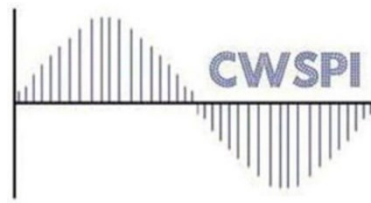


CWSPI'19



<https://cwspi.cs.ucy.ac.cy/>

12th Cyprus Workshop on Signal Processing and Informatics

FINAL PROGRAM AND BOOK OF ABSTRACTS

LOCATION:

University of Cyprus (New Campus)
THEE001, ROOM 147-148 (Building of the Department of Computer Science)
14:00-19:00, July 10, 2019

Organized and Sponsored



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Preface:

Following the successful one-day workshop hosted over the past 11 years, we would like to cordially invite you to participate in the upcoming 12th Cyprus Workshop on Signal Processing and Informatics (CWSPI 2019).

The overall objective of CWSPI 2019 is to disseminate new research findings in the areas of signal processing, image processing, analysis and informatics. Over the years, CWSPI has grown to become the primary forum of Cyprus' graduate students to present their latest research endeavors. Moreover, this one-day workshop hosts presentations by faculty and industry researchers serving a key mission of CWSPI, towards establishing strong industry – academia and multi – university collaborations. This year's efforts are further embraced by Cyprus' newly founded Research Centers of Excellence, namely RISE CoE and KIOS CoE, constituting CWSPI an ideal event for sharing new knowledge while building effective research networks.

We would like to express our sincere thanks to IEEE Cyprus Section, the IEEE Engineering in Medicine Biology and Signal Processing Societies (EMBS & SPS) Cyprus Chapters, the IEEE CIS Cyprus Chapter and the IET Cyprus Network for their support and sponsorship.

Wishing you a fruitful and joyful event.

A. S. Panayides , M. Neofytou
July 2019

Topics:

- Digital signal and image processing
- Interactive Media, Virtual Reality and Augmented Reality Systems and Applications
- Speech, and audio, processing
- Intelligent and Cognitive systems
- Sensor networks and signal analysis
- Biomedical signal, image, and video analysis
- Wireless communications and signal processing
- FPGAS in signal, image and video processing.

Workshop Organizing Committee	
Chair	A. S. Panayides, SiGiNT Solutions LTD, Cyprus and University of Cyprus, Cyprus
Co-Chair	M. Neofytou, 3aHealth, LTD, Cyprus
Program Chair	C. P. Loizou, Cyprus University of Technology, Cyprus
Program Committee	M.S. Pattichis, University of New Mexico, USA E. Kyriacou, Frederick University, Cyprus A. Spanias, Arizona State University, USA C. S. Pattichis, University of Cyprus, Cyprus
Local Arrangements	C. S. Pattichis, University of Cyprus, Cyprus
Publications	C. P. Loizou, Cyprus University of Technology, Cyprus
Liaison/Publicity	T. Kasparis, Cyprus University of Technology, Cyprus
Webmaster	M. Neofytou, 3aHealth, LTD, Cyprus

Venue

Department of Computer Science, University of Cyprus (New Campus),
THEE001 ROOM 148,
P.O.Box. 20537, CY-1678 Nicosia,
CYPRUS

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Webpage:

<http://cwspi.cs.ucy.ac.cy>

<http://www.ehealthlab.cs.ucy.ac.cy/>

Facebook

<https://www.facebook.com/cwspi.cyprus>

Technical Program

TIME	SESSIONS
13:45	Introductions and Refreshments
13:55-14:00	Welcome Andreas Spanias <i>Arizona State University, USA</i>
	KEYNOTE SESSION
14:00-14:40	Keynote 1: Biometrics Through Time, Space and Disciplines Prof. Andreas Lanitis <i>Department of Multimedia and Graphic Arts, Cyprus University of Technology and "Biometrics for Smart Human-centered Emerging Technologies (BIO-SCENT)" MRG Leader, Research Centre of Excellence on Interactive Media Smart Systems and Emerging Technologies (RISE)</i>
14:40-15:20	Keynote 2: Precision Agriculture and UAV Coverage Prof. Nikolaos Papanikolopoulos <i>Department of Computer Science and Engineering, University of Minnesota, USA</i>
15:20-16:00	Keynote 3: Efficient Deep-Learning-Based Object Detection for Unmanned Aerial Vehicles Dr. Christos Kyrkou <i>Research Associate at the KIOS Research & Innovation Center of Excellence at the University of Cyprus</i>
16:00-16:30	Coffee Break
16:30-17:30	SESSION 1: The ASU SenSIP– UCy KIOS IRES Program Funded by NSF Chair: Andreas Spanias <i>Director SenSIP Center</i>
16:30-16:45	The ASU SenSIP– UCy KIOS IRES Program Funded by NSF Andreas Spanias¹ ¹ Director SenSIP Center
16:45-17:00	Anomaly Detection Using Time Series Energy Analysis J. Chauvin¹, K. Jaskie¹, A. Spanias¹ ¹ SenSIP IRES, ASU
17:00-17:15	Fault Detection in PV Arrays using Machine Learning Methods E. Pedersen¹, S. Rao¹, S. Katoch¹, A. Spanias¹, E. Kyriakides² ¹ SenSIP IRES, ASU ² University of Cyprus, Nicosia, Cyprus
17:15-17:30	Machine Learning for Reliable MIMO Systems Jayden Booth¹ ¹ SenSIP IRES, ASU
17:30-18:15	SESSION 2: Biomedical Signal and Image Analysis Chair: Marios Neofytou <i>3aHealth LTD</i>
17:30-17:45	Automatic detection and classification of breast micro-calcifications in digital mammograms using temporal subtraction K. Loizidou¹, G. Skouroumouni¹, C. Nikolaou², C. Pitris¹ ¹ Department of Electrical and Computer Engineering and KIOS Research and Innovation Center of Excellence, University of Cyprus, ² Radiology Department, Nicosia General Hospital, and Radiology Department, Limassol General Hospital
17:45-18:00	Dual-Angle Optical Coherence Tomography for Index of Refraction Estimation Using Rigid Registration and Cross-Correlation C. Photiou¹ and C. Pitris¹

	¹ KIOS Center of Excellence for Intelligent System and Networks, Dept. of Electrical and Computer Engineering, University of Cyprus
18:00-18:15	Modeling of the BOLD signal using event-related simultaneous EEG-fMRI and convolutional sparse coding analysis P. C. Prokopiou¹ and G. D. Mitsis¹ ¹ Integrated Program in Neuroscience (IPN) and Department of Bioengineering, McGill University, McGill University, Montreal, QC, Canada
18:15-18:30	Multiscale AM-FM Ultrasound Image Analysis for the Assessment High-Risk Asymptomatic Carotid Plaques K. Constantinou¹, I. Constantinou¹, E. Kyriacou², A. Nicolaidis³, M. S. Pattichis⁴, C. S. Pattichis¹ ¹ University of Cyprus, Nicosia, Cyprus ² Frederick University, Nicosia, Cyprus ³ Cyprus Cardiovascular Disease Educational Research Trust, Nicosia, Cyprus ⁴ University of New Mexico, Albuquerque, USA
18:30-18:45	Virtual Reality Intervention For Physical Rehabilitation A. Hadjivasiliou¹, A. Michael¹, T. Souroulla¹, E. Schiza¹, M. Matsangidou¹, K. Neokleous¹, C. S. Pattichis¹ ¹ Research Centre on Interactive Media, Smart Systems and Emerging Technologies (RISE CoE), Nicosia, Cyprus
14:00-19:00	SESSION 3: Poster Session Chair: Andreas Panayides SiGiNT Solutions LTD and University of Cyprus
3.1	Co-creation of Virtual Reality Re-Usable Learning objectives for 360° video scenarios for the surgical excision of skin lesion K.C. Neokleous¹, E. Gkougkoudi¹, M. Hatziaros¹, E. Schiza¹, M. Matsangidou¹, M. N. Avraamides¹, S. Konstantinidis¹, P. Bamidis², C. S. Pattichis¹ ¹ Research Centre on Interactive Media Smart Systems and Emerging Technologies, Cyprus ¹ Aristotle University of Thessaloniki. Thessaloniki, Greece
3.2	Innovative Enhancement of the Navarchos Fleet Management System I. Constantinou¹, C. Constantinou¹, P. Gouvas², T. Bouras² ¹ Istognosis LTD, Nicosia, Cyprus ² UBITECH LTD, Nicosia, Cyprus
3.3	eHealth4Ageing: Electronic Health Record for the Elderly E. Eliadou¹, A. S. Panayides², Z. Antoniou², I. Constantinou², K. Neokleous², C. Christodoulou², M. Kouyoumdjian¹, E. Papayianni¹, M. Neofytou² ¹ Archangelos Michael Elderly People Nursing home, Nicosia, Cyprus ² 3AHealth LTD, Nicosia, Cyprus
3.4	Carotid Plaque Motion Characterization using Ultrasound Video E. Kyriacou¹, C. S. Pattichis², M. S. Pattichis³, A. Nicolaidis⁴ ¹ Frederick University, Nicosia, Cyprus ² University of Cyprus, Nicosia, Cyprus ³ University of New Mexico, Albuquerque, USA ⁴ Cyprus Cardiovascular Disease Educational Research Trust, Nicosia, Cyprus
3.5	AVARIS - Emergency Health Care Services Support Platform C. Kronis¹, G. Hadjichristofi¹, R. Constantinou, E. Kyriacou¹ ¹ Frederick University, Nicosia, Cyprus ² Ambulance Services Department, Ministry of Health, Nicosia, Cyprus
3.6	The Battle of Codecs in the Healthcare Domain: VVC or AV1? A. S. Panayides^{1,2}, C. P. Loizou², M.S. Pattichis³, M. Pantziaris⁴, C.S. Pattichis² ¹ SiGiNT Solutions LTD, Nicosia, Cyprus

	<p>²University of Cyprus, Nicosia, Cyprus ³University of New Mexico, Albuquerque, USA ⁴Cyprus Institute of Neurology and Genetics, Nicosia, Cyprus</p>
3.7	<p>Stroke Risk Stratification Using Transfer Learning A. S. Panayides¹, E. Kyriacou², C. S. Pattichis¹, A. Nicolaides³ ¹University of Cyprus, Nicosia, Cyprus ²Frederick University, Nicosia, Cyprus ³Cyprus Cardiovascular Disease Educational Research Trust, Nicosia, Cyprus</p>
3.8	<p>Robotic Systems for general Surgery, Regulatory approvals and Market potential S. Avgousti¹, P. Masouras¹, E. G. Christoforou², A. S. Panayides², C. S. Pattichis^{2,3} ¹Cyprus University. of Technology, Limassol, Cyprus ²University of Cyprus, Nicosia, Cyprus ³Research Centre on Interactive Media, Smart Systems and Emerging Technologies (RISE CoE), Nicosia, Cyprus</p>
3.9	<p>ENDORSE: Safe, Efficient and Integrated Indoor Robotic Fleet for Logistic Applications in Healthcare and Commercial Spaces M. Mellado¹, N. Ramdani², A. S. Panayides³, et al. ¹Universitat Politècnica de Valencia, Valencia, Spain ²Univ. Orleans, PRISME Laboratory, Orleans, France ³University of Cyprus, Nicosia, Cyprus</p>
19:00-19:15	CLOSING REMARKS

Abstracts

14:00-14:40

Keynote 1: Biometrics Through Time, Space and Disciplines

Prof. Andreas Lanitis

Department of Multimedia and Graphic Arts, Cyprus University of Technology and leader of the "Biometrics for Smart Human-centered Emerging Technologies (BIO-SCENT)" multidisciplinary research group of the Research Centre of Excellence on Interactive Media Smart Systems and Emerging Technologies (RISE)

Abstract:

Biometrics is the measurement and analysis of physical or behavioral human characteristics that can primarily be used as a means of verifying personal identity. The need for accurate methods for identity verification prompted the development of several advanced biometric techniques that operate either on single or multiple modalities. Techniques and ideas developed for biometrics could also be applied to other disciplines. As part of the presentation an overview of research work that involves the application of biometric-based techniques to different problems and disciplines is presented. More specifically, past and ongoing work in the areas of age-progression, digital restoration and classification of paintings, avatar generation, virtual aging simulation and the use of biometric measurements for the design of virtual reality applications will be presented.

Short bio: Andreas Lanitis is a Professor, in the Department of Multimedia and Graphic Arts, Cyprus University of Technology and the leader of the "Biometrics for Smart Human-centered Emerging Technologies (BIO-SCENT)" multidisciplinary research group of the Research Centre of Excellence on Interactive Media Smart Systems and Emerging Technologies (RISE). Andreas received the degree of B.Eng in Electronic Engineering (1991) and PhD in Image Processing and Computer Vision (1995), both from the University of Manchester, UK. Subsequently he was a Research Associate in the Division of Imaging Science and Biomedical Engineering, University of Manchester. Between 1997 and 2007 he worked at the School of Sciences and Engineering, Cyprus College. His research interests are focused on applications involving face image interpretation and synthesis, age progression, non-invasive multi-modal human computer interaction, biometrics and other related applications of computer vision and virtual reality. Andreas has published more than 150 papers in scientific journals, edited books and conference proceedings. Andreas was the principal investigator or partner in more than 20 externally funded research projects that received funding mainly from the national Research Promotion Foundation or the European Union.

14:40-15:20

Keynote 2: Precision Agriculture and UAV Coverage

Prof. Nikolaos Papanikolopoulos

Department of Computer Science and Engineering, University of Minnesota, USA

Abstract:

This paper describes a new algorithm for Unmanned Aerial Vehicle (UAV) coverage with applications to precision agriculture. As UAVs are deployed more and more in the real world, an important constraint is omnipresent; the limitation in battery life. This paper presents a new algorithm for UAV coverage based on hexagonal tiling of the area of interest which allows covering larger areas using the standard power resources of a UAV. Several results and comparisons to other algorithms are presented.

Short bio: Nikolaos Papanikolopoulos' research interests include robotics, sensors for transportation applications, computer vision, and control systems. As the director of the Center for Distributed Robotics and a faculty member of the Artificial Intelligence and Robotic Vision Laboratory, his transportation research has included projects involving vision-based sensing and classification of vehicles, and the recognition of human activity patterns in public areas and while driving.

Papanikolopoulos received a diploma in electrical and computer engineering from the National Technical University of Athens, Greece, an M.S.E.E. in electrical engineering from Carnegie Mellon University (CMU) and a Ph.D. in electrical and computer engineering from Carnegie Mellon University in 1992. He is the recipient of numerous academic awards including the University of Minnesota's Faculty Creativity Award. He has authored or coauthored more than 160 journal and conference papers; one of these (co-authored with Osama Masoud) which was awarded the IEEE VTS 2001 Best Land Transportation Paper Award.

Note: Extended abstract appears in ANNEX I.

15:20-16:00

Keynote 3: Efficient Deep-Learning-Based Object Detection for Unmanned Aerial Vehicles

Dr. Christos Kyrkou

Research Associate at the KIOS Research & Innovation Center of Excellence at the University of Cyprus

Abstract:

Deep Learning based object detectors can provide state-of-the-art accuracy for remote sensing technologies such as Unmanned Aerial Vehicles (UAVs), potentially enhancing their capabilities in a wide spectrum of applications. However, the integration of deep learning introduces heavy computational requirements, preventing the deployment of such computer vision algorithms in many scenarios that impose low-latency constraints on inference. This talk will highlight recent techniques to significantly reduce the computational workload of deep-learning-based detection systems that improve the inference time with minimal impact on the detection accuracy.

Short bio: Christos Kyrkou is a Research Associate at the KIOS Research & Innovation Center of Excellence at the University of Cyprus. He received the B.Sc., M.Sc., and PhD degrees in Computer Engineering in 2008, 2010, and 2014 respectively from the University of Cyprus. In 2011 he cofounded ACC innovations Ltd and served as the Director of Technology until 2017 working on computer vision apps and embedded software. He is an author/co-author of more than 40 scientific publications in international peer reviewed conferences and journals. His research interests include computer vision, smart cameras, real-time embedded vision systems, and deep learning/machine learning for visual intelligence. In 2017 he graduated from the Self-Driving Car Engineering Nanodegree program by UDACITY. He has received GPU grants from NVIDIA in support for his research.

TIME	SESSIONS
16:30-17:30	SESSION 1: The ASU SenSIP– UCy KIOS IRES Program Funded by NSF Chair: Andreas Spanias <i>Director SenSIP Center</i>
16:30-16:45	The ASU SenSIP– UCy KIOS IRES Program Funded by NSF Andreas Spanias <i>Director SenSIP Center</i>
Abstract	This International Research Experiences for Students (IRES) program promotes international multidisciplinary research at the overlap of sustainability, power systems and signal processing with the aim of improving efficiency in PV power generation. Algorithms for shading prediction and fault optimization will advance the state of the art in remote solar array management. IRES participants will be immersed in producing and understanding solar analytics and creating algorithms and software to control solar arrays. The IRES program engages faculty researchers from the Arizona State University SenSIP center and from the University of Cyprus KIOS Center in solar energy research. This collaborative IRES project between Arizona State University SenSIP Center and the University of Cyprus KIOS will engage students in the following research problems: a) how do we use imaging to detect cloud movement, predict shading and elevate efficiency?, b) How can the array connections be reconfigured based on imaging, weather, and I-V data to elevate efficiency? c) how can we detect and classify panel faults real time using machine learning and other algorithms? d) How do we extend these solar monitoring and control concepts from utility scale solar farms to rooftop systems?
16:45-17:00	Anomaly Detection Using Time Series Energy Analysis J. Chauvin¹, K. Jaskie¹, A. Spanias¹ <i>¹SenSIP IRES, ASU</i>
Abstract	As household demand for energy increases there is a need to predict the amount of energy that is needed for consumers. In this paper, we used a large dataset of individual household load values gathered every hour to find patterns of consumption. We used Machine Learning algorithms for clustering and anomaly detection. Clustering algorithms are used to find normal energy usage patterns. Anomaly detection is used to find load irregularities. Through the use of these algorithms, we predict the average consumption of electricity per group of customers and detect anomalous usage.
17:00-17:15	Fault Detection in PV Arrays using Machine Learning Methods E. Pedersen¹, S. Rao¹, S. Katoch¹, A. Spanias¹, E. Kyriakides² <i>¹SenSIP IRES, ASU</i> <i>²University of Cyprus, Nicosia, Cyprus</i>
Abstract	An increase in grid-connected photovoltaic arrays creates a need for efficient and reliable fault detection. In this study, machine learning strategies for fault detection are presented. An unsupervised approach was successfully implemented using the k-means clustering algorithm to detect arc and ground faults. To distinguish and localize additional faults such as shading and soiling, a supervised approach is adopted using a Radial Basis Function Network. A solar array dataset with voltage, current, temperature, and irradiance was examined. This dataset had labeled data with normal conditions and faults due to soiling and shading. The direction for this study is to apply machine learning strategies to household-scale PV arrays within a zip code. Unlike the utility-scale arrays, aggregate data is used in rooftop installations, meaning that statistical methods will be examined alongside the fault detection.
17:15-17:30	Machine Learning for Reliable MIMO Systems J. Booth¹ <i>¹SenSIP IRES, ASU</i>

Abstract	<p>The recent rapid increase in users of cellular networks necessitates the use of new technologies to meet this demand. Massive multiple input multiple output (MIMO) communication systems have the potential of significantly increasing the user capacity of the coming 5G cellular networks. Massive MIMO systems have especially shown great advantages for millimeter wave (mmWave) systems. However, dynamic performance optimization of massive MIMO systems requires large and complex models, and physically testing any designed algorithms for such a system is not feasible due to the scale and complexity of such networks. To address this, the current IRES project seeks to apply machine learning to both mmWave and other massive MIMO systems. This project will also implement a MIMO software defined radio system to test machine learning algorithms and make projections from simulations on larger systems.</p>
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TIME	SESSIONS
17:30-18:45	SESSION 2: Biomedical Signal and Image Analysis Chair: Marios Neofytou <i>3aHealth LTD</i>
17:30-17:45	Automatic detection and classification of breast micro-calcifications in digital mammograms using temporal subtraction K. Loizidou¹, G. Skouroumouni², C. Nikolaou², C. Pitris¹ ¹ <i>Department of Electrical and Computer Engineering and KIOS Research and Innovation Center of Excellence, University of Cyprus,</i> ² <i>Radiology Department, Nicosia General Hospital, and Radiology Department, Limassol General Hospital</i>
Abstract	<p>Breast cancer remains until today one of the most deadly cancers worldwide for women. Early detection is crucial in order to reduce the mortality rate. This study investigates if the use of temporal sequential mammogram pairs can improve the diagnosis of micro-calcifications (MCs). MCs are microscopic particles of calcium that appear in clusters and they are associated with breast cancer. For the purpose of this study, we created a new dataset, which includes sequential mammograms from two screening rounds with detailed marking on the locations of the MCs. Initially, the mammogram pairs were registered and subtracted. Using machine learning the falsely detected regions were removed and the true MCs were classified as benign vs. suspicious. For comparison, the developed algorithm was tested only on recent mammograms. With Support Vector Machines, we achieved 99.6% accuracy using temporal subtraction and 91.9% using only recent mammograms ($p=0.025$). These results demonstrate the effectiveness of temporal subtraction for the detection of MCs.</p>
17:45-18:00	Dual-Angle Optical Coherence Tomography for Index of Refraction Estimation Using Rigid Registration and Cross-Correlation C. Photiou¹ and C. Pitris¹ ¹ <i>KIOS Center of Excellence for Intelligent System and Networks, Dept. of Electrical and Computer Engineering, University of Cyprus</i>
Abstract	<p>The index of refraction (n) of materials and tissues serves as a source of optical contrast in imaging. Index variations have been investigated for diagnostic purposes in various fields, such as oncology, since they can signify disease and cell dynamic changes. Optical coherence tomography (OCT) has been used in the past to measure the index <i>ex vivo</i>. However, most methodologies in the literature are not appropriate for <i>in vivo</i> imaging since they require either a mirror below the sample or complicated imaging algorithms. The technique described in this paper, uses two images, obtained at different angles, to estimate the index of refraction and can, thus, also be applied <i>in vivo</i>. The index of refraction is calculated from the path-length difference observed by the OCT beam at the two different angles. When a reflector is not available, the path-length difference can be estimated using image registration and the cross-correlation of adjacent A-Scans. The proposed technique validated experimentally using both clear and scattering samples. The main limitation of this technique is the effect of misalignment on the results, requiring the precision provided by an angular-resolved OCT system. These very promising results provide evidence that the dual-angle method should be further investigated and validated on human tissues so that it can be developed into a clinically useful diagnostic tool in the future.</p>
18:00-18:15	Modeling of the BOLD signal using event-related simultaneous EEG-fMRI and convolutional sparse coding analysis P. C. Prokopiou¹ and G. D. Mitsis¹ ¹ <i>Integrated Program in Neuroscience (IPN) and Department of Bioengineering, McGill University, McGill University, Montreal, QC, Canada</i>

<p style="text-align: center;">Abstract</p>	<p>In this work, we employ simultaneous EEG-fMRI data acquired during a visually-guided attention task along with convolutional sparse coding (CSC) analysis to extract transient events from the EEG. Subsequently, we use these events in a standard voxel-wise fMRI analysis and compare the resultant activation maps with maps obtained using the subjects' response time (RT) in detection of visual target stimuli. Our results show concordance between the resultant activation maps, suggesting that CSC can be used as a tool for the detection of reliable neural events in the EEG.</p>
<p style="text-align: center;">18:15-18:30</p>	<p>Multiscale AM-FM Ultrasound Image Analysis for the Assessment High-Risk Asymptomatic Carotid Plaques K. Constantinou¹, I. Constantinou¹, E. Kyriacou², A. Nicolaides³, M. S. Pattichis⁴, C. S. Pattichis¹ ¹<i>University of Cyprus, Nicosia, Cyprus</i> ²<i>Frederick University, Nicosia, Cyprus</i> ³<i>Cyprus Cardiovascular Disease Educational Research Trust, Nicosia, Cyprus</i> ⁴<i>University of New Mexico, Albuquerque, USA</i></p>
<p style="text-align: center;">18:30-18:45</p>	<p>Virtual Reality Intervention For Physical Rehabilitation A. Hadjivasiliou¹, A. Michael¹, T. Souroulla¹, E. Schiza¹, M. Matsangidou¹, K. Neokleous¹, C. S. Pattichis¹ ¹<i>Research Centre on Interactive Media, Smart Systems and Emerging Technologies (RISE CoE), Nicosia, Cyprus</i></p>
<p style="text-align: center;">Abstract</p>	<p>Recent advancements in Virtual Reality (VR) immersive technologies provide new tools for the development of novel and promising applications for neurological rehabilitation. The purpose of this paper is to review the emerging VR applications developed for the evaluation and treatment of patients with neurological diseases. Overall, this review paper examined the use of VR in certain neurological conditions such as dementia, stroke, spinal cord injury, Parkinson's and multiple sclerosis.</p>

TIME	SESSIONS
14:00-19:00	SESSION 3: Poster Session Chair: <i>Andreas Panayides, University of Cyprus</i>
3.1	Co-creation of Virtual Reality Re-Usable Learning objectives for 360° video scenarios for the surgical excision of skin lesion <i>K.C. Neokleous¹, E. Gkougkoudi¹, M. Hatziaros¹, E. Schiza¹, M. Matsangidou¹, M. N. Avraamides¹, S. Konstantinidis¹, P. Bamidis², C. S. Pattichis¹</i> ¹ <i>Research Centre on Interactive Media Smart Systems and Emerging Technologies, Cyprus</i> ¹ <i>Aristotle University of Thessaloniki, Thessaloniki, Greece</i>
3.2	Innovative Enhancement of the Navarchos Fleet Management System <i>I. Constantinou¹, C. Constantinou¹, P. Gouvas², T. Bouras²</i> ¹ <i>Istognosis LTD, Nicosia, Cyprus</i> ² <i>UBITECH LTD, Nicosia, Cyprus</i>
3.3	eHealth4Ageing: Electronic Health Record for the Elderly <i>E. Eliadou¹, A. S. Panayides², Z. Antoniou², I. Constantinou², K. Neokleous², C. Christodoulou², M. Kouyoumdjian¹, E. Papayianni¹, M. Neofytou²</i> ¹ <i>Archangelos Michael Elderly People Nursing home, Nicosia, Cyprus</i> ² <i>3AHealth LTD, Nicosia, Cyprus</i>
3.4	Carotid Plaque Motion Characterization using Ultrasound Video <i>E. Kyriacou¹, C. S. Pattichis², M. S. Pattichis³, A. Nicolaidis⁴</i> ¹ <i>Frederick University, Nicosia, Cyprus</i> ² <i>University of Cyprus, Nicosia, Cyprus</i> ³ <i>University of New Mexico, Albuquerque, USA</i> ⁴ <i>Cyprus Cardiovascular Disease Educational Research Trust, Nicosia, Cyprus</i>
3.5	AVARIS - Emergency Health Care Services Support Platform <i>C. Kronis¹, G. Hadjichristofi¹, R. Constantinou, E. Kyriacou¹</i> ¹ <i>Frederick University, Nicosia, Cyprus</i> ² <i>Ambulance Services Department, Ministry of Health, Nicosia, Cyprus</i>
3.6	The Battle of Codecs in the Healthcare Domain: VVC or AV1? <i>A. S. Panayides^{1,2}, C. P. Loizou², M.S. Pattichis³, M. Pantziaris⁴, C.S. Pattichis²</i> ¹ <i>SiGiNT Solutions LTD, Nicosia, Cyprus and University of Cyprus, Nicosia, Cyprus</i> ² <i>University of Cyprus, Nicosia, Cyprus</i> ³ <i>University of New Mexico, Albuquerque, USA</i> ⁴ <i>Cyprus Institute of Neurology and Genetics, Nicosia, Cyprus</i>
3.7	Stroke Risk Stratification Using Transfer Learning <i>A. S. Panayides¹, E. Kyriacou², C. S. Pattichis¹, A. Nicolaidis³</i> ¹ <i>University of Cyprus, Nicosia, Cyprus</i> ² <i>Frederick University, Nicosia, Cyprus</i> ³ <i>Cyprus Cardiovascular Disease Educational Research Trust, Nicosia, Cyprus</i>
3.8	Robotic Systems for general Surgery, Regulatory approvals and Market potential <i>S. Avgousti¹, P. Masouras¹, E. G. Christoforou², A. S. Panayides², C. S. Pattichis^{2,3}</i> ¹ <i>Cyprus University of Technology, Limassol, Cyprus</i> ² <i>University of Cyprus, Nicosia, Cyprus</i> ³ <i>Research Centre on Interactive Media, Smart Systems and Emerging Technologies (RISE CoE), Nicosia, Cyprus</i>
3.9	ENDORSE: Safe, Efficient and Integrated Indoor Robotic Fleet for Logistic Applications in Healthcare and Commercial Spaces <i>M. Mellado¹, N. Ramdan², A. S. Panayides³, et al.</i> ¹ <i>Universitat Politècnica de Valencia, Valencia, Spain</i> ² <i>Univ. Orleans, PRISME Laboratory, Orleans, France</i>

	³ <i>University of Cyprus, Nicosia, Cyprus</i>
19:00-19:15	CLOSING REMARKS

ANNEX I - Extended Abstracts

Precision Agriculture and UAV Coverage

Esra Kadioglu*, Cetin Urtis, Vassilios Morellas, and Nikolaos Papanikolopoulos, *Fellow, IEEE*

Abstract— This paper describes a new algorithm for Unmanned Aerial Vehicle (UAV) coverage with applications to precision agriculture. As UAVs are deployed more and more in the real world, an important constraint is omnipresent; the limitation in battery life. This paper presents a new algorithm for UAV coverage based on hexagonal tiling of the area of interest which allows covering larger areas using the standard power resources of a UAV. Several results and comparisons to other algorithms are presented.

I. INTRODUCTION

Precision Agriculture (PA) offers to improve crop productivity and farm profitability through improved management of farm inputs, leading to better environmental quality. Unfortunately, PA has not yet produced a comprehensive answer for the early identification of nutrient deficiencies during the crop growing season. Current approaches rely on either laborious, manual data collection or remote sensing methodologies that utilize satellites, or airplanes. However, satellite and aerial remote sensing is severely limited by cloud cover, cannot offer the required plant-specific spatial and temporal resolution and thus nutrient deficiencies might not be diagnosed early enough to prevent crop losses.

Robotics can provide a variety of solutions to PA. Ground robots can collaborate with Unmanned Aerial Vehicles (UAVs) to provide abundant information at both the plant level and the whole farm level. This approach is limited however by the limited battery life of the UAVs. For example, a typical UAV flight time is around 20 minutes. This paper introduces an algorithm that can improve the region covered by the UAV by using hexagonal coverage of the region of interest.

II. PROBLEM

The problem of covering a region of interest is known in the robotics community as the Coverage Path Planning (CPP). It includes (i) a decomposition step where the region is decomposed into cells and (ii) a planning step that allows path planning among the cells. The traditional coverage approaches involve a back-and-forth motion (zigzag), spiral motion, etc. We propose a hexagon tessellation of the region of interest and we then compute the Hamiltonian circuit of the center points of the hexagons tiling the region as the coverage path.

We also show that given a rectangular region, hexagon tessellation gives a smaller number of polygons than a square

tessellation. We use this result to compute the Hamiltonian circuit. The hexagon tessellation produces a shorter coverage path than a square tessellation. Therefore, the size of the area that can be covered by a drone on a single charge is larger in the case of the path generated by hexagonal tessellation than that of square tessellation. The sizes of hexagons and squares, and hence their numbers, are specified by the desired image resolution. The desired image resolution is associated with the radius of the viewing cone (r) of the downward looking camera of the UAV (Fig. 1). It is possible to compute the size of the area that can be inspected by the drone with a single charge based on this value r .



Fig. 1. Drone camera sweeping the region.

Let's assume $r = 20\text{m}$ and a drone speed not exceeding 2m/s . A square region with a side length of 230m can be covered with a hexagonal tessellation which creates a coverage path of length 2400m . Whereas, the coverage path length of the same region with a square tessellation is 2608m . The region can be covered by the drone on a single charge when the path is generated using hexagonal tessellation but it cannot be completed using the zigzag coverage path from the square tessellation. As the area of the target region increases, the size of the extra area that can be covered through hexagonal tessellation increases.

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Anomaly Detection Using Time Series Energy Analysis

Jovita Chauvin, Kristen Jaskie, Andreas Spanias

Abstract— As household demand for energy increases there is a need to predict the amount of energy that is needed for consumers. In this paper, we used a large dataset of individual household load values gathered every hour to find patterns of consumption. We used Machine Learning algorithms for clustering and anomaly detection. Clustering algorithms are used to find normal energy usage patterns. Anomaly detection is used to find load irregularities. Through the use of these algorithms, we predict the average consumption of electricity per group of customers and detect anomalous usage.

Keywords- energy analytics; machine learning; k-means clustering; anomaly detection.

I. INTRODUCTION

To provide energy effectively and efficiently, power companies must predict energy usage the goal of time series analytics is to identify patterns that describe the behavior of what is being analyzed, in this case, energy demand [1]. Anomaly detection finds patterns that differ from the expected [2]. Smart meters collect large amounts of utility data from their customers [3]. Energy consumption is not the same per person, nor per season [3].

K-means clustering is used to identify patterns of energy consumption by grouping consumers with similar energy usage together. The number of clusters is needed in order to lower cost and still represent the grouping of energy users [6].

There has been a trend towards smart renewable energy and energy conservation in recent years [4]. Smart meters are used to gather large amounts of data. Some challenges in data collection involve errors in trying to collect the data and analyze the data accurately. For example, a misalignment with the sensors, like time delay, could lead to inaccurate data regarding the amount used and required [4]. This could be solved by analyzing larger amounts of data and grouping similar energy users together.

Anomaly detection helps determine inaccuracies in energy usage data. It could also aid in forecasting energy requirements for irregular events such as holidays. There are multiple algorithms that could aid in the detection of those anomalies. An Auto-Regressive Integrated Moving Average (ARIMA) model uses earlier data points and a random variable to forecast possible energy usage patterns [7].

To accurately determine the amount of energy usage, large amounts of energy usage data is necessary. By taking the average energy consumption of different groups of houses, we

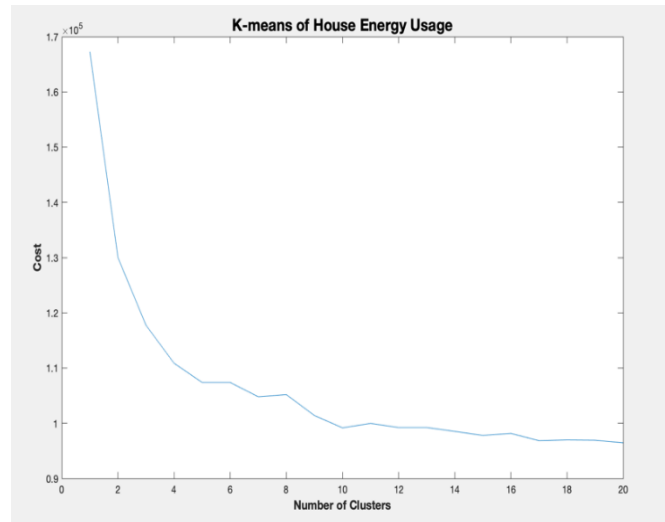


Figure 1: K-means of London data house energy usage [5].

show that energy forecasting and anomaly detection are improved.

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Automatic detection and classification of breast micro-calcifications in digital mammograms using temporal subtraction

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Abstract—Breast cancer remains until today one of the most deadly cancers worldwide for women. Early detection is crucial in order to reduce the mortality rate. This study investigates if the use of temporal sequential mammogram pairs can improve the diagnosis of micro-calcifications (MCs). MCs are microscopic particles of calcium that appear in clusters and they are associated with breast cancer. For the purpose of this study, we created a new dataset, which includes sequential mammograms from two screening rounds with detailed marking on the locations of the MCs. Initially, the mammogram pairs were registered and subtracted. Using machine learning the falsely detected regions were removed and the true MCs were classified as benign vs. suspicious. For comparison, the developed algorithm was tested only on recent mammograms. With Support Vector Machines, we achieved 99.6% accuracy using temporal subtraction and 91.9% using only recent mammograms ($p=0.025$). These results demonstrate the effectiveness of temporal subtraction for the detection of MCs.

I. INTRODUCTION

Mammography is the most reliable screening tool for the diagnosis of breast cancer and Computer Aided Detection (CAD) systems are being developed to assist radiologists. There have been several works for the diagnosis of micro-calcifications (MCs) using CAD [1]. The main drawback is the lack of prior knowledge regarding the timeline of the MC appearance. In this work, we developed a new dataset (Fig. 1) and utilized subtraction of temporal sequential pairs of mammograms. The goal was to increase the contrast ratio (CR), eliminate the MCs that appear in both screening rounds, remove the false positives (FPs) and characterize MCs as benign vs. suspicious with higher accuracy (compared to the analysis with only recent images).

II. METHODS

Eighty digital temporal pairs, forty normal and forty abnormal (with at least 1 suspicious MC in the recent image), were processed. For an effective subtraction, 2 registration algorithms were evaluated and Demons was selected due to its better performance [2]. Next, machine learning was implemented to reduce the large number of FPs. Finally, the true MCs were classified as benign or suspicious. For the classification, 24 features (intensity, shape and texture) were extracted and 4 classifiers were used in a leave-one-patient-out

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cross-validation. Following, the algorithm was tested only on recent mammograms for comparison.

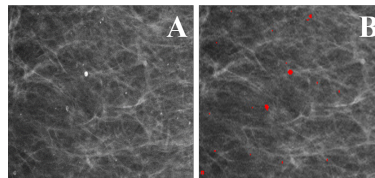


Fig. 1. Dataset example. (A) Zoomed region of a mammogram with MCs. (B) The same image with precise marking (red regions) at MC locations, as defined by two expert radiologists.

III. RESULTS

The CR of the subtracted image was significantly higher compared to the recent one and from the 30% overlapping MCs we effectively removed 23% (Fig. 2). Support Vector Machines, achieved the best classification performance with 99.6% accuracy using temporal subtraction and 91.9% using only recent images.

IV. DISCUSSION & CONCLUSION

The results produced by temporal subtraction were superior compared to those using only most recent mammograms (7% accuracy increase, $p=0.025$). The proposed algorithm has the potential to significantly contribute to the development of automated CAD systems, provide invaluable assistance to radiologist and impact patient prognosis. Given these points, the algorithm must be tested on larger datasets.

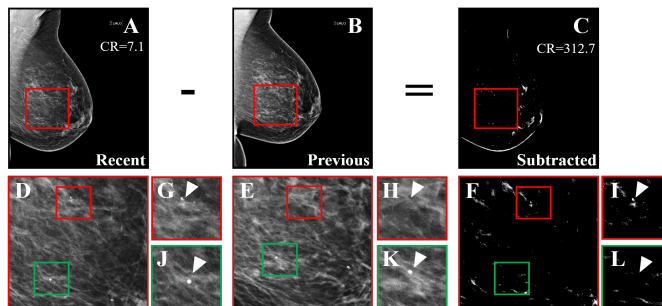


Fig. 2. Improvement of CR and subtraction of pre-existing MCs. (A) Most recent mammogram. (B) Prior mammogram. (C) The result of subtracting the registered version of B from A. (D)-(F) are the zoomed regions marked by the red squares in A-C. The CR has increased 44 times, after subtraction. The red squares in D-F correspond to the zoomed images (G)-(I) and show a new suspicious MC cluster, which was not subtracted. On the contrary, the green squares, which correspond to (J)-(L), show a pre-existing benign MC, which was completely subtracted.

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Dual-Angle Optical Coherence Tomography for Index of Refraction Estimation Using Rigid Registration and Cross-Correlation

Christos Photiou, Costas Pitris

Abstract— The index of refraction (n) of materials and tissues serves as a source of optical contrast in imaging. Index variations have been investigated for diagnostic purposes in various fields, such as oncology, since they can signify disease and cell dynamic changes. Optical coherence tomography (OCT) has been used in the past to measure the index *ex vivo*. However, most methodologies in the literature are not appropriate for *in vivo* imaging since they require either a mirror below the sample or complicated imaging algorithms. The technique described in this paper, uses two images, obtained at different angles, to estimate the index of refraction and can, thus, also be applied *in vivo*. The index of refraction is calculated from the path-length difference observed by the OCT beam at the two different angles. When a reflector is not available, the path-length difference can be estimated using image registration and the cross-correlation of adjacent A-Scans. The proposed technique validated experimentally using both clear and scattering samples. The main limitation of this technique is the effect of misalignment on the results, requiring the precision provided by an angular-resolved OCT system. These very promising results provide evidence that the dual-angle method should be further investigated and validated on human tissues so that it can be developed into a clinically useful diagnostic tool in the future.

Introduction

Medical imaging systems use n values as optical contrast for label free tissue imaging. Studies show that tissue n measurements could be used as a biomarker for diagnosis such as computed tomography (CT) and OCT [1-3]. Using OCT images, n can be measured *in vitro* [4]. However, this method cannot be used *in vivo* since it requires a reflector under the tissue. Other methods, that have been recently developed for *in vivo* estimation of n , require very complicated experimental setups or algorithms [5,6]. A new method, appropriate for *in vivo* and *in situ* measurement of n in tissues, without the need for a reflector as a reference, is proposed here. It could be developed into a useful *in vivo* diagnostic tool in the future.

I. METHODS

Dual-Angle (DA) method is based on the measurement of the path-length increase traveled by a beam incident at an angle vs. a perpendicular beam. Path-lengths (L_1, L_2) and incidence angles ($\theta_{1,1}, \theta_{1,2}$) are measured and by using Snell's law:

$$\sin \theta_{1,2} = n \sin \theta_{2,2} \quad (1)$$

n can be calculated by:

$$n = \sqrt{\frac{L_1^2 \sin(\theta_{1,1}) - L_2^2 \sin(\theta_{1,2})}{L_1^2 - L_2^2}} \quad (2)$$

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To apply this technique *in vivo*, the path-length change can be achieved by first registering and aligning the two images, with a rigid affine transformation, and subsequently using the cross-correlation of corresponding A-Scans from each image to estimate the path-length change for each A-Scan [7].

II. EXPERIMENTAL PROCEDURE

A Santec IVS 300 swept source OCT system was used for imaging. Initially, the proposed methodology was tested on glass. Images of glass were acquired at different incidence angles, ranging from 5° to 20° , with eight repetitions for each combination, for a total of 48 images. Images from cucumber and rabbit trachea with different scattering properties were also evaluated. The index of refraction was calculated using Matlab.

III. RESULTS

The average results are shown in Table 1. When compared to the reference value of the index of the glass, $n = 1.509$, the error was 1.36%. The average results, when using the reflector below the sample to measure the path-lengths, are used in Table 1 as a reference. By using DA method with a reflector, the estimated n for cucumber slices compared to the reference value, exhibited a mean error of $\sim 0.7\%$. The index was also determined using the cross-correlation method and the error was $\sim 1.1\%$. For rabbit trachea images the proposed methods perform equally accurately as the reference method.

Table 1. Index of Refraction Estimates

	Reference		Path-length Changes Measured Using a Reflector				Path-length Changes Measured Using Xcorr			
	Mean	Std	Mean	Std	Error	% Error	Mean	Std	Error	% Error
Glass	1.509 [†]	N/A	1.530	0.091	0.021	1.36	-	-	-	-
Cucumber	1.369 [†]	0.015	1.379	0.025	0.009	0.688	1.354	0.024	0.015	1.097
Rabbit Trachea	1.391 [†]	0.002	1.390	0.001	0.001	0.001	1.392	0.002	0.001	0.001

[†] Provided by the manufacturer.

[‡] Measured using the method of Tearney et al

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Modeling of the BOLD signal using event-related simultaneous EEG-fMRI and convolutional sparse coding analysis

Prokopis C. Prokopiou and Georgios D. Mitsis

Abstract— In this work, we employ simultaneous EEG-fMRI data acquired during a visually-guided attention task along with convolutional sparse coding (CSC) analysis to extract transient events from the EEG. Subsequently, we use these events in a standard voxel-wise fMRI analysis and compare the resultant activation maps with maps obtained using the subjects' response time (RT) in detection of visual target stimuli. Our results show concordance between the resultant activation maps, suggesting that CSC can be used as a tool for the detection of reliable neural events in the EEG.

I. PROJECT SUMMARY

BOLD-fMRI has been widely used for studying brain function and its organization into functional networks. However, it is only an indirect measurement of neuronal activity through a cascade of physiological events, which is typically modelled with the hemodynamic response function (HRF) [1].

Recent studies in the literature attempted to model the resting-state HRF using neural events detected in the BOLD-fMRI signal [2]–[3]. These works laid on the hypothesis that the neural events that govern the dynamics of the brain in resting-state are reflected in the large amplitude peaks in the BOLD signal. However, large amplitude peaks in the BOLD, in addition to neural events may reflect physiological noise, such as respiration and cardiac pulsatility. Therefore, a propitious avenue for obtaining the HRF is by using multimodal imaging techniques, such as simultaneous EEG-fMRI.

In this work, we employ simultaneous EEG-fMRI data obtained during a visual oddball paradigm [4] and convolutional sparse coding analysis [5] to detect transient events in the EEG, and used these events to describe changes in BOLD-fMRI. To show the functional relevance of the detected events, we perform a voxel-wise analysis and compare the results with traditional fMRI analysis using behavioral response time (RT) events, which reflect fluctuations in the subjects' internal attentional state. Our results show that the detected events can explain BOLD signal changes in the visual, motor and cingulate cortical networks. Therefore, this analysis could be used to detect events in resting-state EEG-fMRI and to obtain reliable estimates of the resting-state HRF, which can be useful for hemodynamic deblurring in resting-state fMRI connectivity studies.

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II. EEG-FMRI DATA ANALYSIS

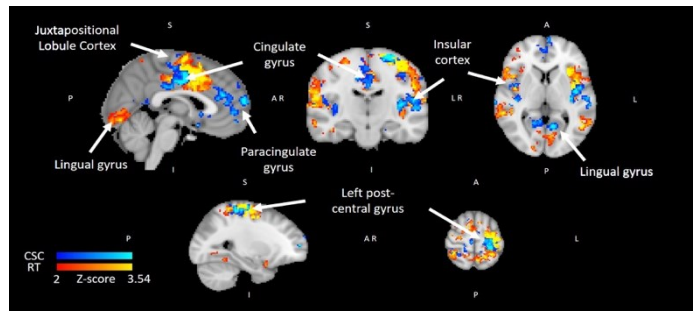


Figure 1. Voxel-wise analysis showing brain activation at the group level during execution of a visual target detection task.

Fig. 1 illustrates group level activation maps obtained from voxel-wise, event-related analyses using CSC and RT events, shown in blue and red/yellow, respectively. Significant regions are displayed with a threshold of $Z > 2$, with a cluster probability threshold of $P < 0.05$ corrected for multiple comparisons. Both CSC and RT events yield significant activations in the cingulate, motor, and visual cortices. Although the RT maps show more wide-spread activation, overall there is considerable overlap between the activation maps obtained with each method, suggesting that CSC is able to successfully detect neural events associated with the task.

Future work consists of using CSC analysis to detect neural events in resting-state EEG data, which can subsequently be used to obtain reliable estimates of the HRF. This line of research is of significant importance for the study of resting-state functional connectivity using BOLD-fMRI as accurate HRF estimates are important to correct for the confounding hemodynamic blurring.

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Virtual Reality Intervention For Physical Rehabilitation

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Abstract— Recent advancements in Virtual Reality (VR) immersive technologies provide new tools for the development of novel and promising applications for neurological rehabilitation. The purpose of this paper is to review the emerging VR applications developed for the evaluation and treatment of patients with neurological diseases. Overall, this review paper examined the use of VR in certain neurological conditions such as dementia, stroke, spinal cord injury, Parkinson's and multiple sclerosis. This project has received funding for the European Union's Horizon 2020 research and innovation programme under grant agreement No 739578.

I. INTRODUCTION

In recent years' Virtual reality (VR) technology has gained recognition as a useful tool for cognitive research, evaluation, and rehabilitation. VR systems allow users to interact in various sensory environments and to obtain real-time feedback on their performance using computer technology. The simulated environments offered via VR technology makes it possible for patients to participate in activities in settings and environments like those encountered in real life. In addition, VR tools can be used to record accurate measurements of the user performance and to deliver greater therapeutic stimulation to users.

II. REAL-LIFE APPLICATIONS OF VR TECHNOLOGIES IN HEALTHCARE

VR is a feasible and effective tool in the treatment of neurological disorders. In addition, low-cost, immersive VR technologies have been proven to be effective for clinical rehabilitation in healthcare and home-based setting with practical implications and uses. The development of VR technologies in recent years has resulted in more accessible and affordable solutions that can still provide promising results. Concluding, VR and interactive devices resulted in the development of holistic, portable, accessible and usable systems for certain neurological disease interventions. It is expected that emerging VR technologies and tools will

further facilitate the development of state of the art applications in the future, exerting a significant impact on the wellbeing of the patient.

III. PROJECT OVERVIEW

VR for rehabilitation is an ongoing project aiming to improve the lives of elderly, disadvantaged and people suffering from dementia by using Virtual Reality technology. The current problem is that a lot of patients need to do physical exercise on a daily basis, (e.g side arm raise, or front arm raise) but they are unable to or they do not cooperate peacefully. This is happening due to a variety of factors, including being unable to remember and follow basic instructions or not understanding the reasons behind the exercises. Patients suffering from dementia have been noted to violently refuse to cooperate to exercise instructions with the current traditional approach. More specifically, we have collaborated with "Archangelos Michael" nursing home, where the physiotherapists have noted a significant difficulty in making the patients do the exercises. We are trying to solve these issues by immersing them in a virtual environment, where they will perform novel daily tasks that they are used to, while at the same time effectively doing the exercises without realizing it. More specifically, they will be put in a virtual valley where they can do things like freeing some birds from a cage or getting water from a small river. Patients should be more comfortable, less stressed and more responsive. The operating physiotherapist will be able to easily customize the environment to better fit the needs and capabilities of different patients. Additionally, their arm movements and several bio-signals will be logged and analyzed using some non-invasive sensors. We will finally compare the results with and without this virtual reality implementation to quantify any potential improvements and drawbacks, such as increased compliance, the accuracy of movement endurance.

IV. ACKNOWLEDGEMENTS

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