

In This Issue

- Note from Editor and Introduction of the Research Groups
- Research and Innovation
- Honors, Awards
- Recent Publications
- Student Achievements
- Spotlight on our Research-R&D Projects

Research Groups

www.wcl.ece.upatras.gr/

Note from Editor

and Introduction of the Research Groups

The Wire Communications and Information Technology Laboratory (WCL-IT) is one of the oldest founding labs of the Electrical and Computer Engineering Department (ECE) of the University of Patras in Greece. It was established in 1967 and began its activities in 1969 with Professor George Kokkinakis as its first Director. From September 2004 until August 2018, Emeritus Professor Nikos Fakotakis served as Director. Since then, Director of WCL-IT is Associate Professor Konstantinos Moustakas.

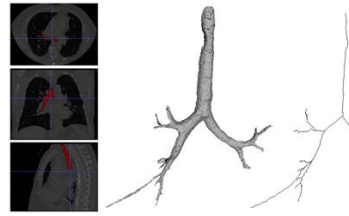
The research activity of WCL-IT covers both **basic** and **applied** research in the areas of communications, networking audio processing, multidimensional signal processing, artificial intelligence, multimedia and virtual reality. The research is strongly supported by European, National and industrial projects, has led to numerous publications of both basic and applied research results leading to the award of several PhD theses. Teaching activities in the context of the Electrical and Computer Engineering undergraduate curriculum and several MSc programs areas are based on the principle of providing to the students both basic scientific knowledge and soft skills in cutting edge and emerging fields.

WCL-IT Research Groups

- Artificial Intelligence Group
- Audio and Acoustic Technology Group
- Communication Networks, Teletraffic Engineering and Applications Group
- Communications and Telematic Applications Group
- Digital Transmission and Coding Group
- Network Architectures and Management Group
- Visualization and Virtual Reality Group (VVR)

Research and Innovation

Open-source lung modeling and simulation framework



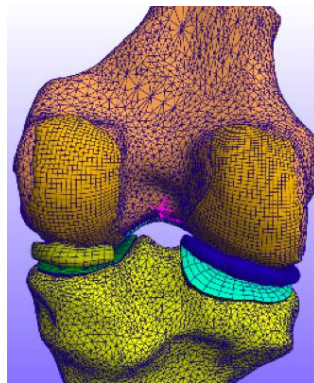
WCL-IT researchers have developed a computational modelling framework that generates Anatomically Valid Airway tree conformations and provides capabilities for simulation of broncho-constriction apparent in obstructive pulmonary conditions. Such conformations are obtained from the personalized 3D geometry generated from computed tomography (CT) data through image segmentation.

The patient-specific representation of the bronchial tree structure is extended beyond the visible airway generation depth using a knowledge-based technique built from morphometric studies. Additional functionalities of AVATREE include visualization of spatial probability maps for the airway generations projected on the CT imaging data, and visualization of the airway tree based on local structure properties. Furthermore, the proposed toolbox supports the simulation of broncho-constriction apparent in pulmonary diseases, such as chronic obstructive pulmonary disease (COPD) and asthma. AVATREE is provided as an open-source toolbox in C++ and is supported by a graphical user interface integrating the modelling functionalities. It can be exploited in studies of gas flow, gas mixing, ventilation patterns and particle deposition in the pulmonary system, with the aim to improve clinical decision making

The research has been recently published in Plos One journal.

S. Nousias, E.I. Zacharaki and K. Moustakas, "AVATREE: An open-source computational modeling framework modeling Anatomically Valid Airway Tree conformations", PLoS One, doi.org/10.1371/journal.pone.0230259, April 2020.

Advanced 3D knee segmentation



Although multi-atlas segmentation has been prevalent in some parts of the body, its exploitation for the segmentation of the knee complex has not been illustrated yet. This work utilizes a multi-atlas segmentation method based on deformable registration and joint label fusion in conjunction with anatomically-adopted mesh refinement in order to generate subject-specific models of the knee. The success of finite element simulations strongly depends on the properties of the 3D surface and the quality of the volumetric meshes. Therefore, emphasis was given to create structured meshes with well-shaped hexahedra for the knee cartilages and menisci. The segmentation

performance is assessed using cross-validation on 7 subjects from the Open Knee project and 78 subjects from the Osteoarthritis Initiative. Our results indicate that our developed state-of-the-art processing scheme can achieve competitive performance, opening the path for better diagnostics and patient-specific interventions.

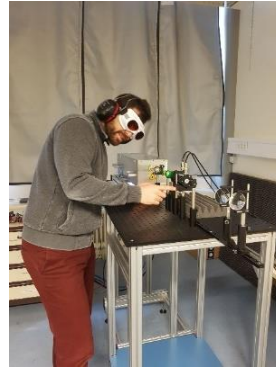
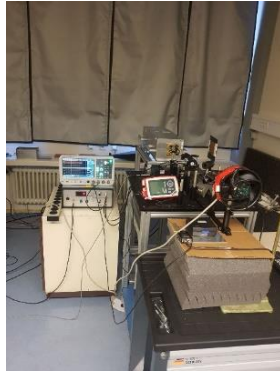
The research has been recently published in IEEE Access journal.

F. Nikolopoulos, E. Zacharaki, D. Stanev and K. Moustakas, "Personalized Knee Geometry Modelling based on Multi-Atlas Segmentation and Mesh Refinement", IEEE Access, vol.8, no. 1, pp. 56766-65781, December 2020.

Laser-driven sound generation technology

The Audiogroup is developing a novel laser-based technology for spatially unbound reproduction of continuous and complex sound signals, supporting direct driving from analog or digital audio streams. The proposed technology is suitable for remote sound reproduction via the transmission and direct demodulation of signals over very long distances without the need for local power supply, as well as for the real-time rendering of moving sound objects. In collaboration with the group of EBI-vbt of the Karlsruhe Institute of Technology (KIT) and under the supervision of Prof. Mourjopoulos, PhD candidate Konstantinos Kaleris has developed a novel laser-sound platform in the premises of KIT in Germany and has carried out proof-of-concept experiments on laser-based continuous and complex sound generation. A joint patent between University of Patras and Karlsruhe Institute of Technology is currently under examination and results have been submitted for publication in a scientific journal.

Moreover, the group, in collaboration with the Institute of Plasma Physics and Lasers (IPPL) of the Hellenic Mediterranean University (HMU), studies the physical mechanisms behind laser-based optoacoustic transduction through plasma generation in air.



Konstantinos Kaleris working on laser-driven sound generation in the EBI-vbt, KIT, Germany

Systematic experiments have been carried out in the premises of IPPL (see photo) with fast and ultrafast laser systems and analytical models have been developed for the description of the acoustic emission of the produced plasma sound sources. The research has led to two publications



Optical and acoustic measurements of the laser-generated plasma sound sources in IPPL, HMU, Crete

The research has been recently published in 2 journal articles

Kaleris, K., Orfanos, Y., Bakarezos, M., Papadogiannis, N. & Mourjopoulos, J. Experimental and analytical evaluation of the acoustic radiation of femtosecond laser plasma filament sound sources in air. Journal of the Acoustical Society of America, 146, EL212-EL218 (2019).

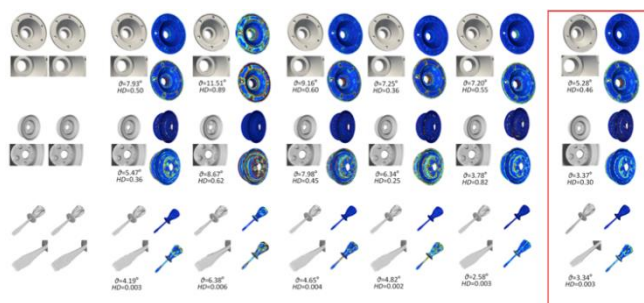
Kaleris, K., Orphanos, Y., Bakarezos, M., Dimitriou, V., M., Tatarakis, M., Mourjopoulos, J. & Papadogiannis, N. On the correlation of light and sound radiation following laser-induced breakdown in air, Journal of Physics D: Applied Physics (2020).

5G facility in Patras

The Network Architectures and Management Group is deploying and operating the **Patras 5G facility**, an exemplary Open Source 5G and IoT facility. This means that most of the installed components are offered as Open Source but there are also dedicated components and services to support 5G and IoT scenarios. Numerous partners have deployed their technologies in the Patras 5G /Greece facility, thus creating a unique 5G playground for KPI validation and support on future verticals.

Patras 5G facility is regularly being used by third parties to host their experiments and provides the necessary toolsets to them to carry out realistic 5G end-to-end experimentation remotely (see [From Service Order to Network Monitoring Service](#)).

3D mesh denoising for Industrial Applications



Through the years, several works have demonstrated high-quality 3D mesh denoising. Despite the high reconstruction quality, there are still challenges that need to be addressed ranging from variations in configuration parameters to high computational complexity. These drawbacks are crucial

especially if the reconstructed models have to be used for quality check, inspection or repair in manufacturing environments where we have to deal with large objects resulting in very dense 3D meshes. Recently, deep learning techniques have shown that are able to automatically learn and find more accurate and reliable results, without the need for setting manually parameters. In this work, motivated by the aforementioned requirements, we propose a fast and reliable denoising method that can be effectively applied for reconstructing very dense noisy 3D models. The proposed method applies conditional variational autoencoders on face normals. Extensive evaluation studies carried out using a variety of 3D models verify that the proposed approach achieves plausible reconstruction outputs, very relative or even better of those proposed by the literature, in considerably faster execution times.

S. Nousias, G. Arvanitis, A.S. Lalos and K. Moustakas, "Fast Mesh Denoising with Data Driven Normal Filtering using Deep Variational Autoencoders", IEEE Transactions on Industrial Informatics, 10.1109/TII.2020.3000491

Honors -Awards

First Prize at BRAIN.IO hackathon, IEEE BIBE 2019, Athens, Greece.

The developed awarded project included the implementation of a Singleplayer and a Multiplayer game developed in Unity Game-engine by interfacing with the provided BCI headset Unicorn Hybrid Black

Honors-Awards



First Prize @BRAIN.IO hackathon at IEEE BIBE 2019, Athens, Greece

WCL-IT group members win First Prize at BRAIN.IO hackathon, IEEE BIBE 2019, Athens, Greece.

Finalist in the category "Tech of Society"

More information:

<http://www.vvr.ece.upatras.gr/awards/166-innovation-radar-prize-2019/>

<https://www.oactive.eu/>

Recent Publications

[VVR Group](#)

vvr.ece.upatras.gr

[Audio and Acoustic Technology Group](#)

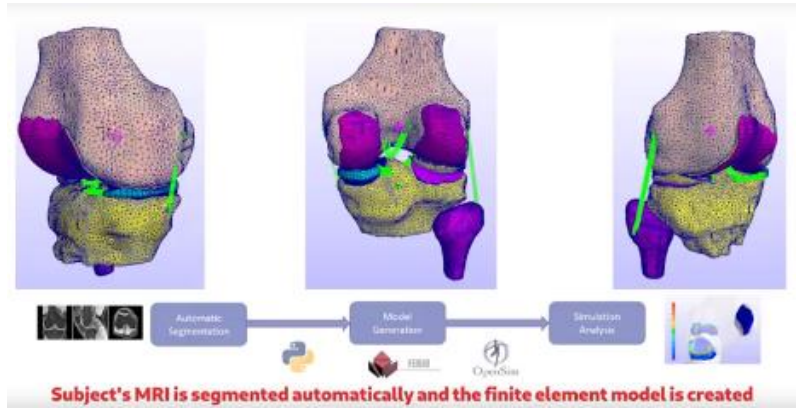
<http://www.wcl.ece.upatras.gr/audiogroup/>

VVR group undergraduate student Michalakis George and graduate students Papandreou Andreas and Chatzikalymnios Aggelos, won the IEEE first prize of the g-tec sponsored BRAIN.IO hackathon in the context of the IEEE BIBE conference that was held in Athens, Greece on October 27-28, 2019.

<http://www.vvr.ece.upatras.gr/news/first-prize-brain-io-hackathon-at-ieee-bibe-2019-athens-greece/>

Finalist in the category "Tech for Society" for the 2019 Innovation Radar Prize

The Innovation Radar is among others a "scouting" activity of the EC and aims to identify innovative research of single organizations in the context of European projects. Initially 40 finalists were selected spread in four



categories. After online voting of the public the VVR group has been ranked 2nd in the Tech for Society category and will now present its achievement in the "European Research and Innovation Days" in Brussels from 24th to the 26th of September 2019 and compete with 11 more finalists for the Innovation Radar winner and the winner of each category.

Recent Publications

A.S. Lalos, G. Arvanitis, E. Vlachos, K. Moustakas and K. Berberidis, "Signal Processing on Static and Dynamic 3D Meshes: Sparse Representations and Applications", *IEEE Access*, vol. 7, no.1, pp. 15779-15803, January 2019.

Kaleris, K., Orfanos, Y., Bakarezos, M., Papadogiannis, N. & Mourjopoulos, J., "Experimental and analytical evaluation of the acoustic radiation of femtosecond laser plasma filament sound sources in air. *Journal of the Acoustical Society of America*", 146, EL212-EL218 (2019).

G. Arvanitis, A. Lalos, K. Moustakas and N. Fakotakis, "Feature Preserving Mesh Denoising Based on Graph Spectral Processing", *IEEE Transactions on Visualization and Computer Graphics*, vol.25, no3, pp. 1513-1527, March 2019.

D, Stanev and K. Moustakas, "Stiffness Modulation of Redundant Musculoskeletal Systems", *Journal of Biomechanics*, vol. 85, pp. 101-107, March 2019.

G. Arvanitis, A. Lalos and K. Moustakas, "Denoising of Dynamic 3D Meshes via Low-Rank Spectral Analysis", *Computers & Graphics*, vol. 82, pp. 140-151, August 2019.

G. Arvanitis, A. Lalos and K. Moustakas, "Adaptive Representation of 3D Meshes for Low-Latency Applications", *Computer Aided Geometric Design*, vol. 73, pp. 70-85, August 2019.

S. Nousias, E.I. Zacharaki and K. Moustakas, "AVATREE: An open-source computational modeling framework modeling Anatomically Valid Airway Tree conformations", *PLoS One*, doi.org/10.1371/journal.pone.0230259, April 2020.

V. Ntalianis, N.D. Fakotakis, S. Nousias, A. Lalos, M. Birbas, E.I. Zacharaki and K. Moustakas, "Deep CNN sparse coding for real time inhaler sounds classification", *Sensors*, doi: 10.3390/s20082363, April 2020.

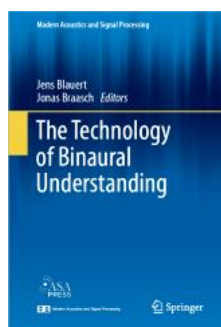
E.I. Zacharaki, et. al., "FrailSafe: An ICT platform for unobtrusive sensing of multi-domain frailty for per-sonalized interventions", *IEEE Journal on Biomedical and Health Informatics*, vol. 24, no. 6, pp. 1557-1568, June 2020.

Kaleris, K., Orphanos, Y., Bakarezos, M., Dimitriou, V., M., Tatarakis, M., Mourjopoulos, J. &

Papadogiannis, N. **On the correlation of light and sound radiation following laser-induced breakdown in air**, *Journal of Physics D: Applied Physics* (2020).

F. Nikolopoulos, E. Zacharaki, D. Stanev and K. Moustakas, **"Personalized Knee Geometry Modelling based on Multi-Atlas Segmentation and Mesh Refinement"**, *IEEE Access*, vol.8, no. 1, pp. 56766-65781, December 2020.

A book on Binaural Technology



A book on state-of-the-art technologies and models for human auditory perception and understanding of sound, has been recently published by Springer, edited by Jens Blauert and Jonas Braasch. The book includes a chapter on "Modeling the aesthetics of audio scene reproduction", by the head of Audiogroup Prof. John Mourjopoulos.

<https://www.springer.com/gp/book/9783030003852>

Student Achievements

Best Student Innovation Challenge Award

"Gamified haptic UI for increasing trust in autonomous vehicles"

Student Achievements

IEEE Worldhaptics 2019, Tokyo : Best Student Innovation Challenge Award

VVR group undergraduate students Nikolaos Tsagkas and Ioannis Koutoulogenis, supervised by Associate Professor Konstantinos Moustakas, won the "Best Student Innovation Challenge Award" of the Hyundai sponsored SIC-Mobility Challenge in the context of the IEEE Worldhaptics conference that was held in Tokyo, Japan on July 9-12, 2019. The developed system simulated the use of an autonomous vehicle in Virtual Reality. The user could manipulate several controls and get feedback through mid-air haptic interfaces.



Spotlight on our Research-R&D Projects

VVR Group/ Trustonomy, H2020 project

Spotlight on our Research - R&D Projects

Trustonomy, H2020 project

The vision of Trustonomy (a neologism from the combination of trust + autonomy) is to raise the safety, trust and acceptance of automated vehicles by helping to address the aforementioned technical and non-technical challenges through a well-integrated and inter-disciplinary approach, bringing domain experts and ordinary citizens to work closely together. Trustonomy will investigate, setup, test and comparatively assess, in terms of performance, ethics and acceptability, different relevant technologies and approaches in a variety of autonomous driving and RtI scenarios, covering different types of users (in terms of age, gender, driving experience, etc.), road transport modes

(private cars, trucks, buses), levels of automation (L3 – L5), driving conditions, etc.

[Link to video](#)



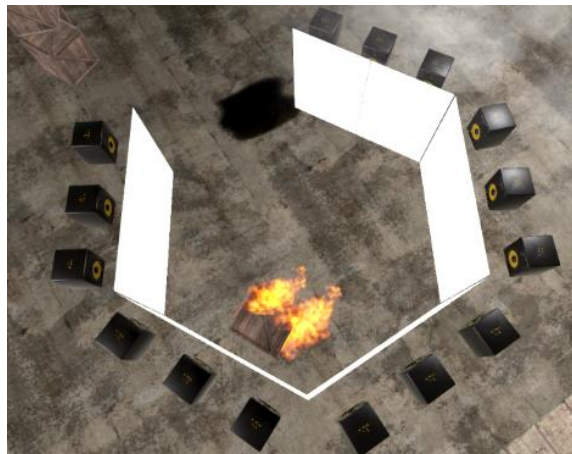
WCL-IT researchers have developed a biophysics-based simulation tool that is used for the evaluation of virtual interactions in different synthetic 3D scenes. Evaluation is based on the simulation of the motion of a digital human skeletal model interacting with virtual 3D objects, followed by inverse dynamics simulation of multi-body systems. This tool can be used for the estimation of body joints loads and energy expenditure during tasks' operation in different environments, thereby allowing to detect potential risks in repetitive movement patterns and to adjust accordingly the

interaction object's design and arrangement. Comparative results of spatiotemporal energy distribution support the validity of the simulation framework.

[Audio and Acoustic Technology Group](#)

Multichannel audio installation for VR project

The Audiogroup participates in the project "VR Simulator for Training Against Fires (V-STAF)" funded by ESPA and coordinated by REALISCAPE TYPORAMA.



The group has designed and supervised the installation and testing of a multichannel audio system implementing a 16.1 speaker planar topology for a Cave Automatic Virtual Environment (CAVE), in the premises of REALISCAPE TYPORAMA, in Patras. The group has also developed custom software plugins for real-time audio rendering of VR firefighting scenes, utilizing state-of-the-art 3D audio technologies such as VBAP and Ambisonics.

[Network Architectures and Management Group](#)

More about Openslice <https://openslice.readthedocs.io/en/stable/> and watching the [video](#).



Openslice is a prototype open source, operations support system that has been initiated by NAM Group. It supports VNF/NSD onboarding to OpenSourceMANO (OSM) and NSD deployment management. It also supports TMFORUM OpenAPIs regarding Service Catalog Management, Ordering, Resource, etc. Openslice allows Vertical Customers to browse the available offered service specifications and also allows NFV developers to onboard and manage VNF and Network Service artifacts. Openslice was demonstrated in the [NFV&MEC Plugtests™ 2020](#), at Sophia Antipolis, France 15-19 June 2020 which is part of the [NFV Plugtests Programme](#), ETSI's Centre for Testing and Interoperability organized the event from 15 to 19 June 2020.

<http://sense.city>

Services offered

sense.city



The sense.city platform provides the tools that engage urban thinking and improves the relationship between citizens, the city municipality and city's public services. By using the sense.city platform, citizens are the city sensors! With their own communication devices (mobile phones) or via the sense.city application, citizens can post in real time issues and problems for something that happens in their city, inform their fellow citizens and the public authorities. The application consists of a mobile application as well as a web application. The mobile app allows citizens to:

- Sent an issue or a problem to city public services, regarding garbage, lightning, road construction, etc
- It allows citizens to express their feelings on a certain area of the city
- Be notified for city events or reported issues
- See an overview of city issues
- Report the issue and their participation in social media (Facebook, Twitter)

Many cities are currently use the services of the platform such as Patras, Aigio, Delphi, Pyrgos, West Achaia, Didymoteicho, with many more expressed interest to join, while the platforms has more than 14000 registered users from the subscribed cities.

[Network Architectures and Management Group](#)

[1]
<https://www.ert.gr/eidiseis/ellada/kinonia/safe-amea-gia-proti-fora-stin-ellada-meso-toy-dimoy-patreon-kai-toy-panepistimioy/>

[2]
<https://www.in.gr/2020/08/26/plus/interviews/ekpliktiki-efarmogi-ta-amea-stin-ellada-pleon-mporoun-na-prostateyontai/>

Contact Us

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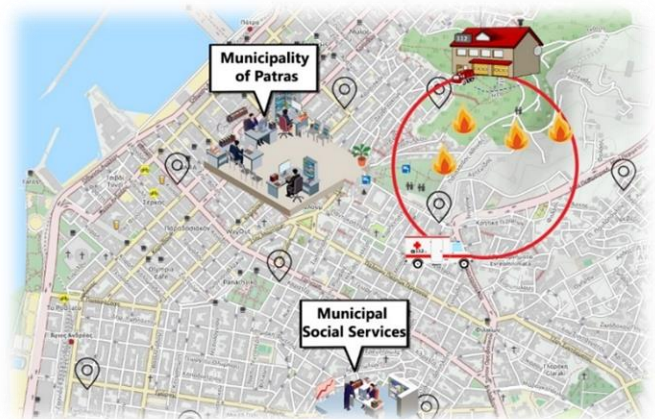
Assistant Editor: Christoyianni Ioanna



SafeAmea is an online registration platform for People with Disabilities validated through Public Authorities, Clubs and Municipal Social Services. It is intended to inform the corresponding Authorities, in case of emergency, of the existence of People with Disabilities who need special

treatment concerning their approach or transportation.

The purpose of this record is to be used as a tool by the local communities, which will contribute to the design of appropriate policies to improve the day-to-day living of People with Disabilities, through the supervision of the geographical distribution of these individuals in the Municipality. (ex. Accessible municipal public areas, public transport, etc.)



The service will soon be tested in a joint pilot between our group and city of Patras and Fire Brigade service while it has received nationwide attention in media ([1], [2]).