CWSPI'24

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

https://ehealth.cut.ac.cy/

https://www.ehealthlab.cs.ucy.ac.cy/

16th Cyprus Workshop on Signal Processing and Informatics

FINAL PROGRAM
AND BOOK OF ABSTRACTS

Venue: Cyprus University of Technology,
Dracos Building Socratous str. 3036, Limassol
Room 001
Directions via Google Maps: https://maps.app.goo.gl/HRVfDJwpssVrCkja6

Connect online via Microsoft teams at the following link:
https://teams.microsoft.com/l/meetup-join/19%3ameeting_YTk5OGFhNzEtMGE3Mi00ODljLTgwYTAtN2VmMzg3ZGE3YTQy%40thread.v2/0?context=%7b%22Tid%22%3a%228f7698bc-b1b4-439f-b259-0213401d1cfb%22%2c%22Oid%22%3a%222ea3842d-3a95-4e44-bbb2-25613314b95a%22%7d

Meeting ID: 358 755 866 415

Passcode: pLg6VK

13:50-19:40, July 10th, 2024

Organized and Sponsored

Technically Co-Sponsored

Table of Contents

Preface:

Following the successful one-day workshop hosted over the past 15 years, we would like to cordially invite you to participate in the upcoming 16th Cyprus Workshop on Signal Processing and Informatics (CWSPI 2024).

The overall objective of CWSPI 2024 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. The workshop is strongly supported by the CYENS, KIOS and Eratosthenes centers of excellence, constituting 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.

The papers will be presented either in physical presence (PP) or via Teams link (ZL).

Wishing you a fruitful and joyful event.

Christos Loizou, Efthyvoulos Kyriacou,
Constantinos S. Pattichis, Andreas Spanias
July 2024

Topics:

- Digital signal and image processing
- Interactive Media, Virtual Reality and Augmented Reality Systems and Applications
- Speech, and audio, processing
- Intelligent and Cognitive systems
- Machine Learning and Deep Learning
- Generative AI in signal and image processing
- 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	E. Kyriacou, Cyprus University of Technology, Cyprus
Co-Chair	C. P. Loizou, Cyprus University of Technology, Cyprus
Program Chair	C. S. Pattichis, University of Cyprus & CYENS, Cyprus
Program Committee	M.S. Pattichis, University of New Mexico, USA E. Kyriacou, Cyprus University of Technology, Cyprus A. Spanias, Arizona State University, USA
Local Arrangements	C. S. Pattichis, University of Cyprus & CYENS, Cyprus
Publications	A. S. Panayides, CYENS Centre of Excellence, Cyprus
Liaison/Publicity	C. S. Pattichis, University of Cyprus & CYENS, Cyprus
Webmaster	C. Christodoulou, University of Cyprus, Cyprus

Venue
Cyprus University of Technology, Dracos Building Socratous str. 3036, Limassol, Cyprus
More info
Tel.: +357 25002022, + 357-22892697 e-mail: **pattichis.costas@ucy.ac.cy**, **efthyvoulos.kyriacou@cut.ac.cy** **christos.loizou@cut.ac.cy**

Webpage:	http://cwspi.cs.ucy.ac.cy
	https://ehealth.cut.ac.cy/
Facebook	https://www.facebook.com/cwspi.cyprus

Technical Program

TIME	SESSIONS
13:50	**Introductions**
13:55-14:00	**Welcome** ***Andreas Spanias & Efthyvoulos Kyriacou* (PP)** *Arizona State University, USA, Cyprus University of Technology*
	SESSION 1: PLENARY TALKS **Chair: *Andreas Spanias,* *Arizona State University, USA***
14:00-14:20	**ERATOSTHENES and the Future of Earth Observation: Expanding Data and AI (PP)** Michalis Mavrovouniotis, Maria Anastasiadou, Department of Big Earth Data Analytics, Eratosthenes Centre of Excellence, Lemesos, Cyprus
	SESSION 2: School of Electronics and Information, Hangzhou Dianzi University, China **Chair: *Christos Loizou,* Cyprus University of Technology**
14:20:14:30	**Enhanced Prostate Segmentation through Multi-modal Image Fusion: Improving nnUNetv2 for Integrating Ultrasound and MRI (TL)** [1,3]Jiale Hou, [1,3]Haohan Yu, [2]Xiwei Huang, [2]G. Rousakis, [3]Christos P. Loizou [1]School of Electronics and Information, Hangzhou Dianzi University, China; [2]German Oncology Center, Medical Physics and Radiotherapy Department, Limassol, Cyprus; [3]Dept. of Electrical Eng.; [3]Computer Eng. and Informatics, Cyprus University of Technology, Limassol, Cyprus
14:30-14:40	**A Deep Multi-Model Fusion Framework Integrating Vision Transformer, Convolutional Neural Networks and Texture Features for Prostate Cancer Classification (TL)** [1,2]Haohan Yu, [1,2]Jiale Hou, [1]Xiwei Huang, [2]G. Rousakis, [3]Christos P. Loizou [1]School of Electronics and Information, Hangzhou Dianzi University, China; [2]German Oncology Center, Medical Physics and Radiotherapy Department, Limassol, Cyprus; [3]Dept. of Electrical Eng., Computer Eng. and Informatics, Cyprus University of Technology, Limassol, Cyprus
14:40-15:10	**COFFEE BREAK**
	SESSION 3: Intelligent Systems, Sensing and Decision Making **Chair: *Efthyvoulos Kyriakou,* Cyprus University of Technology**
15:10-15:20	**Advanced Unsupervised Anomaly Detection for Vehicle Predictive Maintenance Using Incomplete Data (TL)** Apostolos Giannoulidis[1], Anna-Valentini Michailidou[2], Theodoros Toliopoulos[2], Ioannis Constantinou[2], Anastasios Gounaris[1] [1]Aristotle University of Thessaloniki, [2]Istognosis Ltd
15:20-15:30	**Real Time Water Quality Monitoring System Using Cutting-Edge Sensors and IoT Technologies (PP)** [1]Christy Karam, [1]Giorgos Demetriou [1]Robotics and Autom Cyprus Systems (RAS) Lab, Department of computer science, Frederick University, Limassol, Cyprus
15:30-15:40	**Exploring parameter impact of multi-altitude UAV object detection (PP)** [1]Michalis Piponidis, [1]Theocharis Theocharides [1]Electrical and Computer Engineering, University of Cyprus, Nicosia, Cyprus
15:40-15:50	**FixCyprus: Automated Classification of Crowdsourced Reports Using Machine Learning (TL)** [1]Leslie Miller, [2]Christos Laoudias, [2]Christos Kyrkou, [1]Andreas Spanias; [1]SenSIP ECEE, Arizona State University, United States; [2]KIOS Research and Innovation Center of Excellence, University of Cyprus, Cyprus

15:50-16:00	**Virtual Reality Gaming based on Brain-Computer Interfacing (TL)** [1,2,3]Marios Hadjiaros, [4]Andria Shimi, [1,4]Marios N. Avraamides, [1]Kleanthis Neokleous, [1,2,3]Constantinos S. Pattichis [1]CYENS – Centre of Excellence, 1016 Nicosia, Cyprus; [2]Department of Computer Science, University of Cyprus, 1678 Nicosia, Cyprus; [3]Biomedical Engineering Research Centre, University of Cyprus, 1678 Nicosia, Cyprus; [4]Department of Psychology, University of Cyprus, 1678 Nicosia, Cyprus
16:00-16:10	**Automated Sound Classification Using CNN and MobileVit for Real-Time Mode Detection (PP)** [1]Andreas Anastasiou, [1]Konstantinos Andreou, [2,3] Basha Shadi, [2,3]Maysam Khatib [1]University of Cyprus, Dep. of Computer Science; [2]Birzeit University Department of Computer Engineering, [3]FINOMENA
16:10-16:20	**Machine Learning Methods on BioVid Heat Pain Database for Pain Intensity Estimation (PP)** [1]Melpo Pittara, [2]Andreas Anastasiou, [2]Konstantinos Andreou, [2,3,4]Constantinos S. Pattichis [1]Bernoulli Institute for Mathematics Computer Science and Artificial Intelligent, University of Groningen, Groningen, Netherlands; [2]Department of Computer Science, University of Cyprus, Nicosia, Cyprus; [3]Biomedical Engineering Research Centre, University of Cyprus, Nicosia, Cyprus; [4]CYENS Center of Excellence, Nicosia, Cyprus
16:20-16:30	**Adaptive 360º Video Streaming Over Wireless Communication Channels (PP)** [1]I. Valiandi, [2]E. Kyriacou, [3]M. S. Pattichis, [1]A. S. Panayides [1]VIDEOMICS group, CYENS CoE, Nicosia; Cyprus, [2]Electrical and Computer Engineering, University of Technology, Cyprus University of Technology, Limassol, Cyprus; [3]Department of Electrical and Computer Engineering, The University of New Mexico, Albuquerque, NM, USA
	SESSION 4: Digital Health Information Systems **Chair: Andreas Panayides,** *CYENS Centre of Excellence*
16:30-16:40	**Modern Information and Communication Technologies (ICT) in Cypriot Hospitals: Challenges, Opportunities and Privacy Issues (PP)** Omirou Rafael, Balis Charalampos, Neofytou Marios, Stylianides Nikolas [1]Cyprus, Mediterranean Hospital of Cyprus, Department Operating Room; [2]Open University of Cyprus, Nicosia, Cyprus
16:40-16:50	**Decentralized Smart Health Records based on Digital Twins (PP)** [1]Stelios Mappouras, [1]Andreas Andreou, [1]Efthyvoulos Kyriacou [1]Department of Electrical Engineering, Computer Engineering and Informatics, Cyprus University of Technology, Limassol, Cyprus
16:50-17:00	**Enhancing Migrant Boat Health Assessment Through AI-enabled Telemedicine (PP)** [1]Stelios Mappouras, [1]Michalis Gemenaris, [2]Riana Constantinou, [2]Theodosis Theodosiou, [1]Efthyvoulos Kyriacou [1]Department of Electrical Engineering, Computer Engineering and Informatics, University of Technology, Limassol, Cyprus; [2]Ambulance Department, State Health Services Organisation, Cyprus
17:00-17:10	**Integrating Chatbots for Enhanced Patient Engagement in Healthcare Systems (PP)** Aliki Vasilia[1], Eirini Schiza[1,2], Christos N. Schizas[3], Constantinos S. Pattichis[1,2] [1]Department of Computer Science and Biomedical Engineering Research Center, University of Cyprus; [2]CYENS Centre of Excellence, Cyprus; [3]National eHealth Authority, Cyprus
17:10-17:20	**AI-based solutions for predicting sepsis in ICUs (TL)** [1]Charithea Stylianides, [1]Andria Nikolaou, [2]Nikos Ioannides, [2]Lakis Palazis, [2]Anna Vavlitou, [1]Constantinos S. Pattichis, [1]Andreas S. Panayides; [2]CYENS CoE, Nicosia, Cyprus; [2]State Health Services Organization, Cyprus
17:20-17:30	**Diagnostic Hysteroscopy Information System (ZL)** Alexandros Theodosiou 3AE Health LTD, Strovolos, Nicosia, Cyprus
17:30-17:50	**COFFEE BREAK**
	SESSION 5: MEDICAL IMAGING AND VIDEO **Chair: Costas Pitiris,** *University of Cyprus*

17:50-18:00	**Prediction of Near-Term Breast Cancer Occurrence in Digital Mammography: The Effect of Subtracting Temporally Consecutive Mammograms (PP)** Kosmia Loizidou[1], Galateia Skouroumouni[2], Gabriella Savvidou[3], Anastasia Constantinidou[3], Eleni Orphanidou Vlachou[4], Anneza Yiallourou[5], Costas Pitris[1], and Christos Nikolaou[6] [1]KIOS Research and Innovation Center of Excellence, University of Cyprus, Cyprus; [2]Ygia Polyclinic Private Hospital Limassol, Cyprus; [3]Medical School, University of Cyprus, Bank of Cyprus Oncology Centre, Cyprus; [4]EIMC Clinic Strovolos, Cyprus; [5]Medical School University of Cyprus, Breast Unit Nicosia General Hospital, State Health Services, Organization, Cyprus; [6]Limassol General Hospital, Cyprus
18:00-18:10	**Early Detection of Acute Radiation Dermatitis Using *In Vivo* Optical Coherence Tomography (OCT) Images of Human Head and Neck and Deep Learning with Late Fusion (PP)** Christos Photiou[1], Constantina Cloconi[2], Iosif Strouthos[1], Costas Pitris[2] [1]KIOS Research and Innovation Center of Excellence; [2]University of Cyprus, Medical School University of Cyprus
18:20-18:30	**An Explainable AI model in the assessment of Multiple Sclerosis using clinical data and Brain MRI lesion texture features (TL)** [1]Andria Nicolaou, [2]Marios Pantzaris, [3]Christos P. Loizou, [4]Antonis Kakas, [4]Constantinos S. Pattichis [1]Department of Computer Science, University of Cyprus, Nicosia, Cyprus; [2]Cyprus Institute of Neurology and Genetics, Nicosia, Cyprus; [3]Dept. of Electrical Eng., Computer Eng. and Informatics, Cyprus University of Technology, Limassol, Cyprus; [4]Department of Computer Science, University of Cyprus, Nicosia, Cyprus
18:30-18:40	**Azimuthal equidistant mapping and projection of head CT scans for skull fracture visualization (PP)** [1]Nicolas Hadjittoouli, [1]Costas Pitris, [2]Christos Nikolaou; [1]KIOS Research and Innovation Center of Excellence, University of Cyprus, Cyprus, [2]Limassol General Hospital, Cyprus
18:40-18:50	**Multi-Spectral Semantic Segmentation in Abnormal Tissue Classification (PP)** [1]Gabrielle Miller, [2]Costas Pitris, [3]Andreas Spanias [1]Texas A&M University, College Station, TX, USA; [2]KIOS Research Center of Excellence, University of Cyprus, Nicosia, Cyprus; [3]SenSIP Center, ECEE, Arizona State University, Tempe, AZ, USA
18:50-19:00	**Enhanced Polyp Detection in Gastrointestinal Endoscopy Using YOLOv8 (TL)** Ioannis Rodosthenous, Constantinos Pattichis Computer Science Department, University of Cyprus, 2109 Nicosia, Cyprus
19:00-19:10	**AtheroRisk - An integrated computer software system for stroke risk stratification utilizing carotid plaque analysis in ultrasound videos (PP)** Michalis Gemenaris[1], Georgia D. Liapi[1], Christos Markides[2], Christos P. Loizou[1], Andrew Nicolaides[3], Maura Griffin[3], Constantinos S. Pattichis[4], Efthyvoulos Kyriacou[1] [1]Dept. of Electrical Eng., Computer Eng. and Informatics, Cyprus University of Technology, Limassol, Cyprus; [2]Dept. of Computer Science and Engineering, Frederick University, Nicosia, Cyprus; [3]Vascular Screening and Diagnostic Center, Nicosia, Cyprus; [4]Department of Computer Science, University of Cyprus, Nicosia, Cyprus
19:10-19:20	**Carotid plaque motion analysis in ultrasound videos to discover rupture-prone plaque areas (PP)** [1]Georgia D. Liapi, [1]Christos P. Loizou, [2]Andrew N. Nicolaides, [2]Maura Griffin, [3]Dimitrios Kardoulas, [4]Constantinos S. Pattichis, [1,4]Efthyvoulos Kyriacou [1]Department of Electrical Engineering, Computer Engineering and Informatics, Cyprus University of Technology, Limassol, Cyprus; [2]Vascular Screening and Diagnostic Centre, Nicosia, Cyprus; [3]Hemodynamic Unit, Vascular Surgery Clinic, National and Kapodistrian University of Athens, Attikon General University Hospital, Athens, Greece; [4]Department of Computer Science, University of Cyprus, Nicosia, Cyprus
19:20-19:30	**Brain Magnetic Resonance Imaging Segmentation System in MS with Deep Neural Networks (TL)** Giorgos Adamides, 3aHealth
19:30-19:40	**Personalized Medicine via AI-based Precision Tracheostomy** Evropi Toulkeridou[1], Panagiota Kosmidou[2] , Kristis Vevis[2], Zinonas Antoniou[3], Loizos Kallinos[3], Ioanna Valiandi[1], Andreas Panayides[1, 3] [1]Videomics FRG, CYENS Center of Excellence, Nicosia, Cyprus

	[2]German Oncology Center (GOC), Limassol, Cyprus [3]3aHealth, R&D Department, Nicosia, Cyprus
	Closing Remarks

Abstracts

SESSION 1: PLENARY TALKS

ERATOSTHENES and the Future of Earth Observation: Expanding Data and AI (PP)

Michalis Mavrovouniotis, Maria Anastasiadou, Department of Big Earth Data Analytics, Eratosthenes Centre of Excellence, Lemesos, Cyprus

Abstract

No abstract.

SESSION 2: School of Electronics and Information, Hangzhou Dianzi University, China MSc Students

Enhanced Prostate Segmentation through Multi-Modal Image Fusion: Improving nnUNetv2 for Integrating Ultrasound and MRI (TL)

[1,3]Jiale Hou, [1,3]Haohan Yu, [2]Xiwei Huang, [2]G. Rousakis, [3]Christos P. Loizou

[1]School of Electronics and Information, Hangzhou Dianzi University, China; [2]German Oncology Center, Medical Physics and Radiotherapy Department, Limassol, Cyprus; [3]Dept. of Electrical Eng., [3]Computer Eng. and Informatics, Cyprus University of Technology, Limassol, Cyprus

Abstract

Background: Prostate image segmentation is important in medical diagnosis because it enables precise localization and quantification of the prostate and its pathological regions, thereby improving the accuracy of diagnosing prostate cancer and other related diseases. Additionally, the fusion of information between images acquired from ultrasound and MRI of the same organ may offer additional information for quantifying the disease gravity.

Materials and Methods*:* Prostate segmentation in ultrasound images is difficult due to the inherent speckle noise and artifacts like shadows, attenuation and signal dropout. In this work, we initially segment the prostate region in ultrasound images using an nnUNetv2. These segmented ultrasound images are then registered to the MRI images to generate fused images, which are further segmented using a neural network. By fusing ultrasound images with MRI images, it is possible to more accurately locate prostate tumors, assess their extent and morphology, and thus improve surgical planning and treatment outcomes. Ultrasound images provide real-time anatomical information, capturing dynamic changes in the organ, while MRI images offer high-resolution and high-contrast static images that clearly display soft tissue structures. Additionally, different preprocessing methods that include min-max normalization, median filtering, and adaptive histogram equalization have been tested for improving the accuracy of the segmentation method. The kernel size for median filtering, the contrast limit and window size for the adaptive histogram equalization still needs to be adjusted.

Results*:* We evaluated 74 ultrasound images from a single patient, with 61 for training and 13 for testing, achieving an average Dice coefficient of 95.89% for the segmentation accuracy when comparing the automated with the manual delineations produced by doctor.

Conclusion: This work is the first step towards the development of an integrated system for the automated segmentation of ultrasound and fused MRI images of the prostate. Future work will continue experimenting with preprocessing methods, optimizing parameters, and improving network architecture with attention mechanisms.

Keywords: Prostate cancer, medical image segmentation, deep Learning, TRUS, MRI.

A Deep Multi-Model Fusion Framework Integrating Vision Transformer, Convolutional Neural Networks and Texture Features for Prostate Cancer Classification (TL)

[1,2]Haohan Yu, [1,2]Jiale Hou, [1]Xiwei Huang, [2]G**.** Rousakis, [3]Christos P. Loizou

[1]School of Electronics and Information, Hangzhou Dianzi University, China; [2]German Oncology Center, Medical Physics and Radiotherapy Department, Limassol, Cyprus; [3]Dept. of Electrical Eng., Computer Eng. and Informatics, Cyprus University of Technology, Limassol, Cyprus

Abstract

Background: Prostate cancer is one of the most common malignant tumours in men, ranking as the fourth most prevalent cancer worldwide in 2022. Early detection is crucial for effective treatment of prostate cancer. Compared to the experience-dependent digital rectal examination in prostate cancer pre-screening, transrectal ultrasound (TRUS) and MRI are more precise examination methods. However, both methods face the challenge of distinguishing prostate cancer from conditions with similar appearances, such as benign prostatic hyperplasia (BPH) and prostatitis. Multi-level features extracted from the segmented prostate areas may aid in the classification and follow up of this disease.

Methods*:* To address this challenge, a diagnostic model based on multi-model fusion is proposed. This model integrates the flexible modal vision transformer (FMViT) model and the RANKGP-CNN framework, with the potential to incorporate additional models in the future to improve diagnostic accuracy and robustness. By extracting multi-layer features from multiple pre-trained CNN models and applying global pooling methods to generate feature vectors, the model utilizes feature ranking and selection methods to identify the most discriminative features. These features are then fused to generate the final feature representation. The fused features are used to train a Support Vector Machine (SVM) classifier, and its performance is evaluated on the test set. Additionally, a supervised learning mechanism is implemented, allowing doctors to input images and manually add labels after the model is deployed. These labels and images are stored in a database, and the model is periodically retrained to continuously improve its diagnostic capabilities and accuracy.
Results*:* The current implementation was evaluated on 74 ultrasound images from a single patient, with 61 for training and 13 for testing, and achieved a classification accuracy of 76.53% and an AUC of 0.875.
Conclusion*:* This research aims to improve prostate cancer diagnosis accuracy, enabling early detection, reducing unnecessary biopsies, and ensuring continuous model improvement. Ultimately, this approach seeks to improve patient outcomes and provide clinicians with a reliable diagnostic tool.

Keywords: Prostate Cancer, Feature Extraction, Supervised Learning, TRUS, MRI

SESSION 3: Intelligent Systems, Sensing and Decision Making

Advanced Unsupervised Anomaly Detection for Vehicle Predictive Maintenance Using Incomplete Data (TL)

Apostolos Giannoulidis[1], Anna-Valentini Michailidou[2], Theodoros Toliopoulos[2], Ioannis Constantinou[2], Anastasios Gounaris[1]

[1]Aristotle University of Thessaloniki, [2]Istognosis Ltd

Abstract
Predicting the need for maintenance in vehicle fleets enhances safety and reduces downtime. While vehicle manufacturers provide built-in alert systems, these systems often fail to alert drivers when issues arise. However, harnessing the power of data analytics and real-time signals can address this problem. In this work, we describe a challenging real-world scenario with scarce and partial data on failures. We propose an unsupervised approach that detects behavioral changes related to failures, avoiding the direct use of raw signals to manage driving behavior and weather volatility. Our solution calculates the differences in the correlations of collected signals between two periods and dynamically creates reference profiles of normal operational conditions, tolerating noise. Initial experiments are particularly promising; for instance, we achieve 78% precision in detecting nearly half of the failures, outperforming a state-of-the-art deep learning technique. More importantly, we consider our solution as a specific instantiation of a broader framework, for which we thoroughly evaluate a wide range of alternatives.

Real Time Water Quality Monitoring System Using Cutting-Edge Sensors and IoT Technologies

[1]Christy Karam, [1]Giorgos Demetriou

[1]Robotics and Autom Cyprus ated Systems (RAS) Lab, Department of computer science, Frederick University, Limassol, Cyprus

Abstract
Background and Objective: The quality of drinking water is at risk due to water contamination, which is posing a serious threat to modern society. Polluted water has wide-ranging negative consequences on ecosystems' delicate equilibrium as well as the health of people and animals. For prompt actions to avert dire circumstances, early detection of water pollution is essential. Maintaining a steady supply of clean water requires constant real-time monitoring of the quality of the water. The need for intelligent solutions for monitoring water pollution is growing as a result of developments in sensors, communication technologies, and the Internet of Things (IoT). A thorough analysis of current advancements in intelligent water pollution monitoring systems is given in this research. The two main goals are to: 1. Stress the significance of early detection and ongoing water quality monitoring; and 2. Demonstrate an economical and effective Internet of Things (IoT)-based smart water quality monitoring system.
Methods: The suggested system combines cutting-edge sensors with Internet of Things technology to enable smooth, real-time water quality parameter monitoring. The device sends data it continuously gathers from different types of water samples to a cloud server. After that, a web application makes this data available for additional analysis, and location monitoring. To verify correctness and dependability, a comprehensive real-time testing program will be applied to the generated model.
Results: The study presents an IoT-based smart water quality monitoring system that is completely functional and can efficiently monitor and evaluate water quality in real-time. The technology guarantees a steady flow of precise data that may be utilized for prompt interventions and water pollution prevention actions.
Conclusions: One major development in the realm of water quality monitoring is the incorporation of IoT technologies. This strategy makes sure that water quality is continuously monitored in real time, which makes it easier to identify contaminants early and take appropriate action. The suggested technology provides a strong response to the escalating problem of water contamination and is both economical and effective.

Keywords: Water Pollution; IoT; Real-Time Monitoring; Water Quality; Smart Systems.

Exploring Parameter Impact of Multi-Altitude UAV Object Detection (PP)

[1]Michalis Piponidis, [1]Theocharis Theocharides

[1]Electrical and Computer Engineering, University of Cyprus, Nicosia, Cyprus

Abstract: Object detection using Unmanned Aerial Vehicles (UAVs) presents distinct challenges compared to traditional object detection, such as the varying angles and altitudes at which the images are captured. Additionally, conventional Convolutional Neural Network (CNN) implementations often require significant memory and computational resources, making them unsuitable for on-board deployment on the UAV's limited resources. This study aims to identify the optimal CNN parameters for UAV-based object detection at various altitudes by examining the effects of two critical parameters: input image resolution and network width (number of channels). We conduct extensive experiments to evaluate the effect of these parameters in terms of accuracy and computational efficiency across multiple altitudes. Lower resolutions reduce computational load but may compromise detection accuracy, while higher resolutions enhance accuracy at the expense of increased processing requirements. Similarly, varying the network width influences the balance between model complexity and detection performance. Most importantly, we showcase that the requirements vary significantly across different altitudes, demonstrating the potential of dynamic network structures that adjust parameters according to the altitude. Our findings provide insights into the optimal configuration of CNN parameters for UAV object detection across different altitudes, contributing to the development of more efficient and adaptable UAV vision systems. This research paves the way for more effective deployment of UAVs in various applications, from surveillance and search-and-rescue to environmental monitoring and beyond.

Keywords: Object Detection, Unmanned Aerial Vehicles (UAVs), Convolutional Neural Networks (CNNs), Computational Efficiency, Resource Utilization

FixCyprus: Automated Classification of Crowdsourced Reports Using Machine Learning (TL)

[1]Leslie Miller, [2]Christos Laoudias, [2]Christos Kyrkou, [1]Andreas Spanias

[1]SenSIP ECEE, Arizona State University, United States; [2]KIOS Research and Innovation Center of Excellence, University of Cyprus, Cyprus

Abstract

Background: In this research, we utilize the FixCyprus dataset, a cost-effective crowd sourcing service that allows road transportation authorities in Cyprus to gather information about the road network and surrounding infrastructure. Users can upload reports on issues such as damage, traffic signs, and road blockages through the FixCyprus app, among others. Statistical analysis on the dataset is performed and machine learning algorithms are applied to extract features and perform image classification.

Materials and Methods: For the purpose of this study, we first begin with a statistical analysis of our image dataset. Each report submitted to the FixCyprus app includes an image and various information including report category, infrastructure category, location, priority level, and more. We analyze various types of data, including the frequency of labels across different categories and pixel information. Next, we aim to develop a machine learning model to classify our data. We utilize convolutional neural etworks to classify the data based on the Report category. More specifically, we design and deploy a ResNet-50 model for feature extraction, and we incorporate the extracted features into various classifiers. The performance of the model is described and measured using F1 scores and classification accuracy.

Results: Feature extraction, combined with the use of various classifiers, proved to be an effective method for classifying the FixCyprus dataset. We achieved F1 scores ranging from 0.70 to 0.85, depending on the categories and models used for classification.

Conclusion: The development of this algorithm has the potential to assist authorities in Cyprus in classifying various scenes uploaded by users, as well as aid in creating an algorithm that can determine if an uploaded scene fits into one of the predefined categories.

Keywords: Machine learning, FixCyprus, Crowdsourcing, Machine Learning, Feature Extraction

Virtual Reality Gaming based on Brain-Computer Interfacing (TL)

[1,2,3]Marios Hadjiaros, [4]Andria Shimi, [1,4]Marios N. Avraamides, [1]Kleanthis Neokleous, [1,2,3] Constantinos S. Pattichis

[1]CYENS – Centre of Excellence, 1016 Nicosia, Cyprus; [2]Department of Computer Science, University of Cyprus, 1678 Nicosia, Cyprus; [3]Biomedical Engineering Research Centre, University of Cyprus, 1678 Nicosia, Cyprus, [4]Department of Psychology, University of Cyprus, 1678 Nicosia, Cyprus

Abstract
Brain-computer interface (BCI) systems combined with virtual reality (VR) gaming have the potential to revolutionize human-computer interaction by providing immersive and intuitive control mechanisms. This study explores deeply the aspect of BCIs, and computer algorithms. It conducts a comprehensive investigation and comparison of the accuracy of six distinct algorithms: Linear Discriminant Analysis (LDA), Black Hole (BH), Multilayer Perceptron (MLP), Support Vector Machine (SVM), Decision Tree (DT), and Random Forest (RF). Forty-four healthy volunteers participated in the study. All participants carried out a BCI-VR Goalkeeper task and underwent a left-hand versus right-hand movement imagery task while wearing a VR headset and sixteen electrodes EEG cap. Six classification algorithms, (LDA, BH, MLP, SVM, DT, and RF) were employed for offline and real-time analysis. The RF algorithm exhibited the highest accuracy rates both offline and in real-time. The classification results obtained from all six algorithms used in the BCI-VR Goalkeeper gaming yielded accuracies that are comparable to those reported in previous BCI studies [1]-[6]. These findings are consistent with prior research that has demonstrated the effectiveness of RF in various BCI applications [7], [8]. Further research should explore other cognitive factors and strive to improve the usability and effectiveness of BCI-VR systems for real-world applications. The findings contribute to advancing BCI technology and its potential for neurorehabilitation, assistive technologies, and gaming entertainment.

Keywords: Brain-Computer Interface (BCI), Electroencephalography (EEG), Gaming, Virtual Reality (VR)

Automated Sound Classification Using CNN and MobileVit for Real-Time Mode Detection (PP)

[1]Andreas Anastasiou, [1]Konstantinos Andreou, [2,3] Basha Shadi, [2,3]Maysam Khatib

[1]University of Cyprus, Dep. of Computer Science; [2]Birzeit University Department of Computer Engineering, [3]FINOMENA

Abstract
The Microsoft x SocialTech Lab x FINOMENA AI/ML Hackathon focused on leveraging AI/ML to address modern challenges. Our team, mentored by IREROBOT, tackled the problem of audio recognition and classification, aiming to develop a system that categorizes sounds into four modes: 'nature,' 'city,' 'house,' and 'music.' Utilizing the ESC50 dataset, we trained a Convolutional Neural Network (CNN) to process audio waveforms and convert them into spectrograms for classification. The CNN achieved a remarkable 98% accuracy, while an alternative MobileViT model reached 60%. The system operates solely on a CPU, ensuring broad applicability. This project demonstrates the potential of AI/ML in effective audio classification, providing a foundation for future enhancements and applications.
Introduction: Accurately recognizing and classifying audio across diverse environments presents a significant challenge. Our team addressed this issue in the Microsoft AI/ML Hackathon on June 2024, under the mentorship of IREROBOT, focusing on the ACETT product. We aimed to develop a robust system capable of categorizing sounds into 'nature,' 'city,' 'house,' and 'music.' This task required effectively filtering out ambient noise and promptly identifying emergency sounds to ensure user safety. Utilizing the ESC50 dataset, we converted audio data into waveforms and spectrograms for analysis by CNNs, enabling precise sound pattern recognition and classification (*fig.1*). To enhance reliability, the model transitions modes only after two consecutive consistent predictions, with an emergency mode activated by exceeding a noise threshold. Additionally, our solution was optimized to function efficiently on a CPU, balancing high performance with

practical deployment constraints. Our project demonstrates the potential of AI in managing complex auditory environments and underscores the innovative strategies necessary to address such challenges.
Materials & Methods: The ESC50 dataset, which comprises 2000 environmental audio recordings categorized into 50 classes, served as our training and testing dataset. Each audio clip in the dataset is 5 seconds long and sampled at 44.1 kHz, which we processed at 16 kHz for our models. Our project utilized a combination of Azure AI services and several Python libraries to develop and train our audio classification models. The primary tools and libraries included Streamlit for web application development, and various PyTorch libraries such as torch, torchaudio, torch.nn, and torchvision.transforms for building and training the neural networks. Visualization and analysis were conducted using matplotlib, seaborn, and scikit-learn. We employed an Intel Core i7 10th generation processor within an Ubuntu virtual machine environment to handle the computational load for model training and testing. The models, including a CNN and a MobileViT, were trained by converting audio waveforms into spectrograms, which were then fed into the networks for classification. This setup ensured efficient processing and accurate classification of audio data.
Results: The CNN model achieved an accuracy of 98% in classifying audio into the specified categories of 'nature,' 'city,' 'house,' and 'music.' The alternative MobileViT model achieved an accuracy of 60%. The CNN model had a capacity of 60-90 MB, whereas the MobileViT model was only 2 MB in size. Both models operated effectively on a CPU without the need for GPU support. The accuracy of the CNN was consistent across different segments of the ESC50 dataset, which includes 2000 audio samples processed at 16 kHz. The system changed modes only after two sequential predictions and triggered an emergency mode switch if the noise exceeded a predefined threshold (fig. 1).

References: CyprusInno AI/ML Hackathon : https://cyprusinno.com/aihackathon/

Machine Learning Methods on BioVid Heat Pain Database for Pain Intensity Estimation (PP)

[1]Melpo Pittara, [2]Andreas Anastasiou, [2]Konstantinos Andreou, [2,3,4]Constantinos S. Pattichis

[1]Bernoulli Institute for Mathematics Computer Science and Artificial Intelligent, University of Groningen, Groningen, Netherlands; [2]Department of Computer Science, University of Cyprus, Nicosia, Cyprus; [3]Biomedical Engineering Research Centre, University of Cyprus, Nicosia, Cyprus; [4]CYENS Center of Excellence, Nicosia, Cyprus

Abstract
Pain assessment is a critical feature in medicine, shaping patients' treatment and well-being. Current pain evaluation methods relying on self-reported scales, leading towards to non-objective and inaccurate approaches of patients' healing. In this research, we explore the usefulness of Convolutional Neural Network (CNN), Vision Transformers (ViTs) models to enhance pain assessment methods and determine the pain intensity only through facial expressions at the peak of pain, and at the moment of no pain only from image frames. The proposed methods used the Biovid heat database with very promising results, that are comparable to other studies. An accuracy of 98% was achieved for the F1 score, recall, and precision metrics with frames with maximum pain and no pain from participants. The results showed that ViTs models act better than CNNs.
Introduction: Pain is an unpleasant experience that includes sensory, emotional, cognitive, and social components and is associated with actual or potential tissue damage. Although physicians and researchers often use self-report tools like the numerical rating scale (NRS) or the visual analogue scale (VAS) to measure pain severity. These tools only work when the person is fully conscious and cooperative [1]. Therefore, automatic pain detection and assessment are particularly important for patients with verbal or cognitive impairments and in situations where pain levels cannot be communicated. This study develops an objective pain measurement model based on machine learning algorithms and vision transformers used data from the open source BioVid Heat Pain database.
Materials & Methods: This study required the Biovid heat pain database, which includes recordings from 90 healthy adults aged 20 to 65 years. Participants were undertaking controlled experiments involving thermal stimuli applied to different body parts. Four pain intensity levels were applied 20 times in a randomized series. For the current study, we used videos from 87 participants, including 20 baseline (no pain) recordings and 4 sets of 20 pain samples per person, resulting in a total of 8,700 samples, each with color and depth video lasting 5.5 seconds [1], [2]. The dataset preparation started with the extraction of a total of 134,316 frames from Pain Level 4 (PA4) videos and 237,914 frames from the baseline (BL1) videos, defined as Pain Level 0. Subsequently, 1000 representative images were selected from each pain level to

create two image sets for system training and evaluation. Frame processing was conducted (see Fig. 1). Following, CNN, and MobileViT 50 models were implemented to image classification (pain, no pain).
Results: Our results shows that MobileViT 50 model can effectively differentiate between facial expressions indicative of pain and those without pain. The model achieved high accuracy, with an average F1 score, recall, and precision metrics reaching 98%. These figures exceed the performance of conventional CNN-based approaches, demonstrating the superiority of ViTs for this application.
Discussion: This study investigates the effectiveness of utilizing CNNs and ViTs to assess pain based on facial expressions, focusing on the BioVid Heat Pain database. The results demonstrate that the MobileViT 50 model, trained on this data, achieved promising outcomes. The study's findings underscore the potential of deep learning approaches in developing objective pain measurement systems.

References

[1] P. Werner, A. Al-Hamadi, R. Niese, S. Walter, S. Gruss and H. C. Traue, "Automatic Pain Recognition from Video and Biomedical Signals," 2014 22nd International Conference on Pattern Recognition, Stockholm, Sweden, 2014, pp. 4582-4587, doi: 10.1109/ICPR.2014.784.
[2] P. Werner, A. Al-Hamadi, K. Limbrecht-Ecklundt, S. Walter, S. Gruss and H. C. Traue, "Automatic Pain Assessment with Facial Activity Descriptors," in IEEE Transactions on Affective Computing, vol. 8, no. 3, pp. 286-299, 1 July-Sept. 2017, doi: 10.1109/TAFFC.2016.2537327

Adaptive 360º Video Streaming Over Wireless Communication Channels (PP)

[1]I. Valiandi, [2]E. Kyriacou, [3]M. S. Pattichis, [1]A. S. Panayides

[1]VIDEOMICS group, CYENS CoE, Nicosia, Cyprus**; [2]**Electrical and Computer Engineering, University of Technology, Cyprus University of Technology, Limassol, Cyprus**; [3]**Department of Electrical and Computer Engineering, The University of New Mexico, Albuquerque, NM, USA

Abstract
The present study proposes adaptive strategies that could be used during adaptive 360o video streaming over wireless communication channels, and those strategies will help to enhance the user's quality of experience.

Introduction: 360° video streaming is emerging as one of the prevalent communication technologies for sharing and enhancing user experience and has thus seen widespread adoption in virtual and mixed reality applications. However, the substantial sizes and associated bitrate demands of 360° videos consume significant resources and necessitate efficient compression tools for storage, processing, and streaming. Delivering content at scale while securing the quality of wirelessly communicated 360° videos in real-time poses additional challenges due to the dynamic, time-varying nature of underlying wireless chAnnels. Securing the quality of real-time, wireless 360o video streaming applications is challenging. The complexity arises from the dynamic nature of the underlying communication channels, which tend to fluctuate over time. Consequently, video systems must seamlessly adjust to the varying, instantaneous bandwidth throughput supported by the wireless medium at a given time, while maintaining the perceptual quality of the communicated videos.
Methodology: We have developed forward prediction models of video quality, bitrate demands, and encoding time, alongside the implementation of a multi-objective optimization framework for real-time video encoding adaptation. The objective is to optimize both video quality and encoding efficiency while minimizing the required bitrate, subject to real-time application constraints, and supporting different video codecs (i.e., x264 and x265). Forward prediction models are built via offline training on many distinct video compression instances, per optimization goal. To describe our approach, let VQ denote video quality, B denote the bitrate demands, and FPS denote the encoding rate in fps. To maximize video quality (VQ) measured by SSIM, while minimizing bitrate (B) and maximizing encoding FPS, the approach is formulated as: MAX (VQ (SSIM), -Bitrate (B), FPS). In the Maximum Video Quality Mode (maxSSIM), the constraints are: Bandwidth constraint: $B \leq B_{max}$ and Frame rate constraint: $FPS \geq FPS_{min}$. To validate the methodology, emulations employing actual network traces from mobile streaming scenarios conducted over 5G wireless networks are utilized. An adaptive controller is then implemented to sense instantaneous bandwidth fluctuations and initiate encoding adaptations using the generated forward models, triggering an encoding configuration switch to match the time-varying wireless network state. For validation, a dataset of 360° omnidirectional videos is used, with 4K resolution (4096x2048 pixels) at 30 frames per second. The dataset

comprises of 5 videos with diverse content, organized in 25 distinct video segments of 2 seconds each. All reference sequences are using the equirectangular projection (ERP) and are in raw format.
Results: We calculated the percentage (%) prediction error for bitrate demands and video quality by averaging the difference between the predicted values from the forward prediction models and the actual video encoding results. In terms of video quality, the average error measured using the SSIM index is less than 1% for all investigated models. The latter emphasizes the accuracy and robustness of the video quality prediction models. Moreover, a number of quality of service (QoS) metrics were used to demonstrate the performance enhancements of the proposed approach, including (i) the number of buffer incidents, (ii) % of buffer fullness above 50%, and (iii) % of buffer level above the panic threshold. With respect to the number of buffering incidents that cause a video to stall due to buffer drainage, continuing until an adequate buffer threshold is restored, again, there is a significant reduction when the in-transit segments are increased from 2 to {3 and 4}, as we can see in Figure 1. Based on the above observations, we can conclude that the duration of downloaded segments may exceed the adaptation interval. This approach can enhance the user's Quality of Experience by allowing the simulator to achieve high buffer fullness, thereby helping to mitigate the number of buffering and video stalling incidents.

Keywords*:* Adaptive Video Streaming, 360° videos, Video compression, HEVC, H264, 360° Video Streaming

SESSION 4: Digital Health Information Systems

Modern Information and Communication Technologies (ICT) in Cypriot Hospitals: Challenges, Opportunities and Privacy Issues (PP)

Omirou Rafael, Balis Charalampos, Neofytou Marios, Stylianides Nikolas

[1]Cyprus, Mediterranean Hospital of Cyprus, Department Operating Room; [2]Open University of Cyprus, Nicosia, Cyprus

Abstract
E-health is the application of Information and Communication Technologies in healthcare, including data collection, exchange and analysis. It is expected to improve global health by providing affordable, better-quality services. However, healthcare continues to be an industry which suffers the highest cost of data breaches. The aim of this study was to conduct a cross-sectional study using questionnaires targeting healthcare providers. In addition, a literature review has also been conducted through PubMed and CINAHL in relation to a deeper exploration of this study's major categories. Subsequently, 450 questionnaires consisting of 26 closed-ended Likert scale questions were distributed to 4 Cypriot private hospitals, of which 394 were fully answered (RR=87.5%). Data analysis was achieved using SPSS Version 23 and the questionnaires were evaluated for reliability and internal consistency using Cronbach's Alpha coefficient. The majority of the responders were female nurses in the age group 21-29 and university graduates. Most of them had basic knowledge about computers, were proficient with regards to computers, personal data security and had good judgement on which applications are good to introduce in the present healthcare system. To conclude, it seems that the skills of most healthcare providers are of high quality, despite their lack of computer-related education. However, the rapid development of such technologies requires the healthcare sector to begin its digital transformation and offer more innovative technologies assisting patients in treatment plans and saving time. Although, there are risks and concerns about their personal data and health related information for which solutions need to be found immediately.

Keywords: Information and Communication Technologies, eHealth, Privacy Issues, Challenges, Opportunities.

Decentralized Smart Health Records based on Digital Twins (PP)

[1]Stelios Mappouras, [1]Andreas Andreou, [1]Efthyvoulos Kyriacou

[1]Department of Electrical Engineering, Computer Engineering and Informatics, Cyprus University of Technology, Limassol, Cyprus

Abstract
Background and Objective: The rapid rise of digital health support has raised the critical need for robust data security, interoperability, as well as raised questions regarding the ownership of the patient's data. The proposed solution integrates blockchain technology and decentralized storage systems within a digital twin ecosystem that aims to create a secure, efficient and transparent platform for managing the patient's health records. The main objectives are: 1. To highlight the potential of blockchain and decentralized technologies in the sector of health, 2. To ease and enhance the doctor's capabilities on diagnosis and treatment planning through immersive visualization on the digital twin. **Methods**: The proposed system stores health record data in a decentralized storage system managed by an Ethereum Virtual Machine (EVM) smart contract. The ownership of the data is handled exclusively from the individual patient and the management of the health records is handled by the patient or his personal doctor. Each time a doctor requests access to the health records, a temporary Non-Fungible Token (NFT) is minted that self-destructs upon reaching an expiry date. This mechanism ensures secure, time-limited access to the sensitive information owned by the patient. Additionally, the health records are visualized within an interactive digital twin in a 3D environment. This supports enhanced diagnostic accuracy and treatment planning by providing a comprehensive view of the patient's medical history across three different human models (organs/skeleton/muscles), as well as simulates the provision of medications, considering the patient's

medical history. **Results**: The results of this research is a fully functional demo of the aforementioned ecosystem that can be demonstrated as an example thriving to motivate the research community for further development of similar applications and tools that leverage the decentralized technologies. **Conclusions**: The integrations of these constitute an innovative approach to digital health record management that prioritizes the data security above all, urging to constitute the healthcare systems and operations more transparent, secure, and immutable.

Keywords: Digital Twins; Blockchain; Smart Contracts; Software Development; NFT

Enhancing Migrant Boat Health Assessment Through AI-enabled Telemedicine (PP)

[1]Stelios Mappouras, [1]Michalis Gemenaris, [2]Riana Constantinou, [2]Theodosis Theodosiou, [1]Efthyvoulos Kyriacou

[1]Department of Electrical Engineering, Computer Engineering and Informatics, Cyprus University of Technology, Limassol, Cyprus**; [2]**Ambulance Department, State Health Services Organisation, Cyprus

Abstract

Background and Objective: The recent surge in migrant boats heading towards Cyprus has created significant pressure on the first responders who are onboard with the Police Border Marine during search and rescue missions. The onboard nurses are equipped with minimal medical tools and face challenges in accurately assessing the health severity of these individuals, leading in some cases to unnecessary, costly, air-assisted hospital transfers that could have been avoided if nurses had a more comprehensive view of the immigrant's health conditions. ***Methods***: The idea is to introduce a patient monitor and a remote ultrasound device that will entail the notion of smartness by capturing and transferring in almost real-time vital bio-signals of the migrants via a satellite network. The medical devices will be controlled by a custom software solution that will analyze biological signals such as respiration, blood pressure, heart rate and oxygen levels to detect patterns that indicate danger to the migrant's life. Likewise, the image taken by the ultrasound machine will be processed through digital image analysis and processing to detect possible abnormalities such as internal bleeding. ***Results***: The findings will constitute a first assessment and will be transferred along with the biosignals to specialized doctors, which will offer decision support so that the doctor can make more informed decisions as whether air assistance is necessary or not. ***Conclusions***: This process is expected to improve the quality of services provided to the migrants and at the same time significantly reduce the operational costs.

Keywords: Telemedicine; Software Development; Medical Image Processing

Integrating Chatbots for Enhanced Patient Engagement in Healthcare Systems (PP)

[1]Aliki Vasilia, **[1,2]**Eirini Schiza, **[3]**Christos N. Schizas, C**[1,2]**onstantinos S. Pattichis

[1]Department of Computer Science and Biomedical Engineering Research Center, University of Cyprus; **[2]**CYENS Centre of Excellence, Cyprus; **[3]**National eHealth Authority, Cyprus

Abstract

The integration of chatbots in healthcare has garnered significant attention for their potential to enhance patient engagement and satisfaction. This study presents a healthcare chatbot that provides users, whether doctors or patients, access to patient summaries in line with the European Patient Summary guidelines. Doctors can access the patient summaries of their patients, while patients can access their own personalized patient summaries. Leveraging advanced Natural Language Processing (NLP) capabilities, our chatbot employs intent classification through a fine-tuned bioBERT model to effectively categorize user queries and extract relevant information from patient summaries stored in a database. The methodology encompasses dataset creation, hyperparameter tuning, and model evaluation, achieving high precision, recall, and F1 scores across various intent classes. Extensive simulations and real-world tests validate the model's effectiveness, demonstrating its capability to handle diverse patient queries accurately. The results indicate that the chatbot significantly improves patient interaction and healthcare delivery, providing a user-friendly interface for accessing personalized medical information. Future work will explore the

integration of newer language models and the incorporation of data augmentation and Knowledge Graphs to further enhance the chatbot's performance. Despite these advancements, limitations such as data quality and ambiguous user inputs present challenges, impacting the chatbot's accuracy in certain scenarios. Overall, our study highlights the transformative impact of sophisticated NLP models like bioBERT on patient care, setting the stage for the broader adoption of intelligent chatbots in healthcare systems.

Keywords: Chatbot, Healthcare, Patient Summary, Natural Language Processing, Digital Health

AI-based solutions for predicting sepsis in ICUs (TL)

[1]Charithea Stylianides, [1]Andria Nikolaou, [2]Nikos Ioannides, [2]Lakis Palazis, [2]Anna Vavlitou, [1]Constantinos S. Pattichis, [1]Andreas S. Panayides

[1]CYENS CoE, Nicosia, Cyprus; [2]State Health Services Organization, Cyprus

Abstract
Artificial Intelligence (AI) advances in healthcare underpin timely and informed interventions that can elevate the quality of care for the benefit of the citizen. This can be especially beneficial for Intensive Care Unit (ICU) patients and life-threatening diseases like sepsis. This study uses the Medical Information Mart for Intensive Care (MIMIC) IV and the Sepsis-3 definition to predict sepsis onset in ICU patients 3 hours in advance experimenting with 5 ML models and 8 different feature combinations. GBM using 10 features outperforms the rest of the models with AUC 0.82. This can constitute an important implementation in the ICU setting, improving quality of care and reducing healthcare costs.

Keywords: Explainable-AI, ICUs, Prediction, Sepsis

Diagnostic Hysteroscopy Information System (TL)

Alexandros Theodosiou

3AE Health LTD, Strovolos, Nicosia, Cyprus

Abstract
Hysteroscopy is essential in gynecology for diagnosing and treating menstrual abnormalities, infertility, and other conditions. However, there is no standardized protocol for reporting findings, leading to inconsistent documentation. In Cyprus, the manual process involving USB transfers and text editors is inefficient and error-prone, highlighting the need for improved health IT solutions. We developed an Electronic Health Record (EHR) system that integrates directly with hysteroscopes via frame grabbers to capture images and videos in real-time. The system was designed in close collaboration with gynecologists to meet clinical needs. It automates report generation, standardizes documentation, and supports AI-guided procedures. The system is CDA certified, ensuring compliance with global health data standards and facilitating international data sharing. Our EHR system revolutionizes the documentation process by eliminating manual data transfers, thus reducing errors and improving efficiency. It standardizes hysteroscopy reports, providing consistent and accurate documentation. The system includes advanced data visualization tools, enhancing diagnostic accuracy and personalized treatment planning. CDA certification ensures interoperability, promoting global health data exchange and collaborative research. Integrating advanced Health IT into hysteroscopy significantly improves the efficiency, accuracy, and standardization of medical documentation. Our EHR system not only enhances patient care by providing a powerful tool for capturing and analyzing data but also facilitates the global sharing of standardized health information. This innovation supports medical research and AI model training, contributing to the advancement of gynecological care and global health initiatives.

Keywords: Health IT solutions, Electronic Health Record (EHR) system, CDA, Diagnostic Hysteroscopy

SESSION 5: MEDICAL IMAGING AND VIDEO

Prediction of Near-Term Breast Cancer Occurrence in Digital Mammography: The Effect of Subtracting Temporally Consecutive Mammograms (PP)

[1]Kosmia Loizidou, [2]Galateia Skouroumouni, [3]Gabriella Savvidou, [3]Anastasia Constantinidou, [4]Eleni Orphanidou Vlachou, [5]Anneza Yiallourou, Costas Pitris[1], [6]Christos Nikolaou

[1]KIOS Research and Innovation Center of Excellence, University of Cyprus, Cyprus; [2]Ygia Polyclinic Private Hospital Limassol, Cyprus; [3]Medical School, University of Cyprus, Bank of Cyprus Oncology Centre, Cyprus, [4]EIMC Clinic Strovolos, Cyprus; [5]Medical School University of Cyprus, Breast Unit Nicosia General Hospital, State Health Services, Organization, Cyprus; [6]Limassol General Hospital, Cyprus

Abstract

Background: An automated algorithm for the prediction of the appearance of a breast mass in the next mammographic screening round, when no abnormality is currently present, was created. This method combines the subtraction of temporally sequential mammograms and feature-based machine learning.

Materials and Methods: For the purposes of this retrospective study, 75 cases each with three consecutive rounds of digital mammograms, were collected. Successive screenings had an average interval of ~2 years. In each case, two mammographic views of each breast, were collected, resulting in a dataset with a total of 450 images (3 × 2 × 75). The most recent mammogram was considered as the "future" screening round and provided the location of the biopsy-confirmed malignant mass, as the ground truth for the training. Subsequently, the two normal previous mammograms ("current" and "prior") were processed, and a new subtracted image was created for the prediction. Region segmentation and post-processing were then applied, along with feature extraction and selection. The selected features were incorporated into several classifiers and by applying leave-one-patient-out and k-fold cross-validation per patient, the detected regions were characterized as benign or possible future malignancy.

Results: Feature selection from benign and possible future malignancy areas revealed that fourteen features provided the best classification. The best and most robust classification performance was achieved using ensemble voting, with 93.6% sensitivity, 98.8% specificity, 98.8% accuracy, and 0.96 AUC.

Conclusion: The incorporation of this algorithm into clinical practice could enable earlier diagnosis leading, and eventually, lower mortality rates.

Keywords: Breast cancer, mammography, sequential analysis, medical image analysis, machine learning.

Early Detection of Acute Radiation Dermatitis Using *In Vivo* Optical Coherence Tomography (OCT) Images of Human Head and Neck and Deep Learning with Late Fusion (PP)

[1]Christos Photiou, [2]Constantina Cloconi, [1]Iosif Strouthos, [2]Costas Pitris

[1]KIOS Research and Innovation Center of Excellence; [2]University of Cyprus, Cyprus, Medical School University of Cyprus

Abstract

Radiation therapy is an important part of cancer treatment, with about half of all cancer patients undergoing this therapy during their illness. However, many patients experience radiation-induced skin damage, known as acute radiation dermatitis (ARD), which can lead to severe discomfort, hinder daily activities, reduce quality of life, and sometimes necessitate discontinuation of essential radiation therapy, thereby negatively impacting the patient. The absence of biomarkers for quantitatively evaluating early changes associated with ARD has impeded research into its causes and potential treatments. This study aims to detect lowgrade ARD using optical coherence tomography (OCT) images combined with traditional image intensity and novel features. Twenty-two patients were imaged twice weekly during their radiation therapy, generating a total of 1487 images. An experienced oncologist assessed the severity of ARD in each case. Preliminary results show that a deep learning approach achieved 88% accuracy in distinguishing between normal skin and early ARD. These findings provide a promising foundation for future research aimed at developing a quantitative assessment tool to enhance ARD management.

Keywords: Acute radiation dermatitis, Optical Coherence Tomography, feature extraction, deep learning, classification

An Explainable AI model in the assessment of Multiple Sclerosis using clinical data and Brain MRI lesion texture features (TL)

[1]Andria Nicolaou, [2]Marios Pantzaris, [3]Christos P. Loizou, [4]Antonis Kakas, [4]Constantinos S. Pattichis

[1]Department of Computer Science, University of Cyprus, Nicosia, Cyprus; [2]Cyprus Institute of Neurology and Genetics, Nicosia, Cyprus; [3]Dept. of Electrical Eng., Computer Eng. and Informatics, Cyprus University of Technology, Limassol, Cyprus; [4]Department of Computer Science, University of Cyprus, Nicosia, Cyprus

Abstract
Magnetic resonance imaging (MRI) is an essential visualizing tool in the diagnosis and monitoring of Multiple Sclerosis (MS) disease. However, the neurological examinations and the MRI assessments are insufficient to provide personalized treatment to the patients due to the complexity of the disease. This study implemented an explainable artificial intelligence (AI) model with embedded rules to assess MS disease evolution. Clinical data were used including demographic and neurological measurements. Texture features were extracted from manually delineated and normalized brain MRI lesions. Statistical analysis was employed to select statistically significant texture features and clinical data. Different models using machine learning algorithms were implemented to differentiate the subjects diagnosed with relapsing-remitting MS (RRMS) from the subjects with progressive MS (PMS). Argumentation-based reasoning was performed by modifying the rules extracted from models with the best evaluation results. The findings indicated that the proposed explainable AI model can predict the clinical conditions of MS disease with high accuracy and provide transparent and understandable explanations with high fidelity. Future work will include further clinical data such as medications and investigate the correlation of the texture features and clinical data with neurological impairment. The proposed model should also be evaluated on more MS subjects.

Keywords: Multiple Sclerosis; Brain MRI; Classification analysis; Rule extraction; Explainable AI

Azimuthal equidistant mapping and projection of head CT scans for skull fracture visualization (PP)

[1]Nicolas Hadjittoouli, [1]Costas Pitris, [2]Christos Nikolaou

[1]KIOS Research and Innovation Center of Excellence, University of Cyprus, Cyprus; [2]Limassol General Hospital, Cyprus

Abstract
Background: Skull fractures affecting the base and facial regions pose significant challenges in diagnosis and treatment within cranial trauma management. The complex structure of the skull, especially at its base, requires careful consideration due to potential impacts on neurological function and patient outcomes.
Method: This study introduces a novel approach using azimuthal equidistant mapping, adapted from cartography, to improve diagnostic accuracy for skull fractures, particularly in challenging areas of the base of the skull. The method maps the spherical nature of the skull into a planar representation, applying azimuthal equidistant mapping to CT volumetric data. The effectiveness of the technique was evaluated using the CQ500 dataset, with qualitative assessments performed to estimate its impact on fracture visibility and detection.
Results: The mapping technique results in fractures consistently appearing perpendicular to the bone's surface, making them more visible and realistic while preserving skull anatomy. This approach offers enhanced visibility of fractures, especially subtle basilar fractures, increasing the likelihood of detection. Qualitative evaluation demonstrated promising advancements in skull fracture diagnostics, particularly in complex regions of the skull base and facial bones.
Conclusion: Azimuthal equidistant mapping, adapted from cartographic techniques, presents a valuable addition to conventional diagnostic methods for skull fractures. By providing a supplementary perspective for radiologists and emergency staff, this innovative approach has the potential to improve the accuracy

and efficiency of skull fracture diagnostics, particularly in challenging cases involving the skull base and facial regions.

Keywords: Computer-Aided Diagnoses, Computed Tomography, Image Processing, Medical Imaging, Skull Fracture

Multi-Spectral Semantic Segmentation in Abnormal Tissue Classification (PP)

[1]Gabrielle Miller, [2]Costas Pitris, [3]Andreas Spanias

[1]Texas A&M University, College Station, TX, USA; [2]KIOS Research Center of Excellence, University of Cyprus, Nicosia, Cyprus; [3]SenSIP Center, ECEE, Arizona State University, Tempe, AZ, USA

Abstract
Background: In this study, we develop a computer algorithm which intakes OCT scans from a colonoscopy and classifies the tissue into two categories. This method utilizes a DC-UNet and takes a five-class system and reduces it to three. The algorithm then trains on the scans and outputs the tissue type: benign or malignant.
Materials and Methods: Colorectal cancer, the second leading cause of cancer-related deaths, necessitates the need for effective preventative screening methods. Traditional pathology analysis of biopsies obtained during colonoscopies is both costly and time-consuming, decreasing the efficiency of the process. In this research, we propose a novel methodology for utilizing deep learning algorithms to classify colonoscopy tissue samples to leave in benign masses and remove malignant ones. A UNet-based model is used to classify samples from a colonoscopy into four categories: normal, Hyperplastic, Adenoma, and SSA. Then, the tissue can be further classified as either benign (normal and hyperplastic result) or possibly malignant (Adenoma and SSA result). The dataset consists of optical coherence tomography scans from 143 patients which were then annotated by a histologist to create masks for the four tissue types observed. The model processes scans in the DICOM format and the corresponding masks in PNG format, which are then layered for training and prediction. Image segmentation is then done by the UNet, and other segmentation methods and the output can be analyzed. The program is then trained and can be used to predict on unannotated images. This can then allow surgeons to utilize Leave-In-Situ and not remove the benign masses, saving time and money. This approach reduces the burden on histologists as it can determine which polyps are benign vs. malignant and if they need further analysis. It not only expedites the diagnostic process but can also enhance the accuracy of early detection of colon cancer.
Results: The UNet model is performing well during training, achieving a 98.7% accuracy. However, it struggles when predicting on unannotated scans, with accuracy dropping to 33.4%. Further research is needed to improve these outcomes.
Conclusion: Machine learning continues to open the door to better classification and diagnostics in medicine. This research is promising and has the potential to reduce both the cost and invasiveness of colonoscopies.

Keywords: Colonoscopy, UNet, Colorectal cancer, machine learning

Enhanced Polyp Detection in Gastrointestinal Endoscopy Using YOLOv8 (TL)

Ioannis Rodosthenous, Constantinos Pattichis

Department of Computer Science, University of Cyprus, Nicosia, Cyprus

Abstract
This research explores the enhancement of gastrointestinal polyp detection through the implementation of YOLOv8, a state-of-the-art deep learning model. Leveraging this advanced convolutional neural network, the study focuses on its application within endoscopic imagery to improve detection rates, which are crucial for early intervention and cancer prevention. The research methodology integrated a comprehensive dataset of labeled endoscopic videos and images, employing the YOLOv8 model to identify and localize polyps with high precision and recall rates. Significant improvements were observed in detection accuracy compared to traditional methods, highlighting the model's robustness against various

challenges inherent in endoscopic procedures. The findings suggest that integrating YOLOv8 can significantly reduce the manual examination burden and enhance diagnostic capabilities, potentially leading to better patient outcomes and streamlined gastroenterological practices. The study not only reaffirms the efficacy of applying artificial intelligence in medical diagnostics but also opens avenues for further refinement in real-time polyp detection systems. This research underscores the transformative potential of AI in enhancing medical imaging technologies and the pivotal role of machine learning in the future of healthcare diagnostics.

Keywords: YOLOv8, polyp detection, gastrointestinal imaging, deep learning, artificial intelligence in healthcare.

AtheroRisk - An integrated computer software system for stroke risk stratification utilizing carotid plaque analysis in ultrasound videos (PP)

[1]Michalis Gemenaris, [1]Georgia D. Liapi, [2]Christos Markides, [1]Christos P. Loizou, [3]Andrew Nicolaides, [3]Maura Griffin, [4]Constantinos S. Pattichis, [1]Efthyvoulos Kyriacou

[1]Dept. of Electrical Eng., Computer Eng. and Informatics, Cyprus University of Technology, Limassol, Cyprus; [2]Dept. of Computer Science and Engineering, Frederick University, Nicosia, Cyprus; [3]Vascular Screening and Diagnostic Center, Nicosia, Cyprus; [4]Department of Computer Science, University of Cyprus, Nicosia, Cyprus

Abstract

Introduction: In the past decade, ultrasound (U/S) based carotid atherosclerosis (ATH) assessment for estimating the risk of stroke has seen significant advancements. We introduce AtheroRisk, an integrated computer software designed to analyse carotid plaque CC-based motion in U/S videos to identify plaques at high risk of rupture. It provides a stroke risk score that combines plaque image and motion features after each video analysis session. **Objective:** To assist physicians in stratifying stroke risk through reproducible real-time analysis of atherosclerotic plaques. **Methodology:** AtheroRisk operates through two main analysis paths: U/S image and video analysis. Each path includes preprocessing, plaque segmentation, and analysis modules, focusing on carotid plaques in selected CCs and phases (systoles and diastoles). It extracts geometric, texture, and motion features of the plaques to derive a combined stroke risk score. Developed incrementally using Python (version 3.11), the system allows continuous feedback and iterative improvements. **System Evaluation:** The initial version of AtheroRisk was verified using 54 U/S videos (27 asymptomatic and 27 symptomatic cases). Clinician satisfaction and feedback were collected via a questionnaire-based validation process. Results indicated that the software effectively distinguishes between asymptomatic and symptomatic cases by simultaneously analyzing carotid plaque image and motion features. Statistical analyses, including Mann-Whitney and Pearson correlation tests, demonstrated significant differences and correlations between motion magnitudes and plaque orientations in the studied cases. **Discussion and Future Directions:** AtheroRisk represents a significant advancement in stroke risk stratification by combining real-time analysis of carotid plaque image and motion features. The software's ability to differentiate between asymptomatic and symptomatic cases supports its clinical relevance and utility. Future work will focus on enhancing video segmentation and motion analysis procedures, incorporating texture analysis for early diagnosis, and addressing complex cases with multiple plaques or plaque ulcers. The goal is to establish AtheroRisk as a certified medical device, further integrating it into clinical workflows to improve patient outcomes by minimizing unnecessary invasive treatments. **Conclusions:** The evaluation of AtheroRisk demonstrates its potential to improve stroke risk assessment through comprehensive analysis of carotid U/S imaging and motion features.

Keywords: Ultrasound video, Carotid Artery Plaque, Risk Stroke Stratification, State Diagram

Carotid plaque motion analysis in ultrasound videos to discover rupture-prone plaque areas (PP)

[1]Georgia D. Liapi, [1]Christos P. Loizou, [2]Andrew N. Nicolaides, [2]Maura Griffin, [3]Dimitrios Kardoulas, [4]Constantinos S. Pattichis, [1,4]Efthyvoulos Kyriacou

[1]Department of Electrical Engineering, Computer Engineering and Informatics, Cyprus University of Technology, Limassol, Cyprus; [2]Vascular Screening and Diagnostic Centre, Nicosia, Cyprus; [3]Hemodynamic Unit, Vascular Surgery Clinic, National and Kapodistrian University of Athens, Attikon General University Hospital, Athens, Greece; [4]Department of Computer Science, University of Cyprus, Nicosia, Cyprus

Abstract

Background and Objective: Identification of carotid plaque motion alterations, throughout the cardiac cycle (CC), may reveal rupture-prone plaque components and assist doctors in ischemic stroke risk stratification. Early studies have used characterization of atherosclerotic plaques based on B-mode ultrasound (U/S) image features, which only depicts a certain echo-density configuration of the plaque, for a distinct point in the CC. Such findings might lead to incomplete conclusions. In this study, we investigated U/S carotid plaque motion, focusing on middle-systole (MS), the interval between early systole (ES) and peak systole (PS) expecting that the dynamic forces applied on the plaque at the beginning of systole are more profound from cardiac ES to MS, compared to PS.

Methods: Here, we deployed a computer software tool, previously developed by researchers of the e-health laboratory at Cyprus University of Technology, for carotid plaque motion estimation in B-mode U/S videos. Carotid plaque motion estimation is acquired using a dense optical flow algorithm to calculate the motion changes between two reference video frames (VFs) within the CC, whose distance is dependent on the initial frame rate. We included 16 carotid U/S videos (8 Asymptomatic, AS; 8 Symptomatic, SY patients), to which, primarily, we performed VF image resolution standardization, manual region of interest (ROI) selection, and identification of 5 consecutive CCs (ES and MS pairs), based on the generation of Motion-mode images (one per video). Then, carotid plaque ROI-specific optical flow calculation enabled usto measure the plaque's motion angular spread (MAXFW20; units: 0° to 360°) for the first 20% of the ROI pixels corresponding to the dominant direction of movement, after comparing five consecutive ES-MS VF pairs.

Results: The MAXFW20, a measure we created to determine angle differences between motion vectors, within the whole all plaque ROI, can assist us in classifying a plaque, based on its motion configuration, as concordant (low-strain; low-risk), moderate(m)-discordant (mid-strain; intermediate risk) or discordant (high-strain; high risk). Here, by comparing plaque motion changes in MS versus their ES counterpart moments, we identified 1 concordant, 8 m-discordant, and 7 discordant plaques, with MAXFW20 ranging from 58±7.45°, 91±43.9°, 156±49.2° (mean±standard deviation), respectively. As expected, we met paradigms where, after plotting the motion change vectors (angle and magnitude) of a given plaque ROI, we could demonstrate the existence of areas localized in the extremities of the plaques, exhibiting high MAXFW20 (high-risk; more susceptible to rupture).

Conclusions: As our primary findings seem to support our hypothesis, in the future, we will proceed with a repetition of the present study, utilizing a prospective larger dataset, and comparing more ES-MS VF pairs, per patient, while we will also address cases presenting with two carotid plaque areas per U/S video.

Keywords: Carotid Ultrasound Video; Standardization; High Risk Plaque; Stroke Risk

Brain Magnetic Resonance Imaging Segmentation System in MS with Deep Neural Networks

Giorgos Adamides, 3aHealth

Abstract

Multiple Sclerosis is a chronic autoimmune disease that affects the central nervous system. Nerves are covered by a layer called myelin, which is responsible for protecting them and maintaining their functionality. In the case of Multiple Sclerosis, the myelin becomes damaged, resulting in the nerves functioning unpredictably. Multiple Sclerosis is a disease characterized by relapses, each of which can cause permanent and irreversible damage to the patient's motor abilities, vision, and sensations unless appropriate medical treatment is administered in time. This highlights the importance of the immediate detection of the presence or differentiation of Multiple Sclerosis using an automatic Seg-mentation System with Deep Neural Networks. The data utilized for this study comprise a total of 1838 T2-type MRI images

collected from a cohort of 38 patients, each having undergone imaging at 2 distinct time points. Each MRI image is accompanied by data, detailing the specific locations of observed damage, that indicates the presence of Multiple Sclerosis. This study employed various variations of the U-Net like U-Net++, Attention U-Net, ResUNet-a and TransUNet. Through a comprehensive series of data preprocessing steps, a Dice Similarity Coefficient (DSC) of 0.70 was achieved, indicating a decent performance in the segmentation accuracy of Multiple Sclerosis in MRI images, com-pared to other similar studies using 2D and 3D approaches. A framework encapsulating the automated model was also developed to optimize the workflow of the medical practitioners contributing to the overall experience.

Index Terms—Convolutional Neural Networks, Deep Neural Networks, Multiple Sclerosis Improving

Personalized Medicine via AI-based Precision Tracheostomy

Evropi Toulkeridou[1], Panagiota Kosmidou[2] , Kristis Vevis[2], Zinonas Antoniou[3], Loizos Kallinos[3], Ioanna Valiandi[1], Andreas Panayides[1, 3,*]

[1]Videomics FRG, CYENS Center of Excellence, Nicosia, Cyprus
[2]German Oncology Center (GOC), Limassol, Cyprus
[3]3aHealth, R&D Department, Nicosia, Cyprus
*a.panayides@cyens.org.cy

Abstract
Tracheostomy is a medical procedure frequently used to secure patients' airways. Typically, healthcare providers measure the patients' neck diameters and tracheas using 3D-CT in order to select specific sizes of tracheostomy tubes. Further, specific decisions before and/or during the procedure may also depend on collected and evaluated data regarding the clinical condition or unique characteristics of the patients. To this day, healthcare providers rely on their intuitive judgment based on previous relevant experience, with no systematic metrics unequivocally guiding their decisions, since no research has been reported in the literature that investigates patterns in these data.

On the other hand, artificial intelligence (AI)-based methods have proven to be powerful tools used in medical care. However, although Deep Learning (DL) methods have already shown excellent performance in image processing and diagnosis, their combination with the analysis of data informing the clinical condition and unique characteristics of patients remains unexplored, especially in the ENT (i.e., ear, nose, throat) surgical practice.

Herein, we will combine these analyses to reveal patterns that previous statistical methods failed to identify. Our model will incorporate both convolutional neural networks for the automated measurement of 3D-CT scans and automated natural language processing of DL to extract clinically relevant information.

We aim to create a tool with high diagnostic accuracy comparable to that of experienced healthcare providers. Our study will provide an implementation of AI-based systems that will be able to assist physicians in handling big data and improving diagnostic eQiciency, as well as in clinical decision making in cases of high complexity or uncertainty