



MEDICON 2016 | March 31st – April 2nd, 2016 | Paphos, Cyprus
XIV MEDITERRANEAN CONFERENCE ON MEDICAL AND BIOLOGICAL ENGINEERING AND COMPUTING

Systems Medicine for the Delivery of Better Healthcare Services

Special Session

TITLE: Optimizing the diagnostic value of Myocardial Perfusion Imaging using a dynamic phantom assembly

Theme: T.2 Biomedical Imaging & Image Processing

Keywords Beating-Breathing-Moving phantom assembly • SPECT/CT MPI • Cardiac defects - physicians reports • Artifacts • Motion correction

The project ΥΓΕΙΑ/ΔΥΓΕΙΑ/0311(BIE)/27 “Optimizing the diagnostic value of SPECT myocardial perfusion images under the influence of respiratory motion” was co-financed by the European Regional Development Fund and the Republic of Cyprus through the Research Promotion Foundation.



First Proposer – Dr. Yiannis Parpottas, yparpottas@frederick.ac.cy

Biographical Sketch

Dr. Yiannis Parpottas is a Faculty Member at Frederick University in Cyprus since 2007 and a member of the Frederick Research Center. He received his Ph.D. degree in Nuclear Experimental Physics from Ohio University in USA (2004) and he was employed at the Triangle Universities Nuclear Laboratory of Duke University in USA. His main interest in fundamental nuclear physics lies in the area of relativistic heavy-ion collisions and his research interests in applications of nuclear physics lie in the areas of nuclear medicine and environmental radioactivity - dosimetry. He is the author/co-author of more than 90 publications with more than 1000 citations. He participated in fifteen projects funded by the U.S. National Science Foundation, the U.S. Department of Energy, the International Atomic Energy Agency, and the European 6th and 7th Framework. He coordinated projects funded by the Cyprus Research Promotion Foundation and the European Regional Development Fund. He is a member in professional societies such as the American Physical Society, the European Science Foundation, the World Association of Radiopharmaceutical and Molecular Therapy, and a board member of the Cyprus Association of Medical Physics and Biomedical Engineering. He is also in the Board of Directors of the Natural Gas Public Company of Cyprus.

Second Proposer – Dr. Stelios Christofides, c4stelios@gmail.com

Biographical Sketch

Dr. Stelios Christofides (CPhys, CSci, MinstP, FIPEM, FIOMP) is the Director General of the Biomedical Research Foundation (BRF) in Cyprus. He is a Medical Physics Expert with more than 30 years of experience. He is also the President of the Cyprus Society for Quality in Healthcare (CSQH). From 2009 to 2011, he was the President of the European Federation for Organisations of Medical Physics (EFOMP) and currently the Chairperson of the EFOMP Professional Matters Committee. He has extensive experience in safety culture and quality assurance in the private and public sectors. He has taken and is taking active part in a number of European funded research projects such as SENTINEL, EUnetHTA, PHGEN, EMAN, MEDRAPET, EUTEMPE-RX, ENETRAP III and CRADL. He was and is an active member of a number of teaching faculties and organiser of many educational programmes with collaboration with the International Atomic Energy Agency (IAEA), the World Health Organisation (WHO), the International Organisation of Medical Physics (IOMP) and the European Federation for Organisations of Medical Physics (EFOMP). He has published a large number of papers, book chapters and has presented his research work in many International and National conferences.

Abstract 300 Words

A dynamic phantom assembly was developed to study SPECT Myocardial Perfusion Imaging. Artifacts were assessed and their impact on cardiac defect detection was investigated. The impact of motion correction on SPECT images and on defect detection was also determined.

The dynamic phantom consists of a beating cardiac phantom and a breathing phantom which are inserted within an anthropomorphic thorax phantom. It simulates normal and deep breathing conditions, an ECG beating and moving left ventricle during respiration, and respiratory phases for the lungs and the left ventricle. The beating LV follows the inferior portion of the inflatable lungs in the cranio-caudal direction at the level of the diaphragm. Diastole and systole follows the Wigger diagram and respiration follows a sinusoidal exponential pattern. A Programmable Logic Controller precisely controls the motions. A number of motion limitations of other physical phantoms have been overcome. Variable cardiac defects can be inserted within the myocardial wall of the left ventricle. The physicians can report on defect presence or absence without prior knowledge of the phantom parameters.

SPECT/CT images were acquired for phantoms with and without small and large cardiac defects during normal and deep breathing, and also at four respiratory phases from end-expiration to end-inspiration. Acquisitions were reconstructed with and without AC, and with misalignment of transmission and emission scans. Motion correction was applied using an image based method with transformation parameters derived from the SPECT data by a non-rigid registration algorithm. A quantitative analysis was performed to assess artifacts and the impact of motion correction on MPI. An evaluation of the physicians' reports on defect detection was also performed.

The dynamic phantom assembly, developed at the "Bioinstrumentation and Biomedical Imaging" laboratory of the Frederick Research Center, as well as the results from the quantitative analysis and the evaluation of the physicians' reports are presented.

Presentations - Speakers

1. Optimizing the diagnostic value of SPECT Myocardial Perfusion Imaging – An Overview

Dr. Yiannis Parpottas (10 min)

2. Construction of inflatable lung to simulate respiration in Myocardial Perfusion Imaging

Dr. Antonis Lontos (10 min)

3. Motions of the phantom assembly for myocardial perfusion imaging studies

Dr. Antonis Antoniou (15 min)

4. Characterization of attenuation and respiratory motion artifacts and their influence on SPECT MP Image evaluation

Dr. Isabelle Chrysanthou-Baustert (15 min)

5. Impact of motion correction on SPECT Myocardial Perfusion Imaging

Dr. Irene Polycarpou (15 min)

6. MPI phantom studies: Diagnostic accuracy of the attenuation corrected and motion corrected images

Dr. Ourania Demetriadou, MD (15 min)

7. Liver extra-cardiac activity: A simulation study

Sotiris Panagi (10 min)

Speakers' biographical sketch

Dr. Antonis Lontos is a Faculty Member at the Department of Mechanical Engineering of Frederick University in Cyprus since 2003 and a member of the Frederick Research Center. Prior to this, he was a research and teaching assistant at the Laboratory for Machine Tools and Manufacturing Engineering, Department of Mechanical Engineering, Aristotle University of Thessaloniki, Greece. He received his Ph.D. degree in Mechanical Engineering from the Aristotle University of Thessaloniki in 2002. He is a member of the Technical Chamber of Cyprus (ETEK), the Balkan Tribological Association, and the Hellenic Society of Biomechanics. He is a national representative for the COST Domain Committee in Materials and Nanoscience. He was a member of the steering committee for the "Development and Operation of Enterprise Liaison Offices in Universities Operating in the Republic of Cyprus" (2011-2015) and a member of the Review Bioethics committee of the National Bioethics in Cyprus (2011-2015). His research interests are in the areas of bioengineering, materials properties determination, rapid prototyping technology, PVD, CVD, thermal sprayed coatings, manufacturing processes, CAD-CAM systems, CNC machine tools, design and manufacturing. Until now, he was a principal investigator and/or a research fellow in more than fifteen research projects.

Dr. Antonis Antoniou is a Faculty Member at the Department of Mechanical Engineering of Frederick University in Cyprus since 2009 and a member of the Frederick Research Center. Prior to this appointment, he was working as a Physicist/Validation Engineer at EXA Corporation in Burlington, Massachusetts, USA. He received his Ph.D. degree in Engineering and Applied Sciences from the University of New Orleans in Louisiana, USA (2005). He is a member of the Technical Chamber of Cyprus (ETEK), the American Society of Mechanical Engineers (ASME), and the American Institute of Astronautics' and Aeronautics (AIAA). His research interests are in the areas of numerical fluid mechanics and heat transfer, simulation of combustion and flame propagation, and mathematical modeling of non-Newtonian fluids. Until now, he participated in two Aerospace projects sponsored by the Stennis Space Center (Mississippi, USA) and the Lockheed Martin Michoud Space systems (Louisiana, USA). He also participated in two projects funded by the Cyprus Research Promotion Foundation and the European Regional Development Fund.

Dr Isabelle Chrysanthou is a Course Lead for Physics in Medicine I and II at the Medical School of the University of Nicosia in Cyprus since 2014. Prior to this, she worked at the Frederick Research Center as a postdoctoral research associate in projects related to the optimization of the diagnostic value of SPECT MPI, funded by the Cyprus Research Promotion Foundation and the European Regional Development Fund (2010-2012, 2013-2014). She was the vice-chair of the working party for the regulatory work in the area of medical devices during the Cyprus Presidency of the Council of the European Union (2012). She founded and managed a high tech start-up on medical imaging after receiving a funding of 240k euros (2005-2008). She worked in radiotherapy at the Bank of Cyprus Oncology Centre and passed the American Board of Radiology Certification (2002-2005). She received her Ph.D. degree in Medical Physics from the Institute of Cancer Research and the Royal Marsden of the University of London in UK (2000). She has over 15 years of experience in the field of medical physics ranging from clinical work, over research and business development to regulatory work at the government. Her research focuses on the optimization of medical imaging techniques to improve diagnosis. She published in the journals of Physics in Medicine and Biology, Magnetic Resonance Imaging, and in the Journal of Nuclear Cardiology.

Dr Irene Polycarpou is a Lecturer in Medical Physics at the European University Cyprus since 2014. She received her Ph.D. degree in Medical Physics from King's College London (2013) and she undertook postdoctoral research at St Thomas' Hospital London. She is working in the field of medical imaging since 2008. Her research interests focus on the enhancement of the diagnostic value of clinical emission tomography. She contributed in correction methods for respiratory motion, attenuation, scatter and data analysis methods with particular emphasis in Positron Emission Tomography (PET) and Magnetic Resonance Imaging (MRI). She participated in several projects including “FP7- EU project, Sublima, PET-MR combined for maximal efficiency” and “FP7-EU project, HYPERimage, Hybrid PET/MR”. Since 2015, she is the Vice President of the Society of Medical Physicists in Cyprus and the Treasurer of the Cyprus Association of Medical Physics and Biomedical Engineering.

Dr. Ourania Demetriadou is the Acting Head of the Nuclear Medicine Department at Limassol General Hospital with 25 years of experience in the field of nuclear medicine. She received her Medical degree in Nuclear Medicine from Charles University in Prague. She organized and lectured in many training courses and congresses of the Ministry of Health, the International Atomic Energy Agency (IAEA), the Institute of Nuclear Medicine of UCL and Middlesex Hospital of London. She has more than 30 presentations (papers, oral, and posters) and participated in more than 70 congresses, seminars and training courses for Nuclear Medicine.

Sotiris Panagi is a Ph.D. candidate at Frederick University in Cyprus. His research focuses in the area of liver extra-cardiac activity and its impact on myocardial perfusion imaging. He received his M.Sc. degree in Physics from the University of Cyprus in 2012 and his B.Sc. degree in Physics from the Aristotle University of Thessaloniki, Greece, in 2010.

Paper Submission

The submissions should contain original, high quality, not submitted or published elsewhere work. Papers should be submitted electronically (through [Medicon 2016 web site](#)) in PDF format and should conform to IFMBE Proceedings template (single-spaced, double-column, 10-point font size, 4 to 6 pages).

Paper Presentation

Each accepted paper should be presented by one of the authors and accompanied by at least one full registration fee payment, to guarantee publication in the proceedings. One full registration fee can cover up to 2 papers only. All accepted papers will be included in the IFMBE proceedings of Medicon 2016 that will be published by Springer.

Important Dates

- **Proposals for workshops or special sessions: Sept. 5, 2015 – extended deadline.**
- Paper Submission: Sep 15, 2015
- Paper Notification: Nov 30, 2015
- Camera-ready paper: Dec 22, 2015

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