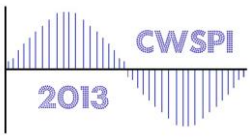
6th Cyprus Workshop on Signal Processing and Informatics

University of Cyprus, *Nicosia, Cyprus*
New Campus, THEE001 ROOM 148

July 9, 2013 13:45-19:45hrs



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FINAL PROGRAM AND BOOK OF ABSTRACTS

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IEEE EMBS Cyprus Section

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Preface:

Following the successful one-day workshop we had in the last five years, we would like to cordially invite you to participate in the upcoming 6th Cyprus Workshop on Signal Processing and Informatics (CWSPI 2013).

The overall objective of CWSPI 2013 is to disseminate new research results in several areas and help establish industry, university, and multi-university collaborations. The workshop is mainly targeted to our graduate students to present their most recent findings.

This one-day workshop hosts presentations by faculty, students, and industry researchers in the areas of signal processing image processing and analysis and informatics. A total of 19 abstracts are presented into 4 different sessions. These sessions are the following: *Multimedia Systems & Image Processing, Biomedical Signal, Image and Video Processing, Speech, and audio, processing, and Sensor Networks and Intelligent Signal Processing.*

Moreover, we would like to express our sincere thanks to the moderator of the special session on *How to Survive the Research Woes?***,** Prof. Nikos Papanikolopoulos, Distinguished McKnight University Professor, Department of Computer Science and Engineering, University of Minnesota, USA, and the panellists Prof. Marios M. Polycarpou, Director of the KIOS Research Center for Intelligent Systems and Networks, Department of Electrical and Computer Engineering, University of Cyprus, Cyprus, Prof. Andreas Spanias, Director SenSIP Consortium, School of Electrical, Computer, and Energy Engineering, Arizona State University, USA and Prof. Marios S. Pattichis, Department of Electrical & Computer Engineering, University of New Mexico, USA. Furthermore, we would like to express our thanks to Prof. Nikos Papanikolopoulos, for willing to give the keynote talk entitled *Truck Parking Availability Using Computer Vision Systems.*

Last but not least, we would like to express our sincere thanks to IEEE Cyprus Section, the IEEE EMBS/Signal Processing Cyprus Chapter, the IEEE CIS Cyprus Chapter and the IET Cyprus Network for their support and sponsorship.

Wishing you a fruitful and joyful event.

E. Kyriacou, C. Loizou, A. Spanias, M.S. Pattichis, C.S. Pattichis
July 2013

Topics:

- Digital signal and image processing
- Sensor networks and signal analysis
- Biomedical signal, image, and video analysis
- Wireless communications and signal processing
- Multimedia systems
- Speech, and audio, processing
- Cognitive systems
- FPGAS in signal, image and video processing.

Workshop Organizing Committee:

Chair:	*E. Kyriacou,* Frederick University, Cyprus
Co-Chair:	*C. Loizou*, Intercollege, Cyprus
Program Chair:	*A. Spanias,* Arizona State University, USA
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http://www.ehealthlab.cs.ucy.ac.cy/

Technical Program

TIME	SESSIONS
13:45	**Introductions and Refreshments**
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14:00- 15:00	**SESSION 1: How to Survive the Research Woes?** **Chair:** *Efthyvoulos Kyriacou,* Frederick University, Cyprus
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15:00- 15:30	**SESSION 2: Keynote Lecture** **Chair:** *Christos P. Loizou,* Intercollege, Limassol, Cyprus
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16:00- 16:50	**SESSION 3: Multimedia Systems & Image Processing** **Chair:** *Takis Kasparis*' Cyprus University of Technology, Cyprus
16:00	**Towards The Design of Personalized Virtual Reality Applications** *Nicholas Michael, Alexios El Kater, and Andreas Lanitis* Visual Media Computing Lab, Department of Multimedia and Graphic Arts, Cyprus University of Technology
16:10	**Automatic Foreground Extraction with Kinect** *Savvas Christodoulou, Georgios Georgakis, Ioannis Konstantinou, Yiorgos Chrysanthou* Department of Computer Science - University of Cyprus
16:20	**Protocol for 3D Stereo Vision Camera-sensor Luminance Calibration** *Lakis Christodoulou[1], Takis Kasparis[2], and Christos P. Loizou[2]* [1,2]Cyprus University of Technology, Department of Electrical Engineering and Information Technology, Limassol, Cyprus
16:30	**Multiscale AM-FM Image Reconstructions Based on Elastic Net Regression and Gabor Filterbanks** *Ioannis Constantinou,* Istognosis LTD, Cyprus *Marios S. Pattichis,* University of New Mexico, USA *Constantinos S. Pattichis,* University of Cyprus, Cyprus
16:40	**A Real-Time Emotion Recognition System for Monitoring the Elderly**

	Chrystalla Miltiadou[1], *Nikolas Papachrysanthou*[1], *Marios Georghiades*[1], *Ioannis Constantinou*[2] [1]Dept. of Computer Science, University of Cyprus, Nicosia, Cyprus [2]Istognosis LTD, Cyprus
16:50-17.30	**SESSION 4: Biomedical Signal, Image, and Video Analysis** **Chair:** *Nicoletta Nicolaou,* University of Cyprus
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17:00	**MRI compatible positioning device for focused ultrasound prostate cancer treatment** *Christos Yiallouras* [*^], *Nicos Mylonas*[$], *and Christakis Damianou*[*#] [*]MEDSONIC LTD, Limassol, Cyprus, [#]Cyprus University of Technology, Limassol, Cyprus, [^]City University, London, UK, [$]Frederick University, Limassol, Cyprus
17:10	**Integrated Executable Software System for Ultrasound Video Despeckling and Analysis of the Carotid Artery** *C. Theofanous, T. Kasparis, and C.P. Loizou* Cyprus University of Technology, Department of Electrical Engineering and Information Technology, Limassol, Cyprus
17:20	**High-resolution, Low-delay, and Error-resilient Medical Ultrasound Video Communication Using H.264/AVC Over Mobile WiMAX Networks** *Z. Antoniou*[1], *A. Panayides*[1,2], *Y. Mylonas*[1], *M.S. Pattichis*[3], *A. Pitsillides*[1], *and C. S. Pattichis*[1] [1]Dept. of Computer Science, University of Cyprus, Nicosia, Cyprus [2]Dept. of Electrical and Electronic Engineering, Imperial College, London, UK [3]Dept. of Elect. and Comp. Eng., University of New Mexico, Albuquerque, USA
17:30-18:00	**Coffee Break**
18:00-18:50	**SESSION 5: Speech, and Audio, Processing** **Chair:** *Alexandros Kyriakides,* University of Cyprus
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18:10	**Finding repeating stanzas in monophonic folk songs of Cyprus** *Andreas Neocleous* [1,2], *Nicolai Petkov*[1], *and Christos N. Schizas*[2] [1]University of Groningen and [2]University of Cyprus
18:20	**Noise-Robust Classification using Rank Order Kernels** *Alexandros Kyriakides*[1], *Andreas Spanias*[2], *Julius Georgiou*[1], *and Costas Pitris*[1] [1]University of Cyprus and [2]Arizona State University
18:30	**"Meleti" – Auditory and Language Support System** *Christos Iliofotou*[1], *Charalambos Theodorou1, Marina Charalambous*[2], *Efthyvoulos Kyriacou1* [1]Department of Computer Science and Engineering, Frederick University, Cyprus [2]Melathron Agoniston EOKA, Lemesos, Cyprus
18:40-19:40	**SESSION 6: Sensor Networks and Intelligent Signal Analysis** **Chair:** *Demetrios Eliades,* University of Cyprus

18:40	**A Path Correction Module for Two-Wheeled Service Robots Under Actuator Faults** *Demetris Stavrou, Demetrios Eliades, Christos Panayiotou, and Marios Polycarpou* KIOS Research Center for Intelligent Systems and Networks Department of Electrical and Computer Engineering , University of Cyprus
18:50	**Fault Tolerant Target Tracking in Binary Wireless Sensor Networks** *Christos. Laoudias[†], Michalis P. Michaelides[‡], Christos G. Panayiotou[†]* [†] KIOS Research Center for Intelligent Systems and Networks, Department of Electrical and Computer Engineering, University of Cyprus [‡] Department of Electrical Engineering and Information Technologies, Cyprus University of Technology
19:00	**Distributed Detection and Isolation of Sensor Faults in HVAC Systems** *Vasso Reppa, Panayiotis Papadopoulos, Marios M. Polycarpou, and Christos G. Panayiotou* KIOS Research Center for Intelligent Systems and Networks, Department of Electrical and Computer Engineering, University of Cyprus, Nicosia, 1678, Cyprus
19:10	**Efficient Monitoring and Control in Smart Water Networks** *Demetrios Eliades, Christos Panayiotou, and Marios Polycarpou* KIOS Research Center, University of Cyprus
19:20	**A Matlab – CONTAM Toolbox for Contaminant Event Monitoring in Intelligent Buildings** *Michalis P. Michaelides[1,2], Demetrios G. Eliades[1], Marinos Christodoulou[1], Marios Kyriakou[1], Christos G. Panayiotou[1], and Marios M. Polycarpou[1]* [1] KIOS Research Center for Intelligent Systems and Networks, and Department of Electrical and Computer Engineering University of Cyprus, Nicosia, 1678, Cyprus [2] Department of Electrical Engineering and Information Technologies, Cyprus University of Technology, Lemesos, 3036, Cyprus
19:30	**A Multi-Objective Wireless Sensor Network Deployment for Real-Time Monitoring of Forest Fires** *Yiannis Hadjicharalmbous[1], Andreas Constantinides[1], Panayiotis Andreou[2], George Samaras[2], and Costas Papageorgiou[3]* [1] Department of Computer Science and Engineering, Frederick University, Cyprus [2] Department of Computer Science, University of Cyprus, Cyprus [3] Department of Forests – Ministry of Agriculture
19:40-19:45	**CLOSING REMARKS**

Abstracts

Session 1: How to Survive the Research Woes?

How to Survive the Research Woes?

Moderator: *Prof. Nikos Papanikolopoulos*
Distinguished McKnight University Professor
Department of Computer Science and Engineering,
University of Minnesota, USA

Abstract:

A personal journey on how to do research, especially in the early stages of your career. Discussion about successes, failures, and everything in between. Most importantly, how to keep your sanity in this journey.

Panellists: *Prof. Marios M. Polycarpou*
Director of the KIOS Research Center for Intelligent Systems and Networks, Department of Electrical and Computer Engineering
University of Cyprus, Cyprus

Prof. Andreas Spanias
Director SenSIP Consortium, School of Electrical, Computer, and Energy Engineering, Arizona State University, USA

Prof. Marios S. Pattichis
Department of Electrical & Computer Engineering,
University of New Mexico, USA

Session 2: Keynote Lecture

Truck Parking Availability Using Computer Vision Systems

Nikos Papanikolopoulos

Distinguished McKnight University Professor
Comp. Science and Engineering
Univ. of Minnesota

Abstract:

This talk covers the development of an automated truck stop management system that can determine the number of occupied parking spaces at Minnesota Department of Transportation (MnDOT) safety rest areas and commercial truck stops. The system uses a network of cameras to monitor parking availability at truck stops, automatically identifying available spaces in real time. In this project, the information is used to notify drivers and carriers about parking availability via a website, in-cab messaging, and variable message displays a few miles ahead of the rest area on the highway.

The system is installed at three MnDOT rest areas and one private truck stop on Interstate 94 (I-94) west and northwest of the Twin Cities. The I-94 corridor is critical to the movement of goods in Minnesota and an important connection between trade centers on the West Coast and multiple marketplaces in the Midwest.

Short bio:

Nikolaos P. Papanikolopoulos (IEEE Fellow) received his Ph.D. in electrical and computer engineering from Carnegie Mellon University, Pittsburgh, PA, in 1992. Currently, he is a Distinguished McKnight University Professor in the Department of Computer Science at the University of Minnesota and Director of the Center for Distributed Robotics and SECTTRA. His research interests include computer vision, sensors for transportation applications, robotics, and control. He has authored or coauthored more than 350 journal and conference papers in the above areas (more than seventy refereed journal papers). He received the Richard P. Braun Distinguished Service Award for his transportation work in 2013.

Session 3: Multimedia Systems & Image Processing

Towards The Design of Personalized Virtual Reality Applications

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Abstract:

The development of low cost 3D visualization devices has prompted an increased interest in interactive Virtual Reality (VR) applications. A key factor in the design and implementation of VR applications is the immersion level that indicates the quality of user experience and level of engagement. In an attempt to enhance the user immersion in VR applications we explore two distinct directions: (i) The use of dedicated image processing techniques that enable the automatic real time generation and subsequent use of personalized avatars and (ii) The adaptation of retro video games to VR applications.

The proposed avatar generation method utilizes a PCA model trained on 111 range scans from a 3D body scan dataset. During the avatar generation process we capture four orthogonal color images of a subject (front, left, right and back) using an un-calibrated camera and extract the silhouette in each image. The mean instance of the PCA model is projected in each of the four silhouette images and the correspondence between points on the model boundary and silhouette points are established using a shape context algorithm. An optimization method that aims to minimize the RMS error between model points and their corresponding silhouette points is used. The optimization process aims to define the optimum transformation (translation, rotation and scaling) and shape parameters that best align a 3D model instance with the four extracted outlines. The resulting shape parameters can be used for reconstructing the shape of the avatar. The final step involves filling in the realistic appearance by texture mapping of the input image information from each view, to the projected model vertices using a cylindrical model.

The re-design of retro video games aims to enhance the user experience by providing user-involved visualizations and interactions. As part of this effort, the Space Invaders game was re-designed in a VR environment where human-sized enemies march forward towards the user. The overall experience is further enhanced through the use of a dedicated data glove ultra so that the interaction is done in a more natural manner. The final application was evaluated by staging a user evaluation process where a number of volunteers had the chance to play the game in the original version (desktop-based) and the VR implementation. The results of the evaluation suggest that a simple existing game concept, combined with the appropriate VR technology can create a whole new immersive experience.

In the future we plan to combine our work on avatar creation and VR game adaptation so that the immersion level in VR applications is further increased through the use of a user's own realistic avatar in interactive VR applications.

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Automatic Foreground Extraction with Kinect

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Department of Computer Science - University of Cyprus

Abstract:

While the process of extracting the foreground from an image and compositing it onto another image, known as Image Matting and Compositing, has been researched for a considerable amount of time, only recently depth information has been used to help solve this issue. Image Matting methods typically require some user input in order to produce a satisfactory result, in this paper we are attempting to automate the procedure of extracting a human figure from the scene with the help of the depth map provided by Kinect. A major challenge in this work is that the depth map includes many errors due to the low resolution of 640X480 pixels, and the low quality of the Kinect's infrared camera. In order to solve this problem we introduce the notion of the five-region-map that helps localize the search and increase the accuracy of the matting process. After an initial filtering of the depth, we separate the image into five regions: gray areas that correspond to definite foreground and background, a black area that corresponds to the unknown area, and white areas that will not be used at all in the process. Then, our method classifies all pixels that are in the unknown area into foreground and background using a K-Nearest Neighbors algorithm that takes samples from the gray areas and creates a feature space based on several color models, texture information, and depth information. The classification takes place locally around each pixel at a fixed radius, and returns the opacity/alpha channel which denotes the percentage of the foreground and the background for each pixel. Processing times in our current prototype are in the order of 2 seconds or less, and with the use of parallel GPU programming we believe that an optimized version will be able to run satisfactorily in real-time applications.

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Protocol for 3D Stereo Vision Camera-sensor Luminance Calibration

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Abstract:

Introduction: 3D Stereo vision (SV) is important for human video-image surveillance. We propose a 3D SV system equipped with a 3D SV camera-sensor, which includes an image pre-processing module for the left and right images, and a stereo matching algorithm for calibrating them. The method may correct problems of rotation, focal length errors, pixel non-linearity, block artifacts, scaling errors, brightness reflection, and color correction.

Methodology: The method uses the Harris-edge corner feature detection and utilizes following steps: 1) image pre-registration, 2) XY spatial division crop, 3) LR registration, 4) gamma correction, 5) histogram equalization, 6) normalization, 7) adaptive filtering, 8) error estimation 9) stereo rotation, 10) transformation, and 11) error metrics. Disparity range is estimated and the SV algorithm is evaluated based on a 3D chess-object phantom for the left and right views.

Results: The algorithm is computing 2x (20 blocks x 4 corners per block (C1, C2, C3, C4)=160 features, measured in x, y coordinates, RGB values, and 21 size dimensions. The 3D phantom used has a box (width, height, depth, 12x12x9cm) and a block size (4x3, 4x3, 3x3cm). The manual software calibration is set with a vertical and a horizontal alignment of -12, and +3 respectively, and a depth distance of 30cm. The pixel resolution for the 3D SV set-up is 1.25mm/pixel and the binocular distance is 49.6 pixels. We found following metrics based on luminance between the left and the right images of the phantom: sum of absolute difference (SAD)=65.75%, sum of squared differences (SSD)=45.26%, normalized cross correlation (NCC)=36.81%, root mean squared error (RMSE)=55.25%, mean absolute deviation (MAD)=45.78%, Mahalanobis distance (MD)=47.86%, normalized Euclidian distance (NED)=2 7.58%, and a Minkowski distance=56.09% of SV calibration improvement rate.

Conclusions: The preliminary proposed luminance calibration protocol can be used for any typical 3D SV system that includes a 3D SV camera-sensor that could maintain the standard SV geometry settings. Future work will investigate the geometric calibration of the left and right images of the phantom.

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Multiscale AM-FM Image Reconstructions Based on Elastic Net Regression and Gabor Filterbanks

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Abstract:

An important step of AM-FM analysis methodology is the selection of the most robust components for feature extraction. At the moment, the selection of the components is based on Dominant Component Analysis (DCA) technique with several variations. In this presentation, we introduce a new AM-FM representation component selection based on elastic net regression. The new approach is implementing using a family of Gabor filterbanks, each of them based on different filter scale overlap and bandwidth. The proposed system was evaluated on a number of synthetic and real images and the results show that the elastic net regression component selection algorithm performed comparatively better than other methods.

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A Real-Time Emotion Recognition System for Monitoring the Elderly

Chrystalla Miltiadou[1], *Nikolas Papachrysanthou*[1],
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Abstract:
The purpose of this study was to develop a real time emotion recognition system (based on face detection, recognition, and emotional classification of the subject into three categories (normal, sad, and happy)). The system covers the need of monitoring the elderly in the general context of ambient assisted living. The system is based on web services where the following components were implemented: i) video capture based on streaming video (30 frames per second) using a number of web controlled cameras in the monitoring premises, ii) video storage, iii) video face detection based on the Viola and Jones Open CV implementation of the algorithm. If a face is detected, the corresponding frames are extracted where the face and mouth borders are traced. iv) face recognition and emotional state identification component. Two different algorithms were developed. The first one is based on eigen face features extracted followed preprocessing with a Gabor filter bank, and the second one is based on eigen mouth features only. The system was evaluated on 15 elderly subjects for the aforementioned three emotional states where the success rate for emotional identification was close to 70%. Certainly, more work is needed both with respect to further development as well as with respect to evaluation on a bigger set of subjects.

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Session 4: Biomedical Signal, Image, and Video Analysis

Non-linear coupling of EEG and ECG signals during sleep

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Abstract:

This work presents investigations of the non-linear dynamic relationship between electroencephalogram (EEG) and electrocardiogram (ECG) signals during sleep. Human sleep can be divided into two main states - rapid eye movement (REM) and non-rapid eye movement (NREM) sleep. The latter is usually subdivided into Stages 1 and 2 (lighter sleep) and Stages 3 and 4 (deep slow wave sleep). The study of sleep and sleep-related disorders can be achieved via all-night recordings of various physiological signals, such as the electrical brain activity (EEG), heart rate (ECG) and eye movements. The sleep staging (hypnogram) can be obtained from 20-s or 30-s EEG segments based on predefined scoring guidelines (Rechtschaffen and Kales – R&K rules). Sleep staging by experts is a time-consuming and somewhat subjective process and recent focus has been on automating the process using various EEG-based features, with different degrees of success. In this work we investigate the feasibility of sleep staging via an advanced non-linear coupling technique, cross-recurrence rate (CRR), which captures the relationships between EEG and ECG during different sleep stages.

The data was obtained from the MIT-BIH Polysomnographic Database, which is available online as part of the Physiobank archive. In this study, a subset of data from 10 male subjects was used. All EEG records were obtained from C3-O1. The data is sampled at 250 Hz. Each record includes an annotation file containing the expert sleep staging score, which was obtained from 30s segments using the R&K rules. These scores can be used to construct the corresponding hypnogram, which is composed of 6 stages (sleep stages 1-4, REM sleep, and wakefulness). The CRR allows us to study the recurrent dynamics between different systems by estimating how many times a particular state occurs simultaneously in both systems with a particular time delay. To estimate the CRR the data is converted to a symbolic sequence and encoded into order patterns. The symbolic sequence is obtained from the phase-space representation of the signals, which can be constructed via time delay embedding. The CRR is estimated from non-overlapping 5s segments. Using the annotations provided for each subject, the mean CRR and standard deviation values representing each of the 5 sleep stages and wakefulness are obtained. A subject-wise mean CRR (with standard deviation) during each sleep stage can then be estimated. Our findings show that, despite the inter-subject variability, wakefulness displays the smallest CRR values in general. The CRR increases as the subject falls from lighter to deeper sleep stages, while showing a slight decrease during REM sleep. Lower CRR values indicate less similarity of the phase-space trajectories of the brain and heart activity. These observations tie in with findings from other studies, where it has been shown that EEG complexity decreases as the sleep deepens and increases again during REM sleep, while ECG activity exhibits a similar decrease in complexity during deep sleep compared to REM sleep. The proposed methodology also allows the study of short segments and captures sleep microstructure in a way that R&K-based sleep scoring does not. Taking into account the sleep microstructure can lead to more accurate hypnograms and sleep staging.

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MRI compatible positioning device for focused ultrasound prostate cancer treatment.

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Abstract:

Object: A prototype magnetic resonance imaging (MRI)-compatible positioning device that navigates a focused ultrasound (FUS) transducer is presented. The positioning device has 2 user-controlled degrees of freedom (linear and angular) and one manual (Z-axis). The intention is to treat prostate cancer in humans in the future.

Materials and Methods: The positioning device was designed and fabricated using construction materials selected for compatibility with high magnetic fields and fast switching magnetic field gradients encountered inside MRI scanners. The positioning device incorporates only MRI compatible materials such as piezoelectric motors, and ABS plastic. The FUS/MRI system includes a) Focused ultrasound system, b) MR imaging, c) Positioning device (robot) and associate drivers, and d) Software written in C Sharp. The system includes MRI compatible optical encoders for feedback controlled movement.

Results: The MRI compatibility of the system was successfully demonstrated in a clinical high-field MRI scanner. The robot has the ability to accurately move the transducer thus creating discrete and overlapping lesions in biological tissue was tested successfully in turkey tissue in vitro. The maximum error of the positioning device is 20 μm.

Conclusion: A simple, cost effective, portable positioning device has been developed which can be used in virtually any clinical MRI scanner since it can be placed on the scanner's table. The proposed system can be used in the future for clinical trials for prostate cancer treatment using HIFU.

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Integrated Executable Software System for Ultrasound Video Despeckling and Analysis of the Carotid Artery

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C.P. Loizou[1]*, Senior Member IEEE*

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Abstract:

Introduction: Noise reduction in ultrasound medical video is essential for increasing the visual quality or as a pre-processing step for further automated analysis in video sequences. It has the the potential in differentiating between normal and abnormal tissue and may be used for border identification or for the evaluation of the motion of moving organs such as the moving atherosclerotic carotid plaque and the intima-media thickness in the common carotid artery (CCA). However, visual perception is reduced by speckle noise affecting the quality of ultrasound B-mode video.

*Methodology***:** We have developed a video analysis software toolbox based on MATLAB® graphical user interface (GUI) that uses video despeckling, texture analysis and image quality evaluation techniques to complement the clinician's evaluation in ultrasound CCA videos. It is based on video normalization, application of 4 different despeckle filtering techniques (DsFlsmv, DsFhmedian, DsFkuwahara and DsFsrad), extraction of 65 texture features and 11 quantitative video quality metrics as well as objective video quality evaluation that can be performed by observers.

*Results***:** The proposed software was validated on 10 ultrasound videos of the CCA, by comparing its results with quantitative visual analysis performed by a medical expert. We have shown, based on texture features and quality metrics, that the despeckle filter DsFlsmv may improve video quality perception as well as further automated video analysis. The software can also be downloaded as an executable software stand alone system from http:// www.medinfo.cs.ucy.ac.cy.

*Conclusions and Future Work***:** We anticipate that the proposed executable video despeckling system could help the physician in the assessment of cardiovascular video analysis. Further evaluation of the proposed software is required as well as its application on a larger number of videos and its further evaluation on additional despeckle filtering methods.

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High-resolution, Low-delay, and Error-resilient Medical Ultrasound Video Communication Using H.264/AVC Over Mobile WiMAX Networks

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Abstract:

In this study, we describe an effective video communication framework for the wireless transmission of H.264/AVC medical ultrasound video over mobile WiMAX networks. Medical ultrasound video is encoded using diagnostically-driven, error resilient encoding, where quantization levels are varied as a function of the diagnostic significance of each image region. We demonstrate how our proposed system allows for the transmission of high-resolution clinical video that is encoded at the clinical acquisition resolution and can then be decoded with low-delay.

To validate performance, we perform OPNET simulations of mobile WiMAX Medium Access Control (MAC) and Physical (PHY) layers characteristics that include service prioritization classes, different modulation and coding schemes, fading channel's conditions, and mobility. We encode the medical ultrasound videos at the 4CIF (704×576) resolution that can accommodate clinical acquisition that is typically performed at lower resolutions. Video quality assessment is based on both clinical (subjective) and objective evaluations.

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Session 5: Speech, and Audio, Processing

Classification of Speech Samples of Cypriot Dialect from two Different Regions of Cyprus Using Time-Frequency Analysis

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Abstract:

Cypriot Greek (CG) is a variety of Greek spoken by Greek citizens of the Republic of Cyprus and the Cypriots of the diaspora. CG differs from Standard Modern Greek (SMG) with regard to its phonetics, phonology, morphology, syntax, and even pragmatics. CG is essentially the ancient-most Greek dialect which has survived, together with the little-spoken Tsakonian dialect, used by some people in the Tsakonia region of Peloponnese. Based on the Arcadocypriot dialect of ancient Greek, CG has been influenced by all the different peoples who ruled the island across the years: Latins, Franks, Venetians, Ottomans - and more recently - English. CG is not homogeneous but exhibits considerable geographical variation. Although influenced by increasing contact with SMG, CG retains most of its phonological and phonetic characteristics virtually intact. The dialect is the subject of undiminished research interest, with projects dealing with various aspects of its use, evolution, and sociocultural effects. However, most of these studies are in the realm of linguistics and do not employ quantitative analysis of the data. The results presented here is the initial attempt to record and quantify aspect of CG and create tools that will further enhance the study of the dialect. In this study, we show that we can successfully recognize the region of origin of a speaker based on recordings of individual words.

Data was collected from two different regions of Cyprus, Pafos and the Famagusta district (Kokkinochoria). Five utterances of 20 words were recorded from five men and five women from each region for a total of 20 speakers and 2000 recordings. The recordings were performed using a standard microphone connected to a laptop computer in a usual, quiet, home setting. The data was initially collected at 44 kHz sampling rate and 16 bit depth. For the purposes of the study presented here, 10 words were used form male speakers only. Each recording was manually segmented by an expert, to assure that only the particular word was included, and downsampled to 16 kHz. The recordings were then further resampled to force all instances to have the same length. A spectrogram was created for each sample based on autoregressive spectral estimation using Burg's method, order 14, and resizing the spectrogram to 64 x 12 points. This data was used as the feature vector for the classification of the region of origin of each speaker. The classification was performed using linear discriminant analysis and leave-one-out-cross-validation. The results show that the region of origin of each speaker can be determined with ~-90% correct classification rate based on a single word and 100% correct classification rate based on a combination of words.

Although these results are very preliminary, they indicate that quantitative analysis of regional differences in CG is possible. They also pave the way for further studies to identify the physical attributes of these differences and construct a tool set which would aid linguist in the study of the dialect.

Finding repeating stanzas in monophonic folk songs of Cyprus

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Abstract:

In this work, we describe a combination of shifted filter responses (COSFIRE) [1] approach for identifying repeating patterns in monophonic folk songs of Cyprus. The audio signal is segmented into frames of 30ms and for each frame, the fundamental frequency is extracted together with the aperiodicity using the YIN algorithm [2]. This results to a representation of each song with two feature vectors containing the fundamental frequency candidates (pitch track) and the aperiodicity for each frame. From the aperiodicity vector, a threshold was used in order to automatically identify the vocal pauses or silences in the songs. The first segmentation is applied based on the duration of the vocal pauses. We make the assumption that between the consecutive melodic phrases there is usually longer vocal pause, indicating the end of a phrase and the beginning of another one. The pitch track is used as a main feature for this approach together with temporal information. In the training phase, we choose the first phrase and we construct a number of filters representing the changes in the pitch contour for a number of points that have been randomly selected. We choose a point in the contour that is the center of the filter and the frequency of this point together with the frequencies of a number of neighboring frames are considered for constructing a filter. We use a Gaussian function for allowing frequency tolerance in the validation process. We use this filter to validate each one of the remaining phrases. The filter responses only to a point in the signal that has similar evolution of fundamental frequencies. We evaluated ten monophonic folk songs of Cyprus and the system is able to correctly identify the most of the repeating stanzas.

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[2] De Cheveigné, A., and Kawahara, H. “YIN, a fundamental frequency estimator for speech and music”, The Journal of the Acoustical Society of America, 111(4), 1917, 2002.

Noise-Robust Classification using Rank Order Kernels

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Abstract:

The need to process and classify signals is encountered in many applications. Signals are abundant in nature and can arise from numerous sources. In many cases however, signals also contain high levels of noise. This poses a unique challenge when processing the signals in order to obtain useful information needed for classification. In this work, we show that by using an appropriate representation transformation of the signal and by kernel-based feature-extraction methods, we can mitigate the effect of noise. We describe a biologically-inspired classification system which can classify various types of noisy signals, without the need to perform extensive preprocessing on the signal. We introduce the concept of rank order kernels which employ rank order coding. Rank order coding is a type of temporal coding which has been proposed as a possible explanation of how neurons encode information. We formulate an image distance metric based on rank order kernels and use it for classification.

We focus on the problem of Automatic Speech Recognition (ASR) in order to demonstrate the capability of our classification system. The accurate recognition of speech is a vital element in human-computer interfaces. One of the main obstacles to building robust ASR systems is the problem of noise. With our methodology, we transform speech signals to two-dimensional time-frequency image representations and classify them using the rank order kernel distance metric. Using our own speech corpus of isolated words we have shown that a simple nearest neighbor classification algorithm which uses the rank order kernel distance metric can outperform even state-of-the-art speech recognition systems at high levels of noise. Compared to the Sphinx4 package and the G.729 standard, the proposed algorithm is much more robust even down to levels of 0 and -5dB signal-to-noise ratio. The outstanding performance is due to the spectrogram image representation used and to the robustness of rank order kernels.

The classification system we develop in this work can be used on any type of signal by first converting the signal to an appropriate two-dimensional image representation and then performing classification using the rank order kernel distance metric. The application of this algorithm to two other applications, not related to speech processing, Raman spectroscopy and Ultrasound, showed that our rank order kernel distance metric can possibly be applied to many types of applications.

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“Meleti” – Auditory and Language Support System

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Abstract:

The main purpose of this system is to support auditory and language development of children with a hearing impairment using hearing aids and/or cochlear implants, children with language delays or any other child with a typical language development pattern (1-5 years).

Language development can be divided into several categories like auditory skills, receptive language, expressive language, speech / articulation. Based on these categories we created a set of applications for Android based devices Tablet computers and Smartphones. These applications can be used anywhere the child and the parent are. These applications include several tasks presented to the child as a game. Their main tasks are to record the way that the user understands and reproduces words, sounds and small phrases. When a user completes a set of games the results can be uploaded to an online database from which speech and language therapists, special educators, audiologists (when concerning hearing impaired children) and all specialists involved in each case, can monitor the development by certain periods of time from the system’s website and act accordingly to improve the children’s performance.

Initial design and development steps have been completed. The two first levels of the system have been tested with 3 users. Future steps will be to expand system usage to a small group of ten users before moving to a larger group. Furthermore the development of several other modules related to the levels of language development will continue in order to cover all language development levels.

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Session 6: Sensor Networks and Intelligent Signal Analysis

A Path Correction Module for Two-Wheeled Service Robots Under Actuator Faults

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Abstract:

Autonomous wheeled robots are receiving significant attention in various applications, including security monitoring of remote or hazardous locations and moving goods in warehouses with the minimum human intervention. At some unknown time, the operation of these robots may be affected due to some actuator fault, which causes the robot to partially lose the ability to navigate and to achieve its goals. In this work, a model-based Fault Detection, Isolation and Path Correction Module (FDI-PC) is presented, suitable for non-holonomic two-wheeled service robots. The first step of the FDI-PC is to determine whether an actuator fault has occurred, based on the measured states and the control inputs. The second step is to determine the type of fault that has occurred, i.e. whether the fault affects the left or right wheel, and to identify its magnitude using adaptive estimation. The third step is to modify the control input using a path-correction algorithm so that the robot maintains its ability to reach its goal. Simulation results on a realistic model of a two-wheeled service robot demonstrate the effectiveness of the FDI-PC Module.

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Fault Tolerant Target Tracking in Binary Wireless Sensor Networks

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Abstract:

Wireless Sensor Networks (WSNs) can well handle difficult tasks in a collaborative fashion and are becoming increasingly popular for demanding and safety-critical applications, including large area monitoring, event localization and target tracking. We address the problem of target tracking using a binary WSN; this is a network where its nodes can only detect the presence of a target or not. Such simple nodes may be preferred in certain applications because they have low circuitry complexity, are less sensitive to calibration errors and can save bandwidth and energy since they communicate only a single bit of information. In such networks, often some nodes may fail and suffer from Byzantine faults, e.g. they may transmit that they have detected a target when they did not or they may not transmit anything (or a packet may be dropped) when a target is actually present.

Several algorithms have been presented for target localization in binary WSNs which differ in complexity, accuracy and fault tolerance. These algorithms are essentially snapshot estimators that do not consider possible correlations among sensor observations while a target is moving inside the field. However, in target tracking applications, the data received by the sensor nodes will appear correlated both in space and time. In particular, several systems exploit this spatiotemporal information and rely on Bayesian filtering, including Kalman and particle filters, to track a target. However, these solutions do not consider sensor faults. The spatiotemporal information provided by the sensors is not only useful for localization and tracking. Additionally, it can assist in detecting sensor faults because it is often the case that certain types of sensor faults appear to be highly correlated in both the time and space domain. The main idea in our approach is to consider the spatiotemporal information obtained while a target is moving through the field to distinguish between healthy and faulty sensors and employ only those sensors that are thought to be healthy for the localization and tracking tasks.

The contribution of this work is two-fold. Firstly, we propose a Markov Chain (MC) fault model to capture the spatiotemporal dynamics of diverse sensor faults. By adjusting the state transition probabilities one can generate various types of sensor faults (e.g., temporary and permanent, reverse status or stuck at a particular value, spatially correlated) which accurately model the faults reported in experimental studies. Secondly, we develop a closed loop architecture, referred to as ftTRACK, that utilizes the spatiotemporal information provided by the sensor network to detect individual faulty sensors which are subsequently excluded from the next step of the target tracking process. The proposed architecture consists of three main components, namely the *sensor health state estimator*, the *target localization* and the *location smoothing* component. Our focus is on the sensor health state estimator that is implemented as a Hidden Markov Model (HMM) to estimate whether each sensor is *healthy* or *faulty* and we investigate three variants for addressing this challenging task. Our simulation results indicate that by incorporating the sensor health state estimator, together with a fault tolerant localization algorithm and particle filtering, the resilience to sensor faults is greatly improved.

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Distributed Detection and Isolation of Sensor Faults in HVAC Systems

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Abstract:

It will be presented the design of a methodology for distributed detection and isolation of multiple sensor faults in heating, ventilation and air-conditioning (HVAC) systems. The proposed methodology is developed in a distributed framework with the HVAC system modeled as a set of interconnected, nonlinear subsystems. A local sensor fault diagnosis (LSFD) agent is designed for each of the interconnected subsystems. The LSFD agent uses input and sensor output data of its underlying subsystem and it may exchange information with the neighboring agents. The distributed sensor fault detection is conducted using robust analytical redundancy relations, formulated by estimation-based residuals and adaptive thresholds. The distributed sensor fault isolation is carried out by combining the decisions of the LSFD agents and applying a reasoning-based decision logic. Simulation results are used for illustrating the effectiveness of the proposed methodology applied to a two-zone HVAC system.

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Efficient Monitoring and Control in Smart Water Networks

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Abstract:

The availability of safe and clean drinking water is vital for human health, as well as for the development of the society. A typical water system is comprised of the following processes: water collection or production, treatment and disinfection, transportation and distribution to consumers. Water which is suitable for consumption and agriculture is a scarce resource which needs to be conserved, and for this reason, methods should be developed to reduce water losses as much as possible. Furthermore, large quantities of energy are required for water production, treatment and distribution, thus efficient methods need to be developed to reduce energy usage as much as possible. In addition, leakage reduction and water quality regulation, as well as maintenance of a sufficient level of security in the system, are key objectives for utilities.

With the advent of sensor technologies and wireless sensor networks, water distribution systems can be better monitored and controlled. By increasing the number of sensors and actuators in the system, along with advanced algorithms for monitoring, control and event detection and accommodation, water distribution system management is becoming more efficient and smarter. In the next decades, these smart water networks will have a large number of sensors installed by utilities and private consumers, for measuring water consumption, hydraulic parameters and water quality in real time. These will produce large volumes of data which will need to be analyzed to perform failure prognosis and schedule maintenance works, detect leakages and contamination events as soon as they occur and automatically apply action to reduce the water losses, forecast consumer demands and regulate accordingly hydraulic and quality to optimize the operation while reducing energy and water costs, as well as to establish a bi-directional communication with the consumers.

To address the research problems in smart water networks, a holistic approach needs to be considered. Some of these challenges will be addressed within the European project “Efficient Integrated Real-time Monitoring and Control of Drinking Water Networks (EFFINET)”, which aims at integrating, through an online platform, advanced algorithms in leakage and contamination event diagnosis, forecasting and control under uncertainties to achieve real-time monitoring and optimal operational control. These methodologies will be evaluated in real field trials in Barcelona and Limassol.

A Matlab – CONTAM Toolbox for Contaminant Event Monitoring in Intelligent Buildings

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Abstract:

An intelligent building should take all the necessary steps to provide protection against the dispersion of contaminants from sources (events) inside the building which can compromise the indoor air quality and influence the occupants' comfort, health, productivity and safety. Multi-zone models and software, such as CONTAM, have been widely used in building environmental studies for predicting airflows and the resulting contaminant transport. This work describes a developed Matlab Toolbox that allows the creation of data sets from running multiple scenarios using CONTAM by varying the different problem parameters. The Matlab-CONTAM Toolbox is an expandable research tool which facilitates the implementation of various algorithms related to contamination event monitoring. In particular, this work describes the implementation of state-of-the-art algorithms for detecting and isolating a contaminant source. The Matlab-CONTAM Toolbox is released under an open- source licence, and is available at https://github.com/KIOS-Research/matlab-contam-toolbox.

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A Multi-Objective Wireless Sensor Network Deployment for Real-Time Monitoring of Forest Fires

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Abstract:

A Wireless Sensor Network (WSN) design often requires the decision of optimal locations of the sensors to be deployed in an area of interest for maximizing the coverage and lifetime of the network, while maintaining the connectivity constraint. In most cases, the two objectives are optimized separately or individually, resulting in loosing "better" solutions due to their conflicting correlation. Therefore, the objectives should be tackled in the context of Multi-Objective Optimization (MOO) by using a Multi-Objective Evolutionary Algorithm (MOEA). In this research study, we aim at monitoring a high-risk forest area located between Kapedes and Lythrodontas, Cyprus, using a WSN. In order to do that, we initially define a 3-D system model by analyzing the terrain and using real data from the Department of Forests – Ministry of Agriculture – such as the aspect and slope, fuel models, risk of initiating or spreading of fire etc. Then we tackle the proposed MOP using a MOEA based on Decomposition (MOEA/D) framework to obtain a set of near-optimal WSN designs, also known as the Pareto Front (PF). The PF is then used for decision making of the most suitable solution based on instant requirements and preferences. Our experimental studies show that the proposed MOEA/D approach outperforms other competitive approaches.

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