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### Note from Editor

#### Research during the COVID pandemic

The COVID pandemic has significantly affected all types of activities worldwide. Research and education have faced significant changes with respect to the means and methods of teaching and scientific experimentation. Within this unprecedented situation, the personnel of WCL-IT has been striving to provide to their students and researchers high quality teaching and safe access to research infrastructure and experimentation.

It would be reasonable to expect a decline in research output due to the harsh lock-downs and mobility restrictions. However, we are proud to report an increase in high quality research output. Faculty, researchers and students used successfully all available means to boost their research. Many reported that creative research was a psychological way-out during the lock downs. As reported in the current newsletter, efforts of the WCL-IT personnel resulted in very high quality publications, patents, awards and distinctions, the kick-off of new European projects and the reform and internationalization of an MSc program on Biomedical Engineering led by the lab.

Expecting 2021 to be the last year with strong restrictions due to the pandemic, we hope you will enjoy our newsletter and scientific activities.

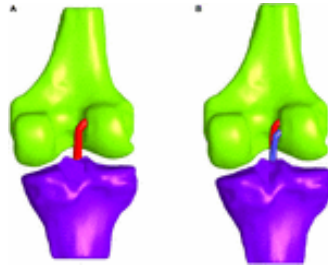
Konstantinos Moustakas  
Professor, WCL-IT Director

### 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

### A Review on Finite Element Modeling and Simulation of the Anterior Cruciate Ligament Reconstruction



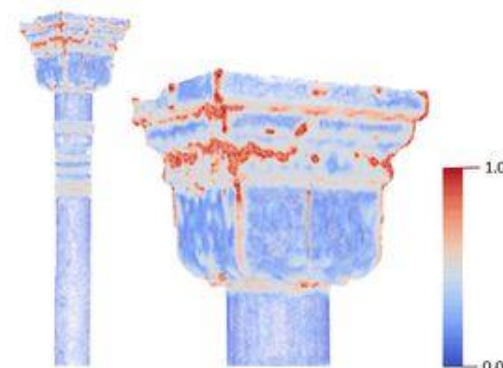
WCL-IT researchers have developed the anterior cruciate ligament (ACL), one of the most important stabilizing tissues of the knee joint whose rupture is very prevalent. ACL reconstruction (ACLR) from a graft is a surgery which yields the best outcome. Taking into account the complicated nature of this operation and the high cost of experiments, finite element (FE) simulations can become a valuable tool for evaluating the surgery in a pre-clinical setting.

The present study summarizes, for the first time, the current advancement in ACLR in both clinical and computational level. It also emphasizes on the material modeling and properties of the most popular grafts as well as modeling of different surgery techniques. It can be concluded that more effort is needed to be put toward more realistic simulation of the surgery, including also the use of two bundles for graft representation, graft pretension and artificial grafts. Furthermore, muscles and synovial fluid need to be included, while patellofemoral joint is an important bone that is rarely used. More realistic models are also required for soft tissues, as most articles used isotropic linear elastic models and springs. In summary, accurate and realistic FE analysis in conjunction with multidisciplinary collaboration could contribute to ACLR improvement provided that several important aspects are carefully considered.

*S. Benos L, Stanev D, Spyrou L, Moustakas K and Tsaopoulos DE (2020) A Review on Finite Element Modeling and Simulation of the Anterior Cruciate Ligament Reconstruction. Frontiers in Bioengineering and Biotechnology, 8:967. doi: 10.3389/fbioe.2020.00967*

### A Saliency Aware CNN-Based 3D Model Simplification and Compression Framework for Remote Inspection of Heritage Sites

Nowadays, the preservation and maintenance of historical objects is the main priority in the area of the heritage culture. The new generation of 3D scanning



devices and the new assets of technological improvements have created a fertile ground for developing tools that could facilitate challenging tasks which traditionally required a huge amount of human effort and specialized knowledge of experts (e.g., a detailed inspection of defects in a historical object due to aging). These tasks demand more human effort, especially in some special cases, such as the inspection of a large-scale or remote object (e.g., tall columns, the roof of historical buildings, etc.), where

the preserver expert does not have easy access to it. In this work, we propose a saliency aware compression and simplification framework for efficient remote inspection of Structure From Motion (SFM) reconstructed heritage 3D models. More specifically, we present a Convolutional Neural Network (CNN) based saliency map extraction pipeline that highlights the most important information of a 3D model. These include geometric details such as the fine features of the model or surface defects. An extensive experimental study, using a large number of real

SFM reconstructed heritage 3D models, verifies the effectiveness and the robustness of the proposed method providing very promising results and draws future directions

S. Nousias et al., "A Saliency Aware CNN-Based 3D Model Simplification and Compression Framework for Remote Inspection of Heritage Sites," in *IEEE Access*, vol. 8, pp. 169982-170001, 2020, doi: 10.1109/ACCESS.2020.3023167.

## Robust and Fast 3-D Saliency Mapping for Industrial Modeling Applications



New generation 3-D scanning technologies are expected to create a revolution at the Industry 4.0, facilitating a large number of virtual manufacturing tools and systems. Such applications require the accurate representation of physical objects and/or systems achieved through saliency estimation mechanisms that identify certain areas of the 3-D model, leading to a meaningful and easier to analyze representation of a 3-D object. 3-D saliency mapping is, therefore, guiding the selection of feature locations and is adopted in a large number of low-level 3-D processing applications including denoising, compression, simplification, and

registration. In this article, we propose a robust and fast method for creating 3-D saliency maps that accurately identifies sharp and small-scale geometric features in various industrial 3-D models. An extensive experimental study using a large number of 3-D scanned and CAD models verifies the effectiveness of the proposed method as compared to other recent and relevant approaches despite the constraints posed by complex geometry patterns or the presence of noise.

G. Arvanitis, A. S. Lalos and K. Moustakas, "Robust and Fast 3-D Saliency Mapping for Industrial Modeling Applications," in *IEEE Transactions on Industrial Informatics*, vol. 17, no. 2, pp. 1307-1317, Feb. 2021, doi: 10.1109/TII.2020.3003455.

## Submission of patent application

The University of Patras (UoP) in collaboration with the Karlsruhe Institute of Technology (KIT) has filed a patent application for the innovative technology of optoacoustic reproduction of sound signals via Laser Induced Breakdown. On behalf of the Audiogroup-UoP, the applicants are Konstantinos Kaleris (PhD candidate) and Dr John Mourjopoulos (Professor) while Dr. Bjoern Stelzner (post doc researcher) and Dr Demosthenes Trimis (Professor) are the applicants from KIT-Verbrennungstechnik laboratory of the Engler-Bunte Institut (EBI-vbt).



Kaleris, K., Mourjopoulos, J., Trimis, D. and Mourjopoulos, J., *Vorrichtung und Verfahren zur Wiedergabe mindestens eines akustischen Signals*, submitted Jan 2021, DPMA.

## Research publication in Nature Scientific Reports

The article titled "Laser-sound: optoacoustic transduction from digital audio streams" authored by Konstantinos Kaleris (PhD Candidate), Dr Panagiotis Hatziantoniou (Lab Teaching Staff), Dr John Mourjopoulos (Professor) Dr Bjoern Stelzner (post doc researcher) and Dr Demosthenes Trimis (Professor) (from

[VVR Group](http://vvr.ece.upatras.gr)

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<https://ieeexplore.ieee.org/document/9193917>

[Audio and Acoustic Technology Group](#)

[Audio and Acoustic Technology Group](#)

<https://doi.org/10.1038/s41598-020-78990-z>

[Audio and Acoustic Technology Group](#)

[VVR Group](#)

[vvr.ece.upatras.gr](http://vvr.ece.upatras.gr)

EBI-vbt, KIT), was published in the Nature Scientific Reports journal. Nature Scientific Reports (IF = 3.998) covers wide range of scientific areas, with emphasis on innovation and interdisciplinarity. The paper presents comparisons between experimental and computational results evaluating a novel laser-audio transducer prototype (Fig.1).

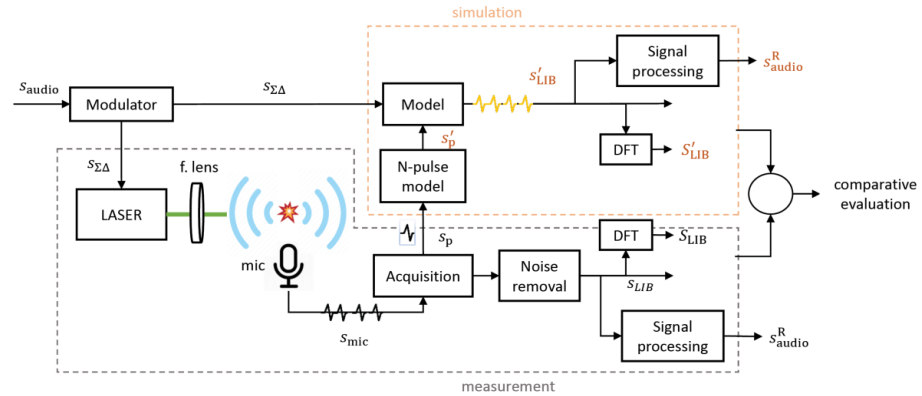


Fig.1

Kaleris, K., Stelzner, B., Hatziantoniou P., Trimis, D. and Mourjopoulos, J. Laser-sound: optoacoustic transduction from digital audio streams. *Sci Rep* 11, 476 (2021).

## Honors-Awards

### Award in European Acoustics Conference

The article “The effect of plasma geometry on acoustic radiation of laser filaments” was awarded the **Best Paper and Presentation Awards** at the Forum Acusticum 2020. This article is the result of a collaboration between the Audio & Acoustic Technology group and the Institute of Plasma Physics and Laser (IPPL) of the Hellenic Mediterranean University, studying the physics of optoacoustic conversion through the creation of plasma by laser. The paper presented experimental and computational study of the acoustic emission of plasma filaments generated by lasers.

Forum Acusticum Conference is organized every three years by the European Acoustics Association (EAA). FA2020 was held virtually with 1100 participants, 700 oral and 56 poster presentations.

A total of 6 paper awards were given out of 82 contestants, while this article took 2nd place. The awards were funded by the Head Genuit Foundation

Kaleris, K., Orphanos, Y., Bakarezos, M., Papadogiannis, N. and Mourjopoulos, J. The effect of plasma geometry on the acoustic radiation of laser filaments, presented in Forum Acusticum 2020, Lyon, France

### Finalists IEEE VR 2021 – 3DUI contest

The purpose of the contest is to stimulate innovative and creative solutions to challenging 3DUI problems. The theme of this year was “Challenging Pandemics” where participants needed to create and submit a 3DUI project that addresses the current COVID-19 situation directly, or indirectly.

**“Remote adversarial VR serious game simulating COVID-19 infection spread and protection protocols.”** by Konstantinos Kalatzis, Michael Pavlou, Agapi



A multiplayer Virtual Reality gamified simulation was developed based on COVID-19 indoor safety guidelines. The simulation was based on the latest literature and included real-time airborne virus transmission and visualization of the transmission effects. The whole experience was accompanied by a 3D user interface with gamification educative challenges.

**More information:**

Finalists IEEE VR 2021 –  
3DUI contest – Visualization  
& Virtual Reality Group  
(upatras.gr)

**"Dr.super: Intubation and Ventilator Troubleshooting VR Simulation"**

by Nikolaos

Kotsarinis, Panagiotis

Sakellaropoulos, George

Michalakis, Maria Kounalaki and

Aspasia Triantafyllou. A VR gamified

simulation was developed regarding

the intubation and ventilator

troubleshooting procedures taking

place in an Emergency Room (E.R.).

The simulations aim to train the end-user

on these actions to enhance their possibilities

of achieving optimal performance

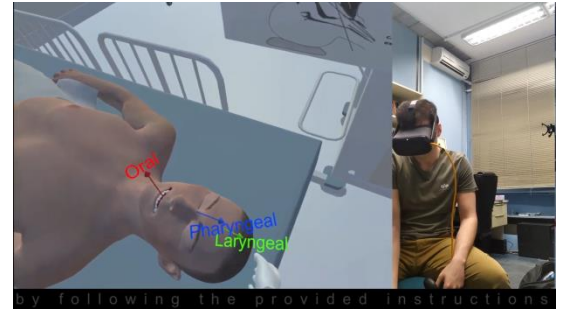
under stress. Through the gamification,

it is, also, expected to empathize the

layman regarding the daily challenges

of the medical staff's job in an Intensive

Care Unit (ICU).



**Students and Education**

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**Student Workshop on "IoT Applications for Smart Cities/Smart Regions"**

Network Architectures and Management Group

<https://www.youtube.com/watch?v=PONJgyG7VCE>  
(in Greek)

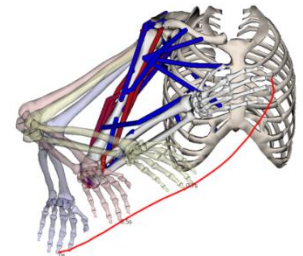
The Internet of Things (IoT) is now an integral part of our daily lives. The ability to interconnect machines, devices, sensors, etc. that interact with each other as well as with the environment in which they operate, gives rise to new technologies, new applications, and new opportunities. Taking into account the above perspectives, a number of projects were assigned to the students who attended the course "Internet of Objects" of the 5th year, in the Department of Electrical Engineering & Computer Technology, University of Patras,. The subjects of the projects were drawn from the thematic area of Smart Cities / Smart Regions.



The workshop "IoT Applications for Smart Cities / Smart Regions" aims to present the results of the projects prepared during the semester. It also aims to highlight the ideas implemented, by opening a dialogue with representatives of the ecosystem of Information and Telecommunications Technologies which aspires to lead on the one hand to the further development of students and their ideas and in a general context to shed light to some future directions in IoT.

## Biomedical Engineering MSc Program reform

The Biomedical Engineering MSc program, currently led by WCL-IT, is one of the most historic MSc programs of the University of Patras. The steering committee decided to perform an extensive reform of the academic program and to strongly focus on internationalization and mobility. New elective courses on cutting edge biomedical engineering technologies like Artificial Intelligence in Medicine, Neuroscience, Biophotonics, Mixed reality in Health, Medical Robotics will kick-off in October 2021. Moreover, formal collaborations both in terms of joint research and joint education activities with Universities across Europe are being established. Memoranda of Understanding with the Heriot-Watt University of Edinburgh and the University of Malta are being signed, while collaboration discussions with the University of Leeds and University of Warwick are in progress.



## NVIDIA workshop on Deep Learning



The NVIDIA Deep Learning Institute (DLI) and the AI-Hub of the University of Patras (UoP) organized a hands-on deep learning workshop on 12/03/2021. This was a repetition of the original workshop that was held on December 2020 and student interest was still very high. Participants learned how deep learning works through hands-on exercises in computer vision and natural language processing. Training focused on developing deep learning models from scratch, learning tools and tricks to achieve highly accurate results. Moreover, students were taught to use freely available, state-of-the-art pre-trained models to save time and get deep learning applications up and running quickly. The workshop lasted about eight hours and gave the opportunity to 70 more students, graduate students and researchers to obtain the NVIDIA certification, which is the basis for attending more specialized workshops to be held in the future.

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## Spotlight on our Research - R&D Projects

### Support for 5G experiment for Media vertical

5G-VINNI Patras5G Testbed supported the Media Vertical from the 5G-SOLUTIONS European project and specifically on a Use-Case of User Generated Content (UGC) & Machine Generated Content (MGC). 5G-SOLUTIONS is the flagship ICT-19 RIA project supporting EC's 5G policy by implementing the last phase (Phase 3b) of the 5GPPP roadmap.

The project aims to prove and validate that 5G provides prominent industry verticals with ubiquitous access to a wide range of forward-looking services with

orders of magnitude of improvement over 4G, thus bringing the 5G vision closer to realization.



The proposed UC involved the generation and sharing of UGC using custom applications provided by partners, which allowed specific tests to be executed on the 5G-VINNI Patras5G facility, such as the contribution of high-quality live video (4K+) as well as lower quality UGC (smartphones). A LiveU equipment is connected to a CPE (Huawei 5G CPE Pro), which communicates over 5G with the gNodeB (Amarisoft Callbox Classic). The gNodeB is directly connected to our Cloud infrastructure, which runs OpenStack and hosts the various network services. The monitoring service is seen through Netdata's Web interface and it is displayed on a monitor, alongside the actual Video Stream.

### University of Patras participated in the 5GASP project kickoff event

University of Patras (Greece), from the 27th to the 29th of January, participated in the online 5GASP project kickoff event. 5GASP aims at



shortening the idea-to-market process through the creation of a European testbed for SMEs that is fully automated and self-service, in order to foster rapid development and testing of new and innovative NetApps built using the 5G NFV based reference architecture. Building on top of existing physical infrastructures, 5GASP intends to focus on innovations related to the operation of experiments and tests across several domains, providing software support tools for Continuous Integration and Continuous Deployment (CI/CD) of VNFs in a secure & trusted environment for European SMEs capitalizing in the 5G market. 5GASP targets the creation of an Open Source Software (OSS) repository and of a VNF marketplace targeting SMEs with OSS examples and building blocks, as well as the incubation of a community of NetApp developers assisted with tools and services that can enable an early validation and/or certification of products and services for 5G. We focus on inter-domain use-cases, development of operational tools and procedures (supporting day-to-day testing and validation activities) and security/trust of 3rd party IPR running in our testbeds.

### University of Patras participated in the 5G-INDUCE project kickoff event

University of Patras (Greece), from the 21st to the 22nd of January, participated in the online 5G-INDUCE project kickoff event. 5G-INDUCE



## Network Architectures and Management Group

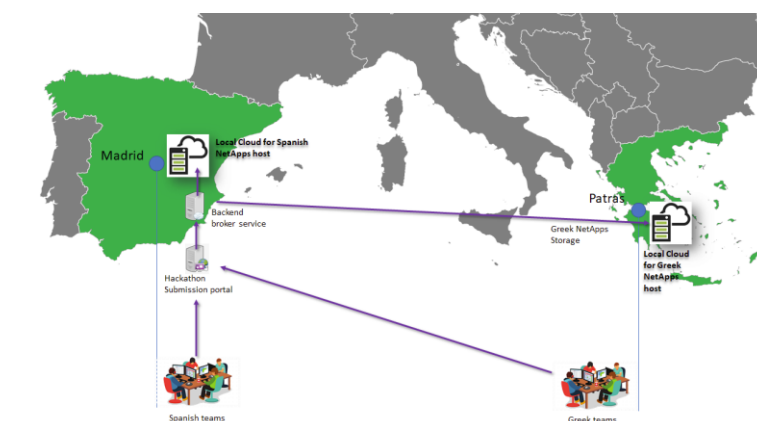
<https://www.etsi.org/events/1905-webinar-zsm-poc-2-showcase-automated-network-slice-scaling-in-multi-site-environments>

## Network Architectures and Management Group

targets the development of an open, ETSI NFV compatible, 5G orchestration platform for the deployment of advanced 5G NetApps. The platform's unique features provide the capability to the NetApp developers to define and modify the application requirements, while the underlay intelligent OSS can expose the network capabilities to the end users on the application level without revealing any infrastructure related information. This process enables an application-oriented network management and optimization approach that is in line with the operator's role as manager of its own facilities, while it offers the development framework environment to any developer and service provider through which tailored made applications can be designed and deployed, for the benefit of vertical industries and without any indirect dependency through a cloud provider.

### University of Patras in ETSI ZSM PoC 2

University of Patras (Greece), together with Telefónica S.A. (Spain), Telenor ASA (Norway) and Universidad Carlos III (Spain) participated in the 2<sup>nd</sup> ETSI ZSM PoC



on Automated network slice scaling in multi-site environments. The Proof of Concept (PoC) has the aim of demonstrating the capability to automatically scale out a deployed network instance across multiple administrative domains. This was achieved by using the 5G assets of 5G-VINNI, which is a

large-scale, end-to-end facility composed of several interworking sites, each deployed at a different geographic location and defining a single administrative domain. The management and orchestration capabilities of individual sites, and the enablers allowing for the interworking across them, are aligned with ZSM architectural design principles. The management and orchestration assets for this PoC, based on the combined use of Open Source MANO (OSM) and Openslice, are aligned with the ZSM architectural principles

<http://osm-download.etsi.org/ftp/osm-9.0-nine/OSM-MR10-hackfest/EcosystemDay/OSM-MR10%20ED1%20-%20Telefonica.pdf>

### Signature of MoU between University of Patras and 5G

The University of Patras and 5G Holdings SA announced on 8<sup>th</sup> of April the signing of an MoU for the exchange of know-how and the support of business groups that develop products and solutions for the exploitation of 5G technology. The cooperation encourages innovation and entrepreneurship and promotes the utilization of our country's human resources and its interconnection with the market.

In detail, the cooperation provides:

- The two sides will exchange information on technology issues, best practices and issues related to innovation and start-up ecosystem development. At the same time, partnerships and partnerships between start-ups, the University and industry will be promoted and incubation and business acceleration programs will be developed.
- The two sides will cooperate for the technical evaluation of investment plans submitted by existing and start-up companies in 5G Holdings.

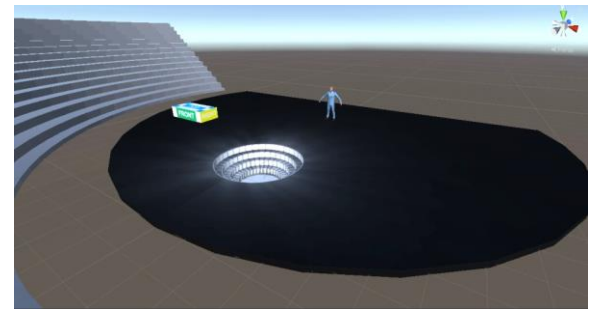


- The companies that participate in the programs of the University and are evaluated by it as having remarkable growth prospects, can be proposed for examination in the 5G Participations for their possible financing from the Phaistos Investment Fund.
- 5G Participations and companies in which Phaistos (the 5G fund) has invested will organize seminars and workshops for undergraduate and postgraduate students of the University on entrepreneurship, investment, technology utilization, product and service development, marketing and sales organization.

The agreement is part of the strategy of 5G Holdings SA. for the creation of a 5G ecosystem in Greece in collaboration with businesses and the academic community. Existing and start-ups will participate in the ecosystem to develop innovative solutions that utilize the features and capabilities of 5G. The Network Architecture Management Group has played an instrumental role in the MoU signing and the Patras 5G testbed will be used in various experiments as part of the collaboration.

### Prometheus project

The Audiogroup and VVR-groups of WCL participate in the project "Context-aware Adaptive 3D Projection based on Motion and Activity Estimation for the Immersive and Interactive Experience of Ancient Drama Performances"-Prometheus funded by ESPA, in collaboration with IRIDA Labs and coordinated by the National Theatre of Northern Greece.



The project aims to develop of a comprehensive system combining computer vision and 3D projection technology, to augment ancient drama performances. The WCL groups design and implement 3D projection tools, which can be driven in real-time via traced objects – actors to provide augmented reality aids for the live performances of the theatrical plays

[Audio and Acoustic Technology Group](#)

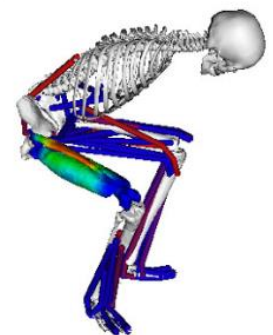
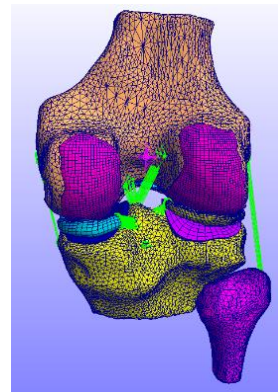
[VVR Group](#)

[vvr.ece.upatras.gr](http://vvr.ece.upatras.gr)

### OACTIVE H2020 project



The OACTIVE H2020 project has been successfully finished with significant research outcomes for WCL-IT. OActive built patient-specific osteoarthritis prediction and interventions by using a combination of mechanistic computational models, simulations and big data analytics. Once constructed, these models are used to simulate and predict optimal treatments, better diagnostics, and improved patient outcomes, overcoming the limitation of the current treatment interventions, Augmented Reality (AR) empowered interventions were developed in a personalised framework allowing patients to experience the treatment as more enjoyable, resulting in greater motivation, engagement, and training adherence.



In the context of OACTIVE WCL-IT received a very significant distinction as a finalist in the Innovation Radar Prize of the European Commission, where it has been ranked second. Moreover, research output has been published in multiple

high quality prestigious scientific journals and received several awards including the OpenSim technical achievement award from Stanford University. Finally, the research foundations laid by WCL-IT through OACTIVE formed the basis for further research in the context of other ongoing project and PhD theses.

## Measurement and analysis of traffic noise

Audiogroup has collaborated with the technical staff of Olympia Odos S.A. in a pilot study to measure and analyse noise disturbance to residences due to bridge expansion joints in the Patras-Athens national motorway. The preliminary measurements and data analysis were carried out by Gabriel Kamaris (PhD candidate) and Prof. John Mourjopoulos .



## Recent Publications

## Recent Publications

Kaleris, K., Stelzner, B., Hatziantoniou, P., Trimis, D. & Mourjopoulos, J. Laser-sound: optoacoustic transduction from digital audio streams. *Nature Scientific Reports* 11, 476 (2021).

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)

Kaleris, K., Orphanos, Y. Bakarezos, M. Papadogiannis, N., & Mourjopoulos, J. "The effect of plasma geometry on the acoustic radiation of laser filaments", proceedings of Forum Acusticum, Lyon (2020). European Acoustics Association (EAA) Best Student Paper and Presentation Award

Zachos P., Kamaris G., Mourjopoulos J. "An Efficient Data Reduction Method for Binaural Parameter Utilization", proceedings of Forum Acusticum, Lyon (2020)

Kamaris G., Zachos P., Mourjopoulos J. Low Filter Order Digital Equalization for Mobile Device Earphones, *J. Audio Eng. Soc.* (2020)

S. Benos L, Stanev D, Spyrou L, Moustakas K and Tsaopoulos DE (2020) A Review on Finite Element Modeling and Simulation of the Anterior Cruciate Ligament Reconstruction. *Frontiers in Bioengineering and Biotechnology*, 8:967. doi: 10.3389/fbioe.2020.00967

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G. Arvanitis, A. S. Lalos and K. Moustakas, "Robust and Fast 3-D Saliency Mapping for Industrial Modeling Applications," in *IEEE Transactions on Industrial Informatics*, vol. 17, no. 2, pp. 1307-1317, Feb. 2021, doi: 10.1109/TII.2020.3003455.

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

M. Pavlou, D. Laskos, E. Zacharaki, K. Risvas and K. Moustakas, "XRSISE: An XR Training System for Interactive Simulation and Ergonomics Assessment", *Frontiers in Virtual Reality*, vol. 2, p. 17, 2021.

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, vol. 17, no. 1, pp. 980-990, February 2021.

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