biomedicale, con particolare riferimento alla valutazione delle caratteristiche prestazionali di strumentazione diagnostica ad ultrasuoni.

Da Dicembre 2008 a ottobre 2010	<p>In servizio a tempo indeterminato presso l'Università degli Studi Roma Tre, in qualità di Tecnico. Tra gli incarichi ufficialmente ricoperti svolge attività di consulenza nell'ambito della sicurezza e salubrità degli ambienti di lavoro, occupandosi della valutazione del rischio e della risoluzione di problematiche specifiche inerenti alla sicurezza di strumentazione, macchine ed impianti negli uffici, aule e laboratori. È Addetto del Servizio Prevenzione e Protezione di Ateneo (ASPP).</p> <p>Svolge attività didattica e di ricerca come collaboratore del prof. S.A. Sciuto, presso il Dipartimento di Ingegneria Meccanica ed Industriale dell'Università degli Studi ROMA TRE, nell'ambito dei seguenti corsi:</p> <ul style="list-style-type: none"> <li>• Fondamenti di Misure Meccaniche e Termiche</li> <li>• Fondamenti di Ingegneria Clinica</li> <li>• Misure Meccaniche</li> <li>• Complementi di Misure Meccaniche</li> </ul>
Da Dicembre 2008 ad oggi	<p>In servizio a tempo indeterminato presso l'Università degli Studi Roma Tre, in qualità di Tecnico.</p> <p>Tra gli incarichi ufficialmente ricoperti svolge attività di consulenza nell'ambito della sicurezza e salubrità degli ambienti di lavoro, occupandosi della valutazione del rischio e della risoluzione di problematiche specifiche inerenti alla sicurezza di strumentazione, macchine ed impianti negli uffici, aule e laboratori. Fino a gennaio 2016 è Addetto del Servizio Prevenzione e Protezione di Ateneo (ASPP).</p> <p>Da gennaio 2016 è in forze al Dipartimento di Ingegneria dell'Ateneo.</p>
Da ottobre 2010 Ad oggi	<p>Svolge attività didattica e di ricerca come collaboratore del prof. S.A. Sciuto, presso il Dipartimento di Ingegneria dell'Università degli Studi ROMA TRE, nell'ambito dei seguenti corsi:</p> <ul style="list-style-type: none"> <li>• Fondamenti di Misure Meccaniche e Termiche</li> <li>• Fondamenti di Ingegneria Clinica / Clinical Engineering</li> </ul>
Da Novembre 2012 a Gennaio 2016	<p>Coordinatore per la Sicurezza in fase di Progettazione e in fase di Esecuzione, ai sensi del Titolo IV del d.lgs. 81/2008 e ss. Mm. E ii, in relazione agli appalti dei servizi di manutenzione ordinaria, conservativa e a chiamata degli immobili, di pulizia, disinfezione, disinfestazione e derattizzazione degli stabili e di manutenzione ordinaria e straordinaria degli impianti termomeccanici dell'Università degli Studi Roma Tre.</p>
Da Ottobre 2014 ad oggi	<p>Svolge attività didattica e di ricerca come collaboratore del prof. S.A. Sciuto, presso il Dipartimento di Ingegneria dell'Università degli Studi ROMA TRE, nell'ambito dei seguenti corsi:</p> <ul style="list-style-type: none"> <li>• Laboratorio Integrato di Applicazioni Elettriche e Misure (LIAEM).</li> </ul> <p>Il corso prevede una prima unità didattica quale parte introduttiva alla programmazione in ambiente Labview con lo svolgimento di esercizi e tutorial dedicati, anche nell'ambito di seminari tecnici che potranno essere organizzati in collaborazione con National Instruments. A valle della parte introduttiva, il laboratorio prevede due unità didattiche specificamente dedicate alla definizione di elementi progettuali di programmazione in LabView con riferimento ad argomenti propri delle Applicazioni Elettriche e delle Misure. Durante lo svolgimento delle attività del corso si ha la possibilità di utilizzare piattaforme hardware National Instruments.</p> <p>Settori Scientifico Disciplinari: ING-IND/12, Misure Meccaniche e Termiche e ING-IND/32. Convertitori, Macchine e Azionamenti Elettrici.</p>
Da Gennaio 2015 a Dicembre 2016	<p>Svolge attività come Tutor nel master universitario di secondo livello "Salute e Sicurezza degli ambienti di Lavoro in Sanità" presso il Dipartimento di Ingegneria dell'Università degli Studi ROMA TRE in collaborazione con l'Ospedale Pediatrico Bambino Gesù di Roma, Istituto Nazionale per l'Assicurazione contro gli Infortuni sul Lavoro (INAIL), Ordine degli Ingegneri della Provincia di Roma, Università Cattolica del Sacro Cuore e LUISS Business School.</p>

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## ATTIVITÀ SVOLTA

### a) Attività scientifica

Ambito disciplinare: Misure Meccaniche, Termiche e Collaudi per l'Ingegneria; Strumentazione Biomedica; Ingegneria Clinica

Elenco delle principali linee di ricerca.

#### *Tecnologia degli ecotomografi e dei trasduttori ad ultrasuoni per diagnostica clinica*

La gran diffusione nelle strutture sanitarie, unitamente al notevole impatto economico sul mercato mondiale della strumentazione diagnostica per immagini (tanto da superare la diagnostica RX tradizionale) e al rapido sviluppo tecnologico degli ultimi 20 anni, fanno dell'Ecografia clinica un settore di notevole interesse non solo per i Medici o gli operatori sanitari ma per tutta la comunità scientifica. La linea di ricerca ha pertanto seguito una serie di studi mirati ad individuare le caratteristiche costruttive di tali apparecchi ed il loro legame con le qualità metrologiche, rivolgendo particolare attenzione ai trasduttori (o sonde ecografiche), vero e proprio "cuore" del sistema ecotomografico.

#### *Metodologie di misura per la valutazione delle prestazioni ed il collaudo dei moderni apparati ecografici d'uso clinico*

Le problematiche inerenti le capacità dei sistemi ecografici di fornire un supporto di elevata qualità alla diagnosi clinica si traducono nella valutazione di caratteristiche metrologiche tra cui Sensibilità, Risoluzione, Accuratezza e Banda passante. Informazioni su tali caratteristiche possono essere ottenute sviluppando apposite metodologie di misura non solo direttamente sull'ecografo e sulla sonda ecografica ma anche a partire dall'immagine da essi prodotta. Nonostante il grande interesse, sia di tipo economico che scientifico, sul collaudo di tali apparecchi è stata riscontrata la mancanza di un vero e proprio standard ed anche le pubblicazioni scientifiche a riguardo sono frammentarie. La linea di ricerca ha pertanto inizialmente seguito una serie di studi, condotti su ecotomografi di tecnologia recente e mirati all'individuazione dei processi su cui è basata la formazione dell'immagine ecografica (comprendendo anche le funzionalità Doppler). Successivamente, basandosi anche sulla realizzazione di appositi strumenti di riferimento (fantocci per ultrasuoni), sono state sviluppate una serie di metodologie automatizzate di misura, applicabili anche in ambito ospedaliero ed i cui risultati, fornendo informazioni preziose sulle prestazioni della strumentazione analizzata, costituiscono una valida base per il suo collaudo.

#### *Valutazione dello stato d'efficienza nel collaudo dei fibroscopi clinici*

L'attività di ricerca ha riguardato la realizzazione e messa a punto di un banco di prova dai costi contenuti per il collaudo e la verifica dello stato di efficienza dei moderni endoscopi a fibre ottiche d'uso in ambito clinico (fibroscopi clinici). L'importanza del lavoro risiede nella gran diffusione di tali strumenti all'interno delle strutture sanitarie (es. nei reparti di Endoscopia Digestiva) e negli elevati costi di manutenzione. A tal scopo sono stati condotti studi preliminari sulla struttura interna e sulla componentistica dei moderni endoscopi flessibili (tra cui l'analisi dei sistemi di orientamento del tipo flessibile e dei sistemi ottici di trasmissione dell'immagine), successivamente lo studio è stato rivolto allo sviluppo di un sistema di acquisizione digitale dedicato ed all'ottimizzazione di indici rappresentativi dello stato di efficienza e della qualità delle immagini prodotte dal fibroscopio, ottenute con l'ausilio di mire e test object.

#### *Metodologie di misura per la valutazione del flusso respiratorio nei neonati*

L'attività di ricerca riguarda il progetto, lo sviluppo e la messa a punto di un banco di misura equipaggiato con un trasduttore di flusso, il cui funzionamento è basato sulla misura dello spostamento dell'estremità libera di una fibra ottica per azione del flusso oggetto di indagine. La rilevazione avviene mediante una schiera di fotodiodi disposta davanti all'estremità emittitrice della fibra al fine di misurarne il profilo di intensità luminosa: tale profilo è caratterizzato dall'avere valore massimo la cui posizione lungo la schiera è funzione del flusso.

#### *Metodologie di misura per la valutazione della pressione nella ventilazione polmonare neonatale*

L'attività di ricerca riguarda il progetto, lo sviluppo e la messa a punto di un banco di misura equipaggiato con un trasduttore di pressione, costituito da un elemento elastico (capsula) solidale ad una fibra ottica, e da un trasduttore secondario realizzato con una schiera di fotodiodi, posta davanti all'estremità emittitrice della fibra. La pressione applicata sulla capsula causa la deflessione della fibra ottica, il cui spostamento viene rilevato mediante la schiera di fotodiodi: la posizione del massimo del profilo di intensità luminosa lungo la schiera sensibile è funzione della pressione.

#### *Metodologie di misura per la valutazione delle caratteristiche reologiche di fluidi biologici*

La linea di ricerca riguarda la realizzazione e messa a punto di un banco di prova per la misura delle caratteristiche reologiche di fluidi biologici di disponibilità limitata. Tale studio ha trovato immediata applicazione, nell'ambito dello



sviluppo di modelli fisici per descrivere il comportamento delle ossa, dove la viscosità del midollo osseo costituisce un parametro critico per il corretto funzionamento fisiologico e, quindi, un possibile indicatore di eventuali patologie ossee. In particolare, la misura della viscosità del midollo presenta difficoltà peculiari, tra cui la scarsa disponibilità di materiale reperibile e valori limitati assunti dalla grandezza d'interesse nelle normali condizioni fisiologiche, determinando la necessità di sviluppare strumenti dedicati, le cui caratteristiche spesso richiedono costi economici elevati. In tale filone di ricerca, a seguito della costruzione e caratterizzazione di un microviscosimetro rotazionale di basso costo e adatto alla misura della viscosità del midollo osseo, è in corso di realizzazione lo sviluppo di un sistema di controllo (anche da remoto) del dispositivo, atto a compiere la misura delle caratteristiche reologiche di fluidi biologici in modalità automatizzata e senza l'intervento diretto di un operatore.

#### ***Metodi per la verifica delle prestazioni ed applicazioni di misura dei tomografi a Risonanza Magnetica (MRI)***

I tomografi a risonanza magnetica (MRI) sono ampiamente utilizzati sia a scopo diagnostico sia negli studi sulle proprietà dei materiali, assumendo un ruolo sempre più di rilievo nella medicina diagnostica e nelle indagini sui materiali. L'attività di ricerca riguarda sia lo studio e sviluppo di nuovi sistemi e metodi per la verifica prestazionale delle suddette apparecchiature sia l'applicazione di queste ultime ai fini della caratterizzazione di materiali e strutture nel settore ingegneristico.

#### ***Metodologie di misura da remoto di grandezze meccaniche per applicazioni nel settore biomedicale e dell'assistenza domiciliare integrata***

A partire dal 1968 (legge n. 132 del 12/02/1968) gli enti ospedalieri sono autorizzati ad istituire anche al di fuori della loro sede istituzionale strutture assistenziali quali ambulatori, consultori, centri per il recupero funzionale, cui viene data la possibilità di erogare prestazioni specialistiche anche a domicilio. Quest'ultimo concetto viene ulteriormente specificato già a partire dal Piano Sanitario Nazionale del 1990/92, che si occupa del servizio di ospedalizzazione domiciliare e per il quale le categorie interessate riguardano anziani non autosufficienti, malati affetti da patologie a decorso cronico, malati affetti da patologie evolutive, pazienti che in seguito ad interventi mutilanti hanno bisogno di assistenza medica rieducativa, neurolesi, malati in fase terminale, appartenenti alla tutela materno-infantile, malati di AIDS. In particolare, l'Assistenza Domiciliare Integrata (ADI) fornisce a domicilio un insieme di interventi socio-sanitari programmati secondo le necessità individuali del paziente, integrando prestazioni mediche, infermieristiche, riabilitative, psicologiche e socio-assistenziali. Ciò da un lato consente il miglioramento della qualità di vita del paziente mentre dall'altro contiene il numero e la durata dei ricoveri ospedalieri: pertanto, l'ADI offre vantaggi in termini di qualità di vita del paziente e di efficienza per le Strutture Sanitarie coinvolte. In tale contesto si inserisce il presente filone di ricerca, mirato allo studio di metodologie atte alla misura e controllo da remoto di grandezze meccaniche legate allo stato patologico ed alle prescrizioni diagnostico-terapeutiche per pazienti in assistenza domiciliare, i quali si avvalgono dell'ausilio di dispositivi diagnostico-terapeutici gestiti a distanza. Tali metodologie si avvalgono delle recenti tecnologie di networking per gestire in piena affidabilità e sicurezza il dato misuristico ed il controllo di strumentazione biomedicale applicata al paziente a fini sia diagnostici sia terapeutici. In particolare, è in corso di sviluppo un sistema di controllo per piattaforme riabilitative ad un grado di libertà, in grado di gestire da remoto sia il funzionamento dell'intero dispositivo, sia la misura di indicatori diagnostici e terapeutici acquisiti dal paziente durante l'attività assistenziale.

#### ***Misure meccaniche per l'apparato muscolo-scheletrico: metodologie innovative e standardizzabili per la verifica delle prestazioni dei sistemi di misura***

La ricerca nasce inizialmente all'interno di un progetto PRIN, ad oggi concluso ed in cui si proponeva lo sviluppo di standard di qualità delle misure meccaniche in laboratori di analisi del movimento. In letteratura è ancora oggi presente il problema della validazione dei risultati di uno stesso soggetto esaminato da più laboratori: per assicurare dati validi per una diagnosi, occorre affrontare la verifica delle prestazioni dei sistemi di misura con una procedura unificata capace di quantificare in modo ripetibile e riproducibile i valori e l'incertezza delle grandezze meccaniche cinematiche e dinamiche. In particolare la linea di ricerca ha riguardato (a) il progetto, sviluppo e validazione di un sistema elettromeccanico di calibrazione dinamica delle pedane di forza per imporre valori noti delle grandezze in ingresso alle menzionate pedane e (b) la conduzione delle prove per la determinazione delle caratteristiche metrologiche delle pedane di forza. Quanto sopra al fine di proporre (1) un sistema di calibrazione di celle di carico multicomponenti e (2) una procedura unificata per la taratura di celle di carico e dei sistemi ottici.

#### ***Misure meccaniche per la caratterizzazione di piattaforme vibranti d'uso in ambito clinico***

Lo studio si svolge in collaborazione con unità di ricerca esterne e riguarda il progetto, sviluppo e validazione di una macchina per la trasmissione controllata di vibrazioni al corpo umano (WBV-Whole Body Vibration machine) o a sue parti. Le WBV attirano sempre più interesse sia in ambito di studio fisiologico che riabilitativo e sportivo, nonostante siano disponibili modelli commerciali di piattaforme vibranti a tale scopo, sono davvero poche quelle che

effettivamente sono in grado di sviluppare sollecitazioni di ampiezza, frequenza ed andamenti rigorosamente noti e controllati. A tale riguardo, nell'ambito dello studio suddetto, è stato proposto un nuovo modello in grado di fornire ampiezze di sollecitazione sinusoidale nel campo 20 - 60 di ampiezza nota e controllabile. Il dispositivo è stato preliminarmente caratterizzato tramite sistemi di misura inerziali (accelerometri) e di spostamento (LVDT). Ulteriori studi e valutazioni sono in corso per migliorare il prototipo anzidetto e al contempo stabilire un protocollo di caratterizzazione applicabile anche ai modelli commerciali con ricadute in ambito normativo ed industriale (attualmente non esiste uno standard in merito).

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## b) Attività didattica

Lezioni, esercitazioni e seminari tenuti:

2001 – 2002	Esercitazioni per il corso di Misure Meccaniche della Facoltà d'Ingegneria dell'Università degli Studi Roma TRE (Ingegneria Meccanica, prof. S.A. Sciuto).
2002 – 2003	Esercitazioni per il corso di Misure Meccaniche della Facoltà d'Ingegneria dell'Università degli Studi di Roma La Sapienza (Ingegneria Meccanica, prof. Z. Del Prete).
2002 – 2003	Esercitazioni per il corso di Misure Meccaniche della Facoltà d'Ingegneria dell'Università degli Studi Roma TRE (Ingegneria Meccanica, prof. S.A. Sciuto).
2003 – 2004	Esercitazioni per il corso di Misure Meccaniche della Facoltà d'Ingegneria dell'Università degli Studi Roma TRE (Ingegneria Meccanica, prof. S.A. Sciuto).
2003 – 2004	Esercitazioni sulla tecnologia e la verifica prestazionale di strumentazione ecotomografica per il corso di Strumentazione Biomedica II della Facoltà d'Ingegneria dell'Università degli Studi di Roma La Sapienza (Ingegneria Clinica, prof. F.P. Branca).
2004 – 2005	Esercitazioni per il corso di Misure Meccaniche della Facoltà d'Ingegneria dell'Università di Roma TRE (Ingegneria Meccanica, prof. S.A. Sciuto).
2004 – 2005	Esercitazioni per il corso di Complementi di Misure Meccaniche della Facoltà d'Ingegneria dell'Università degli Studi Roma TRE (Ingegneria Meccanica, prof. S.A. Sciuto).
2004 – 2005	Esercitazioni sulla tecnologia e la verifica prestazionale di strumentazione ecotomografica per il corso di Strumentazione Biomedica II della Facoltà d'Ingegneria dell'Università degli Studi di Roma La Sapienza (Ingegneria Clinica, prof. F.P. Branca).
2005 – 2006	Seminari/Esercitazioni per il corso di Misure Meccaniche della Facoltà d'Ingegneria dell'Università degli Studi Roma TRE (Ingegneria Meccanica, prof. S.A. Sciuto).
2005 – 2006	Seminari/Esercitazioni per il corso di Complementi di Misure Meccaniche della Facoltà d'Ingegneria dell'Università degli Studi Roma TRE (Ingegneria Meccanica, prof. S.A. Sciuto).
2005 – 2006	Esercitazioni sulla tecnologia e la verifica prestazionale di strumentazione ecotomografica per il corso di Strumentazione Biomedica II della Facoltà d'Ingegneria dell'Università degli Studi di Roma La Sapienza (Ingegneria Clinica, prof. F.P. Branca).
2006 – 2007	Seminari/Esercitazioni per il corso di Complementi di Misure Meccaniche della Facoltà d'Ingegneria dell'Università degli Studi Roma TRE (Ingegneria Meccanica, prof. S.A. Sciuto).
2006 – 2007	Seminari/Esercitazioni per il corso di Misure Meccaniche della Facoltà d'Ingegneria dell'Università degli Studi Roma TRE (Ingegneria Meccanica, prof. S.A. Sciuto).
2006 – 2007	Lezioni per il corso di Misure Meccaniche presso la S.S.I.S. Lazio – Indirizzo Tecnologico, relativo ai corsi abilitanti speciali ex Legge 143/04 D.M. 85/05. Membro della commissione valutatrice per gli Esami di Stato.
2007 – 2008	Seminari/Esercitazioni per il corso di Complementi di Misure Meccaniche della Facoltà

	d'Ingegneria dell'Università degli Studi Roma TRE (Ingegneria Meccanica, prof. S.A. Sciuto).
2007 – 2008	Seminari/Esercitazioni per il corso di Misure Meccaniche della Facoltà d'Ingegneria dell'Università degli Studi Roma TRE (Ingegneria Meccanica, prof. S.A. Sciuto).
2008 – 2009	Seminari/Esercitazioni per il corso di Misure Meccaniche della Facoltà d'Ingegneria dell'Università degli Studi Roma TRE (Ingegneria Meccanica, prof. S.A. Sciuto).
2008 – 2009	Seminari/Esercitazioni per il corso di Complementi di Misure Meccaniche della Facoltà d'Ingegneria dell'Università degli Studi Roma TRE (Ingegneria Meccanica, prof. S.A. Sciuto).
2009 – 2010	Seminari/Esercitazioni per il corso di Fondamenti di Ingegneria Clinica della Facoltà d'Ingegneria dell'Università degli Studi Roma TRE (Ingegneria Meccanica, prof. S.A. Sciuto).
2009 – 2010	Seminari/Esercitazioni per il corso di Misure Meccaniche della Facoltà d'Ingegneria dell'Università degli Studi Roma TRE (Ingegneria Meccanica, prof. S.A. Sciuto).
2009 – 2010	Seminari/Esercitazioni per il corso di Fondamenti di Misure Meccaniche della Facoltà d'Ingegneria dell'Università degli Studi Roma TRE (Ingegneria Meccanica, prof. S.A. Sciuto).
2010 – 2011	Seminari/Esercitazioni per il corso di Fondamenti di Ingegneria Clinica della Facoltà d'Ingegneria dell'Università degli Studi Roma TRE (Ingegneria Meccanica, prof. S.A. Sciuto).
2010 – 2011	Seminari/Esercitazioni per il corso di Fondamenti di Misure Meccaniche della Facoltà d'Ingegneria dell'Università degli Studi Roma TRE (Ingegneria Meccanica, prof. S.A. Sciuto).
2011 – 2012	Seminari/Esercitazioni per il corso di Fondamenti di Ingegneria Clinica della Facoltà d'Ingegneria dell'Università degli Studi Roma TRE (Ingegneria Meccanica, prof. S.A. Sciuto).
2011 – 2012	Seminari/Esercitazioni per il corso di Fondamenti di Misure Meccaniche della Facoltà d'Ingegneria dell'Università degli Studi Roma TRE (Ingegneria Meccanica, prof. S.A. Sciuto).
2012 – 2013	Seminari/Esercitazioni per il corso di Fondamenti di Ingegneria Clinica della Facoltà d'Ingegneria dell'Università degli Studi Roma Tre (Ingegneria Meccanica, prof. S.A. Sciuto).
2012 – 2013	Seminari/Esercitazioni per il corso di Fondamenti di Misure Meccaniche e Termiche presso la Facoltà di Ingegneria dell'Università degli Studi Roma Tre (Collegio didattico: Ingegneria Meccanica, prof. S.A. Sciuto, SSD: ING-IND/12)
2013 – 2014	Seminari/Esercitazioni per il corso di Fondamenti di Ingegneria Clinica della Facoltà d'Ingegneria dell'Università degli Studi Roma Tre (Ingegneria Meccanica, prof. S.A. Sciuto)
2013 – 2014	Seminari/Esercitazioni per il corso di Fondamenti di Misure Meccaniche e Termiche presso il Dipartimento d'Ingegneria dell'Università degli Studi Roma Tre (Collegio didattico: Ingegneria Meccanica, prof. S.A. Sciuto, SSD: ING-IND/12)
2013 – 2014	Lezioni per il corso di Didattica delle Misure Meccaniche, classi A020 – A069 – C320



	dei Percorsi Abilitanti Speciali, presso il Centro di servizio di Ateneo per la Formazione e lo sviluppo professionale degli Insegnanti della Scuola secondaria (CAFIS). Membro della commissione valutatrice degli Esami di Stato finali.
2014 – 2015	Seminari/Esercitazioni per il corso di Fondamenti di Ingegneria Clinica del Dipartimento d'Ingegneria dell'Università degli Studi Roma Tre (Collegio didattico: Ingegneria Elettronica, prof. S.A. Sciuto, SSD: ING-IND/12)
2014 – 2015	Lezioni per il Laboratorio Integrato di Applicazioni Elettriche e Misure presso il Dipartimento di Ingegneria dell'Università degli Studi Roma Tre (Sez. Ingegneria Meccanica e Industriale, prof. S.A. Sciuto, prof. L. Solero)
2014 – 2015	Seminari/Esercitazioni per il corso di Fondamenti di Misure Meccaniche e Termiche del Dipartimento d'Ingegneria dell'Università degli Studi Roma Tre (Collegio didattico: Ingegneria Meccanica, prof. S.A. Sciuto, SSD: ING-IND/12)
2014 – 2015	Lezioni per il corso di Didattica delle Misure Meccaniche, classi A020 del Tirocinio Formativo Attivo (TFA), presso il Centro di servizio di Ateneo per la Formazione e lo sviluppo professionale degli Insegnanti della Scuola secondaria (CAFIS).
2015 – 2016	Seminari/Esercitazioni per il corso di Fondamenti di Ingegneria Clinica del Dipartimento d'Ingegneria dell'Università degli Studi Roma Tre (Collegio Didattico: Elettronica, prof. S.A. Sciuto, SSD: ING-IND/12)
2015 – 2016	Lezioni per il Laboratorio Integrato di Applicazioni Elettriche e Misure presso il Dipartimento di Ingegneria dell'Università degli Studi Roma Tre (Sez. Ingegneria Meccanica e Industriale, prof. S.A. Sciuto, prof. L. Solero)
2015 – 2016	Seminari/Esercitazioni per il corso di Fondamenti di Misure Meccaniche e Termiche del Dipartimento d'Ingegneria dell'Università degli Studi Roma Tre (Collegio Didattico: Meccanica, prof. S.A. Sciuto, SSD: ING-IND/12)
2016 – 2017	Seminari/Esercitazioni per il corso di Clinical Engineering del Dipartimento d'Ingegneria dell'Università degli Studi Roma Tre (Collegio Didattico: Elettronica, prof. S.A. Sciuto, SSD: ING-IND/12)
2016 – 2017	Lezioni per il Laboratorio Integrato di Applicazioni Elettriche e Misure presso il Dipartimento di Ingegneria dell'Università degli Studi Roma Tre (Sez. Ingegneria Meccanica e Industriale, prof. S.A. Sciuto, prof. L. Solero)
2016 – 2017	Seminari/Esercitazioni per il corso di Fondamenti di Misure Meccaniche e Termiche del Dipartimento d'Ingegneria dell'Università degli Studi Roma Tre (Collegio Didattico: Meccanica, prof. S.A. Sciuto, SSD: ING-IND/12)
2017 – 2018	Seminari/Esercitazioni per il corso di Clinical Engineering del Dipartimento d'Ingegneria dell'Università degli Studi Roma Tre (Collegio Didattico: Elettronica, prof. S.A. Sciuto, SSD: ING-IND/12)
2017 – 2018	Lezioni per il Laboratorio Integrato di Applicazioni Elettriche e Misure presso il Dipartimento di Ingegneria dell'Università degli Studi Roma Tre (Sez. Ingegneria Meccanica e Industriale, prof. S.A. Sciuto, prof. L. Solero)
2017 – 2018	Seminari/Esercitazioni per il corso di Fondamenti di Misure Meccaniche e Termiche del Dipartimento d'Ingegneria dell'Università degli Studi Roma Tre (Collegio Didattico: Meccanica, prof. S.A. Sciuto, SSD: ING-IND/12)

**c) Partecipazioni a conferenze come relatore**

Ha partecipato come autore/relatore alle seguenti conferenze nazionali ed internazionali:

Novembre 2008	IV European Congress of the International Federation for Medical and Biological Engineering eMBEC2008, Antwerp (Belgium)
Luglio 2010	VIII congresso Nazionale di Misure Meccaniche e Termiche MMT2010, Roma
Maggio 2011	VI International Symposium on Medical Measurements and Applications MeMeA2011, Bari
Febbraio 2012	IASTED International Conference on Biomedical Engineering BioMed2012, Innsbruck (Austria)
Febbraio 2013	Conferenza annuale Associazione Italiana Sensori e Microsistemi AISEM2013, Brescia
Settembre 2013	XIII Convegno Nazionale di Misure Meccaniche e Termiche MMT2013, Trento
Settembre 2014	IX Congresso del Gruppo Nazionale di Misure Meccaniche e Termiche MMT2014, Ancona
Settembre 2014	20th IMEKO TC-4 International Symposium Measurement of Electrical Quantities "Research on Electrical and Electronic Measurement for the Economic Upturn" and 18th TC-4 Workshop on ADC and DAC Modelling and Testing, Benevento
Maggio 2015	2015 IEEE International Symposium on Medical Measurements and Applications (MEMEA 2015), Torino
Maggio 2015	2015 IEEE International Instrumentation and Measurement Technology Conference (I2MTC 2015), Pisa
Agosto 2015	37 <sup>th</sup> Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Milano, Italy, 2015
Settembre 2015	XIV Convegno nazionale dell'Associazione del Gruppo di Misure Meccaniche e Termiche GMMT2015, Lecco
Marzo 2016	XIV Mediterranean Conference on Medical and Biological Engineering and Computing 2016 (MEDICON 2016), Cyprus
Maggio 2016	2016 IEEE International Symposium on Medical Measurements and Applications (MEMEA 2016) Benevento
Settembre 2016	XV Convegno nazionale dell'associazione del Gruppo di Misure Meccaniche e Termiche GMMT2016, Benevento
Maggio 2017	2017 IEEE International Instrumentation and Measurement Technology Conference (I2MTC 2017), Torino
Settembre 2017	I Forum Nazionale delle Misure – XXV Congresso del Gruppo Nazionale di Misure Meccaniche e Termiche GMMT2017, XXXIV Congresso Nazionale di Misure Elettriche ed Elettroniche, Modena

Settembre 2017

22th IMEKO TC-4 International Symposium and 20th TC-4 International Workshop on ADC Modelling and Testing supporting world development through electrical & electronic measurements, Iasi, Romania

**d) Attività in progetti di ricerca nazionali ed internazionali**

- |             |   |
|-------------|---|
| 2005 – 2006 | Collabora al progetto di ricerca di Facoltà presso la Facoltà di ingegneria dell'Università di Roma La Sapienza, dal titolo "Progetto e realizzazione di un fantoccio prototipo per la verifica delle prestazioni della Tecnica Doppler Tessutale"  |
| 2005 – 2006 | Svolge attività di collaborazione esterna presso il Dipartimento di Meccanica ed Aeronautica della Facoltà di Ingegneria dell'Università degli Studi di Roma "La Sapienza" nell'ambito del progetto MIUR 40% - cofinanziamento 2004 con incarico di "Analisi delle prestazioni di sensori di pressione per ventilatori polmonari".  |
| 2007-2008   | Svolge attività di collaborazione, in qualità di assegnista di ricerca, presso il Dipartimento di Ingegneria Meccanica e Industriale della Facoltà di Ingegneria dell'Università degli Studi di Roma Tre nell'ambito del progetto di ricerca PRIN 2006 su "Sistemi per la misura remota di grandezze meccaniche per il recupero della salute dell'uomo".                      |
| 2014-2016   | Svolge attività di collaborazione presso il Dipartimento di Ingegneria Meccanica e Industriale della Facoltà di Ingegneria dell'Università degli Studi di Roma Tre nell'ambito del progetto di ricerca PRIN 2012 su "Misure meccaniche per l'apparato muscolo-scheletrico: metodologie innovative e standardizzabili per la verifica delle prestazioni dei sistemi di misura" |

## PUBBLICAZIONI MAGGIORMENTE SIGNIFICATIVE

- A. Scorza, Massaroni C., Orsini F., D'anna C., Conforto S., Silvestri S., Sciuto S.A. "A review on methods and devices for force platforms calibration in medical applications"(2018) Journal of Engineering Science and Technology Review (in press).

Nowadays force platforms are widely employed both for diagnostic purposes and for monitoring the execution of motor tasks such as stance, both static and perturbed, and gait. Moreover, even if a clinical assessment based on the knowledge of the forces the patients can exchange with the environment can be useful, some guidelines are needed to determine the practical limitations of the measurements for motion analysis and postural control. In particular, in situ calibration is a fundamental practice especially when the force platforms are either used as reference or are connected with other devices in the measurement chain. Several calibration procedures for force platforms have been proposed in the literature, some of them dealing with only one force component, others with all the force and moment components, and some research groups have also developed and tested some innovative devices or introduced some corrective equations, performing either static or dynamic calibration

- A. Rossi, F. Orsini, F. Botta, A. Scorza, L. Schinaia, D. Bibbo, S. A. Sciuto "A Novel Method for Whole Body Vibration Platform Characterization for Clinical Applications", 22nd IMEKO TC4 International Symposium & 20th International Workshop on ADC Modelling and Testing SUPPORTING WORLD DEVELOPMENT THROUGH ELECTRICAL&ELECTRONIC MEASUREMENTS, IASI, ROMANIA, September 14-15, 2017 (in press),

In the last decades, many studies have been conducted on the biological effects resulting from Whole-Body Vibration (WBV) platforms, even if benefits or side effects resulting from exposure to whole-body vibrations in sport and rehabilitation applications are often conflicting. These discrepancies are likely due also to different operating conditions such as load, unload, load position on footboard, etc. Since acceleration differences could affect the biological response of the patient it would be suitable to verify the actual vibrations. Nevertheless a standard and widespread accepted method for measuring and verifying the actual vibrations provided by a WBV device has not been established yet. The authors performed a characterization of a novel WBV platform by developing a method reported in section II. The tests carried out in different conditions show that the footboard doesn't provide quite uniform vibrations along the vertical direction over the platform. Furthermore, transversal accelerations have been detected and in some cases they reached the 25% of the vertical ones. Currently, very few studies have investigated whether a WBV platform produces comparable accelerations in at least two points of the footboard. This paper proposes a method for the characterization of WBV platforms and the comparison of their performances.

- L. Schinaia, A. Scorza, F. Orsini, S. A. Sciuto. "Ultrasound image Uniformity Assessment by Means of Sparse Matrices: Algorithm Implementation and First Results". 22nd IMEKO TC4 International Symposium & 20th International Workshop on ADC Modelling and Testing SUPPORTING WORLD DEVELOPMENT THROUGH ELECTRICAL&ELECTRONIC MEASUREMENTS, IASI, ROMANIA, September 14-15, 2017 (in press),

The current study is focused on an image segmentation algorithm for Uniformity Quality assessment in Diagnostic Ultrasounds. In particular a mathematical definition of the uniformity in ultrasound images is introduced with a split and merge algorithm performed on sparse matrices to measure it. The algorithm is based on the Gray-Level Co-occurrence Matrices and the relative descriptors, i.e. the Haralick features Entropy, Energy, Maximal Correlation Coefficient and Information Measures of Correlation. Results on 2 different data sets of test images with different non-uniformities have been carried on. Several outcomes show a good sensitivity and agreement with the mean judgment by 7 human observers, i.e. differences are below 40% in most of the cases. On the basis of previous studies, the latest developments and results are proposed and commented.

- D. Bibbo, I. Bernabucci, A. Scorza, F. Orsini, S. A. Sciuto, M. Schmid. "Using IMUs to monitor body kinematics while cycling in different in-field conditions". 22nd IMEKO TC4 International Symposium & 20th International Workshop on ADC Modelling and Testing SUPPORTING WORLD DEVELOPMENT THROUGH ELECTRICAL&ELECTRONIC MEASUREMENTS, IASI, ROMANIA, September 14-15, 2017 (in press),

Wearable sensors and system can profitably be used in bicycle riding to help evaluating the performance and provide trainers and athletes with indications about the strategy used to execute the gesture. In this paper a set of commercial Inertial Measurement Units (IMUs) was used to assess body segment accelerations while pedalling outdoor in different conditions, obtained combining tracks with different slopes and different positions on the saddle. Results show an evident variation on data recorded by the IMUs placed in the upper body segments, as a function of both slope and saddle position, that can be interpreted as a different inertial contribution of the trunk to the gesture. This information can be used to both evaluate different strategies and monitor the evolution of a functional recovery while using cycling in rehabilitation contexts.

- L. Schinaia, A. Scorza, F. Orsini, S. A. Sciuto. "Feature Classification in Ultrasound Textures for Image Quality Assessment: a Preliminary Study on the Characterization and Selection of Haralick Parameters by Means of Correlation Matrices". 22nd IMEKO TC4 International Symposium & 20th International Workshop on ADC Modelling and Testing SUPPORTING WORLD DEVELOPMENT THROUGH ELECTRICAL&ELECTRONIC MEASUREMENTS, IASI, ROMANIA, September 14-15, 2017 (in press),



This paper describes a preliminary study on the feature selection from the gray level co-occurrence matrix (GLCM) among the 14 features proposed by R.M. Haralick (1979) with the aim to apply them to ultrasound image classification and Quality Assessment. In particular 4 main-classes of images with different patterns (Lines, Chess, alternates Row and Circles) have been implemented and different levels of speckle noise have been added to simulate ultrasound images with different textures. With the aim to characterize the relationship between Haralick features and the pattern type, size, contrast and noise, some Correlation Matrices have been implemented. Preliminary results are explained and discussed.

- A. Scorza, D. Pietrobon, F. Orsini, S. A. Sciuto. "A preliminary study on a novel phantom based method for performance evaluation of clinical Colour Doppler systems". 22nd IMEKO TC4 International Symposium & 20th International Workshop on ADC Modelling and Testing SUPPORTING WORLD DEVELOPMENT THROUGH ELECTRICAL&ELECTRONIC MEASUREMENTS, IASI, ROMANIA, September 14-15, 2017 (in press),

Ultrasound Colour Flow is an imaging technique that combines velocity with anatomical information obtained by means of ultrasonic Doppler techniques and pulse-echo methods respectively to generate colour coded maps of the blood flow velocity superimposed on grey-level images of the tissue anatomy. Ultrasound Colour Flow Imaging (CFI) has been found to be effective in assessing blood flow in many clinical conditions and its use is widespread in many diagnostic applications. Although this technique for obtaining the blood velocity information is technically demanding and requires specific tests for its assessment, a shared worldwide standard on CFI equipment testing is not published yet and in the scientific literature there is no agreement on the choice of parameters to be tested, measurements methods and the timing of the test. After a brief introduction to the main principles and main methods in the scientific literature for quality assessment of CFI systems, a novel phantom based method is proposed and applied for a quantitative analysis of the performances of a commercial ultrasound scanner. Finally first results are shown and commented.

- A. Rossi, F. Orsini, A. Scorza, F. Botta, F. Leccese, E. Silva, K. Torokhtii, I. Bernabucci, S. A. Sciuto. "A preliminary performance validation of a MEMS accelerometer for blade vibration monitoring". 22nd IMEKO TC4 International Symposium & 20th International Workshop on ADC Modelling and Testing SUPPORTING WORLD DEVELOPMENT THROUGH ELECTRICAL&ELECTRONIC MEASUREMENTS, IASI, ROMANIA, September 14-15, 2017 (in press),

Nowadays a large number of studies are being carried out on active vibration control, especially in the aeronautical gas turbine industry. Indeed, uncontrolled vibration in aeronautical engine blades can lead to fatigue failure with catastrophic consequences. For this reason, many efforts are made to implement an embedded active vibration control on rotors. Furthermore in this particular kind of application a compact, integrated and robust system, controlled by a wireless remote system, is necessary. Before designing the vibration active control it is mandatory to characterize the vibration monitoring system of the blade in order to develop a feedback system for active damping. To this regard a MEMS accelerometer for mobile applications (MEMSWMAA) may be considered a good choice, since the wireless features are relevant in a rotor vibration monitoring application, its cost is usually low and its size and weight allow to obtain a lower insertion effect. However, the metrological limits of this type of sensors are not well investigated. In this work a preliminary characterization of a MEMSWMAA for blade vibration monitoring application is proposed. In particular the authors evaluate the actual performance of MEMSWMAA by means of a direct and simultaneous comparison with a reference sensor. The frequency range of investigation (10 Hz up to 1080 Hz) includes the first three resonant frequencies of a cantilever beam that will be used in a future work to experimentally validate the vibration control algorithm.

- F. Orsini, S. Scena, C.D'Anna, A. Scorza, L. Schinaia, S.A. Sciuto. "Uncertainty Evaluation of a Method for the Functional Reach Test Evaluation by Means of Monte-Carlo Simulation". 22nd IMEKO TC4 International Symposium & 20th International Workshop on ADC Modelling and Testing SUPPORTING WORLD DEVELOPMENT THROUGH ELECTRICAL&ELECTRONIC MEASUREMENTS, IASI, ROMANIA, September 14-15, 2017 (in press),

The Functional Reach Test (FRT) is a simple, portable, clinically accepted tool that is used to measure semi-static balance. In a recent study, video recordings and software elaborations have been performed by a computerized system to determine the FRT objectively (computerized FRT, cFRT); here an in-depth study on the measuring error of the above system is proposed. Main uncertainty sources identified are (a) geometrical errors due to the alignment of the camera calibration plane with the real motion plane, (b) the difference in depth between the above planes, (c) the image aberration due to the lens that compress the pixels and (d) the software error in position estimation using a template matching algorithm. The uncertainty evaluation is performed by means Monte Carlo Simulations and results suggest that both the depth error and the barrel distortion are the more relevant source of error, although the aberration can be corrected by one of the many algorithms available in literature. Results can be useful to define a measurement protocol to improve the performances of the system for a better clinical effectiveness.

- F. Orsini, A. Rossi, A. Scorza, F. Botta, S. A. Sciuto. "A comparison between a commercial WBV platform and an experimental prototype". 22nd IMEKO TC4 International Symposium & 20th International Workshop on ADC Modelling and Testing SUPPORTING WORLD DEVELOPMENT THROUGH ELECTRICAL&ELECTRONIC MEASUREMENTS, IASI, ROMANIA, September 14-15, 2017 (in press),

There are many commercial WBV platforms for clinical applications but in literature very few of them have been tested to verify their actual amplitude, frequency spectra and waveform shape of vibration, although some clinical studies showed that these parameters can influence significantly the muscles performance. In this study the performances of a prototype WBV1 designed by the authors are compared with a commercial platform WBV2 typically used in clinical and rehabilitation investigations. Tests performed with four accelerometers in 3 different directions show the presence of transversal accelerations that in some cases

exceeded the vertical one in WBV2 while they were always lower than the 25% in WBV1. Also the waveform shape of the vibration provided by WBV1, evaluated by means of the SINAD parameter, show a better value compared to the commercial device: indeed secondary harmonics reaches the 30% of the fundamental in WBV2 but they are always below the 25% in the prototype.

- **Scorza A., Pietrobon D., Orsini F., Sciuto S. A. "Studio preliminare su un nuovo metodo per la valutazione delle prestazioni dei sistemi color doppler per la diagnostica clinica" Atti del I Forum Nazionale delle Misure, pp. 559-567, Modena 14-16 Settembre 2017, ISBN 978-88-903149-9-5**

Sebbene il Color Flow Imaging ad ultrasuoni (CFI) sia una tecnologia molto utilizzata in ambito clinico, ad oggi se da un lato non è ancora possibile identificare uno standard condiviso a livello internazionale in merito alla verifica completa e dettagliata delle prestazioni delle macchine che ne fanno uso, dall'altro appare comunque estremamente difficile individuare anche nella letteratura scientifica del settore una linea comune sulla scelta dei parametri da verificare così come dei metodi di misura e della tempistica delle prove. Dopo una breve introduzione ai sistemi diagnostici CFI e alla loro verifica, si propone un metodo basato sull'utilizzo di un fantoccio per ultrasuoni a tubi di flusso e sull'analisi delle corrispondenti immagini CFI prodotte dall'apparecchiatura in esame. I risultati dell'applicazione del metodo ad un sistema ecografico commerciale vengono infine riportati e commentati, dimostrando valori coerenti con quanto riscontrabile nella letteratura tecnico-scientifica.

- **Orsini F., Scorza A., Sciuto S. A. "Sviluppo di una procedura di prova per la caratterizzazione in situ di piattaforme vibranti per applicazioni cliniche" Atti del I Forum Nazionale delle Misure, pp. 437-440, Modena 14-16 Settembre 2017, ISBN 978-88-903149-9-5**

Negli ultimi anni è cresciuto l'interesse in ambito scientifico nei confronti delle piattaforme vibranti e degli effetti biologici indotti sull'uomo in virtù delle vibrazioni da esse prodotte. Nonostante l'importanza della tematica, nella letteratura scientifica del settore si riscontra però una limitata attenzione alla caratterizzazione metrologica dei suddetti dispositivi e delle sollecitazioni da essi prodotte, con conseguenze negative in merito alla validazione dei risultati clinici. In tale contesto il presente lavoro propone in via preliminare un protocollo di prova per la caratterizzazione in situ delle piattaforme vibranti per applicazioni cliniche, riportando un esempio applicativo su un dispositivo di tipo commerciale e commentandone i risultati.

- **Sassaroli, E., Scorza, A., Crake, C., Sciuto, S.A., Park, M.-A. "Breast ultrasound technology and performance evaluation of ultrasound equipment: B-mode" (2017) IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control, 64(1), art. no. 7731138, pp. 192-205.**

Ultrasound (US) has become increasingly important in imaging and image-guided interventional procedures. In order to ensure that the imaging equipment performs to the highest level achievable and thus provides reliable clinical results, a number of quality control (QC) methods have been developed. Such QC is increasingly required by accrediting agencies and professional organizations; however, these requirements typically do not include detailed procedures for how the tests should be performed. In this paper, a detailed overview of QC methods for general and breast US imaging using computer-based objective methods is described. The application of QC is then discussed within the context of a common clinical application (US-guided needle biopsy) as well as for research applications, where QC may not be mandated, and thus is rarely discussed. The implementation of these methods will help in finding early stage equipment faults and in optimizing image quality, which could lead to better detection and classification of suspicious findings in clinical applications, as well as improving the robustness of research studies.

- **D'Anna, C., Schmid, M., Scorza, A., Sciuto, S.A., Lopez, L., Conforto, S. "Time-to-boundary function to study the development of upright stance control in children" (2017) Open Biomedical Engineering Journal, 11, pp. 49-58.**

Background: The development of postural control across the primary school time horizon is a complex process, which entails biomechanics modifications, the maturation of cognitive ability and sensorimotor organization, and the emergence of anticipatory behaviour. Postural stability in upright stance has been thus object of a multiplicity of studies to better characterize postural control in this age span, with a variety of methodological approaches. The analysis of the Time-to-Boundary function (TtB), which specifies the spatiotemporal proximity of the Centre of Pressure (CoP) to the stability boundaries in the regulation of posture in upright stance, is among the techniques used to better characterize postural stability in adults, but, as of now, it has not yet been introduced in developmental studies. The aim of this study was thus to apply this technique to evaluate the development of postural control in a sample population of primary school children. Methods: In this cross-sectional study, upright stance trials under eyes open and eyes closed were administered to 107 healthy children, divided into three age groups (41 for Seven Years' Group, Y7; 38 for Nine Years' Group, Y9; 28 for Eleven Years' Group, Y11). CoP data were recorded to calculate the Time-to-Boundary function (TtB), from which four spatio-temporal parameters were extracted: the mean value and the standard deviation of TtB minima (Mmin, Stdmin), and the mean value and the standard deviation of the temporal distance between two successive minima (Mdmin, Stdmin). Results: With eyes closed, Mmin and Stdmin significantly decreased and Mdmin and Stdmin increased for the Y7 group, at Y9 Mmin significantly decreased and Stdmin increased, while no effect of vision resulted for Y11. Regarding age groups, Mmin was significantly higher for Y9 than Y7, and Stdmin for Y9 was higher than both Y7 and Y11; Mdmin and Stdmin resulted higher for Y11 than for Y9. Conclusion: From the combined results from the spatio-temporal TtB parameters, it is suggested that, at 9 years, children look more efficient in terms of exploring their limits of stability than at 7, and at 11 the observed TtB behaviour hints at the possibility that, at that age, they have almost completed the maturation of postural control in upright stance, also in terms of integration of the spatio-temporal information.



- Pompeo, N., Torokhtii, K., Leccese, F., Scorza, A., Sciuto, S., Silva, E. "Fitting strategy of resonance curves from microwave resonators with non-idealities" (2017) I2MTC 2017 - 2017 IEEE International Instrumentation and Measurement Technology Conference, Proceedings, art. no. 7969903,

Microwave resonators are of widespread use in technological applications as well as in many research fields. In all cases, as microwave filters or as material characterisation devices or as sensors, their use requires the accurate measurement of their quality factor  $Q$  and resonance frequency  $\nu_0$ , which are the main parameters shaping their response. The most accurate measurements are obtained through a full determination of all the complex scattering coefficients  $S_{ij}$  of a two-port coupled resonator, through a Vector Network Analyzer, and subsequent fitting in the complex plane. These approaches allow also to compensate for resonator non-idealities which alter the resonator response and thus impact on  $Q$  and  $\nu_0$  accuracies. On the other hand, cost effective and fast measurement setups rely on power sensors which allow scalar measurements only. In these cases, the resonator ideal response takes the shape of a lorentzian curve. It is therefore of interest to optimise the fitting strategy of scalar measurements in order to obtain the better fit goodness and robustness against perturbations. In this work we study the most common sources of perturbation and their models, in order to assess which fitting strategy yields the best results when the perturbation cause is not known a-priori. We perform both numerical simulations and tests on actual experimental data. We find that the fit model describing a cross-coupling between two resonator ports is the most robust approach.

- D'Anna, C., Scorza, A., Schmid, M., Orsini, F., Andrea Sciuto, S., Conforto, S., Scena, S. "A preliminary study on the validation of an automatic measurement method for functional reach assessment by stereophotogrammetry" (2017) I2MTC 2017 - 2017 IEEE International Instrumentation and Measurement Technology Conference, Proceedings, art. no. 7969819

In this work a preliminary study is proposed to assess the validity of an automatic and low cost measurement method for Functional ReachTest (FRT) implementation. To this aim FRT was performed on 10 trials of 4 healthy men and results from the system under validation are compared with the corresponding data from a calibrated stereo-photogrammetric system: the percentage variation between them is lower than 3% in all subjects - 3 outlier trials excluded - and it is significantly lower than the percentage variation obtained in daily clinical practice. Since none of the subjects is affected by pathologies, all of them have normal visual acuity and have been trained to the experimental procedure, uncertainty of the outcomes may be mainly attributed to the calibration procedure and to the measurement system. Anyway results seem to confirm that the proposed system can be used to support the physician in acquiring the clinical information about the motor control deterioration or restoring in patients with various pathologies. Despite the encouraging results, further studies are needed to achieve a more accurate and quantitative evaluation of the sources of uncertainty, i.e. by extending the population sample and increasing the number of trials with the support of a Monte Carlo simulation.

- Leccese, F., Cagnetti, M., Sciuto, S., Scorza, A., Torokhtii, K., Silva, E. "Analysis, design, realization and test of a sensor network for aerospace applications" (2017) I2MTC 2017 - 2017 IEEE International Instrumentation and Measurement Technology Conference, Proceedings, art. no. 7969946

A sensor network for aerospace applications is presented. The single node has been designed to follow important requirements in aerospace environments such as low power consumption, lightweight and reliability. Moreover, the network does not use radiofrequency transmitter/receiver to send the information, using infrared technology instead. The network has been designed, realized and tested. Some sample measurements are shown.

- Orsini, F., Rossi, A., Scorza, A., Sciuto, S. A. "Development and preliminary characterization of a novel system for the force platforms dynamic calibration" (2017) I2MTC 2017 - 2017 IEEE International Instrumentation and Measurement Technology Conference, Proceedings, art. no. 7969843,

In this work a transportable calibration system for dynamic performance testing of medical force platforms (FP) is proposed. Although in literature many devices have been proposed for the calibration of force platforms, most of them are static and among those proposed to simulate a dynamic phenomenon it is difficult to satisfy ergonomic needs (i.e. transportability) with performance characteristics as the capability to control the frequency and the amplitude of the calibration force with continuity in the useful range of the human gait analysis and posturography. In particular the system proposed is equipped with a calibrated load cell (LC) to provide force measurement feedback and can apply a calibration force in every point of the FP under testing, with amplitude range 0-1500N, frequency range 1-12 Hz and a preload range 300-1000N with an inclination to the FP of 0-15°. With the aim to do a first validation of the system some test and a first application to a novel Force Platform are described. Tests at different preloads (30-100 daN), frequencies (1-12Hz) and amplitudes (7.5-25 daN) are carried out to study the dynamic behavior of the device: some difference on the peak to peak measurements are shown, nevertheless the ratio of the mean force ratio platform/calibrator is very close to 1 in quite all cases, although a little distortion (<4%) is revealed at 2 Hz. Moreover the evaluation of the total harmonic distortion (THD) is carried out and results show some difference in the readings between the FP and the system LC. In future works it seems interesting to investigate how the frequency influences the dynamic behavior of FP and propose a calibration procedure where the calibration parameters are frequency dependent and the control software is optimized to improve the system performance and the force signal characteristics.

- Scorza, A., Orsini, F., Andrea Sciuto, S. "Use of phantoms and test objects for local dynamic range evaluation in medical ultrasounds: A preliminary study" (2017) I2MTC 2017 - 2017 IEEE International Instrumentation and Measurement Technology Conference, Proceedings, art. no. 7969844

In the ultrasound image the relationship between echo amplitudes and gray levels is expressed by means of the Grayscale Mapping Function (GMF), that is the grayscale transfer function associated with the echo displayed. The GMF allows the determination of

some image quality parameters and quantities, among which the Local Dynamic Range (LDR) is relevant, since it is defined as the  $20 \cdot \log_{10}$  of the ratio of the minimum echo amplitude that yields the maximum grey level in the digitized image to that of the echo that yields the lowest grey level at the same location in the image and the same settings. This study reports the implementation of a method for the automatic determination of the LDR on medical ultrasound scanners and its application by means of a commercial grayscale ultrasound phantom. nevertheless it can be used also with general purpose phantoms: the LDR is obtained from the estimation of the GMF, based on processing of a sequence of uncompressed bidimensional ultrasound images provided by the scanner. In the manuscript, some theoretical considerations have been done to determine the GMF and its fitting model, as well as the LDR values, after that an experimental setup is described and some results are shown for an ultrasound system equipped with two different probes.

- B. D'Elia, I. Bernabucci, D. Bibbo, S. Conforto, T. D'Alessio, S. A. Sciuto, A. Scorza, M. Schmid. "Measuring regularity of fine upper limb movements with a haptic platform for motor learning and rehabilitation" (2016) *Lekar a Technika*, 46 (1), pp. 5-12.

Robot-assisted systems for arm training are being increasingly used to target moderate-to-severe upper limb impairments in rehabilitation facilities, while hand fine motor skills are seldom being targeted by these machines. This manuscript describes and tests the feasibility of a system based on a haptic interface aimed to complement the efficacy of robotic training in the rehabilitation and motor learning associated with upper extremities movements. End-effector kinematics associated with different trajectory tasks performed by 11 healthy adults were used to extract measures of smoothness, under different testing conditions that included the presence or absence of visual and haptic feedback, the use of dominant vs. non dominant hand, different shapes (crosses and circles), and the verse with which movements were done. The normalized mean square jerk, extracted from the system together with specific speed parameters, was able to capture differences in regularity between the different shapes (MSJratio significantly higher when drawing crosses,  $p < 1.0 \cdot 10^{-4}$ ), and that haptic feedback significantly influences this smoothness measure (MSJratio significantly higher when haptic feedback is present,  $p < 5.0 \cdot 10^{-4}$ ). The proposed system may be used as a means to monitor the progress of movement regularity in robot-mediated therapy, and the results obtained experimentally highlight the influence of haptic feedback on the smoothness of finalized upper extremity fine movements.

- F. Orsini, A. Scorza, A. Rossi, F. Botta, S. A. Sciuto, R. di Giminiani (2016). "A preliminary uncertainty analysis of acceleration and displacement measurements on a novel WBV platform for biologic response studies". In: 2016 IEEE International Symposium on Medical Measurements and Applications (MEMEA 2016) Proceedings, Benevento, Italy, 2016, pp.137-142

Over the last decade, many studies have been conducted on the effects of mechanical vibration on the physical hormonal and neuromuscular responses of muscles: in some works the growth hormone response showed a dependence on the acceleration provided by Whole Body Vibration (WBV) platforms with respect to subjects responsiveness. Therefore the accuracy of acceleration measurements related to the excitation system is important and should be assessed. To this aim a preliminary study on the identification and evaluation of the measurement uncertainty sources in the measurement chain of a novel WBV platform developed by the Authors is here proposed. After the main measurement error sources have been identified, a Monte Carlo simulation Method has been implemented to obtain the uncertainty in accelerations and displacements provided by the WBV platform. Since main causes of uncertainty have been identified in the accelerometer sensitivity, its mounting and the data acquisition processing. Results of the test showed a relative uncertainty of about  $\pm 4\%$  for acceleration and displacement measurements for frequencies between 20 Hz and 60 Hz.

- Andrea R., F. Orsini, A. Scorza, F. Botta, S. A. Sciuto, R. di Giminiani (2016). "A preliminary characterization of a Whole Body Vibration platform prototype for medical and rehabilitation application". In: 2016 IEEE International Symposium on Medical Measurements and Applications (MEMEA 2016) Proceedings, Benevento, Italy, 2016, pp.131-136

Whole-body vibration (WBV) is receiving increasing interest as an exercise intervention in physiology and rehabilitation. Although there are many commercial and professional WBV platforms to provide controlled vibrations, very few have actually been tested in terms of amplitude (mm), frequency spectra (Hz) and shape of the vibratory motion wave. In this regard a prototype of a novel WBV platform where the vibration amplitude can be set to three values in the frequency range 20 - 60 Hz is here proposed. The device has been preliminarily characterized by processing the measurement signal from a piezoelectric monoaxial accelerometer mounted in the center of the WBV plate. In particular the accelerometer signal has been processed to evaluate frequency spectrum, waveform shape and displacement. Moreover to evaluate the performance of the prototype, same tests were carried out on an equivalent professional WBV platform, so that data coming from the two platforms have been compared and commented: test results have shown that the vibrations produced by the two WBV plates are very similar, nevertheless it has been found that the prototype works with a maximum error of about 5 % in frequency, that is less than in the other devices, furthermore the greater distortion of the signal is always at the twice of the operating frequency (second harmonic). Further investigations are needed to complete the characterization of the prototype and assess the vibration amplitude is not load dependent.

- A. Scorza, S. Conforto, M. Schmid, D. Bibbo, and S. A. Sciuto (2016). A Preliminary Comparison of Two Different Methods for Objective Uniformity Evaluation in Diagnostic Ultrasound Imaging. In: XIV Mediterranean Conference on Medical and Biological Engineering and Computing 2016 (MEDICON 2016), IFMBE Proceedings 57, Paphos, Cyprus, 2016, pp. 470-475

Although ultrasound image uniformity is a very important parameter for quality assurance in diagnostic ultrasounds, it is usually assessed by a qualitative and subjective judgement of technicians. In this work two novel method to obtain an objective measurement of the B-mode image uniformity over the whole field of view (or some of its part) are briefly described and compared: with the aim to quantify non-uniformities the first method is based on the image gray level histogram weighted by a



sigmoid function (Sigma Weighted Histogram Method or SWHM) while the second one applies a segmentation of the Region of Interest, depending on some texture features from co-occurrence matrices processing (Texture Distribution Analysis Method or TDAM). Results from the two methods are preliminary compared and discussed on a set of 9 test images provided by means of two commercial ultrasound phantoms applied on different ultrasound scanners: the sensitivity to non-uniformities in SWHM is lower than in TDAM, on the other hand TDAM scores are more unstable and affected by higher uncertainties due to co-occurrence matrices calculations. Both methods require improvements and an in depth validation testing, nevertheless results are encouraging.

- **D. Bibbo, M. Schmid, A. Scorza, S. A. Sciuto and S. Conforto (2016). "A Novel Approach to Improve the Technical Maintenance of Biomedical Equipment". In: XIV Mediterranean Conference on Medical and Biological Engineering and Computing 2016 (MEDICON 2016), IFMBE Proceedings 57, Paphos, Cyprus, 2016, pp. 1028-1033**

The wide diffusion of Biomedical Equipment (BmE) is associated with the general problem of their maintenance. In most cases of BmE failures, it could be very useful to recover activity data recorded before the malfunction. Moreover, these devices are often provided with one or more sections of the function menu associated to the technical settings. In this case it is important to guarantee a secure access to this menu only for authorized people, such as the BmE technicians or the factory technicians. In this work, a new and automated system to be integrated on into commercial medical devices to monitor performance and data during the regular functioning has been developed. Also clinical data, that can be useful to medical personnel, are acquired. The system is composed by an acquisition data device installed on the medical instrument and by a wireless device. Both ends are managed through a microcontroller architecture. The wireless device is used to access and manage an equipment maintenance menu and to transfer data to a PC hosting a Software User Interface. The system has been tested by simulating a medical device by means of a PC and a Serial Port Terminal software. Results are satisfactory in terms of reliability.

- **L Battista, A Scorza, F Botta and S A Sciuto (2016). "A novel fiber-optic measurement system for the evaluation of performances of neonatal pulmonary ventilators". Measurement Science and Technology, 27, 025704 (12pp)**

Published standards for the performance evaluation of pulmonary ventilators are mainly directed to manufacturers rather than to end-users and often considered inadequate or not comprehensive. In order to contribute to overcome the problems above, a novel measurement system was proposed and tested with waveforms of mechanical ventilation by means of experimental trials carried out with infant ventilators typically used in neonatal intensive care units; the main quantities of mechanical ventilation in newborns are monitored, i.e. air flow rate, differential pressure and volume from infant ventilator are measured by means of two novel fiber-optic sensors (OFSs) developed and characterized by the authors, while temperature and relative humidity of air mass are obtained by two commercial transducers. The proposed fiber-optic sensors (flow sensor Q-OFS, pressure sensor P-OFS) showed measurement ranges of air flow and pressure typically encountered in neonatal mechanical ventilation, i.e. the air flow rate  $Q$  ranged from  $3 \text{ l min}^{-1}$  to  $18 \text{ l min}^{-1}$  (inspiratory) and from  $-3 \text{ l min}^{-1}$  to  $-18 \text{ l min}^{-1}$  (expiratory), the differential pressure  $\Delta P$  ranged from  $-15 \text{ cmH}_2\text{O}$  to  $15 \text{ cmH}_2\text{O}$ . In each experimental trial carried out with different settings of the ventilator, outputs of the OFSs are compared with data from two reference sensors (reference flow sensor RF, reference pressure sensor RP) and results are found consistent: flow rate  $Q$  showed a maximum error between Q-OFS and RF up to 13 percent, with an output ratio  $Q_{\text{RF}}/Q_{\text{OFS}}$  of not more than  $1.06 \pm 0.09$  (least square estimation, 95 percent confidence level,  $R^2$  between 0.9822 and 0.9931). On the other hand the maximum error between P-OFS and RP on differential pressure  $\Delta P$  was lower than 10 percent, with an output ratio  $\Delta P_{\text{RP}}/\Delta P_{\text{OFS}}$  between  $0.977 \pm 0.022$  and  $1.0 \pm 0.8$  (least square estimation, 95 percent confidence level,  $R^2$  between 0.9864 and 0.9876). Despite the possible improvements, results were encouraging and suggested the proposed measurement system can be considered suitable for performances evaluation of neonatal ventilators and useful for both end-users and manufacturers.

- **C. D'Anna, M. Schmid, A. Scorza, M. Goffredo, S. A. Sciuto, and S. Conforto (2015). "Can a Visual Biofeedback system based on predictive information improve postural performance?" In: Proceedings of Engineering in Medicine and Biology Society (EMBC) 2015 Annual International Conference of the IEEE, Milano, Italy, pp.6951-6954**

The aim of this study is to assess if predictive information can be used to implement visual biofeedback (VBF) systems to improve postural performance. The Centre of Pressure (CoP) coordinates, extracted directly from a force plate, are used to implement two different real-time VBF, which respectively use current CoP coordinates (VBF<sub>real\_time</sub>) and predictive stability information (VBF<sub>predictive</sub>). Predictive coordinates are calculated in agreement with time-to collision theory, using the real-time CoP components. In both VBF, subjects know if they are or are not in the stability area by an emoticon image displayed on the computer monitor. The expression of emoticon was smiling if the CoP coordinates were inside the area of stability, it was sad if the CoP coordinates exceed the stability area. Two groups of eighteen healthy young subjects performed the protocol in two different sequences: noVBF-VBF<sub>real\_time</sub> and noVBF-VBF<sub>predictive</sub>. Each condition was repeated three times, and its effect was studied by four parameters extracted directly from CoP coordinates (sway path, sway area, mean amplitude and mean frequency). Both VBFs determine a modification of postural parameters compared to the baseline condition (noVBF) with decrease of sway area and mean amplitude and increase of mean frequency. The comparison between the two VBFs shows significant difference for all parameters except for mean frequency. In particular, sway path, sway area and mean amplitude values for the VBF<sub>predictive</sub> decreased more than the same values for the VBF<sub>real\_time</sub>. The preliminary results may prove useful for the possibility of using this kind of VBF as a tool to improve postural performance.

- **Scorza A., Conforto S., Lupi G. and Sciuto S.A. (2015) "A texture analysis approach for objective uniformity evaluation in diagnostic ultrasound imaging: a preliminary study" In: Proceedings of Engineering in Medicine and Biology Society (EMBC) 2015 Annual International Conference of the IEEE, Milano, Italy, pp.6317-6320**

Ultrasound image uniformity is an important parameter for quality assurance in diagnostic ultrasounds, but it is usually assessed by a qualitative judgement of technicians so its estimation is rough and subjective. In this work a novel method is developed to give an objective measurement of the B-mode image uniformity over the whole field of view or some of its part: the Texture Distribution Analysis Method (TDAM) is based on a segmentation of the Region of Interest, depending on some texture features calculated from co-occurrence matrices. Results on a set of 10 test images with different non-uniformities (Uniformity Image Test Set or UITS) show a good sensitivity and agreement of TDAM with the mean judgment by 5 human observers (TUV): TDAM and TUV uniformity values are coherent for the whole UITS, nevertheless a high uncertainty in uniformity values has been observed (up to 28 percent). Preliminary results look encouraging and more efforts are worth to refine the method.

- Scorza A., Conforto S., Sciuto S.A. (2015) "A comparative study on the influence of probe placement on quality assurance measurements in B-mode Ultrasound by means of ultrasound phantoms", *The Open Biomedical Engineering Journal*, 9:164-78

To check or to prevent failures in ultrasound medical systems, some tests should be scheduled for both clinical suitability and technical functionality evaluation; among them, image quality assurance tests performed by technicians through ultrasound phantoms are widespread today and their results depend on issues related to scanner settings as well as phantom features and operator experience. In the present study variations on some features of the B-mode image were measured when the ultrasound probe is handled by the technician in a routine image quality test: ultrasound phantom images from two array transducers are processed to evaluate measurement dispersion in distance accuracy, high contrast spatial resolution and penetration depth when probe is handled by the operator. All measurements are done by means of an in-house image analysis software that minimizes errors due to operator's visual acuity and subjective judgment while influences of ultrasound transducer position on quality assurance test results are estimated as expanded uncertainties on parameters above (uncertainty reproducibility at 95 percent confidence level): depending on the probe model, they ranged from  $\pm 0.1$  to  $\pm 1.9$  mm in high contrast spatial resolution, from  $\pm 0.1$  to  $\pm 5.5$  percent in distance measurements error and from  $\pm 1$  to  $\pm 10$  mm in maximum depth of signal visualization. Although numerical results are limited to the two examined probes, they confirm some predictions based on general working principles of diagnostic ultrasound systems: (a) measurements strongly depend on settings as well on phantom features, probes and parameters investigated; (b) relative uncertainty due to probe manipulation on spatial resolution can be very high, i.e. from 10 to more than 30 percent; (c) Field of View settings must be taken into account for measurement reproducibility as well as Dynamic Range compression and phantom attenuation.

- A. Scorza, G. Lupi, S. A. Sciuto, L. Battista, J. Galo (2015) "A preliminary study on a method for objective uniformity assessment in diagnostic ultrasound imaging." In: 2015 IEEE International Instrumentation and Measurement Technology Conference (I2MTC 2015) Proceedings, Pisa, Italy, 2015, pp. 1628-1633

Ultrasound image uniformity is a parameter often used in medical ultrasound system testing, as an object can be displayed in different shapes and textures within the field of view, depending on instrumentation performances. Therefore Ultrasound Image Uniformity evaluation can be used for failures detection as well for quality assurance. In this paper a novel method is developed to measure B-mode image uniformity over the whole field of view or its part (Region Of Interest): it is based on the image gray level histogram weighted by a sigmoid function to detect non-uniformities. Preliminary results are explained and discussed.

- A. Scorza, G. Lupi, S. A. Sciuto, F. Bini, F. Marinozzi (2015) "A novel approach to a phantom based method for maximum depth of penetration measurement in diagnostic ultrasound: a preliminary study" In: 2015 IEEE International Symposium on Medical Measurements and Applications (MEMEA 2015) Proceedings, Torino, Italy, 2015, pp.369-374.

In the present work a new approach for maximum depth of ultrasound signal visualization has been proposed by means of a tissue mimicking phantoms: the novel method is based on a threshold on the tangent applied to the mean depth profile that is drawn by averaging adjacent columns in the diagnostic image. It has been implemented and preliminary tested on three different diagnostic systems equipped with linear array probes under similar settings: results have been compared with the mean judgment of 5 observer and with output from another method, based on a threshold of the mean depth profile above the noise level, as suggested in literature. Even though a not negligible difference among some results is observed, due likely to the high electronic noise level displayed in the ultrasound image, the tangent method seems to agree with observer judgment and be more sensitive to echo signal than the other one, even at higher noise levels. Nevertheless other test are going to be performed in the next future for a more detailed characterization of the method.

- G. Lupi, A. Scorza, M. L. Rugiano, S. A. Sciuto, F. Bini (2015) "Preliminary study for a water-paraffin based phantom in MRI quality assurance test" In: 2015 IEEE International Symposium on Medical Measurements and Applications (MEMEA 2015) Proceedings, Torino, Italy, 2015, pp.308-313.

Magnetic Resonance Imaging (MRI) scanners are widely used both for diagnostic purpose and in studies on material properties. As a consequence they play an important role in diagnosis of diseases and in materials investigations. MRI Quality assurance tests are mandatory to obtain and maintain optimal images during time, some institutional organizations have proposed requirements on MRI image quality even if there are no worldwide standardization procedures. The purpose of this study is to design a novel MRI phantom useful to evaluate basic image quality requirements: our phantom is designed, realized and tested in order to define specific image assurance protocols and tests. Moreover the developed device is low cost, reusable and can be filled with different MRI-compatible materials. In our application the phantom is filled with water and paraffin to compare contrast resolution and signal-to-noise ratio measurements for a same scanner. Tests have been performed on a 3T scanner with 7 different scanion settings. First experimental results are encouraging and confirm a previous theoretical investigation on the employed material characteristics. Therefore other tests and data are going to be collected for the future development and performance improvement of the device.



- Massaroni C., Schena E., Scorza A., Saccomandi P., Lupi G., Sciuto S. A., Silvestri S. (2014) "Development Of A Bio-Inspired Mechatronic Chest Wall Simulator For Evaluating The Performances Of Opto-Electronic Plethysmography", *The Open Biomedical Engineering Journal*, 8:120-30, 2014

Instrumented gait analysis based on optoelectronic systems is an expensive technique used to objectively measure the human movement features and it is generally considered the gold standard. Opto-electronic plethysmography (OEP) is a particular motion analysis system able to: (i) determine chest wall kinematic via the evaluation of marker displacements placed on the thorax and (ii) compute respiratory volumes during breathing. The aim of this work is to describe the performances of a custom made, bio-inspired, mechatronic chest wall simulator (CWS) specifically designed to assess the metrological performances of the OEP system. The design of the simulator is based on the chest wall kinematic analysis of three healthy subjects previously determined. Two sets of experiments were carried out: (i) to investigate the CWS dynamic response using different target displacements (1 - 12 mm), and (ii) to assess the CWS accuracy and precision in simulating quiet breathing, covering the physiological range of respiratory frequency and tidal volume. Results show that the CWS allows simulating respiratory frequency up to ~ 60 bpm. The difference between the actual displacement and the set one is always < 9  $\mu$ m. The precision error, expressed as the ratio between measurement uncertainty and the actual displacement, is lower than 0.22 %. The observed good performances permits to consider the CWS prototype feasible to be employed for assessing the performances of OEP system in periodical validation routines.

- Scorza A, Battista L, Silvestri S., Sciuto S A (2014). Design and development of a rheometer for biological fluids of limited availability. *Review of Scientific Instruments*, vol. 85, ISSN: 0034-6748, doi: 10.1063/1.4897490

From studies on the dynamic characterization of human bones, it is noticed that reference data on the viscous behavior of the bone marrow are quite poor. Dependently from marrow limited availability and its opacity, we have not been able to retrieve a tool of appropriate characteristics able to measure bone marrow viscosity. Therefore, principal techniques for the viscosity measurement have been preliminarily examined, and a device suitable for viscosity measurements of biological fluids has been realized. In particular, a rotational rheometer has been developed: it is a coaxial cylinders system, where the fluid flows dragged by the inner cylinder. The device is an absolute rheometer, that is, particularly useful as nowadays it is not known the classification of the bone as far as it concerns its viscous behavior. In this work a preliminary evaluation of the metrological characteristics of the measurement system has been carried out and its main metrological performances have been evaluated.

- Scorza A, Battista L, Lupi G, Galo J, Sciuto S A (2014). Influence of transducer position on quality assurance measurements in B-mode Ultrasound: a case study. In *proceedings of IX Congress National Group of Mechanical and Thermal Measurements*, Ancona, Italy, 11–13 September 2014

Image quality assurance tests on medical ultrasound systems are often performed by technicians using ultrasound phantoms and results depend on phantom features as well as scanner settings and operator experience. The aim of the present study is the evaluation of variations on some features of the B-mode image when the ultrasound probe is handled by the technician during a routine quality test: ultrasound images of two different ultrasound phantom are acquired and processed from two transducer to evaluate measurement dispersion in spatial resolution, penetration depth and accuracy in distance measurements when probe is handled by the operator. Results are then investigated and discussed.

- Battista L, Scorza A, Lupi G, Sciuto S A (2014). Experimental investigation on dynamical performances of a novel fiber-optic pressure sensor for pulmonary ventilation. In: *Proceedings of the 20th IMEKO TC4 International Symposium and 18th IMEKO TC4 International Workshop on ADC and DAC Modelling and Testing: Research on Electrical and Electronic Measurement for the Economic Upturn*, Benevento, Italy, 15–17 September 2014

A new optical fiber differential pressure sensor has been proposed for neonatal pulmonary ventilation and an experimental investigation on its dynamical metrological performances is here reported. The proposed measurement system has been preliminarily tested by monitoring the mouth pressure during simple respiratory tests in healthy patients and during mechanical ventilation performed by means of a infant ventilator typically used in the neonatal intensive care units: results show that the output of the transducer is consistent with that measured by means of a reference sensor.

- Battista L, Scorza A, Sciuto S A (2014) "Fiber-optic flow sensor for the measurement of inspiratory efforts in mechanical neonatal ventilation". In: *Lecture notes in Electrical Engineering 268 - Sensors and Microsystems*, BERLIN: Springer, 2014 - *Proceedings of the 17th National Conference*, Brescia, Italy, 5-7 February 2013. ISBN: 978-3-319-00683-3, ISSN: 1876-1100

A novel fiber-optic flow sensor has been developed for monitoring inspiratory efforts during neonatal mechanical ventilation. The considered sensor is based on fiber-optic sensing techniques, allowing the reduction of the effects due to electromagnetic interferences and a possible improvement of the electrical safety conditions. In the arrangement described here, the fiber-optic sensor is able to measure, with an accuracy of 5 %, flow variations in the range between 0.5 l/min and 5 l/min that are the typical flow variations due to infants' inspiratory attempts and typical flow trigger levels set during assist-control ventilation (ACV). Moreover, a good agreement ( $r^2 = 0.998$ ) between experimental data and the parabolic theoretical model can be deduced. The metrological characteristics confirm that the novel proposed configuration for the optical fiber air flow sensor is suitable for monitoring flow variations due to infants' inspiratory attempts.

- **Battista L, Sciuto S A, Scorza A. (2013) "An air flow sensor for neonatal mechanical ventilation applications based on a novel fiber-optic sensing technique". Rev. Sci. Instrum., 84, ISSN: 0034-6748, doi:10.1063/1.4798298 (2013)**

In this work, a simple and low-cost air flow sensor, based on a novel fiber-optic sensing technique has been developed for monitoring air flows rates supplied by a neonatal ventilator to support infants in intensive care units. The sensing principle is based on the measurement of transversal displacement of an emitting fiber-optic cantilever due to action of air flow acting on it; the fiber tip displacement is measured by means of a photodiode linear array, placed in front of the entrance face of the emitting optical fiber in order to detect its light intensity profile. As the measurement system is based on a detection of the illumination pattern, and not on an intensity modulation technique, it results less sensitive to light intensity fluctuation independent by measurand than intensity-based sensors. The considered technique is here adopted in order to develop two different configurations for an air flow sensor suitable for the measurement of air flow rates typically occurring during mechanical ventilation of newborns: a mono-directional and a bi-directional transducer have been proposed. A mathematical model for the air flow sensor is here proposed and a static calibration of two different arrangements has been performed.

- **F. P. Branca, S.A. Sciuto, A. Scorza (2012) "Comparative evaluation of ultrasound scanner accuracy in distance measurement", Rev. Sci. Instrum. 83, 105103 (2012)**

The aim of the study is to develop and compare two different automatic methods for accuracy evaluation in ultrasound phantom measurements on B-mode images: both of them give as a result the relative error  $\epsilon$  between measured distances, performed by 14 brand new ultrasound medical scanners, and nominal distances, among nylon wires embedded in a reference test object. The first method is based on a least squares estimation (LSM) while the second one applies the mean value of the same distance evaluated at different locations in ultrasound image (SDM). Results for both of them are proposed and explained.

- **Marinozzi F, F. P. Branca, F. Bini, A. Scorza (2012) "Calibration procedure for performance evaluation of clinical Pulsed Doppler Systems". Measurement, Volume 45, Issue 5, June 2012, Pages 1334–1342**

This paper describes the analysis of an experimental setup for the performance evaluation of Pulsed Doppler feature in clinical ultrasound scanners. The equipment basically consist on a commercial flow phantom made by a straight tube having a known and constant cross sectional area in which a blood mimicking fluid is forced to flow at laminar conditions. Given the accuracy declared by the manufacturer ( $\pm 0.7$  cm/s), unsatisfactory for low flow rates, we calibrated the phantom using the gravimetric method. From the digitized images of the Pulsed Doppler spectra over time, the mean velocities have been computed with the software package developed by the authors. Moreover, to test the calibration procedure in effective conditions, we carried out performance test on five different ultrasound platforms, equipped with phased array and convex array probes with a nominal mean velocity of the blood mimicking fluid ranging from 1.1 cm/s to 12.7 cm/s. The pooled data showed an overestimation of the mean velocity, from over 200% down to about 50%, depending on nominal flow rate and ultrasound equipment. The same data, corrected via the calibration curve, showed a sensible recovery of the estimated accuracy of the tested platforms at low flow rates ( $<3$  cm/s).

- **L. Battista, S.A. Sciuto, A. Scorza (2012) "Experimental characterization of a novel fiber-optic accelerometer for the quantitative assessment of rest tremor in parkinsonian patients", Proceedings of IASTED International Conference on Biomedical Engineering BioMed2012, Innsbruck (Austria) 2012**

A novel fiber-optic accelerometer has been developed for the quantitative assessment of parkinsonian tremor at rest. The transducers is based on a fiber-optic sensing technique that reduce some important drawbacks of biomedical applications, such as patient electrical safety and electromagnetic interference, and allows a non-invasive solution for monitoring of human movement, due to their limited mass. The sensing principle is based on the measurement of the transversal displacement of an emitting optical fiber cantilever due to the acceleration, conducted by means of a photodiode array: the detection of the light intensity profile makes the developed measurement system less sensitive to the light intensity variations independent from acceleration than intensity-based sensors. A dynamic calibration of the optical fiber accelerometer has been performed and a linear relationship between the lateral displacement of the fiber cantilever and acceleration has been experimentally evaluated. Moreover, a flat frequency response function between 3 Hz and 7 Hz (the typical frequency range in which tremor at rest occurs in parkinsonian patients) and an high sensitivity in this frequency range (about 14 pixel/(m·s<sup>-2</sup>)) have been experimentally derived. These metrological features confirm that the proposed measurement system is particularly suitable for the quantitative assessment of parkinsonian tremor at rest.

- **L. Battista, S.A. Sciuto, A. Scorza (2012) "Preliminary evaluation of a simple optical fiber measurement system for monitoring respiratory pressure in mechanically ventilated infants", Proceedings of IASTED International Conference on Biomedical Engineering BioMed 2012, Innsbruck (Austria) 2012**

A novel fiber-optic pressure sensor is proposed for monitoring respiratory pressure in mechanically ventilated infants. The sensor principle is based on the measurement of the displacement of an emitting optical fiber cantilever due to the differential pressure applied on a capsule, performed by means of a photodiode array. The proposed fiber-optic sensing technique can reduce typical drawbacks affecting all biomedical fields, such as patient electrical safety and electromagnetic interference; moreover the device is not sensitive to optical power variations independent by pressure, because it is based on a detection of the illumination pattern of the emitting optical fiber. Two different arrangements of the fiber-optic pressure sensor have been examined: optimal configuration was found when the displacement of a capsule is amplified by means of an optical fiber cantilever, with a measurement range up to 15 cmH<sub>2</sub>O (i.e. the usual range of airway pressures encountered during tidal breathing of infants) and a high sensitivity (2.6 pixel/cmH<sub>2</sub>O) are obtained. The achieved metrological characteristics confirm that the proposed optical fiber pressure sensor is particularly suitable for monitoring respiratory pressure in mechanically ventilated infants and for detecting pressure drops due to infant's inspiratory attempts. The proposed measurement system has been preliminarily verified through simple respiratory tests.



- L. Battista, S.A. Sciuto, A. Scorza (2011) "Preliminary evaluation of a fiber-optic sensor for flow measurements in pulmonary ventilators", *Proceedings of 6th International Symposium on Medical Measurement and Applications MeMeA2011, Bari (Italy) 2011*

A novel optical fiber air flow transducer was developed for monitoring flow rates supplied by infant ventilators. The device is based on a fiber optic sensing technique and overcomes some important problems in biomedical applications, such as electromagnetic interference and possible electrical hazard. The sensing principle is based on measuring the displacement of an emitting optical fiber cantilever by means of a photodiode linear array: the detection of the illumination pattern makes the developed system less sensitive than intensity-based sensors to light intensity source variations. The preliminary evaluation of the relationship between displacement and flow rate is experimentally conducted, as well as a measurement range up to  $3 \cdot 10^{-4} \text{ m}^3/\text{s}$  (18 l/min) has been verified, in accordance to the flow range usual for tidal breathing of infants.

- F.P. Branca, S.A. Sciuto, A. Scorza, L. Battista (2010) "*Sviluppo e analisi comparativa di metodi per la valutazione dell'uniformità di campo per la verifica delle prestazioni di sistemi diagnostici ad ultrasuoni*", *Atti del VIII Congresso Nazionale di Misure Meccaniche e Termiche, Roma 2010*

Nel lavoro si propone l'utilizzo di una definizione specifica del parametro uniformità, inteso come misura della capacità del sistema diagnostico di visualizzare lo speckle di un medesimo tessuto in modo omogeneo all'interno del campo di vista o di una sua parte. In particolare lo studio svolto riguarda la definizione, sviluppo ed implementazione di due metodi finalizzati alla quantificazione dell'uniformità di campo in Imaging Ecografico ed applicabili in laboratorio, o in ambito ospedaliero, durante le procedure di routine per la valutazione delle prestazioni degli apparecchi ecotomografici. Il primo metodo si avvale di un'analisi statistica del primo ordine, condotta sull'istogramma dei livelli di grigio presenti nell'area di definizione del parametro. Il secondo metodo applica alla regione di interesse un algoritmo di pattern recognition specificamente sviluppato allo scopo: tale procedura fornisce come risultato la segmentazione della regione di interesse dipendentemente delle caratteristiche di tessitura riscontrate durante una serie di iterazioni. La dispersione delle caratteristiche suddette viene assunta come indice di disomogeneità ed utilizzata ai fini della misura del parametro uniformità. Entrambi i metodi vengono applicati ad un medesimo insieme di apparecchi ecotomografici al fine di valutarne i risultati ed individuarne prestazioni e limiti.

- S.A. Sciuto, A. Scorza, S. Silvestri "Sviluppo di un reometro per fluidi biologici di disponibilità limitata", *Atti della Giornata di Studio INGEGNERIA BIOMEDICA: progettazione dei materiali protesici ed aspetti clinico-applicativi, Messina 2009.*

Il lavoro si inserisce nell'ambito di uno studio volto alla caratterizzazione dinamica del comportamento delle ossa. Dipendentemente dagli stringenti requisiti derivanti dal tipo di materiale da esaminare (midollo osseo), tra i quali, in particolare, l'assai limitata quantità di fluido disponibile e la sua opacità, non è stato possibile reperire sul mercato uno strumento di caratteristiche appropriate a costi accessibili: ciò ha condotto ad uno studio preliminare delle principali tecniche utilizzate per la misura della viscosità, in modo tale da identificare, sulla base delle limitazioni operative individuate, il metodo più adeguato su cui basare la progettazione e la realizzazione di un dispositivo a basso costo per la misura della viscosità di fluidi biologici. È stato pertanto sviluppato un viscosimetro rotazionale del tipo a cilindri coassiali tra i quali il fluido scorre per trascinamento (viscosimetro assoluto). È stata quindi condotta una valutazione preliminare delle caratteristiche metrologiche dello strumento di misura realizzato mediante l'impiego di fluidi con comportamento reologico noto e sono state valutate la precisione del dispositivo con un livello confidenza pari al 95% e lo scarto percentuale del valore di viscosità misurato rispetto a quello nominale del fluido di riferimento.

- Collaborazione alla stesura del testo: F. P. Branca, "*Fondamenti di Ingegneria Clinica – volume 2: Ecotomografia*", Springer, 2008, ISBN: 9788847007383.

La pubblicazione si articola in 12 capitoli che descrivono gli argomenti di fisica di base, la tecnologia, e le modalità operative per una buona conoscenza del funzionamento degli ecotomografi e contiene più di 400 illustrazioni a colori originali, immagini tecniche e diagnostiche, fotografie e disegni illustrativi, molte delle quali costruite a partire da sperimentazioni condotte in laboratorio o da modelli utilizzati nel corso delle esperienze sulla formazione del fascio ultrasonoro.

- A. Scorza (2009) "A novel method for automatic evaluation of the effective dynamic range of medical ultrasound scanners", *IFMBE Proceedings, Volume 22, Issue 1-3, pages 1607-1611, Springer, 2009, ISBN: 978-3-540-89207-6.*

Quality of imaging in medical ultrasound system can be described by means of parameters such as spatial resolution, accuracy in distance measurements and depth of penetration: despite of their importance, it must be pointed out that the information which can be obtained from an ultrasound image is determined also by the dynamic range of signal levels displayed (gray scale characteristic) and by the minimum detectable changes in echo signal amplitude. Moreover, the knowledge the relationship between echo amplitude and gray level on the image (Gray Scale Mapping Function or GSMF) allows to evaluate the other parameters, like low contrast spatial resolution and depth of penetration, referring to the echo strength and so to the sensitivity of the diagnostic system. If system control settings are carefully selected, the echo range between lower and upper saturation of the GSMF determines the effective dynamic Range (EDR), that is the echo range (in dB) that corresponds to the "useful" gray levels spanned on the image: also EDR can be used as a performance indicator of ultrasound systems. Tissue equivalent test objects (ultrasound phantoms) are today available for direct determination of the gray scale characteristic and minimum detectable echo signal changes: they are usually embedded with large targets of different size and image contrast (contrast target in a background matrix). Contrast target provide a gray scale reference with uncertainty on echo level difference with respect to the background usually over  $\pm 1 \text{ dB}$  and a few points of contrast, moreover they are very expensive. The aim of the present study is the implementation of a novel and less expensive method for the automatic determination of the GSMF and EDR on medical ultrasound scanners: by means of a general purpose ultrasound phantom, the method allows the evaluation of the GSMF by a least squares estimation on the results of the analysis and processing of a series of

uncompressed bi-dimensional ultrasound images directly produced by the scanner. Finally EDR has been investigated on 3 medical ultrasound scanners of different technologies and results are proposed and explained.

- S.A. Sciuto, A. Scorza (2009) "*Preliminary study on a remote system for diagnostic-therapeutic postural measurements*", IFMBE Proceedings, Volume 22, Issue 1-3, pages 110-113, Springer, 2009, ISBN: 978-3-540-89207-6

The study refers to an experimental set up to achieve the remote control of a therapeutic-diagnostic system composed of (a) a local host, connected with (b) a rotating platform, (c) a helmet instrumented with transducers, (d) an audio-video acquisition system and (e) a webcam with microphone. The whole system is able to collect acquired signals related to some diagnostic parameters of a patient submitted to a body rotation applied by in an integrated service of home care assistance. On the basis of available scientific literature, the requirements of measuring and control remote system are investigated and some methods for the optimal data transmission between client (diagnostic station at hospital) and server (measurement station in home care assistance) were implemented by means of a set of virtual tools on Labview and the performances are evaluated. Sinusoidal signals were used to test the proposed device during operative conditions. Frequency sweep test signals were applied to the file server and the comparison between transmitted and received signals was adopted to estimate the effective bandwidth of the whole system. Measurements are carried out in different experimental conditions within city areas. In particular various connection types were tested, such as analogue telephone line and an asymmetric digital subscriber line: results confirm that by an appropriate bandwidth limit can be reached in order to fulfill the diagnostic system requirements.

- S. Conforto, S. A. Sciuto, D. Bibbo, A. Scorza (2009) "*Calibration of a measurement system for the evaluation of efficiency indexes in bicycle training*", IFMBE Proceedings, Volume 22, Issue 1-3, pages 106-109, Springer, 2009, ISBN: 978-3-540-89207-6

Every athlete aims to establish the best performances in his sport activities. This can be reached by means of indications to the athlete on specific parameters to check during his training and so optimizing the effectiveness of the athletic gesture. The present study is developed within a research project on the evaluation, validation and application of efficiency indexes of the athletic gesture in cycling, by means of the measurements of the effective force to the pedal carried on by an Instrumented Pedal (iPed) and displaying measurement results in real time: the final aim is to provide a feedback to the athlete, on the basis of some efficiency indexes, in order to improve the efficiency of the sport performance. The specific goal of this contribution deals with the set-up of the measurement chain and with the implementation of the system calibration. In particular, calibration was performed with known dead weights. During calibration the crosstalk effects between measurement channels have been evaluated and modeled with a cross sensitivity matrix. Accuracy on force measurement is between 3% and 5%. Also angle and power measurements underwent a calibration procedure with a relative uncertainty between 8% and 15% of the measured value. The obtained results validate the iPed and the measurement chain and open wide scenarios for the system applicability. A cycloergometer embedded with an aerodynamic brake has been used for some tests on the efficiency indexes as obtained by athletes during different training sessions. Preliminary evaluations of efficiency indices under controlled conditions are encouraging and seem to confirm the validity of the method.

- F. Marinozzi, F. Bini, A. D'Orazio, A. Scorza (2008) "*Performance Tests of Sonographic Instruments for the Measure of Flow Speed*", Proceedings of 2008 IEEE International Workshop on Imaging Systems and Techniques, Pages 50-55, 2008, DOI: 10.1109/IST.2008.4659939, ISBN: 978-1-4244-2496-2

This paper describes the performance test of the Pulsed Doppler feature of clinical ultrasound platforms of various manufacturers via a blood flow phantom. This is made up by a tissue mimicking material containing a blood mimicking fluid which circulates in a vessel with a constant mean velocity by means of a centrifuge pump. From the digitized images of the Pulsed Doppler spectra over time, the mean and maximum velocities have been computed with a software package developed by the Authors. For laminar flows with a mean velocity ranging from 1.1 +/- 0.7 cm/s and 12.7 +/- 0.7 cm/s, measurements on the blood mimicking fluid were obtained using 7 different ultrasound scanner platforms, equipped with phased array and convex array probes. The pooled data have shown an overestimation of the mean velocity, from over 200 percent down to about 40 percent, depending on nominal flow rate and ultrasound equipment composition.

Autore del trattamento dei miei dati personali ai sensi del D. Lgs. 196/2003

Roma, li 8 marzo 2018

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