Curriculum Vitae et Studiorum

Pietro Cerveri, PhD, Full Professor of Bioengineering

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SHORT RESUME

Pietro Cerveri, holding an MSc in Electronics Engineering (1994) and a PhD in Bioengineering (2001), currently serves as Full Professor of Bioengineering at Università di Pavia (IT) at the Department of Industrial Engineering and Informatics. He is also holding an academic and research appointment with Politecnico di Milano-EssilorLuxottica Smart Eyewear Laboratory. In Pavia, he is lecturer of "Biomedical instrumentation to both bachelor and master degree in Biomedical Engineering. At Politecnico di Milano, he is lecturer of "NeuroEngineering" at master degree in Biomedical Engineering. He is responsible of the Laboratory of Technologies and Intelligence for Health (TIH Lab) at Politecnico di Milano. He is also research fellow at Istituto Auxologico Italiano IRCCS in Milan, where he is responsible for the Laboratory of Innovative Technologies in Sleep Medicine. His recent research activities concern medical robotics, wearable devices and biosensors, AI-based signal/image processing and analysis. His extensive research output comprises over 110 scientific papers, about 50 contributions to international conference proceedings, and national and international patent applications.

His academic development includes notable positions such as a research fellow at the Neuroscience and Bioimages Institute of the National Council of Research (Milan, IT) (1997-1998), a research fellow at National Library of Medicine del National Institute of Health (Bethesda, MD, USA) in Fall 1998, a research fellow at the European Institute of Oncology (2000-2001), and a research fellow at Fondazione Pro Juventute Don Gnocchi (Milan, IT) (2001-2003). In the subsequent years, he contributed significantly to the field as a post-doctoral research fellow at the Bioengineering Department of Politecnico di Milano (2004-2006) and a research scientist at the National Center of Oncologic Hadrontherapy (CNAO, Pave, IT) since 2012.

He has been participating in several research and industrial project, both at national and international levels. Between 2008 and 2010, he actively contributed to the EU project, ROBOCAST (Robotic technologies in neurosurgery), where he assumed the pivotal role of overseeing the "System Integration" workpackage. From 2011 to 2013, he engaged in a Research and Development project funded by the National Center of Oncology Hadron Therapy (CNAO, Pave, IT). His responsibilities extended to spearheading the "Robotic Technology" work package, focusing on the design of a tailored in-room robotic platform for cone-beam CT image acquisition. This innovative platform was dedicated to the assessment and correction of patient positioning. His multifaceted role encompassed various aspects such as robot framework design, room virtualization, robotic motion planning, robot programming, as well as implementing safety measures and software integration. Through his dedicated efforts, he significantly contributed to the successful development and implementation of such advanced robotic technology that was fully functional in clinics since end of 2013. Between 2015-2018, He played a key role in the "4D C.A.P.H." project, generously funded by CNAO. His significant contribution extended to spearheading the "Innovative Techniques for Patient Motion Tracking" work package. Within this role, he delved into the study of neural network architectures aimed at assessing breathing motion during thoracic hadron-therapy. Since 2019, he was workpackage responsible in the R&D project entitled "Robotic imaging system in room 1 for hadron-therapy treatment", funded by CNAO. More recently he has started a research collaboration with Houston Methodist and MD Anderson Cancer Center (Houston, TX) in two main scientific domains namely mathematical modeling of tumor progression and response to therapy, and deep-learning-based multiphoton image processing and analysis. He is currently participating in the project entitled "SMASH-HCM - Stratification, Management, and Guidance of Hypertrophic Cardiomyopathy Patients using Hybrid Digital Twin Solutions" (2004-2027) funded by Horizon-HLTH-20023-tool-05 (Coordinator: Tampere University). He is also task responsible in the PNRR-PE-AI – FAIR Future Artificial Intelligence Research – Spoke 4 Adaptive AI (2022-2025). He is Principal or co-Principal Investigator of the following scientific and R&D projects:

- "Innovative AI-based tools for augmented reality in surgery" (2023-2024, funded by EU PON-FESR 2014-2020 program, Regione Lombardia

- "Artificial intelligence tools for automated image segmentation in PSI-based knee joint replacement surgery" (2021-2024, funded by Medacta International, CH)

- "Analysis of Innovative Wearables for ECG detection" (2023-2024 funded by Huawei, CN)

- "Glass-ECG: A feasibility study" (2023-2024 funded by EssilorLuxottica, IT)

- "GlutenSens: ammonia sensor" (2023-2024 funded by Università degli Studi di Milano, IT)

- "Heartic – Artificial intelligence to fight the coronary disease" (2024-2025 funded by Fondo Beneficenza Intesa Sanpaolo, IT)

- "EEG recording on glasses" (2024-2025 funded by EssilorLuxottica, IT)

- Capacitive sensors for non-invasive monitoring of facial expression" (2024-2025 funded by EssilorLuxottica, IT)

- A Pilot Study for the Application of Virtual Reality to Animal Experimentation Training (2024-2026 funded by Regione Lombardia - Direzione Generale Welfare)

His technical contributions in the Bioengineering field have been recognized with the "Best Innovation Award" at K-Idea – Scientific Technological Park Kilometro Rosso (Bergamo, Italy) in 2008 for the work entitled "Robotic technologies for vision in mini-invasive transluminal endoscopic surgery". In 2022, he was awarded at a Finalist Seed4Innovation – Fondazione Unimi, Università degli Studi di Milano for the invention "GlutenSens: an innovative tool for portable gluten detection". In 2023, he was awarded as a Finalist of Switch2Product – Politecnico di Milano with the proposal entitled "SegMentor: AI tools for automatic digital 3D anatomical model reconstruction from medical imaging.

RELEVANT CONTRIBUTION TO SCIENCE
The leading themes throughout the recent research trajectory have been focused on innovative methodologies and biomedical instrumentation in the fields of oncology, orthopaedics and cardiovascular diagnosis and treatment

- METHODS AND TECHNOLOGIES IN ONCOLOGY

Image processing

1. Rossi M, Belotti G, Mainardi L, Baroni G, <u>Cerveri P</u>, Feasibility of proton dosimetry overriding planning CT with daily CBCT elaborated through generative artificial intelligence tools. (2024) Comput Assist Surg (Abingdon), 29(1):2327981.

2. Sarti M, Parlani M, Diaz-Gomez L, Mikos AG, <u>Cerveri P</u>, Casarin S, Dondossola E, Deep learning systems for automated analysis of cellular and extracellular components of the foreign body response in multiphoton microscopy images. Frontiers in Bioengineering and Biotechnology. (2022), 25;9:797555.

3. Rossi M, Belotti G, Paganelli C, (...), <u>Cerveri P</u>, Baroni, G., Image-based shading correction for narrow-FOV truncated pelvic CBCT with deep convolutional neural networks and transfer learning. (2021), Medical Physics, 48(11):7112-7126.

4. Rossi M., <u>Cerveri P</u>, Comparison of supervised and unsupervised approaches for the generation of synthetic CT from cone-beam CT. (2021) Diagnostics, 11(8),1435.

5. Montin E, Belfatto A, Bologna M, (...), <u>Cerveri P</u>, Mainardi L, A multi-metric registration strategy for the alignment of longitudinal brain images in pediatric oncology. (2020), Medical and Biological Engineering and Computing, 58(4):843-855.

Medical robotics

1. Belotti G, Rossi M, <u>Cerveri P</u>, Baroni G, A new system for in-room image guidance in particle therapy at CNAO. (2023) Physica Medica: European Journal of Medical Physics, 114:103162.

2. Fattori G, Riboldi M, Pella A, Peroni M, <u>Cerveri P</u>, Desplanques M, Fontana G, Tagaste B, Valvo F, Orecchia R, Baroni G, Image guided particle therapy in CNAO room 2: Implementation and clinical validation. (2015) Physica Medica, 31(1):9-15.

3. Fattori G, Saito N, Seregni M, Kaderka R, Pella A, Constantinescu A, Riboldi M, Steidl P, <u>Cerveri P</u>, Bert C, Durante M, Baroni G, Commissioning of an Integrated Platform for Time-Resolved Treatment Delivery in Scanned Ion Beam Therapy by Means of Optical Motion Monitoring. (2014) Technol Cancer Res Treat. 13(6):517-28.

4. Pella A, Riboldi M, Tagaste B, Bianculli D, Desplanques M, Fontana G, <u>Cerveri P</u>, Seregni M, Fattori G, Orecchia R., Baroni G, Commissioning and Quality Assurance of an Integrated System for Patient Positioning and Setup Verification in Particle Therapy. (2014) Technol Cancer Res Treat. 13(4):303-14.

Tumor motion tracking in radio- and hadron-therapy

1. Fassi A, Seregni, M, Riboldi M, <u>Cerveri P</u>, Sarrut D, Ivaldi G, Liotta M, Baroni G, Surrogate-driven deformable motion model for organ motion tracking in particle radiation therapy. (2015) Phys Med Biol. 60(4):1565-1582.

2. Seregni M, Kaderka R, Fattori G, Riboldi M, Pella A, Constantinescu A, Saito N, Durante M, <u>Cerveri P</u>, Bert C, Baroni G, Tumor tracking based on correlation models in scanned ion beam therapy: an experimental study. (2013) Phys Med Biol, 58(13):4659-78.

3. Seregni M, <u>Cerveri P</u>, Riboldi M, Pella A, Baroni G, Robustness of external/internal correlation models for real-time tumor tracking to breathing motion variations. (2012) Phys Med Biol, 57(21):7053-7074.

Mathematical modeling tumor progression and therapy response

1. Belfatto A, Jereczek-Fossa BA, Baroni G,<u>Cerveri P</u>P, Model-supported radiotherapy personalization: In silico Test of Hyper- and Hypo-Fractionation Effects (2018) Frontiers in Physiology, 9:1445.

2. Belfatto A, Vidal Urbinati AM, Ciardo D, Franchi D, Cattani F, Lazzari R, Jereczek-Fossa BA, Orecchia R, Baroni G, <u>Cerveri P</u>, Comparison between model-predicted tumor oxygenation dynamics and vascular-/flow-related Doppler indices., (2017) Med Phys. May;44(5):2011-2019.

3. Belfatto A, Riboldi M, Baroni G, Ciardo D, Cecconi A, Lazzari R, Jereczek-Fossa B, Orecchia R, <u>Cerveri P</u>, (2016) Adaptive mathematical model of tumor response to radiotherapy based on CBCT data. IEEE J Biomed Health Inform. 20(3):802-809.

4. Belfatto A, Riboldi M, Ciardo D, Cattani F, Cecconi A, Lazzari R, Jereczek-Fossa BA, Orecchia R, Baroni G, <u>Cerveri P</u>, Modeling the Interplay Between Tumor Volume Regression and Oxygenation in Uterine Cervical Cancer During Radiotherapy Treatment. (2016) IEEE J Biomed Health Inform., 20(2):596-605.

Towards exhaled breath analysis using biosensors for early cancer detection

1. Rescalli, A; Marzorati D, Gelosa S, Cellesi F, <u>Cerveri P</u>, Temperature Modulation of MOS Sensors for Enhanced Detection of Volatile Organic Compounds. (2023) Chemosensors, 11, 501.

2. Marzorati D, Mainardi L, Sedda G, Gasparri R, Spaggiari L, <u>Cerveri P</u>, Mos sensors array for the discrimination of lung cancer and at-risk subjects with exhaled breath analysis. (2021) Chemosensors, 9(8),209.

3. Marzorati D, Mainardi L, Sedda G, Gasparri R, Spaggiari L,<u>Cerveri P</u>, A review of exhaled breath: A key role in lung cancer diagnosis. (2019) Journal of Breath Research, 13(3).

- METHODS IN ORTHOPEDIC SURGERY

Statistical shape bone models

1. <u>Cerveri P</u>, Belfatto A., Manzotti A, Representative 3D shape of the distal femur, modes of variation and relationship with abnormality of the trochlear region (2019) Journal of Biomechanics, 94, 67-74.

2. <u>Cerveri P</u>, Belfatto A, Manzotti, A. Pair-wise vs group-wise registration in statistical shape model construction: representation of physiological and pathological variability of bony surface morphology (2019) Computer Methods in Biomechanics and Biomedical Engineering, 22 (7),772-787

3. <u>Cerveri P</u>, Belfatto A, Baroni G, Manzotti A, Stacked sparse autoencoder networks and statistical shape models for automatic staging of distal femur trochlear dysplasia (2018) International Journal of Medical Robotics and Computer Assisted Surgery, 14(6),e1947.

4. <u>Cerveri P</u>, Sacco C, Olgiati G, Manzotti A, Baroni G, 2D/3D reconstruction of the distal femur using statistical shape models addressing personalized surgical instruments in knee arthroplasty: A feasibility analysis, (2017) International Journal of Medical Robotics and Computer Assisted Surgery, 13(4).

Image processing

1. Marsilio L, Moglia A, Rossi M, Manzotti A, Mainardi L., <u>Cerveri P</u>, Combined Edge Loss UNet for Optimized Segmentation in Total Knee Arthroplasty Preoperative Planning. (2023) Bioengineering, 10(12), 1433.

2. Moglia ., Marsilio L, Rossi M, Pinelli M, Lettieri E, Mainardi L, Manzotti A, <u>Cerveri P</u>, Mixed Reality and Artificial Intelligence: a Holistic Approach to Multimodal Visualization and Extended Interaction in Knee Osteotomy. (2024) IEEE Journal of Translational Engineering in Health and Medicine, 12:279-290.

3. Rossi M, Marsilio L, Mainardi L, Manzotti A, <u>Cerveri P</u>, CEL-Unet: distance weighted maps and multi-scale pyramidal edge extraction for accurate osteoarthritic bone segmentation in CT scans. (2022), Frontiers in Signal Processing, 857313.

4. Marzorati D, Sarti M, Mainardi L, Manzotti A, <u>Cerveri P</u>, Deep 3D Convolutional Networks to Segment Bones Affected by Severe Osteoarthritis in CT Scans for PSI-based Knee Surgical Planning. (2020), IEEE Access 8:196394–19640.

Computer-assisted surgery

1. Manzotti A, Colizzi M, Brioschi D, <u>Cerveri P</u>, Larghi M M, Grassi M Preoperative infection risk assessment in hip arthroplasty a matched-pair study of the reliability of 3 validated risk scales. (2023) Acta Orthopaedica Belgica, 89(4):613-618.

2. Larghi M M, Grassi M, Placenza E, Faugno L, <u>Cerveri P</u>, Manzotti A, Septic arthritis following joint injections: a 17 years retrospective study in an Academic General Hospital. Acta Biomed. (2022) 19;92(6):e2021308.

3. Manzotti A, Larghi M M, Schianchi A, (...), Pullen C, <u>Cerveri P</u>, Femoral Neck Fractures in HIV- Positive Patients: Analysis of 10 Years Short-Term Post-operative Complications. (2021), Malaysian Orthopaedic Journal, 15(3):65-70.

- WEARABLE SENSORS AND AI-BASED TOOLS FOR BIOSIGNAL ACQUISITION AND PROCESSING

Artificial Intelligence-based Processing

1. Rossi M, Sala D, Bovio D, Salito C, Alessandrelli G, Lombardi C, Mainardi L, <u>Cerveri P</u>, SLEEP- SEE-THROUGH: Explainable Deep Learning for Sleep Event Detection and Quantification From Wearable Somnography, IEEE J Biomed Health Inform 2023 27(7):3129-3140.

2. Rossi M, Alessandrelli G, Dombrovschi A, Bovio D, Salito C, Mainardi L, <u>Cerveri P</u>, Identification of Characteristic Points in Multivariate Physiological Signals by Sensor Fusion and Multi-Task Deep Networks, (2022) Sensors, 22 (7), 2684.

3. Marzorati D, Dorizza A, Bovio D, Salito C, Mainardi L, <u>Cerveri P</u>, Hybrid convolutional networks for end-to-end event detection in concurrent PPG and PCG signals affected by motion artifacts. (2022) IEEE Transaction on Biomedical Engineering, 60(8):2512-2523.

4. Marzorati D, Bovio D., Salito C., Mainardi L, <u>Cerveri P</u>, Chest Wearable Apparatus for Cuffless Continuous Blood Pressure Measurements Based on PPG and PCG Signals (2020), IEEE Access 8, 9037228, pp. 55424-55437.

UNIVERSITÀ
DI PAVIA

CAREER AND APPOINTMENTS

- 1994 MSc Electronic Engineering - Politecnico di Milano (Milano, Italy). 1996-1997 Research Fellow at National Research Council (Milano, Italy). 1998 Research Fellow at National Library of Medicine del National Institute of Health (Bethesda MD- USA).

- 1998 – 2001 PhD candidate in Bioengineering at Politecnico di Milano. 2001 PhD degree in Bioengineering at Politecnico di Milano.

- 2001 – 2003 Research Fellow at Bioengineering Department, Politecnico di Milano.

- 2006 – 2008 Research Consultant at Bioengineering Department, Politecnico di Milano.

- 2008 – 2015 Assistant professor, Politecnico di Milano.

- 2012 – present Board Member of PhD Degree Program in Bioengineering, Politecnico di Milano.

- 2014 National Scientific Qualification (art. 16 Law 240/2010) Competition Sector 09/G2 BIOINGEGNERIA as Associate Professor from Italian Minister of Education, University and Research.

- 2015 – 2024 Associate Professor of Bioengineering, Politecnico di Milano.

- 2017 National Scientific Qualification (art. 16 Law 240/2010) Competition Sector 09/G2 BIOINGEGNERIA as Full Professor from Italian Minister of Education, University and Research (30/03/2017- 30/03/2028).

- 2022 – present Responsible of the Laboratory of Innovative Technologies in Sleep Medicine - Istituto Auxologico Italiano IRCCS (Milan – Italy).

- 2023 – present Responsible of the Laboratory of Technologies and Intelligence for Health (TIH Lab), Politecnico di Milano.

- 2023 – present, Research appointment at EssilorLuxottica Smart Eyewear Lab (Milan – Italy).

- 2024 – present Full Professor of Bioengineering, Università di Pavia (Pavia, Italy).

- 2024 – 2026 Research and academic appointment at Politecnico di Milano.

ADVANCED EDUCATION

- 1997 "Projective geometry for Computer Vision", London Royal Society (London - UK)

- 1998 "Specific and quality control of information system: object-oriented and formal methods", Politecnico di Milano.

- 1999 "Object-oriented language and JAVA", CILEA Segrate (Milano - Italy).

- 2005 "ITK Advanced Course", Ecole Polithecnic Federal Lausanne, (Lausanne - CH).

- 2008 "Interface, supervision and control programming for KAWASAKI robotic platforms", TIESSEROBOT (Brescia - Italy).

TEACHING

- 1998 – 2000 Teacher assistant of "Medical Informatics" Master Degree in Biomedical Engineering, School of System Engineering at Politecnico di Milano.

- 1998 – 2001 Teacher of "Information Technologies for Clinical Data Management", Accademia di Bergamo per le Scienze Avanzate Villa Elios (Bergamo - Italy).

- 1999 – 2000 Teacher of "Information technologies in Medicine", Master program "Information Technology" – CEFRIEL (Milano - Italy).

- 2001 – 2006 Teacher assistant of "Fundamentals of Electronics Enginering" Bachelor Degree in Biomedical Engineering, School of System Engineering at Politecnico di Milano.

- 2002 – 2003 Lecturer of "Electronic technologies in Biomedical Engineering", PhD degree in Bioengineering - Politecnico di Milano.

- 2004 – 2007 Teacher assistant of "Biosensors and Microtechnologies" Master Degree in Biomedical Engineering, School of System Engineering at Politecnico di Milano.

- 2005 – 2008 Lecturer of "Computer assisted surgery in orthopaedics", Master program "Engineering and Surgery" - Politecnico di Milano (Milano - Italy).

- 2003 – 2008 Lecturer of "Cognitive System Engineering" , Master degree in Biomedical Engineering – School of System Engineering - Politecnico di Milano (Milano - Italy).

- 2009 – 2024, Reader of "Neuroengineering part I" (5CFU), Master degree in Biomedical Engineering – School of Industrial and Information Engineering - Politecnico di Milano (Milano - Italy).

- 2015 – 2024 time, Reader of "Laboratory of Biomedical Technologies and Biosensors" (5 + 5 CFU – I and II semenster), Master degree in Biomedical Engineering – School of Industrial and Information Engineering - Politecnico di Milano (Milano - Italy).

- 2022 – present time, Reader of "AI Methods For Bioengineering Challenges" (5CFU), PhD Program in Bioengineering – Politecnico di Milano.

- 2024 - 2025 Reader of "Biomedical Instrumentation", Bachelor degree in Biomedical Engineering – School of Engineering – Università di Pavia.

- 2024 - 2025 Reader of "Biomedical Instrumentation", Master degree in Biomedical Engineering – School of Engineering – Università di Pavia.

SCIENTIFIC AND CLINICAL COLLABORATIONS

- Istituto Auxologico Italiano IRTCCS, Milan (IT) – Prof. Carolina Lombardi
  Methods and wearable technologies for sleep detection and analysis

- Hospital ASST FBF-Sacco, Milan (IT) – Dr. Alfonso Manzotti
  AI-based techniques for image processing in orthopedics

- Houston Methodist (Houston TX) – Prof. Stefano Casarin
  Mathematical modeling for tumor response to therapy

- MD Anderson Cancer Center (Houston TX) – Dr. Eleonora Dondossola
  Histopathological multiphoton image analysis using deep learning

- University of Porto (Porto, PT) - Prof. Francesco Renna
  Heart sonography

- University of Vicosa (Vicosa, Minas Gerais, BR) – Prof. Amanda Silvatti
  Sport data science

- University of Dundee (Dundee, Scotland UK) – Prof. Sir Alfred Cuschieri
  LLM in medicine

- University of Washington (Washington, WA) – Prof. Richard M. Satava
  LLM in medicine

- University of North Carolina at Chapel Hill (NC), Prof. Koji Sode
  MOSFET sensors for organic compound detection in biofluids

DEVELOPMENT OF THE TECHNICAL AND SCIENTIFIC CAREER

Following the work done during the master thesis period, his scientific research activity developed initially in the field of video-based 3D human motion capture and kinematic analysis. He specifically addressed automatic calibration of multi-camera systems and motion tracking methodologies in collaboration with the company BTS Engineering (Milano, IT). The main achievement was the development of a fully automatic methodologies for calibrating a multi-camera system using a single rigid bar exploiting epipolar geometry, absolute conic invariance and evolutionary optimization. The PhD program in Bioengineering, co-funded by National Institute of Health (Bethesda, MD - USA), was focused on different topics, namely knowledge representation and methodologies for medical image processing and analysis. He designed and implemented an integrated Java-based SW framework to join symbolic to visual-based information in volumetric diagnostic images, exploiting semantic networks and content-based access to database. During this period, he also cooperated with European Institute of Oncology (Milano, IT) in the field of bioinformatics. The main achievement was the development of SW platform able to manage and process hundreds of thousand complex genomic data acquired through micro, gene-chips, oligonucleotides array (genomic differential expression data) to evaluate the differential gene expression in a single experiment (i.e. test vs. control condition) and the determination of gene regulation (i.e. significant differential gene expression) across multiple replica experiments. After the PhD period, he extended the research in the field of human motion analysis proposing pioneering methods, mimicking human perception, integrating kinematic models and predictive filters. The main achievement was the development of a 3D human-motion tracking method, able to work even with a single camera, addressing into an integrated framework kinematic model uncertainty and soft tissue artifacts. He focused on kinematic modeling proposing static- and dynamic-based methods to model human joints of the specific subject and studied motion synthesis approaches based on neural networks. He then extended the research activity to computer assisted surgery (CAS) and medical imaging. He was involved in projects in the field of CAS techniques for Orthopaedic surgery (in collaboration with Lima Spa, Udine, IT) dealing with image-based and image-less navigation approaches for knee and hip joint replacement surgery. He developed registration algorithms based on bone-morphing, method to compute intra-operatively the limb mechanics starting from measurements of points or areas on the bone surfaces, automatic methods to track in 3D surgical instruments, procedures to compute the optimal positioning and size of the prosthesis, and finally methods for real-time visualization. In collaboration with San Bortolo Hospital (Vicenza, IT), he investigated medical imaging techniques and processing, especially for volumetric image registration, applied to the neuro-radiosurgery field. In collaboration with Ist Orthopaedic Department, C.T.O. Hospital, Istituti Clinici di Perfezionamento, (Milano, IT), he developed automatic approaches for orthopedic surgery planning proposing operator-free methods for determining the clinical parameters of interest on a patient-specific basis from diagnostic CT and MRI imaging and 3D bone models as well. He then addressed medical robotics from the system integration point of view in different national and international projects, spanning orthopedics (Orthorob project), neurosurgery (Robocast Project) and radiotherapy (In-Room Imaging project). In this last activity, the main achievement was the assembly of an in-room robotic platform, devoted to patient alignment in hadron-therapy, carrying a C-arm for cone-beam CT image acquisition, in collaboration with National Center of Oncology Hadron Therapy (CNAO, Pave, IT) and TiesseRobot (Visano, Brescia, IT). The work was extremely complex and challenging, with responsibility of the robot installation design, room virtualization and robotic motion planning, robot programming, safety measures and SW integration. The installation is fully functional and used clinically since the end of 2013. In collaboration with CNAO, he was involved in activities for the development of innovative methods for monitoring the motion of the patient during the radiotherapy treatment based on artificial neural networks. In the field of human motion analysis and robotics he has been a participant to a national project funded by Italian Ministry of Education, University and Research. "Biomechatronic hand prostheses endowed with bio-inspired tactile perception, bi-directional neural interfaces and distributed sensori-motor control". Since 2018, he extended its research interest to the field of oncological modeling to investigate new mathematical approaches to predict tumor regression response to radiation and chemo-therapy of cervical cancer in collaboration with European Institute of Oncology (Milano, IT). He also contributed to the development and testing of biosensors for exhaled breath analysis in the domain of early diagnosis of lung tumor. In 2019, he extended his collaboration with CNAO towards the implementation of an innovative in-room robotic platform dedicated to acquiring cone-beam

CT images, featuring an expanded field- of-view to properly address hadron-therapy treatment of thoracic, abdominal and pelvic districts. Coping with this specific need, he conceptualized and engineered a sophisticated motor system to precisely shift the flat panel in relation to the radiographic tube. This transformation enabled the transition from the conventional full-fan acquisition to a more advanced double half-fan acquisition mode scan. Following meticulous design and development, the system successfully underwent comprehensive commissioning, reaching completion by the close of 2023. Anticipated to be fully operational for clinical use by Spring 2024, this technological advancement marks a significant stride in enhancing imaging capabilities within the medical field. Recently, he has expanded his scientific endeavors into the realm of machine and deep learning, specifically focusing on signal and image processing and analysis. A notable collaboration has been initiated with Houston Methodist and MD Anderson Cancer Center (Houston, TX), delving into two primary scientific domains: mathematical modeling of tumor progression and response to therapy, and the application of deep learning in multiphoton image processing and analysis. Notably, he has devised groundbreaking deep neural architectures for CT image segmentation and bone surface reconstruction, particularly for applications in orthopedic surgical planning. This collaborative effort involves partnering with Medacta International SA (CH). Additionally, his scientific and technical advancements have highlighted a compelling convergence of wearable sensors and artificial intelligence, particularly in the realms of cardiovascular and sleep monitoring. The research contributions underscore a steadfast dedication to advancing the field through innovative approaches and cutting-edge methodologies, particularly evident in the domain of sleep monitoring. Collaborative projects with Biocubica srl and Istituto Auxologico IRCCS (Milan, IT) exemplify this commitment. Furthermore, in the arena of wearable sensors, he is pioneering the development of new technologies integrated into glasses, aimed at recording both ECG and EEG, through a collaborative effort with Essilor/Luxottica (IT, FR).

PARTICIPATION IN SCIENTIFIC RESEARCH AND INDUSTRIAL PROJECTS

1. Scientific research projects

- 2024-2027 PhD executive funded by STMICROELECTRONICS srl, "Real-time data analysis for electrical wafer sorting", role: **P.I.** - Politecnico di Milano (40k€).
- 2024-2025 R&D project funded by Fondo Beneficenza Intesa Sanpaolo B/2023/0201 (IT) "Heartic – Artificial Intelligence to fight the coronary disease", role: **P.I.** - Politecnico di Milano (67k€).
- 2024-2025 R&D project funded by EssilorLuxottica (IT) "EEG recording on glasses", role: co **P.I.** - Politecnico di Milano (148k€).
- 2023-2024 European Research Project POR-FESR 2014-2020 - Lombardia Region ARIA-2020-403 - "REFINE: ImmeRsive surgEry through artiFicial intelligence, mixed reality, Integration of multi-modal data and augmeNted interaction – Phase III", Role **P.I.** - Politecnico di Milano. (330k€).
- 2024-2027 Horizon-HLTH-20023-tool-05 "SMASH-HCM - Stratification, Management, and Guidance of Hypertrophic Cardiomyopathy Patients using Hybrid Digital Twin Solutions", (Coordinator: Tampere University), role: Task Responsible - Politecnico di Milano Unit (698k€). 2023-2024 R&D funded by Università degli Studi di Milano (IT) "Gluten-Sens: ammonia sensor", role: co **P.I.** - Politecnico di Milano (30k€).
- 2023-2024 R&D funded by Fondazione UNIMI (IT) "Gluten-Sens: electronic transducer", role: **P.I.** - Politecnico di Milano (30k€).
- 2023-2024 R&D funded by EssilorLuxottica (IT) "Glass-ECG: A feasibility study", role: co **P.I.** - Politecnico di Milano (143k€).
- 2023-2024 R&D funded by Huawei (CN) "Analysis of innovative wearables for ECG detection", role: co **P.I.** - Politecnico di Milano (50k€).
- 2022-2025 PNRR-PE-AI – FAIR Future Artificial Intelligence Research – Spoke 4 Adaptive AI, PI N. Gatti - Politecnico di Milano. role: Task Responsible (150k€).
- 2022-2023 Precommercial procurement R&D funded by POR-FESR Lombardia 2014-2020 - "REFINE: ImmeRsive surgEry through artiFicial intelligence, mixed reality, Integration of multi-modal data and augmeNted interaction – Phase II", role: P.I. - Politecnico di Milano. (358k€).

- 2022-2023 Precommercial procurement R&D funded by EU Por-Creo-FESR Toscana 2014-2020 "SMART: A System for Multi-imaging Advance Remote control and Tele-medicine in ablation treatment of the prostate" role: co **P.I.** - Politecnico di Milano (82k€).

- 2021-2023 R&D funded by Medacta International (Castel San Pietro, CH). "AI tools for automatic image segmentation in PSI-based joint replacement surgery" role: **P.I.**, - Politecnico di Milano (70k€).

- 2020-2021 Precommercial procurement R&D funded by POR-FESR 2014-2020 - ASST Pavia "CAPTURE: Technology innovation for the evaluation of the fragility of the coronary atherosclerotic plaque – Phase II", P.I. G. Dubini - Politecnico di Milano. Role – WP responsible (460k€).

- 2019-2023 R&D funded by CNAO (Centro Nazionale di Adroterapia Oncologica, Pavia Italy). "Robotic imaging system in room 1 for hadron-therapy treatment". P.I. G. Baroni - Politecnico di Milano. Role: WP responsible (350k€).

- 2019-2020 Precommercial procurement R&D funded by POR-FESR 2014-2020 - ASST Pavia "CAPTURE: Technology innovation for the evaluation of the fragility of the coronary atherosclerotic plaque – Phase I", P.I. G. Dubini - Politecnico di Milano. Role: WP responsible (120k€).

- 2018-2020 Research Project funded by European Institute of Oncology (Milano, Italy). "Study and development of new approaches to lung tumor diagnosis based on breath exhale detection and analysis". Role: **P.I.** (70k€).

- 2017-2018 R& project funded by Kawasaki Robotics and TiesseRobot (BS, Italy). "Sensor integration for real-time robot cooperation for Kawasaki-based robotic platforms". Role: P.I. (25k€). 2015-2018 Research Project funded by CNAO (Centro Nazionale di Adroterapia Oncologica, Pavia Italy). "4D C.A.P.H.: Four-Dimensional Computer Aided Positioning for Hadrontherapy". P.I. G. Baroni - Politecnico di Milano. Role: WP responsible (520k€).

- 2013-2015 National Project funded by Italian Ministry of Education, University and Research. "Biomechatronic hand prostheses endowed with bio-inspired tactile perception, bi-directional neural interfaces and distributed sensori-motor control". P.I. Prof. E. Guglielmelli - Università "Campus Bio- Medico" Roma - Italy. Role: Co-Responsible of the Politecnico di Milano Research Unit (1.2M€).

- 2012-2014 National Project funded by AIRC "Short-term high precision radiotherapy for early prostate cancer with concomitant boost on the dominant lesion". P.I. Dr. B. A. Alicja Jereczek – IEO (Milano – Italy). Role: Participant Politecnico di Milano Operative Unit (150k€).

- 2012-2013 R& project funded by CNAO (Centro Nazionale di Adroterapia Oncologica, Pavia Italy). "Development of a robotic imaging system for hadron-therapy treatment room". P.I. G. Baroni - Politecnico di Milano. Role: WP responsible (560k€).

- 2010-2013 European Research Project: "ULICE - Union of Light Ion Centers in Europe" FP7-INFRA- 2008-1.1.2). P.I. Prof. R. Orecchia CNAO. Role: participant (8.5M€). 2010-2013 European Research Project: "ENVISION - European NoVel Imaging Systems for ION therapy" N. 241851. P.I. Dr. M. Donsanj, CERN (Geneva – CH). Role: participant (6.5M€).

- 2010-2014 International Research Project: "CRISP - International Dual Degree in Computing, Robotics and Imaging for Surgery Platform" funded by European Commission Programme EU-US Atlantis programme, cooperation in higher education and training. P.I. Prof. G. Baselli - Politecnico di Milano. Role: Scientific and Technical Responsible (144k€).

- 2010-2012 National Project funded by Ministry of Education and University: Innovative modular micro robotic instruments for transluminal endoscopic surgery". P.I. Prof. R. Molfino, University of Genova (Genova – Italy). Role P.I of Politecnico di Milano Research Unit. (135k€).

- 2010 International Research Project funded by University of Campinas Foundation and CAPES (Brasil). "Methods and technologies in Sport Science". (60k€). P.I. Prof. R. Machado Leite De Barros University of campinas (BR). Role: Brasilian PhD student supervisor.

- 2009-2010 International Project funded by European Space Agency: TEC-MMG/2009/8 "Self propelled Instrument Carrier for surgery through natural orifices". role: **P.I.** - Politecnico di Milano (25k€).

- 2008-2010 European Project: FP7-ICT-2007-215190 "ROBOCAST: ROBOt and sensors integration for Computer Assisted Surgery and Therapy". Theme: Advanced robotics for neurosurgery. P.I. Prof. G. Ferrigno - Politecnico di Milano. Role: WP responsible (3.5M€).

- 2007-2009 Interuniversity project funded by Politecnico di Milano and Politecnico di Torino "ORTHOROB, ORTHOpaedic Surgery and ROBotics" P.I. Prof. G. Ferrigno - Politecnico di Milano. Role: WP responsible (75k€).

- 2007 Regional Collaborative Research Project funded by FSE INGENIO and Lombardia Region. "New technologies for surgical navigation", role: **P.I.** - Politecnico di Milano (30K€).

- 2005-2007 National Research Project funded by San Bortolo Hospital (Vicenza, Italy). "Innovative methods for 3D image registration in the domain of radiosurgery using the CyberKnife". P.I. Dr. C. Francescon - San Bortolo Hospital (Vicenza – Italy). Role: WP participant (70k€).

- 2005-2006 National Industrial Research Project funded by LIMA Lto (Udine, Italy). "Technologies and methods for surgical navigation in knee and hip arthroplasty". P.I. Prof. G. Ferrigno - Politecnico di Milano. Role: WP responsible (350k€).

- 2005-2006 National Industrial Development Project funded by DIES srl (Roma, Italy) "VIMS : An innovative system for surgical training in ophthalmic mini-invasive surgery". P.I. Prof. N.A. Borghese - Università degli Studi di Milano (Milano – Italy). Role: WP responsible (70k€).

- 2005-2006 National Research Project HINT-Lecco funded by Fondazione CARIPLO. "Biomechanical models of the hand and methods for parameter estimation in the domain of Haptics " P.I. Prof. C. Frigo - Politecnico di Milano. Role: participant.

- 2002-2004 National Industrial Development Project funded by BTS Engineering (Milano, Italy): "Model-based human motion tracking" P.I. Prof. G. Ferrigno - Politecnico di Milano. Scientific and technical responsible (60k€).

- 1999-2003 National Research Project funded by ASI (Italian Space Agency): "ELITE-S2": P.I. Prof. G. Ferrigno - Politecnico di Milano. Role: WP responsible (440K€). 2000-2002 National Research Project funded by IEO – European Oncology Institute (Milano, Italy), "Development and implementation of new methodologies for management and analysis of large scale micro-array genomic data. Studies of differential regulation." P.I. Dr. P.G. Pelicci – European Oncology Institute. Role: WP responsible (75k€).

- 1998-2000 International Research Project: "Visible Human Dataset". P.I. Dr. M.J. Ackerman, National Library of Medicine, NIH Bethesda, (MD - USA). Responsible of Politecnico di Milano Research Unit: F. Pinciroli. Role: participant (45k€).

- 1998-2000 National Project funded by Ministry of Education, University and Research: "Development of Software Agents for Healthcare Information Systems" P.I. Prof. M. Stefanelli – University of Pavia. Role: participant (110k€).

- 1998-1999 National Research Project funded by ASI (Italian Space Agency): "ELITE-S2 Phase A Feasibility study 2000 PI": P.I. Prof. G. Ferrigno - Politecnico di Milano. Role: participant (125K€).

- 1997-1999 European Research Project: EC Brite-EuRam Project BE96-3433 "ANNIE: Application of Neural Networks to Integrated Ergonomics," Responsible of Politecnico di Milano Research Unit: Prof. G. Ferrigno. Role: participant (2.8M€).

- 1997-1998 National Industrial Research Project co-funded by BTS Engineering and Centro di Bioingegneria Fondazione Don Gnocchi (Milano, Italy). "Innovative calibration techniques in human motion capture" P.I. Prof. A. Pedotti - Politecnico di Milano. Role: participant (30k€).

2. Industrial development projects

- 2005-2006 DS Medica srl (Milano, IT): 3D anatomical models for dermatological inspection

- 2005 Valtechnic SNC and Rally-art Mitsubishi-Italia (Como, IT): dynamic supervision of a rally car using distributed sensors: feasibility analysis, data acquisition and processing methods.

- 2004-2005 Netcont srl (Milano, IT): web-based distributed framework for finance data management, processing and visualization

- 2000 Electronic Arts Canada (Vancouver - British Columbia, CA): automated multi-camera calibration algorithms

- 1998 BTS Engineering (Milano, IT): analysis of commercial motion capture systems and potentiality for entertainment

- 1998 National Library of Medicine - National Institute of Health (Bethesda MD, USA): semantic-based multimedia management framework.

EDITORIAL AND SCIENTIFIC REVIEWING ACTIVITIES

1. Scientific Reviewer

   - Annals of Biomedical Engineering (Biomedical Engineering Society); BMC Medical Imaging; Clinical Biomechanics; Computer Methods in Biomechanics and Biomedical Engineering; Computerized Medical Imaging and Graphics; IEEE Transaction on Pattern Analysis and Machine Intelligence (Institute of Electronic and Electrical Engineering); IEEE Transaction Biomedical Engineering (Institute of Electronic and Electrical Engineering); International Journal of Medical Robotics and Computer Assisted Surgery;Journal of Neuroscience Methods (Elsevier Science); Journal of Biomechanics; Medical & Biological Engineering & Computing ; Medical Engineering & Physics; Medical Physics; Sports Biomechanics;

2. Associate editor

   - Medical Physics
   - Brazilian Journal of Sport Science

3. Editorial Board

   - Brazilian Journal of Sport Science
   - International Journal of Orthopaedics
   - The Scientific Pages of Orthopedic Surgery
   - Frontiers in Physiology

4. International Project Reviewer

   - (06/2009 - 07/2009) Evaluator expert EU ICT for Health, under Call 4 of the Information and Communication Technologies Theme of FP7. Call Objective ICT-2009.5.2: Patient Safety (PS)

   - (11/2011 - 01/2012) Evaluator expert Natural Sciences and Engineering Research Council of Canada. Collaborative Health Research Projects Selection Panel NSERC/CRSNG.

   - (06/2015 - 07/2015) Evaluator expert H2020 ICT-24 Robotics. Call Objective Robotics

AWARDS, CONFERENCE CHAIR AND INVITED LECTURES

- 2024 Special Session Organization entitled "Challenges with novel wearable sensor technologies" at MeMeA

- 2023 Finalist Award of Switch2Product – Politecnico di Milano" – "SegMentor: AI tools for automatic digital 3D anatomical model reconstruction from medical imaging

- 2023 Invited lecture "An introduction to Artificial Intelligence with applications in reproductive medicine", 2nd Meeting Reproduction Health: what is the future?, 5-6 May 2023, Regina palace Hotel, Stresa VB.

- 2022 Finalist Award Seed4Innovation – Fondazione Unimi, Università degli Studi di Milano – "GlutenSens: an innovative tool for portable gluten detection".

- 2022 Special Session Organization entitled "Non-invasive blood pressure monitoring" at CINC2022 Computers in Cardiology (September 4-7, 2022) Tampere, Finland.

- 2021 Course organization entitled "AI and Big Data in Ematology" by Philadelphia University (digital Event).

- 2020 May 16th – Invited lecture at Besta Hospital, Milan, Italy "Artificial intelligence in healthcare: from expectations to real impact".

- 2020 February 6th – Invited lecture at Policlinico Hospital, Milan, Italy "Prospective of artificial intelligence in healthcare"

- 2015 Invited seminar "Assessing tactile interaction at the fingertips by means of wearable piezo-resistive force transducers" IIT Genova (Italy).

- 2012 Invited talk in "Robotica – The International Humanoid and Service Robots Expo", Milan 7-8 November 2012. Title: "Robotics between research and clinical application: the experience of CART-CAS laboratory of the Politecnico di Milano".

- 2010 Invited lecturer in post-graduation course "Fundamentals and quantitative methods for biomechanics" at University of Campinas (Brazil) supported by FUNCAMP foundation. Title: "Methods and technologies in Sport Science", (Campinas - Brazil).

- 2010 Invited speaker in the Symposium of Science and Technologies in Sport - University of Campinas (Campinas - Brazil).

- 2010 Invited seminar at European Space Agency ESA-ESTEC, (Noordwijk - The Netherlands. Title: "Innovative surgical robotics for natural-orifice transluminal endoscopic surgery: perspectives for space applications".

- 2010 Invited Member of the Committee of "The Hamlyn Symposium on Medical Robotics" held at The Royal Society of Science (London - UK).

- 2008 Award "Best Innovation" at K-Idea – Scientific technological park Kilometro Rosso. Robotic technologies for the vision in mini-invasive transluminal endoscopic surgery. (Bergamo - Italy).

- 2006 Invited talk "Evolutionary computation". Università degli Studi di Milano (Milano - Italy).

- 2003 Invited lecturer "3D human motion analysis in sport science: present technologies and emerging approaches". University of Campinas (Campinas - Brazil).

RTA, PHD AND POST-DOC SUPERVISION

- Sara Pagotto, PhD candidate in Bioengineering (Politecnico di Milano), supported by Horizon-HLTH- 20023-tool-05 "SMASH-HCM - Stratification, Management, and Guidance of Hypertrophic Cardiomyopathy Patients using Hybrid Digital Twin Solutions", 2024-2026

- Andrea Massimo Bartolozzi, Research Fellow, supported by Fondo Beneficenza Intesa Sanpaolo, 2024-2025

- Andrea Costanzo Palmisciano, PhD candidate in Bioengineering (Politecnico di Milano), supported by Essilor/Luxottica, 2023-2025.

- Andrea Moglia, RTA supported by PNRR – FAIR, 2023-2025

- Prof. Amanda Silvatti - Universidade Federal de Viçosa, Minas Gerais (BRASIL), Research Fellow supported by Research Program for Foreign Faculty - Politecnico di Milano, 2023

- Fabio Tawadrous, Executive PhD candidate in Informatics (Politecnico di Milano), supported by STMicroelectronics, 2024-2027

- Matteo Leccardi – PhD candidate in Bioengineering (Politecnico di Milano), supported by Italian Ministry of University and Research (PNRR 118), 2023-2025

- Matteo Cavicchioli - PhD candidate in Bioengineering (Politecnico di Milano), supported by AIMS Academy (Milan, Italy) and Ministry of University and Research (PNRR 357), 2023-2025

- Luca Marsilio - PhD candidate in Bioengineering (Politecnico di Milano), supported by Medacta International (CH), 2022-2024

- Andrea Rescalli - PhD candidate in Bioengineering (Politecnico di Milano), supported by Interdoctoral Program, 2022-2024

- Giulia Alessandrelli - PhD candidate in Bioengineering (Politecnico di Milano), supported by PON Program, Italian Ministry of University and Research, 2022-2024

- Matteo Rossi – PostDoc supported by POR-FESR 2014-2020 program, 2023-2025

- Davide Marzorati – PhD degree in Bioengineering (Politecnico di Milano) supported by European Institute of Oncology, 2020-2022

- Antonella Belfatto - PhD degree in Bioengineering (Politecnico di Milano) supported by Italian Ministry of Education, Research and University, 2015-2017

- Matteo Seregni - PhD degree in Bioengineering (Politecnico di Milano) supported by Italian Ministry of Education, Research and University, 2012-2014

- Aurora Fassi - PhD degree in Bioengineering (Politecnico di Milano) supported by Italian Ministry of Education, Research and University, 2012-2014

- Paolo Patete – Post-doc position funded by EON Medica (Italy), 2010-2012

- Andrea Pella – Post-doc position funded by CNAO (Pavia, Italy), 2010-2012

- Cynthia Zazzarini – Research assistant supported by Italian Ministry of Education, Research and University, 2010-2011

- Marialuisa Mandelli - PhD degree in Bioengineering (Politecnico di Milano) supported by Besta Neurological Institute (Milano – Italy), 2006-2008

- Amanda Piaia Silvatti – PhD degree in Physical Education (Campinas University, Brasil) supported by FAPESP (Brazil). Stage at Politecnico di Milano supported by CAPES foundation (Brazil), 2010-2011

- Nicola Lopomo - PhD degree in Bioengineering (Politecnico di Milano) supported by Istituti Ortopedici Rizzoli (Bologna - Italy), 2004-2006

- Joseph Stancanello - PhD degree in Bioengineering (Politecnico di Milano) supported by San Bortolo Hospital (Vicenza - Italy), 2004-2006

EXPERTISE IN SCIENTIFIC RESEARCH AREAS

1. **Machine vision**: in this scientific area, Pietro Cerveri started its activity by coping with the calibration of multi- camera systems and dealt with methods and technologies for object and human motion real-time tracking. He conceived innovative methods for camera calibration based on Evolutionary Computation validated across different motion capture systems. He developed calibration and tracking applications that were acquired by

an Italian Company in the field (BTS Engineering, Milano – Italy). The related scientific aspects were object of publication in ISI peer-review international journals of the biomechanical community [113, 112, 111, 109]In particular, the innovative evolutionary approach was published in the most relevant scientific journal (IEEE Transaction on Evolutionary Computation) in the area of evolutionary computation. Due to his skills in this field of research he collaborated to different research and industrial projects: a) in July-August 2000 he was recruited by Electronic Arts Canada in Vancouver (British Columbia, Canada) as a software engineer to collaborate to a project for the development of automatic algorithm for camera calibration of multi-camera system (20 cameras); b) since 1999 to 2004 he was involved in the project "ELITE-S2" funded by Italian Space Agency (ASI) where he was responsible of Workpackage 3 "System calibration". The project consisted in the development of a new motion capture platform for acquisition of astronaut movements in microgravity conditions (physiological motion adaptation to microgravity); c) since 2005 to 2006, he was involved in a national industrial project funded by DIES srl (Roma, Italy), named "VIMS: An innovative system for surgical training in ophthalmic mini-invasive surgery", as responsible of the Workpackage 2 "Camera calibration and surgical tip tracking"; c) since 2004 he started a collaboration with University of Campinas (BR) and University of Vicosa (BR) for the application of innovative camera calibration methodologies applied to sport science [6],[30],[31],[33],[37],[40],[69],[67],[75],[73].

2. **Biomechanics**: in this scientific area, Pietro Cerveri coped with the problem of the human kinematic estimation from surface markers for clinical and sport applications. Starting from the development of full body kinematic models, he focused its investigation on the analysis of anatomical subparts as the spine, the lower limb and the hand. He developed method to the estimation of kinematic parameters (centers and axes of rotation), he faced the problem of reduction of the effect of soft tissue artifacts and developed innovative algorithm based on state-space filters and neural networks for the simulation of human-like trajectories, and volume capture for the motion analysis without surface markers [105],[103],[101],[99],[97],[94],[93],[89]. Since 2005-2006, he participated to a project in cooperation with by Biomotion Laboratory-Mechanical Engineering Department – Stanford University, Stanford, CA (USA) named "Markerless Motion Capture". He was involved in a project co-funded by Nuclear Medicine Department and CERMAC - San Raffaele Scientific Institute aiming at using MRI-based bone surface models to analysis the kinematics of hand and finger joints. He participated in National Project funded by Ministry of Education, University and Research. "Biomechatronic hand prostheses endowed with bio-inspired tactile perception, bi-directional neural interfaces and distributed sensori-motor control" (2013-2015), focusing on tactile sensors [36].

3. **Medical informatics**: in this scientific area, the research activity of Pietro Cerveri can be split in two main subjects: knowledge representation and bioinformatics. As far as the knowledge representation is concerned, he spent he doctoral period dealing with the problem of symbolic anatomical knowledge representation and the integration of such information with the visual information coming from image (histological, morphological) data. His doctoral program was co-funded by the National Library of Medicine, National Institute of Health in Bethesda (MD - USA) under the "Visible Human Dataset" (the greatest digital archive in the world of histological images of a human cadaver) project. He investigated semantic networks and database technology as infrastructure for representing and coding symbolic information. He focused his research on conceptual classification, ontology and digital medical vocabularies as UMLS and SNOMED to cite few. He developed a software framework for joining visual and symbolic anatomical information by allowing an interactive querying of digital images. In the bioinformatics field, Pietro Cerveri dealt with the management and the analysis of human genetic data (genomic differential expression data) coming from micro, gene-chips, oligonucleotides arrays. He collaborated to a project funded by IEO – European Institute of Oncology (Milano, Italy), called "Development and implementation of new methodologies for management and analysis of large-scale micro-array genomic data. Studies of differential regulation" aiming at developing a SW platform for the management and analysis of large-scale micro-array data of differential gene expression. In particular, he was responsible of the Workpackage 3 "Data management, clustering methods and analysis". He developed automatic procedures for managing large amount of genomic data (5-25GB every study), algorithms for intra-inter experiment calibration, for data clustering and statistical analysis of differential genomic expression and co-expression. The results of the research activity in this areas were published in ISI peer-review international journals and conference proceedings [161], [160], [159], [156], [155], [154], [153], [151], [111], [109], [102].

4. **Computer aided surgery and medical robotics**: in this broad scientific area, he dealt with medical im-

age processing, - segmentation, fluoroscopic image rectification, multi-modal volume registration (CT-MR, CT-ANGIO) - for planning of the radio-surgery treatment through the Cyberknife. He extensively collaborated with San Bortolo Hospital in Vicenza (Italy) and Department of Neurosurgery, Neuromed IRCCS, 86077 Isernia (Italy). Particularly, he contributed to the development and validation of methods for registration (rigid and non-rigid) based on the mutual information paradigm. The work focused the automatic identification in the images of organs at morphological and functional risk [86], [88], [90] [91], [92], [95], [96]. In the field of orthopaedics. he started delaling with video-based navigation technologies for knee and hip surgery. He developed registration algorithms based on bone-morphing, method to compute intra-operatively the limb mechanics starting from measurements of points or areas on the bone surfaces, automatic methods to compute the optimal positioning and size of the prosthesis, method for real-time visualization. From 2005 to 2006 he was involved in an Industrial Research project funded by Lima LTO (Udine, Italy) named "Technologies and methods for surgical navigation in knee and hip arthroplasty". He was responsible of the Workpackage 5 "Intra-operative software module". His activity in this field evolved as he moved to the design and development of intra-operative monitoring devices that leaded to a number of patents. In 2007, he was leader of the Collaborative Research Project funded by FSE INGENIO (Lombardia Region) "New technologies for surgical navigation" where he investigated different technologies for surgical navigation based on electromagnetic trackers. Since 2007, he has been participating to the National project funded by Politecnico di Milano and Politecnico di Torino "ORTHOROB, ORTHOpaedic Surgery and ROBotics" (2007-2009) in quality of responsible of Workpackage 2 "Robot interface" devoted demonstrate the feasibility of tracking surgical instrument in total knee replacement [136],[130],[131],[74],[78],[77],[79],[80],[81],[83],[66],[56]. In the field of medical robotics, he has been participating in the European Project: FP7-ICT-2007-215190 "ROBOCAST: ROBOt and sensors integration for Computer Assisted Surgery and Therapy" (2008-2010) in quality of responsible of workpackage 6 "System interface" [129]. Along this direction, in early 2010 he started a research activity in collaboration with Niguarda hospital in Milano (Italy) with the goal of developing innovative robotic technologies for abdominal surgery. In this domain, he was principal investigator of two projects, namely "Self propelled Instrument Carrier for surgery through natural orifices", concerning a feasibility study on robotics for surgery in microgravity funded by the European Space Agency (2009-2010) and "Innovative modular micro robotic instruments for transluminal endoscopic surgery" (2010-2012) funded Italian Ministry of Education, University and Research [62],[128],[52].

5. **Oncology and Radiotherapy**: In the this field, since 2010 he has been collaborating with National Center of Oncology Hadron Therapy and he has been included in three main projects: "Robotic imaging system for hadron-therapy room" (2012-2013), "ULICE (Union of Light Ion Centers in Europe, FP7-INFRA-2008-1.1.2) (2010-2013) and "ENVISION - European NoVel Imaging Systems for ION therapy" (2010-2013), "4D C.A.P.H." (2013-2016), and "Robotic imaging system in room 1 for hadron-therapy treatment" (2019-2023). In the first project, he was responsible of the WP 2. Robotic framework to manage the feasibility analysis, the robot selection, room setup, robot programming and safety measures. Within ULICE, he was cooperating in the development of innovative strategies for real-time tumor tracking in hadron-therapy using artificial neural networks. Within ENVISION, he was cooperating in the development of a HW/SW framework for real-time steering of the particle beam in hadron-therapy to cope with tumor localization uncertainty [124],[53],[51],[48],[47],[61],[63],[64], [70]. Within 4D C.A.P.H., he was responsible of the workpackage "Innovative techniques for patient motion tracking", devoted to study neural network architectures to assess breathing motion during thoracic hadron-therapy. Since 2019, he was workpackage responsible in the R&D project entitled "Robotic imaging system in room 1 for hadron-therapy treatment" [17][19]. In the field of tumor growth modeling and response to therapy, he started a collaboration with European Institute of Oncology (Milan, Italy) in 2015 coordinating a feasibility study to tailor treatment planning based on computational tools for tumor grow modelling and response to radiotherapy [20],[39],[42],[43],[45],[46]. In 2018, European Institute of Oncology funded a project about exhaled breath analysis for early cancer diagnosis, focusing on the development testing custom breath analysis platforms based on MOSFET sensors [32],[20],[8].

6. **Wearable sensors and Artificial Intelligence**: in this recent area of scientific interest, he focused on deep neural architectures devoted to biosignal processing (fiducials and event detection), recorded by wearable sensors [9],[12],[13] and image segmentation [15],[17],[19],[21]. The work was focused on tailoring special deep architectures, implementing optimized models and running efficiently training sessions on distributed clusters. He is

coordinating an R&D project funded by Regione Lombardia (REFINE) focusing on immersive technologies via head-mounted display with application in the field of planning and surgical intervention. In this project, a custom dual-task deep model, devoted to 3D image segmentation, was developed and tested on knee and abdominal CT scans. He is also collaborating with the company Medacta International (CH) towards the development of innovative tools, based on deep learning, for image processing and surgical planning in the domain of arthroplasty 1) [49],[38],[34]. The developed models for image segmentation are being now tested to automatic segment the coronary arteries within the project "Heartic – Artificial Intelligence to fight the coronary disease".

References

[1] A.L. Lopes, K.J. Sarro, I.M. Rodrigues, R.D. Leite, C. Massaroni, P.R.D.S. Amorim, P. Cerveri, and A.P. Silvatti. Breathing motion pattern in cyclists: Role of inferior against superior thorax compartment. International Journal of Sports Medicine, 45(6):450–457, 2024. doi: 10.1055/a-2211-9421. URL https://www.scopus.com/inward/record.uri?eid=2-s2.0-85179939979&doi=10.1055%2fa-2211-9421&partnerID=40&md5=37ea6cb2fba59f310ec01633cad78a3c. cited By 0.

[2] G. Santicchi, S. Stillavato, M. Deriu, A. Comi, P. Cerveri, F. Esposito, and M. Zago. Validation of step detection and distance calculation algorithms for soccer performance monitoring. Sensors, 24(11), 2024. doi: 10.3390/s24113343. URL https://www.scopus.com/inward/record.uri?eid=2-s2.0-85195878248&doi=10.3390%2fs24113343&partnerID=40&md5=c8135d09302e81a58789d0c35c62fb64. cited By 0.

[3] G.R.D. Bernardina, A.G.P. de Andrade, T. Monnet, P. Cerveri, and A.P. Silvatti. Simultaneous in-air and underwater 3d kinematic analysis of swimmers: Feasibility and reliability of action sport cameras. Journal of Biomechanics, 168, 2024. doi: 10.1016/j.jbiomech.2024.112078. URL https://www.scopus.com/inward/record.uri?eid=2-s2.0-85191028502&doi=10.1016%2fj.jbiomech.2024.112078&partnerID=40&md5=538bd65ab076836cf4504d696b3ba992. cited By 0.

[4] M. Rossi, G. Belotti, L. Mainardi, G. Baroni, and P. Cerveri. Feasibility of proton dosimetry overriding planning ct with daily cbct elaborated through generative artificial intelligence tools. Computer Assisted Surgery, 29(1), 2024. doi: 10.1080/24699322.2024.2327981. URL https://www.scopus.com/inward/record.uri?eid=2-s2.0-85187697793&doi=10.1080%2f24699322.2024.2327981&partnerID=40&md5=484f0f2ab9fafcd5ecca9f2b3817db2c. cited By 0.

[5] A. Moglia, L. Marsilio, M. Rossi, M. Pinelli, E. Lettieri, L. Mainardi, A. Manzotti, and P. Cerveri. Mixed reality and artificial intelligence: A holistic approach to multimodal visualization and extended interaction in knee osteotomy. IEEE Journal of Translational Engineering in Health and Medicine, 12:279–290, 2024. doi: 10.1109/JTEHM.2023.3335608. URL https://www.scopus.com/inward/record.uri?eid=2-s2.0-85178077610&doi=10.1109%2fJTEHM.2023.3335608&partnerID=40&md5=8afb934c24559526ddcafd6cc464425b. cited By 0.

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PATENTS

- Title: Dispositivo per la rilevazione di superfici anatomiche all'interno di articolazioni
  Pub. No.: MI2007A001469
  Assignee : IST ORTOPEDICO GALEAZZI SPA Via Riccardo Galeazzi 4, I-20161 Milan (IT)
  Inventor(s): G. Ferrigno, P. Cerveri, E. De Momi, W. Pascale
  Date: 20-07-07

- Title: Device for the detection of articular forces
  Pub. No.: WO/2008/129414 International Application No.:PCT/IB2008/001011
  Assignee: IST ORTOPEDICO GALEAZZI SPA Via Riccardo Galeazzi 4, I-20161 Milan (IT)

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Date: 30-10-2008

- Title: Architettura di robot articolato per uso medico
  Pub. No.: n. BI.11.013.A
  Assignee: POLITECNICO DI MILANO, Piazza Leonardo da Vinci 32, 20133 Milan Italy
  Inventor(s): P. Cerveri, R. Zaltieri
  Date: 24-10-2011

- Title: Apparato miniaturizzato per visione endoscopica
  Pub. No.: n. BI.12.010.A
  Assignee: POLITECNICO DI MILANO, Piazza Leonardo da Vinci 32, 20133 Milan Italy
  Inventor(s): P. Cerveri, C.C. Zazzarini
  Date: 25-05-2012

- Title: Endoscope
  International Application No.: PCT/IB2013/054370
  Assignee: POLITECNICO DI MILANO, Piazza Leonardo da Vinci 32, 20133 Milan Italy
  Inventor(s): P. Cerveri, C.C. Zazzarini
  Date: 31-05-2012

- Title: Endoscope
  International Application No.: US2015157187
  Assignee: POLITECNICO DI MILANO, Piazza Leonardo da Vinci 32, 20133 Milan Italy
  Inventor(s): P. Cerveri, C.C. Zazzarini
  Date: 11-06-2015

- Title: Glutensens
  Italian Application Submission No. 102023000023916
  Assignee: UNIVERSITA' DEGLI STUDI DI MILANO, Via Festa del Perdono 7 - 20122 Milano, Italy
  Inventor(s): P. Cerveri, F. Cellesi, M.C. De Lorenzo
  Date: 13-11-2023

- Title: Head-mountable device and ECG detection system for detecting an electrocardiogram signal comprising said head-mountable device
  European Application submission No. 24425024.7
  Assignee: LUXOTTICA S.R.L.and POLITECNICO DI MILANO
  Inventor(s): D. Trojaniello, T. Ongarello, L- Mainardi, P. Cerveri
  Date: 07/06/2024

Sincerely, Pietro CERVERI