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SI-Lab Annual Research Report 2020

SI lab., CNR-ISTI, Pisa, Italy

Istituto di Scienza e Tecnologie dell'Informazione "A. Faedo"
Consiglio Nazionale delle Ricerche
ISTI

SI-Lab. Annual Research Report 2020
SI lab.
ISTI-AR-2021/001

Abstract

The Signal & Images Laboratory (http://si.isti.cnr.it/) is an interdisciplinary research group in computer vision, signal analysis, smart vision systems and multimedia data understanding. It is part of the Institute for Information Science and Technologies of the National Research Council of Italy. This report accounts for the research activities of the Signal and Images Laboratory of the Institute of Information Science and Technologies during the year 2020.

Computer vision, Signal Processing, Artificial Intelligence, Intelligent systems, Topological data analysis, Human Computer Interaction, Inclusion and accessibility, Quality-of-Life

ISTI-AR-2021/001

SI-Lab Annual Research Report 2020

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ISTI-CNR

ABSTRACT The Signal & Images Laboratory (SI-Lab) is an interdisciplinary research group in computer vision, signal analysis, smart vision systems and multimedia data understanding. It is part of the Institute for Information Science and Technologies of the National Research Council of Italy. This report accounts for the research activities of the Signal and Images Laboratory of the Institute of Information Science and Technologies during the year 2020.

INDEX TERMS Computer vision, Signal Processing, Artificial Intelligence, Intelligent systems, Topological data analysis, Human Computer Interaction, Inclusion and accessibility, Quality-of-Life

I. INTRODUCTION

SIGNAL & IMAGES LABORATORY (SI-Lab) is an interdisciplinary research laboratory in computer vision, signal analysis, intelligent vision systems and multimedia data understanding. It is part of the Institute for Information Science and Technologies of the National Research Council of Italy. Researchers and technologists in computer science, mathematics, engineering and physics work together to produce original and effective research in computer vision and signal analysis and transfer knowledge and innovative solutions to society and industrial production and services. Application fields range from cultural heritage to tourism, from mobility to entertainment, from security to environment, and healthcare and wellness.

This report aims to give a global and comprehensive view of the activities that were carried on during 2020, a year that has been singular due to well-known and extensively debated issues and changes related to the COVID19 outbreak. Notwithstanding these difficulties, the lab was not only able to continue the research activities based on its solid basis and background but new activities and projects were conceived and brought to life during the year, as we report in the Highlights (Section II) of this report. Then in Section III we summarize consolidated research topics on our main research fields. In Section IV, we describe the projects in which we were involved during the year 2020. Section V is a complete list of the publications, including PhD and Master thesis developed this year. Section VI finally lists the publicly available code.

II. HIGHLIGHTS

THIS section reports some highlights of SI Lab activities starting with the end of 2019 and going through the whole 2020.

A. COMPUTER VISION AND INTELLIGENT SYSTEMS

During the period, research in this area saw an excellent enhancement of the activities carried out in the previous PAR FAS regional projects. In addition to the development of systems for the inspection of infrastructures using multimodal analysis and deep learning paradigms [46], a work in collaboration with WN Lab on Structural Health Monitoring (SHM) published on IEEE Access [49] was finalized. The work describes the research and experimentation activities carried out within the Moscardo project, focusing on networking issues, processing of data acquired by drones and sensors in situ and their representation in interactive virtual reality interfaces (see moscardo.isti.cnr.it for a demo).

A new application is represented by the use of AI models for precision agriculture. With IBE, a research contract was activated with Barilla (see Project IV-A) for the creation of an expert system (to be used on mobile apps) to detect and classify durum wheat plant diseases and weeds using images. Various models taken from the state of the art are being studied and evaluated and, at the same time, research is being carried out for the generation of new convolutional network architectures, also based on ensemble learning approaches.

Similarly, new architectures are being studied to select features and generate models based on radiomics to identify intrinsic signatures that from medical images can bring new knowledge towards more personalized, precise and predictive medicine. The methods have been tested on prostate cancer datasets and are in the process of being published.

B. TOPOLOGICAL DATA ANALYSIS (TDA)

Based on previous research interests and after the success of the PhD course organized in cooperation with VC Lab at the Department of Mathematics, we have tried to enhance the activities on TDA by promoting a workshop on topics related to ICPR 2020 (imta.isti .cnr.it – the workshop is organized as an event of the IAPR TC16) and funding a PhD scholarship in mathematics on the topic "TDA and Machine Learning".

C. BIOINFORMATICS AND COMPLEXITY

In the field of bioinformatics, ChromStruct, a method for the three-dimensional reconstruction of the chromatin fiber inside the cell nucleus starting from experimental data that provide information on the points of DNA contact of populations of millions of cells (Chromatin Conformation Capture data) was presented and refined in the period. The proposed algorithm consists of a multilevel approach with Bayesian optimization, in order to explore the space of the possible configurations that the DNA can assume, compatibly with the biochemical constraints and the experimental ground truth. The multilevel approach allows to navigate between the various resolution levels of the chromosome structure, ranging from a few thousand bases to hundreds of millions of bases and allowing the introduction of information deriving from laboratory experiments with very different resolution scales.

Two major publications were presented on IEEE / ACM Transactions on Computational Biology and Bioinformatics [20], [21], one of which dedicated to the algorithm and related open-source software implemented in Python. The software, made available on Researchgate (see also Section VI-B), is equipped with a GUI for setting free parameters. The importance of inferring and studying the three-dimensional structure of DNA inside the cell lies in the fact that the spatial organization of the chromatin fiber has a functional character and is involved in gene regulation processes; its alteration is strictly connected with pathological correlates and is implicated in the development of tumors and other diseases.

A similar topic is represented by the study of stochastic diffusion models in media with high heterogeneity. In this case, the heterogeneity of the medium generates an anomalous diffusion process, not Gaussian and with long-range correlation characteristics. The introduction of appropriate complexity indices allows us to infer the characteristics of heterogeneity. In particular, non-Gaussianity and memory phenomena represent a signature of the emergence of self-organized structures in complex systems. During the study of the model, published in Frontiers in Physics [27], the heterogeneous medium par excellence is represented by the cytoplasm and the cell membrane. Potential applications concern both biological transport (with Single Particle Tracking) and, more generally, diffusion on networks for telecommunication, social or biological networks.

D. TELEMEDICINE

During the period, some works on telemedicine were completed, both intended as assistance for Active and Healthy Aging (AHA) and as support for fragile populations and/or in remote areas. This is the case of mountain medicine for which a software platform has been developed, enhanced in the publication [69] in the Journal of Telemedicine and Telecare. The developed platform integrates intelligent systems for decision support favouring both the population and the various welfare figures. The platform had implications during the COVID 19 emergency with some pilot experiences of use for emergency medicine (assistance by 118 operators for the evaluation of patients) and for continuity of care (for use by both people in quarantine and of those who, due to existing frailties, are not advised to access health services in presence).

E. AUGMENTED REALITY (AR) BETWEEN INDUSTRY 4.0 AND ART

The line of research connected with Augmented Reality (AR) interfaces has evolved over the months, extending from applications in the Industry 4.0 sector (where it was used to provide support for the operation and maintenance of production lines in the paper industry [22], [79]) to cultural heritage.

In particular, augmented reality systems can foster greater and wider involvement of the public, helping to overcome cognitive barriers for more inclusive access. The technology has made it possible to start a cooperation with the Carlo Collodi Foundation and at the same time to launch a sub-project of CNR4C, called VERO (see also IV-T). The aim is to explore the potential offered by the most modern technologies, including wearable ones, both for the production of new content and for the enhancement and the enrichment of the cultural offer, evaluating virtual and augmented reality thematic itineraries.

The research activities include constructing a demonstrator inside the Pinocchio Park in Collodi, for which an interactive interface in augmented reality is being developed to make the mosaics of the Piazzetta by Venturino Venturi animated by retracing the Adventures of Pinocchio.

To this end, another collaboration started with the "Alma Artis" Academy of Fine Arts in Pisa is synergistic, particularly regarding the artistic supervision of the animations and the definition of the direction and storyboard.

F. RECENTLY ACQUIRED PROJECTS AND NEW PROPOSALS

During the period, we secured several projects , including 2 EU H2020 projects (of which 1 as coordinators), 1 H2020 CSA (in collaboration with WN Lab), 1 COST Action, 2 RT Salute 2018 tender projects, 1 project in phase of activation with ASI (INTECS leader), 1 project in the activation phase with ESA (Mapsat leader; represents the continuation of OSIRIS). Three other H2020 proposals are being evaluated (2 of which in collaboration with WN lab and 1 in collaboration with NEMIS-AIMIR), as well as various regional proposals, specifically 3 on the COVID19 Research Call and 6 on POR CREO FESR 2014- 2020 RS, of which 4 on Call 1 and 2 on Call 2 (the latter in collaboration with WN Lab and MMS Lab).

III. RESEARCH TOPICS

RESEARCH, DEVELOPMENT AND TECHNOLOGY transfer programs are carried out by SI-Lab on issues that address various topics: Assistive technologies and systems integration, Computational biology, Computational intelligence in Computer Vision, Computational topology and geometry for vision, Document image analysis and restoration, Hybrid intelligent methods, Nature-inspired computation for Smart Sensors, Real-Time imaging and Embedded Systems, Shape analysis and description, and Statistical signal processing.

A. ASSISTIVE TECHNOLOGIES AND SYSTEMS INTEGRATION

Integrated imaging, biomedical and gestural sensing technologies for enhancing and/or maintaining health and well being.

B. COMPUTATIONAL BIOLOGY

The research aims to provide understanding and solutions to genomics and in general biological processes in the cell through the use of statistical signal processing methodology and information theory framework. In particular, we concentrate on: epigenetics, gene interaction networks modelling, cancer mutation modelling, evolution modelling, chromosome conformation and 3D chromation structure capture.

C. COMPUTATIONAL INTELLIGENCE IN COMPUTER VISION

Methods for categorizing and interpreting heterogeneous, multimodal and multisource imagery data. The activities in this field is particularly focused on advanced and innovative intelligent methods designed and developed for categorizing,understanding and interpreting heterogeneous, multimodal and multisource imagery data.

D. COMPUTATIONAL TOPOLOGY AND GEOMETRY FOR VISION

The main aim of this activity is to introduce advanced geometrical and topological methods for tackling computer vision and pattern recognition problems. In particular, using approaches capable to turn multidimensional images and datasets into discrete objects treatable by computational topology, it is possible to explore, discover and measure interesting features of the original data.

E. DOCUMENT IMAGE ANALYSIS AND RESTORATION

The focus is on all those methodologies aimed at improving readability, analysis, and recognition of the content of a document. In particular we mention: use of multispectral, multisensory or multiview acquisitions, models of degradations and features, digital restoration and enhancement, content disclosure and segmentation, correction of geometrical and radiometric distortions, application to ancient archival documents and historical manuscripts.

F. HYBRID INTELLIGENT METHODS

Hybrid systems based on the combination of different types of learning and reasoning techniques have emerged as a viable solution to overcome limitations of single techniques in the attempt to mimic human-like cognitive processes. The goal is to blend deductive strategies (e.g., knowledge-based systems), inductive techniques (e.g., connectionist systems), and reasoning by analogy approaches (e.g., case-based reasoning) to build robust information processing solutions. Our research here focuses on the definition of multilevel systems able to make sense of heterogeneous data for decision making, by combining sub-symbolic data interpretation with knowledge-based reasoning and meta-reasoning. Eligible application fields are eHealth, and new emerging trends such as the quantified self and the personalized informatics.

G. NATURE-INSPIRED COMPUTATION FOR SMART SENSORS

Smart sensors and actuators should provide support for various modes of operation and interfacing. Some applications require additionally fault-tolerance and distributed computing. Such high-level functionality can be achieved by adding specific embedded computing capabilities to the classical sensor/actuator, which increases the ability to cope with complexity at a fair price. Nature-inspired computation denotes all the efforts for producing algorithms directly taking inspiration by Nature, for example, looking at the smart behavior of animals, or at all scales, both in classical or quantum vision of the physical world. The topics enclosed in the field denoted Nature inspired computation for Smart Sensors try to translate methods such Machine learning and Artificial Intelligence to sensors and actuators in order to improve sensing functionality in the most wide of possible applications.

H. REAL-TIME IMAGING AND EMBEDDED SYSTEMS

Analysis and development of algorithms for real-time image analysis, aiming to achieve a low-cost, low-consumption and pervasive implementation on platforms like embedded systems.

I. SHAPE ANALYSIS AND DESCRIPTION

Shape analysis and description serve to derive machine-understandable representations of the content of shape models, such as images and 3D objects. Shape analysis and description are key to shape matching, retrieval, classification, and annotation. We study mathematical methods and algorithms for 2D and 3D shape analysis and description, with application to disparate fields.

J. STATISTICAL SIGNAL PROCESSING.

Complex signal elaboration, ranging from DSP hardware development to signal compression and analysis.

IV. PROJECTS

DURING 2020 several projects have been carried out at SI-Lab. Since signals, images and more general multimedia data are ubiquitous, the variety of project applications fields is wide, ranging from e-health and well-being to environmental monitoring, from remote sensing to cultural heritage and urban intelligence. At the same time, the lab has been able to secure projects responding to several calls at the regional, national and European levels. There are indeed two active European H2020 projects, plus an European Space Agency (ESA) funded project and a COST action, two national projects, eight regional projects, two projects supported by foundations and two commercial contracts. Besides funded projects, other scientific collaborations have been activated with relevant associations and stakeholders. Below, we first list the projects clustering them in macro-areas; then, we provide details about each of them in alphabetical order.

AUTOMATION & MONITORING: Advanced and smart ICT technologies for factory automation and environment monitoring.

- COMPTO-NM : *Computed Tomography To Nuclear Medicine*
- IRIDE : *Design and prototype of a smart converting line for tissue paper*

CULTURAL HERITAGE: Advanced and smart ICT solutions for preserving and fruition of Cultural Heritage.

- VERO : *Virtual reality in Pinocchio's amusement park*

E-HEALTH & TELE-MEDICINE: Advanced and ICT technologies for healthcare, wellbeing, ambient assisted living and active & healthy ageing.

- GOODBROTHER : *Network on Privacy-Aware Audio and Video-Based Applications for Active and Assisted Living*
- NAVIGATOR : *An Imaging Biobank to Precisely Prevent and Predict cancer, and facilitate the Participation of oncologic patients to Diagnosis and Treatment*
- PINK STUDY : *Prevention, Imaging, Network and Knowledge*
- PLATFORMUPTAKE.EU : *Assessing the State of the Art and Supporting an Evidence-Based Uptake and Evolution of Open Service Platforms in the Active and Healthy Ageing Domain*
- PRAMA : *Proteomics, RAdiomics and Machine learning-integrated strategy for precision medicine for Alzheimer's*
- PROCANCER-I : *An AI Platform integrating imaging data and models, supporting precision care through prostate cancer's continuum*
- RADIOPOGE : *Ionizing Radiations, General Population*
- Scientific collaboration with iCARE : *Interactive and robotics technologies for neuromotor rehabilitation*
- Scientific collaboration with Lega del Filo d'Oro : *Innovation in the field of assistive technologies*
- Scientific collaboration with SIMeM : *Research and applications for mountain medicine*
- TIGHT : *Tactile InteGration between Humans and arTificial systems*
- TRACKHOLD : *Neuromotor rehabilitation based on a passive robotic arm and integrated software*

MULTIMEDIA AND SENSORIZED ENVIRONMENTS: Advanced and smart ICT technologies for assistive technologies.

- Scientific collaboration with K-ARRAY : *Development and testing of a hardware and software infrastructure that optimizes the interaction between all the elements of the electroacoustic chain*

SENSING AND AI FOR THE ENVIRONMENT: Advanced and smart ICT technologies for monitoring and preserving the environment with applications to precision agriculture, maritime safety and blue growth.

- AGROSAT+: *Deep learning for precision agriculture*
- NAUTILOS : *New Approach to Underwater Technologies for Innovative, Low-cost Ocean obServation*
- OSIRIS-FO : *Optical/SAR data and system Integration for Rush Identification of Ship models*
- S4E : *Safety & Security Systems for Sea Environment*

URBAN INTELLIGENCE : Advanced and smart ICT technologies for smart city planning and monitoring.

- WEARECLOUDS@LUCCA : *Audio visual sensor networks supporting Urban Intelligence in the municipality of Lucca*

As already mentioned, in the following, we describe in alphabetical order the details of each project listed above.

A. AGROSAT+
Deep learning for precision agriculture

Funded under: Commercial contract with Barilla
Amount (Total): EUR 80,000 (201,000)
Protocol: Prot. ISTI n. 317/2020 (dated 2/7/2020)
Contract: CUP B19E20000040007
Start date: 27 January 2020
End date: 27 July 2023
Coordinator: Barilla G. e R. Fratelli Spa
Other partners: IBE-CNR
Start date: 1 February 2020
End date: 31 January 2022
Keywords: Precision Agricolture; Deep-learning

Contact: Massimo Martinelli (massimo.martinelli@isti.cnr.it)

In the framework of precision agriculture, Agrosat+ project aims at developing methods for the classification of images and videos based on cutting-edge machine learning algorithms. The ultimate goal is to develop a real-time software system for the classification of plants, their diseases, weeds and insects based on images shot by mobile devices in uncontrolled scenarios to support farmers and operators during the daily routine. The precise knowledge of diseases and weeds (also obtained thanks to correlation with other data and computational models) will help farmers choose adaptive and optimal treatment to prevent crop losses.

During 2020 the work was focused on developing classification modules using Artificial Intelligence (AI), specifically Deep Learning models. Moreover, with the development of interfacing solutions between the mobile App and the Artificial Intelligence module, the workflow of the AI module development has started. A set of load-balancing solutions has been implemented and tested.

B. COMPTO-NM
Computed Tomography To Nuclear Medicine

Funded by: POR CREO FESR Toscana 2014-2020
Amount (Total): EUR 85,215 (170,560.96)
Protocol: registered in Pistoia - n. 3240/IT (dated 5/10/2018)
Contract: ATS - repertorio n. 137897
Start date: 1 February 2018
End date: 14 March 2020
Coordinator: Imaginalis Srl
Other partners: ACTA Srl, Università degli Studi di Firenze - Dip. di Scienze Biomediche, Sperimentali e Cliniche "Mario Serio"
Keywords: Predictive Maintenance; Image Quality Estimation; Hybrid Diagnostic Devices; Neurodegenerative and Cerebrovascular Diseases

Contact: Sara Colantonio (sara.colantonio@isti.cnr.it)

CompTo-NM is working to design, prototype and validate a hybrid diagnostic platform that integrates nuclear medicine sensors (Positron Emission Tomography - PET or Single Photon Emission Computed Tomography- SPECT) and Cone Beam Computed Tomography (CBCT) technology, into a single, compact, and transportable device that may serve clinical and pre-clinical investigations of brain anatomy and function. The ultimate goal is to create a high-performance device for the study of neurodegenerative and cerebrovascular disorders, whose epidemiological impact is constantly growing, especially in the western world, and is expected to become very significant in the coming few years, with an increase of social costs. Although, hybrid technology is already available in clinical practice, yet it is not optimized for the neck and encephalic zones, since consisting in full-body devices used in oncology (only 5% of these is dedicated to neuro-vascular diseases). A dedicated device may guarantee lower costs, reduced doses, decongestion of waiting lists and ease of use.

CompTo-NM moves in this direction, leveraging the technologies that enable the Industry 4.0 paradigm to support the design and development processes of the hybrid device and to implement its predictive maintenance. To this end, ISTI team is working to devise a physical-virtual platform to virtualize the components of the hybrid device and simulate their functioning. The platform will provide feedback of tests on real components, thus supporting design and maintenance activities. The corresponding cyber-physical framework maps the behaviours of the hybrid device in various use cases and validates its adherence to the theoretical models. By serving the monitoring, diagnosis and prognosis of the state of the device, this framework aims to optimise:

- the development phase, through a controlled, modular and reusable modelling of the production process
- the performance of the final device, in terms of reliability, maintainability, efficiency and safety, reducing maintenance costs and times and optimizing after-sales services

SI-Lab is working on the definition of data analytics methods to diagnose the status of the device components and enact predictive maintenance interventions. The lab team is also devising algorithms to assess the quality of both nuclear and tomographic images. CompTo-NM has closed its activities in May 2020. The work mainly concerned the delivery of applications for predictive maintenance. The work was organized using two main databases, corresponding to two different abstraction levels: (i) a macro level, in which the assistance requests of CBCT machines previously developed by the project partners, but whose technology was employed in the project, and (ii) a micro level in which images from gamma and CBCT sensors used within the project were analyzed to evaluate their quality, mainly in terms of uniformity. At a macro level, the descriptive analysis of the requests for

assistance resulted in the conclusion that many of the requests belong to the "training" type, thus highlighting how the real failures are fewer than the totality of the database. This has also affected the inability to find obvious time patterns when considering features as priority and type of request. This problem has effectively prevented the development of precise forecasting models in this area. Starting from this analysis, we have analyzed the text present in the requests in order to increase the number of features available to us. The activity carried out is an initial analysis of the text and a descriptive study; this lays the foundations for any other studies on the text to be carried out at a later stage, such as applications of NLP algorithms or Sentiment Analysis [48] to further classify requests. At a micro level, the idea addressed in the design context is to develop a temporal model of uniformity degradation to predict the optimal time to recalibrate the gamma sensor or perform maintenance in the CBCT system. From a technical point of view, the initial idea was to determine timeseries prediction models using state-of-the-art approaches based on LSTM neural networks [85].

C. GOODBROTHER

Network on Privacy-Aware Audio- and Video-Based Applications for Active and Assisted Living

Website: https://goodbrother.eu
Funded under: COST Program
Project reference: COST Action CA 19121
Contract: CA N.19121
Start date: 29 September 2020
End date: 28 September 2024
Coordinator: Universidad de Alicante – Spain
Other partners: 37 managing partners and 3 observing partners available at https://goodbrother.eu/
Keywords: Video-based Health Monitoring; Privacy-preservation; Active and Assisted Living

Contact: Sara Colantonio (sara.colantonio@isti.cnr.it)

Europe faces crucial challenges regarding health and social care due to the demographic change and current economic context. Active and Assisted Living (AAL) are a possible solution to face them. AAL aims at improving health, quality of life, and well-being of older, impaired and frail people. AAL systems use different sensors to monitor the environment and its dwellers. Cameras and microphones are being more frequently used for AAL. They allow to monitor an environment and gather information, being the most straightforward and natural ways of describing events, persons, objects, actions, and interactions. Recent advances have given these devices the ability to see and hear. However, their use can be seen as intrusive by some end users (assisted persons, and professional and informal caregivers.)

The General Data Protection Regulation (GDPR) establishes the obligation for technologies to meet the principles of data protection by design and data protection by default. Therefore, AAL solutions must consider privacy-by-design methodologies in order to protect the fundamental rights of those being monitored.

The aim of GoodBrother is to increase the awareness on the ethical, legal, and privacy issues associated to audio- and video-based monitoring and to propose privacy-aware working solutions for assisted living, by creating an interdisciplinary community of researchers and industrial partners from different fields (computing, engineering, healthcare, law, sociology) and other stakeholders (users, policy makers, public services), stimulating new research and innovation. GoodBrother will offset the Big Brother sense of continuous monitoring by increasing user acceptance, exploiting these new solutions, and improving market reach. ISTI is involved with the Signals & Images Lab, by contributing on privacy-preserving image and video analysis methods and as part of the Management Committee of the Action.

The Cost Action TheGoodBrother has started its core activities at the end of September 2020 with a kick-off meeting involving all the partners and representatives and officers from the Cost Association. Since then, two meetings of the Core Management Team have been organized, discussing and agreeing on the activity plan for the action and organizing liaison initiatives with other Cost Actions. A meeting with the Italian members has been also organized at the beginning of November. SI-Lab started discussing with other partners from Catholic University of Croatia, the Centre for Science, Society and Citizenship and the Staffordshire University, the preparation of a paper about the ethical challenges and the user perceptions of monitored sensory environments in AAL applications.

D. IRIDE

Design and prototype of a smart converting line for tissue paper: ICT technologies for Advenced Automation

Funded by: POR CREO FESR Regione Toscana 2014-2020
Amount: EUR 219,862 (1,539,726.07)
Protocol: Prot. ISTI n. 2025
Contract: CUP Sviluppo Toscana: 7165.24052017.112000003, 5/23/2018
Start date: 1 December 2017
End date: 14 July 2020
Coordinator: Futura Converting Spa
Other partners: Time Srl, Sysdat.it, Efffegroup Srl
Keywords: Augmented Reality; Artificial Intelligence; Computer Vision; Industry 4.0; Predictive Maintenance; Smart glasses

Contact: Davide Moroni (davide.moroni@isti.cnr.it)

Tissue converting lines represent one of the key plant in the paper production field: paper tissue is converted into its final form for domestic and sanitary usage. Despite the present-day lines having high productivity, the state of the art

study has shown that bottlenecks still exist, mainly depending on inadequate automation. IRIDE aims at removing such obstacles towards the complete automation by introducing a set of innovation points based on ICT solutions applied to the advanced automation.

In detail, advanced computer vision and video analytics methods are applied to monitor converting lines pervasively and extract process information to self-regulate machine and global parameters automatically. Big data analysis methodologies are also integrated to obtain new knowledge and to infer optimal management models that could be used for predictive maintenance.

Augmented reality interfaces are designed and developed to support converting line monitoring and maintenance, both ordinary and extraordinary. An Artificial Intelligence module provides suggestions and instruction to the operators to guarantee production level even in the case of unskilled staff.

Advanced automation will be linked with tissue drawing-in and production line cleaning thanks to the new sensor equipment. Automating such processes will improve factory safety, decrease manual interventions and, thus, will increase production line uptime and efficiency.

The research team of the Signal & Images Lab involved in IRIDE project focused on:

- Study and development of image-based methods to monitor the converting process and detect faults and anomalies;
- Augmented reality solutions for Industry 4.0;
- Intelligent systems and decision support for predictive maintenance.

The work has been reported in several technical documents produced during the year [24]–[26], [36]–[38]. Two conference papers [22], [79] and a presentation [3] focus on the use of Augmented reality solutions for Industry 4.0 in IRIDE.

E. NAUTILOS

New Approach to Underwater Technologies for Innovative, Low-cost Ocean obServation

Website: https://www.nautilos-h2020.eu
Funded under: H2020-BG-2020-1
Project reference: Grant Agreement n. 101000825
Amount: EUR 537,067
Protocol: Prot. ISTI 0002767/2020 (dated 04/09/2020)
Start date: 1 October 2020
End date: 30 September 2024
Coordinator: ISTI-CNR
Other partners: Hellenic Centre for Marine Research, Norsk Institutt for Vannforskning, Suomen Ymparistokeskus, Institut Francais de Recherche pour l'exploitation de la Mer, Centre National de la Recherche Scientifique CNRS, ETT Spa, Edgelab Srl, Universidade do Algarve, NKE Instrumentation Sarl, Aquatec Group Limited, Subctech Gmbh, CEIIA - Centro de Engenharia e Desenvolvimento, Haute Ecole Specialisee de Suisse Occidentale,

CSEM Centre Suisse d'Electronique et de Microtechnique SA - Recherche et Developpement, Univerza v Ljubljani, Fundacao Eurocea, Deutsches Forschungszentrum fur Kunstliche Intelligenz Gmbh, Universita della Calabria, IMAR - Instituto do Mar, Evroproject OOD
Keywords: Maritime Observation; Marine Data Management; Underwater Technologies for Augmented Observation

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NAUTILOS will fill in existing marine observation and modelling gaps through the development of a new generation of cost-effective sensors and samplers for physical (salinity, temperature), chemical (inorganic carbon, nutrients, oxygen), and biological (phytoplankton, zooplankton, marine mammals) essential ocean variables, in addition to micro-/nanoplastics, to improve our understanding of environmental change and anthropogenic impacts related to aquaculture, fisheries, and marine litter. Newly developed marine technologies will be integrated with different observing platforms and deployed through the use of novel approaches in a broad range of key environmental settings (e.g. from shore to deep-sea deployments) and EU policy-relevant applications:

- Fisheries and Aquaculture Observing Systems,
- Platforms of Opportunity demonstrations,
- Augmented Observing Systems demonstration,
- Demonstrations on ARGO Platform,
- Animal-borne Instruments.

The fundamental aim of the project will be to complement and expand current European observation tools and services, to obtain a collection of data at a much higher spatial resolution and temporal regularity and length than currently available at the European scale, and to further enable and democratise the monitoring of the marine environment to both traditional and non-traditional data users. The principles that underlie the NAUTILOS project will be those of the development, integration, validation and demonstration of new cutting-edge technologies with regards to sensors, interoperability and embedding skills. The development will always be guided by the objectives of scalability, modularity, cost-effectiveness and open-source availability of software and data products produced. NAUTILOS will also provide full and open data feed towards well-established portals and data integrators (EMODnet, CMEMS, JERICO).

The activities of the H2020-EU NAUTILOS Project has just started, with the firsts technical meetings regarding the involved WPs. In particular, meetings regarding Management and Communication and Dissemination Work Packages are the first deadlines to be met for the year 2020 of the Project. See also the communication in ERCIM News [42].

F. NAVIGATOR

An Imaging Biobank to Precisely Prevent and Predict cancer, and facilitate the Participation of oncologic patients to Diagnosis and Treatment

Funded under: Par Fas Salute Toscana 2014-2020
Amount: EUR 232,000
Protocol: Prot. ISTI 0003093/2020 (dated 21/10/2020)
Contract: CUP I58D20000500002
Start date: 9 October 2020
End date: 8 October 2023
Coordinator: Università di Pisa
Other partners: IFAC-CNR, AUSL Toscana Centro, Azienda Ospedaliera Universitaria Senese, Azienda Universitaria Ospedaliera Careggi
Keywords: Imaging Biobanks; Oncology; Radiomics; Predictive Models; Data Analytics; Machine Learning; Open Science

Contact: Sara Colantonio (sara.colantonio@isti.cnr.it)

Oncology may strongly benefit from a paradigm shift towards personalised medical solutions that account for the great heterogeneity and intra-variability of tumour biology, manifestation and treatment response. Quantitative imaging and imaging-guided interventions play a key role in this frame, as they provide, for individual patients, multi-parametric morphologic and functional information, precious to personalised predictions and prognoses, and new insights into the mechanisms underlying patient's responses to therapy.

NAVIGATOR aims to boost precision medicine in oncology by advancing translational research based on quantitative imaging and multi-omics analyses, towards a better understanding of cancer biology, cancer care, and, more generally, cancer risk. The project will deliver a technological solution relying on:

- an open imaging Biobank, collecting and preserving large amount of quality, standardised imaging data and related omics data in a secure and privacy-preserving model. Data will include CT, MRI and PET data for various neoplasms, clinical data from regional healthcare services (i.e., from Azienda Regionale di Sanità - ARS), molecular and liquid biopsy data
- an open-science oriented, Virtual Research Environment, available for medical researchers and general clinical stakeholders, to process the multi-omics data to extract gold-standard and novel imaging bio-markers based on *Radiomics* analyses; and create and test digital patient models, through data analytics techniques, based on cancer phenotypes, stratified risks and responsiveness to therapy.

Three highly-impacting, solid neoplasms will be initially considered as use cases to populate the Biobank ($\geq$ 1500 cases) and to advance clinical findings in their respect. Nonetheless, the Biobank data model will be highly flexible to ensure its scalability to integrate other tumour types.

NAVIGATOR relies on a strong regional network of Hospitals and University hospitals and Research Institutions in Pisa, Florence and Siena, which have partnered with European universities (i.e., Cambridge and Bournemouth) to grant an international grounding of the work. ISTI-CNR plays a key role in the project, as the three Labs involved (i.e., NeMIS, HPC and SI-Lab) will lead the design and deployment of the Virtual Research Environment as well as of the AI algorithms for the *Radiomics* analyses.

NAVIGATOR started its activities with a kick-off meeting in October 2020. Since then, the activities have mainly concerned the definition of the working groups corresponding to the various workpackages of the project and several meetings to set up the collaboration with the Tuscany Region towards future sustainability of the BioBank.

G. OSIRIS F.O.
Optical/SAR data and system Integration for Rush Identification of Ship models

Funded by: ESA
Amount: EUR 21,000
Start date: November 2020
End date: October 2022
Coordinator: Mapsat
Other partners: Sistemi Territoriali
Keywords: Maritime Traffic Surveillance; Optical/SAR Image Analysis; Ship Classification; Ship Kinematics Estimation; Ship Behavior Analysis

Contact: Emanuele Salerno (emanuele.salerno@isti.cnr.it)

OSIRIS-FO is a 1.5-year follow-on of the past ESA GSTP project OSIRIS (Optical and SAR data and system Integration for Rush Identification of Ship models). A system with classification, behavior and route prediction for collaborative and non-collaborative ships detected by optical and synthetic aperture radar satellite-borne sensors was developed during the previous project. With the aim at improving the technological readiness level of the system, OSIRIS-FO will optimize or extend the functionalities of some of its SAR processing modules. The SI-Lab contribution to this effort is twofold. A ground-truth database for ship classification will be populated with data extracted from a public annotated data set. This will help the studies devoted to refine classification from the moderate-resolution images obtained by ESA's Sentinel-1 constellation. Another contribution consists in an improved target velocity estimation module that avoids the need of detecting the ship wake in the SAR image.

H. PINK STUDY
Prevention, Imaging, Network and Knowledge

Website: https://www.pinkstudy.it
Funded under: Fondazione Umberto Veronesi
Amount: EUR 46,100
Protocol: Prot. ISTI n. 0003531 (dated 04/10/2018)
Start date: 02 January 2017
End date: 01 October 2022

Coordinator: IFC-CNR
Other partners: IEO Milano, IRCSS Ospedale San Luca Milano, Univ. Politectnica Marche, Senologica Srl, Studi Med Cadorna Srl, Studio Radiologico Bazzocchi de Morpurgo, Poilluci Srl, AOU Careggi, Studio Michelangelo Firenze, Ospeale Maggiore Senologia Parma, AUSL Imola, Ospedale Villa Scassi Genova, Azienda USL Toscana Nord-Ovest, RSM Spa
Keywords: Breast Cancer Screening; Artificial Intelligence; Radiomics

Contact: Sara Colantonio (sara.colantonio@isti.cnr.it)

Screening activities are undoubtedly our best ally against the spread of oncological pathologies. In the case of breast cancer, the screening program mainly encompasses radiological investigations based on mammography. However, other diagnostic modalities may prove to be crucial in the early detection of a tumour lesion, in relation to the peculiarity of the breast tissue and to the different types of cancer. The PINK study - Prevention, Imaging, Network and Knowledge - is an important national research project, funded by the Umberto Veronesi Foundation, which aims to evaluate the validity of the different imaging methods. Led by the Institute of Clinical Physiology (IFC) of CNR, PINK sees the participation of numerous public and private radiological centres throughout Italy. The main goal is to identify the diagnostic imaging technique, among mammography, ultrasound and tomosynthesis, or the combination of techniques that may better suit an individual woman thus ensuring to detect promptly potential tumour. SI-Lab collaborates in the project by working, jointly with IFC, on the creation of the digital infrastructure for the collection and management of epidemiological data from the centres that collaborate with the study. The infrastructure provides, as part of the so-called *Imaging Petal* of the project, the storage of image data for supporting the application of innovative investigation techniques based on radiomics for the identification of new biomarkers relevant to phenotyping cancer cases.

The PINK Study is reaching the final stages of its initial 5-year activity plan. Further refinements of the data collection infrastructure have been requested by the Scientific Committee and implemented. The activities required by the Imaging Petal have been discussed with the Fondazione Umberto Veronesi and a plan prepared for their approval.

I. PLATFORMUPTAKE.EU
Assessing the State of the Art and Supporting an Evidence-Based Uptake and Evolution of Open Service Platforms in the Active and Healthy Ageing Domain

Start date: 1 January 2020
End date: 28 February 2022
Coordinator: SYNYO GmbH
Other partners: Fraunhofer Gesellschaft zur Foerderung der Angewandten Forschung E.V., Universidad Politecnica de Madrid, Institute of Communication and Computer Systems, Institut Jozef Stefan, Afedemy, Academy On Age-Friendly Environments in Europe BV, Caritas Diocesana de Coimbra, Linkopings Universitet, Universitat de les Illes Balears, Stichting Smart Homes, Etablissementsa Lievens Lanckman
Keywords: Active and Healthy Ageing (AHA); Active Assisted Living (AAL)

Contact: Andrea Carboni (andrea.carboni@isti.cnr.it)

The PlatformUptake.eu seeks to deliver an inventory of the state of the art and analyse the use of open service platforms in the Active and Healthy Ageing domain, covering both open platforms -such as UniversAAL, FIWARE and partly-open/proprietary platforms developed by industry, and address the interactions between these platforms. To measure the impacts of such platform and enhance their uptake, the project proposal presents a methodology for monitoring open platform development, adoption and spread across Europe, by listing key factors that determine success or hinderance in their uptake by the end-user groups, and also the evolution of their ecosystems and stakeholder networks.

The proposed methodology shall be employed in the project to evaluate the use of open platforms by collecting and processing data from past and currently running European projects and other initiatives that are built upon such platforms. As such, the evolution in the further development of existing platforms and their sustainability will also be addressed. Following such knowledge acquisition, the project will elaborate evaluation guidelines and best practice models of integrating multiple platforms, taking account of technical, organisational, financial/business and legal aspects, with the aim to promote their future evolutions and a wider uptake by the end-user communities.

The activities carried out during the year 2020 began in January with the kick-off of the project held in Vienna. During this meeting the activities to be carried out were presented, with particular regard to WP2, of which ISTI-CNR is WP-Leader. During the year, notwithstanding the difficulties due to the pandemic, the team was able to propose a pathway (as part of an overarching methodology) to define and select for Key Performance Indicators (KPIs), taking into account an extensive amount of parameters related to success, uptake and evolution of platforms. An analysis structured along with the 4 main actions of mapping, observing, understanding, and defining has been detailed. The analysis focuses on Platforms, defined as operating environments, under which various applications, agents and intelligent services are designed, implemented, tested, released and maintained. By following the proposed pathway, we were able to define a practical and effective methodology for monitoring and

evaluating the uptake and other success indicators of AHA platforms. In addition, by the same token, we were able to provide guidelines and best practices for the development of the next generation platforms in the AHA domain.

J. PRAMA

Proteomics, RAdiomics & Machine learning-integrated strategy for precision medicine for Alzheimer's

Funded under: Par Fas Salute Toscana 2014-2020
Amount (Total): EUR 160,000 (736,000)
Protocol: Prot. ISTI 0003162/2020 (dated 27/10/2020)
Contract: CUP B94I20001200007
Start date: 22 October 2020
End date: 21 October 2023
Coordinator: IFAC-CNR
Other partners: Università degli Studi di Firenze, Azienda Ospedaliero-Universitaria Careggi
Keywords: Alzheimer's Disease; Artificial Intelligence; Disease Phenotypes

Contact: Sara Colantonio (sara.colantonio@isti.cnr.it)

Common clinical trials for Alzheimer's Disease (AD) rely on outdated hypotheses on disease pathogenesis and on approximate criteria for patient selection, grouping together patients with diverse manifestations of the disease. Recent studies have suggested that AD may come with several clinical phenotypes and that the differentiation between disease subtypes can be due to the pathway followed by the AD precursor beta-amyloid (Aβ) peptide when it self-assembles into amyloid aggregates in the brain. An integrated survey taking advantage of multiple marker modalities is, thus, perceived as a desirable solution to support clinicians in identifying different disease subtypes, even in their early stages, and to accordingly decide on personalized treatments for individual patients.

In the PRAMA project, we intend to build up a strategy for personalized prediction of the disease based on the hypothesis that the main precursors of AD can form specific aggregates responsible for distinct clinical pictures of the disease, with consequent different sensitivity to drugs. In detail, a combined biochemical, biophysical and optical spectroscopy characterization of molecular biomarkers found in the cerebrospinal fluid of 100 individuals will be carried out, by including patients with progressive clinical signs of AD. This data will provide information on biomarker composition, structure, aggregation level and toxicity. This will constitute the proteomic profile of the biomarker content for each individual. The same patients will be subjected to magnetic resonance imaging (MRI) followed by a radiomics-based image analysis. The entire set of biochemical, optical, MRI data including clinical parameters and neuropsychological evaluation of patients will be elaborated through data analytics techniques to, firstly, discover correlations among novel and gold-standard biomarkers and, then, to mine and

identify different AD phenotypes. The most recent Artificial Intelligence and Machine Learning techniques will be employed to model and process the complex high-dimensional data gathered in PRAMA. Data analyses will also aim at discovering specific diagnostic, prognostic or predictive responses at the different stages of disease stages, on a personalized basis.

The outcomes of PRAMA are expected to have a high socio-economic impact, with significant advantages that include reducing healthcare costs and improving the well-being of the ageing population.

The project is coordinated by IFAC-CNR and will last three years. SI-Lab is involved in the analysis of the multimodal data to define the disease phenotypes.

The kick-off meeting of PRAMA was organized in November 2020. Preliminary actions on data collection and relevant features to be extracted from the diagnostic data have been discussed between the two CNR institutes involved in the Project.

K. PROCANCER-I

An AI Platform integrating imaging data and models, supporting precision care through prostate cancer's continuum

Website: https://www.procancer-i.eu
Funded under: H2020-EU.3.1.5
Project reference: Grant Agreement n. 952159
Amount (Total): 345,000 (9,997,870)
Protocol: Prot. ISTI 0002430/2020 (dated 02/09/2020)
Start date: 9 October 2020
End date: 8 October 2023
Coordinator: Idryma Technologias kai Erevnas
Other partners: Fundacao d. Anna Sommer Champalimaud e dr. Carlos Montez Champalimaud, Stichting Katholieke Universiteit, Fundacion para la Investigacion del Hospital Universitario La Fe de la Comunidad Valenciana, Università di Pisa, Institut Jean Paoli & Irene Calmettes, Hacettepe Universitesi, Fundacio Institut D'investigacio Biomedica de Girona Doctor Josep Trueta, Joao Carlos Costa - Diagnostico por Imagen, S.A., Nacionalinis Vezio Institutas, Geniko Antikarkiniko Ogkologiko Nosokomeio Athinon o Agios Savvas , the Royal Marsden National Health Service Trust, Qs Instituto de Investigacion E Innovacion Sl, Fondazione Del Piemonte per l'Oncologia, the General Hospital Corporation, Biotronics 3d Limited, Advantis Medical Imaging Monoprosopi Idiotiki Kefaleouchiki Etairia, Quibim S.L., Universitat Wien
Keywords: Medical Imaging; Artificial and Computational Intelligence; Prostate Cancer; Open Image Space; Trustworthy AI

Contact: Sara Colantonio (sara.colantonio@isti.cnr.it)

Prostate cancer (PCa) is the second most frequent type of cancer in men and the third most lethal in Europe. Current clinical practices suffer from lack of precision, often lead-

ing to overdiagnosis and overtreatment of indolent tumours. This calls for advanced AI models to go beyond the state for the art by deciphering non-intuitive, high-level medical image patterns and increase performance in discriminating indolent from aggressive disease, early predicting recurrence and detecting metastases or predicting effectiveness of therapies. To date, efforts in the field are fragmented, based on single–institution, size-limited and vendor-specific datasets, thus making model generalizability impossible.

The ProCAncer-I project brings together 20 partners, including PCa centres of reference, world leaders in AI and innovative SMEs, with recognized expertise in their respective domains, working to design, develop and sustain a cloud based, secure European Image Infrastructure with tools and services for data handling. The platform will host the largest collection of PCa multi-parametric MRI, anonymized image data worldwide (>17,000 cases), in line with EU legislation through data donorship. Robust AI models will be developed, based on novel ensemble learning methodologies, leading to vendor-specific and vendor-neutral AI models for addressing eight PCa clinical scenarios.

To accelerate clinical translation of PCa AI models, the project will focus on improving the trust of the solutions with respect to safety, accuracy and reproducibility. Metrics to monitor model performance and inner causal relationships will shade lights on model outcomes, also informing decision makers on possible failures and errors. A roadmap for AI models certification will be defined, by interacting with regulatory authorities, thus contributing to a European regulatory roadmap for validating the effectiveness of AI-based models in clinical decision making.

ISTI-CNR's role in the project is key as the team is involved in the development of robust AI models able to cope with the heterogeneity of imaging data and the biases and confounders this might introduce in the learning models. The team will lead the task related to AI trustworthiness, based on safety, transparency and reproducibility of results as well as on performance monitoring when used in clinical practice.

The activities of ProCancer-I started with a kick-off meeting in October 2020. Initial activities have been carried out on setting the environment and the working groups for the management and technical work. SI-Lab has drafted and circulated the first deliverable D1.4 on the Data Management Plan, as Sara Colantonio is serving as the Quality Manager for the project. First meetings on the management of the GIT software repositories and the data anonymization actions have been organized.

L. RADIOPOGE
Ionizing Radiations, General Population

With the support of: Federazione Nazionale Ordini TSRM-PSTRP; MEDITEC.
Start date: 31 January 2020
End date: 31 December 2020
Keywords: Ionizing Radiations; People Empowerment; Ra-

dio Diagnostic; Medical Imaging

Contact: Massimo Martinelli (massimo.martinelli@isti.cnr.it)

The "Ionizing Radiations, General Population" (RadIo-PoGe) project has officially ended in December. The main aim was to understand what does the general population know about ionizing radiation. The RadIoPoGe project moved in two directions: a) establish the degree of knowledge by the population of ionizing radiation used in medical diagnostics; b) give healthcare professionals tools to demystify preconceived ideas and to inform patients in a targeted manner that they can benefit from diagnostic investigations based on the use of ionizing radiation. A survey was carried out on 2866 people in 9 Italian regions. The results have just been published, while a Web site will be published containing the results. In addition, a presentation has been accepted at the ESR EuroSafe Imaging (2021). A scientific article is being written and will be soon submitted to a journal.

M. S4E
Safety & Security Systems for Sea Environment

Funded under: PON Smart Cities
Amount: 154,000 EUR
Contract: Decreto di concessione n. 418 del 28.02.2018, D.D. 44 24-01-2000
Start date: 1 January 2018
End date: 30 June 2021
Coordinator: iCampus
Other partners: University of Naples "Federico II", INGV, LASAP, Nexsoft
Keywords: Sea Technologies; Safety; Voluntered Geographical Information; Wireless Sensor Networks; Active and Passive Radar

Contact: Davide Moroni (davide.moroni@isti.cnr.it)

The final objective of the S4E project is to build the first technological supply chain in Italy for the implementation of an intelligent integrated system capable of pervasive and continuous monitoring of the chemical-physical parameters of the water column, to simplify surveillance and increase safety in the coastal areas and to facilitate and monitor navigation in areas not served by traditional radar systems. The achievement of this technological development objective will allow users of the platform to be able to combine the needs of promoting the protection of the environment and marine resources in terms of safety, monitoring, remediation and conservation of the marine environment with the search for greater efficiency in the administrative-management processes related to surface navigation.

ISTI-CNR's role in the project is related to the provision of intelligent services for the analysis of Volunteered Geographic Information (VGI) [71]. A mobile app will be developed and tested to facilitate the collection of crowdsourced

information regarding possible pollution events at sea. By converse, the app will provide helpful information and early warning for superior maritime safety.

N. SCIENTIFIC COLLABORATION WITH ICARE
The collaboration permits experimentation and transfers technology.

Protocol: ISTI-CNR 1253 (dated 11/05/2020)
Start date: 11/05/2020
End date: 10/12/2020
Keywords: Computer Graphics; Motion Analysis; Prognostics and Health; Rehabilitation Robotics; Robotics

Contact: Massimo Magrini (massimo.magrini@isti.cnr.it) and Marco Righi (marco.righi@isti.cnr.it)

After the conclusion of the PAR FAS Project INTESA the collaboration with iCare has continued in several directions. In particular, since iCare manages the the "Tabaracci" Assisted Living Facility (ALF) in Viareggio, an experimentation of new technologies for exergames is being carried out for motor rehabilitation. At the end of the ALF experimentation, the desirable results are an increase in ROM capacity, an increase in precision and speed of movements, and a decrease in pathological tremors. Track-Hold is a system used for neuromotor rehabilitation based on a passive robotic arm and integrated software. The system consists of a special hardware and a software running on Windows platform.The hardware, a passive robotic arm, was developed entirely b Wearable Robotics while the software, a set of special exergames, has been developed by Wearable and SI-Lab. During the execution of these exergames the subjects, wearing the robotic arm, must execute set of movements while watching a large monitor. The special system of weights of the device can fully balance the weight of the patient's arm., so that the tasks are purely neurological, thus overcoming muscular effort of similar, free hand, exercises. This system can be very useful treating post-stroke (mostly neurological) disorders damage (see [55], in Italian, for more information.

O. SCIENTIFIC COLLABORATION WITH K-ARRAY
Under project E.CH.O. - Electroacoustic Chain Optimization

Protocol: ISTI-CNR 124/2019 (dated 21/01/2019)
Start date: 20 January 2019
End date: 19 January 2022
Keywords: Professional Audio; Hi-power Audio Systems; Digital Interface

Contact: Giuseppe Fusco (giuseppe.fusco@isti.cnr.it)

The collaboration is connected to the research project E.CH.O (Electroacoustic Chain Optimization) which aims the development and testing of a hardware and software infrastructure that optimizes the interaction between all the elements of the electroacoustic chain and between them and the environment. The optimization goals are to maximize the quality and intelligibility of sound with the constraint of minimizing the number of devices, the time required for setting up events, the noise pollution and the energy consumption.

P. SCIENTIFIC COLLABORATION WITH LEGA DEL FILO D'ORO
Innovation in the field of assistive technologies via scientific collaboration with Filo d'Oro ONLUS

Protocol: ISTI-CNR 440/2020 (dated 18/02/2020)
Start date: 12 February 2020
End date: 11 February 2023
Keywords: Assistive Tecnologies; Disability; Assisted Living; Training

Contact: Giuseppe Fusco (giuseppe.fusco@isti.cnr.it)

The subject of the scientific collaboration between ISTI and the Lega del Filo d'Oro is "joint research, development, training and transfer activities, related to technological innovation in the field of assistive technologies". Due to the pandemic, the work done in 2020 is limited to periodic virtual meetings for planning the future activities.

Q. SCIENTIFIC COLLABORATION WITH SIMEM
Researches and applications for mountain medicine via scientific collaboration with Italian Society of Mountain Medicine (SIMeM)

Protocol: ISTI-CNR 221/2020 (dated 31/01/2020)
Start date: 31 January 2020
End date: 30 January 2022
Keywords: Mountain Medicine; Artificial Intelligence

Contact: Massimo Martinelli (massimo.martinelli@isti.cnr.it)

This project is about a set of researches and applications in the field of mountain medicine have been performed and implemented. The telemedicine system studied and implemented in the e-Rés@mont Interreg-Alcotra European Project has been published by the top journal of telemedicine [69]. A presentation was performed at an international conference [80]. An article on effects of high-altitude was published too.

R. TIGHT
Tactile InteGration between Humans and arTificial systems

Funded under: PRIN
Amount (Total): EUR 88,049 (670,792)
Protocol: DD n. 2068 (dated 29/10/2019) + Decreto di proroga termine progetti n.788 (dated 05/06/2020)
Contract: 2017SB48FP
Start date: 27 January 2020

End date: 27 July 2023
Coordinator: Università degli Studi di Siena
Other partners: Università di Pisa, Politecnico di Milano, Università degli Studi di Roma "Tor Vergata"
Keywords: Haptics; Robotics; Human-centred design; Neuroscience; Wearable Haptics

Contact: Barbara Leporini (barbara.leporini@isti.cnr.it)

In a world where humans work with machines and communicate via computers or smartphones, we need to re-consider the concepts of confidence and awareness towards artificial devices. Confidence is essential, since it allows humans to tackle both known and unfamiliar tasks with hope, optimism, and resilience. Awareness enables confidence, because the more we know about the task we have to perform, and about the agent we must interact with, the more we are confident. In the TIGHT (Tactile InteGration between Humans and arTificial systems) project, the aim is to communicate that sense of awareness to humans that need to be assisted by other humans or by artificial systems. The mutual understanding between a human and her/his collaborator, no matter whether another connected human or a robot, will be enabled by novel tactile communication paradigms formulated within TIGHT. The tactile channel has several advantages, but it is still under-exploited in complex assistive and industrial applications. Capitalizing on the successful results of the newly established field of wearable haptics, TIGHT will tackle the technological and neuroscientific challenges that derive from the development of wearable haptic interfaces suitable for human-human (e.g., visually-impaired people guidance) and human-robot (e.g., cooperative assembly) collaboration scenarios. ISTI-CNR will provide its contribution especially on the design of user interfaces thanks to its knowledge and experience in the Human-Computer Interaction and accessibility field. The main activities carried out in the 2020 year focused especially on the user requirements gathering and analysis. To this end, surveys and interviews with users to acquire information in the field of orientation and mobility have been conducted to define the requirements and technical specifications for:

- The design of tools for supporting the visually-impaired in indoor and outdoor navigation.
- The design of applications able to support the blind person in navigation in indoor and outdoor environments.
- The identification of a possible taxonomy of use cases to be considered during the development of the HW prototype.

S. TRACKHOLD
A system used for neuromotor rehabilitation based on a passive robotic arm and integrated software

Funded under: POR FESR 2014-2020 Azione 1.1.2
Amount (Total): EUR 20,000 (20,000)
Protocol: Notifica PEC 0004122/2019

Contract: CUP B59J19000340003
Start date: 28 October 2019
End date: 13 November 2020
Coordinator: Wearable Robotics srl
Other partners:
Keywords: Computer Graphics; Motion Analysis; Prognostics and Health; Rehabilitation Robotics; Robotics

Contact: Marco Righi (marco.righi@isti.cnr.it)

T. VERO
Virtualità intErattiva nel paRco di pinOcchio

Funded under: POR FSE 2014 -2020
Amount: EUR 56,000
Protocol: Prot. ISTI n. 0004423/2019 (dated 11/27/2019)
Contract: B15J19001040004
Start date: 1 June 2020
End date: 31 May 2022
Coordinator: CNR -ISTI
Other partners: Operatore Culturale Fondazione Nazionale Carlo Collodi
Keywords: Augmented Reality; Cultural Heritage; Interaction Design

Contact: Massimo Magrini (massimo.magrini@isti.cnr.it)

ICT technologies can foster understanding and fruition of cultural heritage supporting and enriching of the visitors experience. In particular, augmented reality (AR) systems can encourage greater and wider involvement of the public. Moreover, they can be useful for overcoming cognitive barriers, for a more inclusive access. In this project we will create a special AR based app for the Pinocchio Park, located in Collodi (Tuscany). The mosaics in the Piazzetta di Venturino Venturi, inside the Park, will be animated with original 3D contents, thanks to AR technologies. The visitors, by framing the scenes of the mosaics (depicting book episodes) with the device, will be able to view 3D animations perfectly integrated with the real scene, giving the illusion that the mosaic comes alive in the space. The AR app will be available both on dedicated wearable viewers (delivered by the staff at the entrance of the park) and via smartphone app. The 3D animated contents will be carried out by digital artists, collaborators of Alma Artis Academy in Pisa, under the artistic supervision of the Collodi Foundation.

U. WEARECLOUDS@LUCCA
Audio visual sensor networks supporting Urban Intelligence in the municipality of Lucca

Funded by: Fondazione CaRi Lucca
Amount (Total): EUR 27,500 (55,000)
Protocol: Prot. ISTI n. 560/2020 (dated 25/2/2020)
Contract: PEC 0004389/2019 - 25/11/2019

Start date: 15 November 2019
End date: 14 November 2022
Coordinator: ISTI-CNR
Other partners: Joint action with AIMH lab
Keywords: Security; Audio Recognition; Image Understanding; Crowd Behaviours

Contact: Andrea Carboni (andrea.carboni@isti.cnr.it)

WeAreClouds@Lucca carries out research and development in the field of monitoring public places, such as squares and streets, through cameras and microphones and using artificial intelligence technologies, in order to collect useful information both for the evaluation of tourist flows and their impact on the city and for the purpose of automatic identification of particular events of interest for statistical or security purposes. The research activity develops artificial intelligence technologies for the analysis of video streams and audio signals capable of providing information on the number of people present, their age, gender, acoustic impact, on the flows of people and on the identification of specific events. The technologies developed, starting from those already in possession of ISTI-CNR researchers, will be adapted to the particular needs of the Municipality of Lucca. The experimental activity is based on the use of cameras and microphones already present in the historic center of Lucca and commonly used for surveillance.

The activities, jointly performed by AIMH and SI-Lab, started effectively in the fall of 2020. In this initial phase, meetings were held with the administration of the city of Lucca, the site of the experimentation, to better calibrate the prototypes of the services we intend to develop. The state-of-the-art analysis and definition of the requirements were also carried out and reported at the end of 2020 [7], [83], [84].

V. PUBLICATIONS

THE publications that appeared during the year 2020 are available on Open ISTI Portal, which is the gateway to the scientific production of the Institute of Information Science and Technologies (ISTI). In the following we list all of them reporting, when available, a short abstract to provide indicative information on the publication itself and on the overall research activities of the laboratory. Publications are listed by their typology, starting with journal papers (18 items) and going on with books and editorials (1 item), conference papers (11 items), posters and presentations (6 items), technical reports (22 items), miscellanea (6 items) and master theses (1 item).

A. JOURNAL PAPERS

Title : The Use of Saliency in Underwater Computer Vision: A Review
Authors : Reggiannini M. and Moroni D.
Source : Remote Sensing 2021, 13(1), 22, MDPI, Basel, Switzerland
DOI : 10.3390/rs13010022

Abstract : *Underwater survey and inspection are tasks of paramount relevance for a variety of applications. They are usually performed through the employment of optical and acoustic sensors installed aboard underwater vehicles, in order to capture details of the surrounding environment. The informative properties of the data are systematically affected by a number of disturbing factors, such as the signal energy absorbed by the propagation medium or diverse noise categories contaminating the resulting imagery. Restoring the signal properties in order to exploit the carried information is typically a tough challenge. Visual saliency refers to the computational modeling of the preliminary perceptual stages of human vision, where the presence of conspicuous targets within a surveyed scene activates neurons of the visual cortex, specifically sensitive to meaningful visual variations. In relatively recent years, visual saliency has been exploited in the field of automated underwater exploration. This work provides a comprehensive overview of the computational methods implemented and applied in underwater computer vision tasks, based on the extraction of visual saliency-related features.* [78]

Title : Can Magnetic Resonance Radiomics Analysis Discriminate Parotid Gland Tumors? A Pilot Study
Authors : Gabelloni, M.; Faggioni, L.; Attanasio, S.; Vani, V.; Goddi, A.; Colantonio, S.; Germanese, D.; Caudai, C.; Bruschini, L.; Scarano, M.; Seccia, V. and Neri, E.
Source : Diagnostics 2020, 10(11), 900, MDPI, Basel, Switzerland
DOI : 10.3390/diagnostics10110900

Abstract : *Our purpose is to evaluate the performance of magnetic resonance (MR) radiomics analysis for differentiating between malignant and benign parotid neoplasms and, among the latter, between pleomorphic adenomas and Warthin tumors. We retrospectively evaluated 75 T2-weighted images of parotid gland lesions, of which 61 were benign tumors (32 pleomorphic adenomas, 23 Warthin tumors and 6 oncocytomas) and 14 were malignant tumors. A receiver operating characteristics (ROC) curve analysis was performed to find the threshold values for the most discriminative features and determine their sensitivity, specificity and area under the ROC curve (AUROC). The most discriminative features were used to train a support vector machine classifier. The best classification performance was obtained by comparing a pleomorphic adenoma with a Warthin tumor (yielding sensitivity, specificity and a diagnostic accuracy as high as 0.8695, 0.9062 and 0.8909, respectively) and a pleomorphic adenoma with malignant tumors (sensitivity, specificity and a diagnostic accuracy of 0.6666, 0.8709 and 0.8043, respectively). Radiomics analysis of parotid tumors on conventional T2-weighted MR images allows the discrimination of pleomorphic adenomas from Warthin tumors and malignant tumors with a high sensitivity, specificity and diagnostic accuracy.* [44]

Title : Design and validation of the readable device: a single-cell electromagnetic refreshable Braille display

Authors : Bettelani G. C., Averta G., Catalano M. G., Leporini B. and Bianchi M.

Abstract : *Blindness represents one of the major disabling societal causes, impacting the life of visually impaired people and their families. Regarding the access to written information, one of the main tools used by blind people is the traditional Braille code. This is the reason why in recent years, there has been a technological effort to develop refreshable Braille devices. These consist of multiple physical dots that dynamically change their configuration to reproduce different sequences of the letters in Braille code. Although promising, these approaches have many drawbacks, which are mainly related to costs, design complexity, portability, and power consumption. Of note, while many solutions have been proposed for multi-cell devices, the investigation of the potentialities of single-cell refreshable systems has received little attention so far. This investigation could offer effective and viable manners to overcome the aforementioned drawbacks, likely fostering widespread adoption of such assistive technologies with end-users. In this paper, we present the design and characterization of a new cost-effective single-cell Electromagnetic Refreshable Braille Display, the Readable system. We report on tests performed with blindfolded and blind expert Braille code readers. Results demonstrate the effectiveness of our device in correctly reproducing alphanumeric content, opening promising perspectives in every-day life applications.* [45]

Title : Optimized dislocation of mobile sensor networks on large marine environments using voronoi partitions

Authors : D'Acunto M., Moroni D., Puntoni A. and Salvetti O.

Abstract : *The real-time environmental surveillance of large areas requires the ability to dislocate sensor networks. Generally, the probability of the occurrence of a pollution event depends on the burden of possible sources operating in the areas to be monitored. This implies a challenge for devising optimal real-time dislocation of wireless sensor networks. This challenge involves both hardware solutions and algorithms optimizing the displacements of mobile sensor networks in large areas with a vast number of sources of pollutant factors based mainly on diffusion mechanisms. In this paper, we present theoretical and simulated results inherent to a Voronoi partition approach for the optimized dislocation of a set of mobile wireless sensors with circular (radial) sensing power on large areas. The optimal deployment was found to be a variation of the generalized centroidal Voronoi configuration, where the Voronoi configuration is event-driven, and the centroid set of the corresponding generalized Voronoi cells changes as a function of the pollution event. The initial localization of the pollution events is simulated with a Poisson distribution. Our results could improve the possibility of reducing the costs for real-time surveillance of large areas, and other environmental monitoring when wireless sensor networks are involved.* [51]

Title : Monitoring ancient buildings: real deployment of an IoT system enhanced by UAVs and virtual reality

Authors : Bacco M., Barsocchi P., Cassarà P., Germanese D., Gotta A., Leone G. R., Moroni D., Pascali M. A. and Tampucci M.

Abstract : *The historical buildings of a nation are the tangible signs of its history and culture. Their preservation deserves considerable attention, being of primary importance from a historical, cultural, and economic point of view. Having a scalable and reliable monitoring system plays an important role in the Structural Health Monitoring (SHM): therefore, this paper proposes an Internet Of Things (IoT) architecture for a remote monitoring system that is able to integrate, through the Virtual Reality (VR) paradigm, the environmental and mechanical data acquired by a wireless sensor network set on three ancient buildings with the images and context information acquired by an Unmanned Aerial Vehicle (UAV). Moreover, the information provided by the UAV allows to promptly inspect the critical structural damage, such as the patterns of cracks in the structural components of the building being monitored. Our approach opens new scenarios to support SHM activities, because an operator can interact with real-time data retrieved from a Wireless Sensor Network (WSN) by means of the VR environment.* [49]

Title : High altitude mountain telemedicine

Authors : Martinelli M., Bastiani L., Moroni D., Mrakic-sposta S., Giardini G. and Pratali L.

Abstract : *An innovative teleconsultation platform has been designed, developed and validated between Summer 2017 and Winter 2018, in five mountain huts and in three remote outpatients clinical centres of the Italian region Valle d'Aosta of the Mont Blanc massif area. An ad hoc video-conference system was developed within the framework of the e-Rés@mont (Interreg Alcotra) European project, to tackle general health problems and high altitude diseases (such as acute mountain sickness, high-altitude pulmonary and cerebral edema). The system allows contacting physicians at the main hospital in Aosta to perform a specific diagnosis and to give specific advice and therapy to the patients in*

an extreme environment out-hospital setting. At an altitude between 1500 and 3500 meters, five trained nurses performed clinical evaluations (anamnesis, blood pressure, heart rate, oxygen saturation), electrocardiographic and echography monitoring on both tourists and residents as necessary; all the collected data were sent to the physicians in Aosta. A total of 702 teleconsultation cases were performed: 333 dismissed (47%), 356 observed (51%), 13 immediate interventions (2%). In 30 cases the physicians decided there was no need for helicopter and ambulance rescue intervention and hospital admissions. The main physiological measures, the classified pathologies, the severe cases, and cost savings are described. The e-Rés@mont teleconsultation platform has been discussed in terms of treated cases, feasibility, proactivity in reducing complexities, direct and indirect advantages, and diagnostics help; moreover general and specific pros and cons have been debated, and future steps have been exposed. [69]

Title : Designing assistive technology for getting more independence for blind people when performing everyday tasks: an auditory-based tool as a case study
Authors : Leporini B., Rosellini M. and Forgione N.
Abstract : *Everyday activities and tasks should in theory be easily carried by everyone, including the blind. Information and Communication Technology (ICT) has been widely used for supporting solutions. However, the solutions can be problematic for the visually impaired since familiarity with digital devices is often required. Or, indeed the procedure can be perceived as fiddly or impractical particularly for repetitive tasks due to the number/type of steps required to complete the task. This paper introduces a simple audio-based tool aimed at supporting visually-impaired people in the seemingly simple activity of checking whether the light in a room is on or off. It is an example of potential low tech devices that can be designed without the need for specific skills or knowledge by the user, and that functions in a practical way. In this context, we discuss the main issues and considerations for totally blind users in identifying whether a light is switched on. The proposed prototype is based on a simple circuit and a form of auditory feedback which informs the user whether they are switching on or off the light. Two prototypes have been designed and built for two different kinds of installation. For the subsequent second prototype, three different versions are proposed to provide a blind person with further support in easily identifying the light status at home. The new design includes enhanced auditory feedback and modifications to the dimensions. The evaluation conducted by involving various groups of end-users revealed the usefulness of the proposed tool. In addition, a survey conducted with 100 visually-impaired people reported the limitations and difficulties encountered by the blind in using*

existing devices. Moreover, the study revealed the interest from 94% of the participants for a potential (new) basic tool integrable with the existing lighting system. This study gives a contribution in the ambient intelligence field by (1) showing how an auditory-based tool can be used to support totally blind people to check the lights in an autonomous and relatively simple way; (2) proposing an idea that can be exploited in other application cases that use light feedback; and (3) proposing seven potential recommendations for designing assistive technology tools and common everyday devices, based on information gathered from the online survey. [16]

Title : Assessment and Diagnostic Accuracy Evaluation of the Reflux Symptom Index (RSI) Scale: Psychometric Properties using Optimal Scaling Techniques
Authors : Nacci A., Bastiani L., Barillari M. R., Lechien J. R., Martinelli M., De Bortoli N., Berrettini S. and Fattori B.
Abstract : *To investigate the psychometric properties of the reflux symptom index (RSI) as short screening approach for the diagnostic of laryngopharyngeal reflux (LPR) in patients with confirmed diagnosed regarding the 24-hour multichannel intraluminal impedance-pH monitoring (MII-pH). From January 2017 to December 2018, 56 patients with LPR symptoms and 71 healthy individuals (control group) were prospectively enrolled. The LPR diagnosis was confirmed through MII-pH results. All subjects (n = 127) fulfilled RSI and the Reflux Finding Score (RFS) was performed through flexible fiberoptic endoscopy. The sensitivity and the specificity of RSI was assessed by ROC (Receiver Operating Characteristic) analysis. A total of 15 LPR patients (26.8%) of the clinical group met MII-pH diagnostic criteria. Among subjects classified as positive for MII- pH diagnoses, RSI and RFS mean scores were respectively 20 (SD ± 10.5) and 7.1 (SD ± 2.5), values not significantly different compared to the negative MII-pH group. The metric analysis of the items led to the realization of a binary recoding of the score. Both versions had similar psychometric properties, α was 0.840 for RSI original version and 0.836 for RSI binary version. High and comparable area under curve (AUC) values indicate a good ability of both scales to discriminate between individuals with and without LPR pathology diagnosis. Based on balanced sensitivity and specificity, the optimal cut-off scores for LPR pathology were >= 5 for RSI binary version and >= 15 for RSI original version. Both version overestimated LPR prevalence. The original version had more sensitivity and the RSI Binary version had more specificity. It would be necessary to think about modifying the original RSI in order to improve its sensitivity and specificity (RSI binary version, adding or changing some items), or to introduce new scores in order to better frame the probably affected of LPR patient.* [9]

Title : Integrating wearable haptics and obstacle avoidance for the visually impaired in indoor navigation: a user-centered approach

Authors : Barontini F., Catalano M. G., Pallottino L., Leporini B. and Bianchi M.

Abstract : *Recently, in the attempt to increase blind people autonomy and improve their quality of life, a lot of effort has been devoted to develop technological travel aids. These systems can surrogate spatial information about the environment and deliver it to end-users through sensory substitution (auditory, haptic). However, despite the promising research outcomes, these solutions have met scarce acceptance in real-world. Often, this is also due to the limited involvement of real end users in the conceptual and design phases. In this manuscript, we propose a novel indoor navigation system based on wearable haptic technologies. All the developmental phases were driven by continuous feedback from visually impaired persons. The proposed travel aid system consists of a RGB-D camera, a processing unit to compute visual information for obstacle avoidance, and a wearable device, which can provide normal and tangential force cues for guidance in an unknown indoor environment. Experiments with blindfolded subjects and visually impaired participants show that our system could be an effective support during indoor navigation, and a viable tool for training blind people to the usage of travel aids.* [32]

Title : Thermal vulnerability detection in integrated electronic and photonic circuits using infrared thermography

Authors : Hussain B., Jalil B., Pascali M. A., Imran M., Serafino G., Moroni D. and Ghelfi P.

Abstract : *Failure prediction of any electrical/optical component is crucial for estimating its operating life. Using high temperature operating life (HTOL) tests, it is possible to model the failure mechanisms for integrated circuits. Conventional HTOL standards are not suitable for operating life prediction of photonic components owing to their functional dependence on the thermo-optic effect. This work presents an infrared (IR)-assisted thermal vulnerability detection technique suitable for photonic as well as electronic components. By accurately mapping the thermal profile of an integrated circuit under a stress condition, it is possible to precisely locate the heat center for predicting the long-term operational failures within the device under test. For the first time, the reliability testing is extended to a fully functional microwave photonic system using conventional IR thermography. By applying image fusion using affine transformation on multi-modal acquisition, it was demonstrated that by comparing the IR profile and GDSII layout, it is possible to accurately locate the heat centers along with spatial information on the type of component. Multiple IR profiles of optical as well as electrical components/circuits were acquired and mapped onto the layout files. In order to ascertain the degree of effectiveness of the proposed technique, IR profiles of complementary metal-oxide semiconductor RF and digital circuits were also analyzed. The presented technique offers a reliable automated identification of heat spots within a circuit/system.* [14]

Title : Reflux Symptom Index (RSI) and singing voice handicap index (SVHI) in singing students. A pilot study.

Authors : Nacci A., Bastiani L., Barillari M. R., Martinelli M., Lechien J. R., Simoni F., Berrettini S. and Fattori B.

Abstract : *Objective: To correlate, RSI with SVHI, in a group of singing students, by means of a specific anamnestic questionnaire which analyzes the physical, social, emotional, and economic impacts of voice problems on their lives. This study is a cross-sectional single-center observational study. Methods: Forty-two modern singing students (26F/16M; average age: 24.9 ± 5.7; range: 16-46 years old) were recruited. A self-assessment of the singing-voice (SVHI) and of reflux symptom (RSI) was performed. Results: Using the validated RSI threshold, 31% of participants were classified as RSI greater than 13 as an indication of suspected LPR. Classifying the SVHI score as proposed in the recent literature (cutoff of 20.35) our sample was a voice disorders prevalence of 71.4%. There was no significant positive or negative relationship between RSI and SVHI total score (rho = 0.238, P = 0.13). Instead, by considering the relationship between the individual items of the two questionnaires, it is highlighted that the item 1 of SVHI was significantly correlated with most of the RSI items (P = 0.0001-0.006). In the same vein, the item 5 of SVHI was correlated to hoarseness and coughing (P = 0.005-0.006). The item 20 of SVHI was significantly correlated with hoarseness, excess mucus in the throat or postnasal drip and with the pharyngeal Globus sensation (P = 0.001-0.005). By aggregating the SVHI item response as a positive response (2-4) versus a negative response (0 or 1) between "RSI pathology classification," a significant association was observed for SVHI item 1 (P < 0.021), item 5 (P < 0.006), item 20 (P < 0.042), item 24 (P < 0.044) item 25 (P < 0.047). These associations were confirmed by univariate binary logistic. Multivariate binary logistic regression confirms that SVHI Item 1, Item 5 were more associated with RSI positive. Based on results, we propose a questionnaire that combines the most relevant SVHI items correlated to LPRD (SVHI-10-LPRD questionnaire). Cronbach's alpha coefficient for the 10 items selected was 0.87; item-total correlation coefficients for each item were in the range of 0.461 to 0.670. Conclusions: This pilot study shows that, in case of significant RSI for LPR, it is possible to observe a significant association with some*

symptoms described in SVHI. These results underline that the association of the RSI and SVHI questionnaires administered to singers and singing students, can represent a simple screening to reveal possible alterations of the singing voice correlate to LPR. Moreover, we propose a Singing Voice Handicap Index correlated to LPR (SVHI-10-LPRD). It will be necessary to increase the sample of subjects in the study to confirm these preliminary data. [8]

Title : Modelling impulsive noise in indoor powerline communication systems
Authors : Karakus O., Kuruoglu E. E. and Altinkaya M. A.
Source : Signal, Image and Video Processing vol. 14, pp.1655–1661, Springer, (2020)
DOI : 10.1007/s11760-020-01708-1
Abstract : *Powerline communication (PLC) is an emerging technology that has an important role in smart grid systems. Due to making use of existing transmission lines for communication purposes, PLC systems are subject to various noise effects. Among those, the most challenging one is the impulsive noise compared to the background and narrowband noise. In this paper, we present a comparative study on modelling the impulsive noise amplitude in indoor PLC systems by utilising several impulsive distributions. In particular, as candidate distributions, we use the symmetric ?-Stable (S?S), generalised Gaussian, Bernoulli Gaussian and Student's t distribution families as well as the Middleton Class A distribution, which dominates the literature as the impulsive noise model for PLC systems. Real indoor PLC system noise measurements are investigated for the simulation studies, which show that the S?S distribution achieves the best modelling success when compared to the other families in terms of the statistical error criteria, especially for the tail characteristics of the measured data sets.* [72]

Title : Unveiling the secrets of Escher's lithographs
Authors : Coltelli P., Barsanti L. and Gualtieri P.
Source : Journal of Imaging 6(2), 5, MDPI, (2020)
DOI : 10.3390/jimaging6020005
Abstract : *An impossible structure gives us the impression of looking at a three-dimensional object, even though this object cannot exist, since it possesses parts that are spatially non-connectable, and are characterized by misleading geometrical properties not instantly evident. Therefore, impossible artworks appeal to our intellect and challenge our perceptive capacities. We analyzed lithographs containing impossible structures (e.g., the Necker cube), created by the famous Dutch painter Maurits Cornelis Escher (1898-1972), and used one of them (The Belvedere, 1958) to unveil the artist's hidden secrets by means of a discrete model of the human retina based on a non-uniform distribution of receptive fields. We demonstrated that the ability of Escher in composing his lithographs by connecting spatial coherent details into an impossible whole lies in drawing these incoherent fragments

just outside the zone in which 3D coherence can be perceived during a single fixation pause. The main aspects of our paper from the point of view of image processing and image understanding are the following: (1) the peculiar and original digital filter to process the image, which simulates the human vision process, by producing a space-variant sampling of the image; (2) the software for the filter, which is homemade and created for our purposes. The filtered images resulting from the processing are used to understand impossible figures. As an example, we demonstrate how the impossible figures hidden in Escher's paintings can be understood. [73]

Title : Color segmentation and neural networks for automatic graphic relief of the state of conservation of artworks
Authors : Amura A., Tonazzini A., Salerno E., Pagnotta S. and Palleschi V.
Source : Color Culture and Science Journal, 12(02), pp. 07-15. (2020)
DOI : 10.23738/CCSJ.120201
Abstract : *This paper proposes a semi-automated methodology based on a sequence of analysis processes performed on multispectral images of artworks and aimed at the extraction of vector maps regarding their state of conservation. The graphic relief of the artwork represents the main instrument of communication and synthesis of information and data acquired on cultural heritage during restoration. Despite the widespread use of informatics tools, currently, these operations are still extremely subjective and require high execution times and costs. In some cases, manual execution is particularly complicated and almost impossible to carry out. The methodology proposed here allows supervised, partial automation of these procedures avoids approximations and drastically reduces the work times, as it makes a vector drawing by extracting the areas directly from the raster images. We propose a procedure for color segmentation based on principal/independent component analysis (PCA/ICA) and SOM neural networks and, as a case study, present the results obtained on a set of multispectral reproductions of a painting on canvas.* [1]

Title : Design guidelines for an interactive 3D model as a supporting tool for exploring a cultural site by visually impaired and sighted people
Authors : Leporini B., Rossetti V., Furfari F., Pelagatti S. and Quarta A.
Source : ACM transactions on accessible computing, vol 13(3),9, (2020).
DOI : 10.1145/3399679
Abstract : *Being able to explore and familiarise themselves with the structure and details of a cultural site before actually visiting it is fundamental for orienting visually impaired people during the visit; otherwise, it is particularly difficult to gain a global understanding of the structure and an overall impression of a square, a church, or a large monument.*

Our project addressed this problem by using low cost 3D models combined with audio descriptions to enable visually impaired users to explore the cultural site autonomously. Audio descriptions are organised into three groups (for historical, practical, and architectural information), and for each group, several tracks are recorded giving increasing levels of details. Users can easily navigate through the audio tracks to follow their tactile exploration by listening to the information they are most interested in. Relevant details are reproduced separately and linked to the main model via the audio tracks. A goal of our model is to enhance the understanding of the cultural site also for partially sighted as well as sighted people, making them able to appreciate the details of the architectural design using both visual and auditory senses. We exploited low-cost and partially open-source technologies, thus rendering our system easily replicable. We evaluated the interactive system with blind, partially sighted, and sighted users. Our user test confirmed the validity of our approach: (1) the 3D models and the tactile reproduction of details obtained via a low-cost 3D printing solution are well perceived by touch; (2) the semantic auditory information activated via perceptible buttons on demand and the different content levels for the audio tracks are suitable for an interactive, autonomous, and satisfying exploration; and (3) relevant details are well perceived. Finally, we propose guidelines to use in the 3D reproduction of buildings or large sites based on our experience. [17]

Title : Effects of acute and sub-acute hypobaric hypoxia on oxidative stress: a field study in the Alps
Authors : Mrakic-sposta S., Gussoni M., Dellanoce C., Marzorati M., Montorsi M., Rasica L., Pratali L., D'Angelo G., Martinelli M., Bastiani L., Di Natale L. and Vezzoli A.
Abstract : *High altitude results in lower barometric pressure and hence partial pressure of O2 decrease can lead to several molecular and cellular changes, such as generation of reactive oxygen species (ROS). Electron Paramagnetic Resonance technique was adopted in the field, to evaluate the effects of acute and sub-acute hypobaric hypoxia (HH) on ROS production by micro-invasive method. Biological biomarkers, indicators of oxidative stress, renal function and inflammation were investigated too. Fourteen lowlander subjects (mean age 27.3 ± 5.9 years) were exposed to HH at 3269 m s.l. ROS production, related oxidative damage to cellular components, systemic inflammatory response and renal function were determined through blood and urine profile performed at 1st, 2nd, 4th, 7th, and 14th days during sojourn. Kinetics of changes during HH exposition showed out significant (range $p < 0.05$-0.0001) increases that at max corresponds to 38% for ROS production rate, 140% for protein carbonyl, 44% for lipid peroxidation, 42% for DNA damage, 200% for inflammatory cytokines and modifica-*

tions in renal function (assessed by neopterin concentration: 48%). Conversely, antioxidant capacity significantly ($p < 0.0001$) decreased - 17% at max. This 14 days in-field study describes changes of oxidative-stress biomarkers during HH exposure in lowlanders. The results show an overproduction of ROS and consequent oxidative damage to protein, lipids and DNA with a decrease in antioxidant capacity and the involvement of inflammatory status and a transient renal dysfunction. Exposure at high altitude induces a hypoxic condition during acute and sub-acute phases accompanied by molecular adaptation mechanism indicating acclimatization. [80]

Title : A New Approach to Underwater Technologies for Innovative, Low-cost Ocean Observation: NAUTILOS
Author : Pieri G.
Abstract : *The NAUTILOS project aims to fill some of the existing gaps in marine observation and modelling by improving the measurement of chemical, biological and deep ocean physics variables. A new generation of cost-effective sensors and samplers is being developed, integrated into observation platforms and deployed in large-scale demonstrations off the coastline of Europe. These will complement and expand existing observation tools and services, allowing researchers to obtain data at a much higher spatial resolution, temporal regularity and length than is currently available at a European scale. It will also facilitate and democratise the monitoring of the marine environment for both traditional and non-traditional data users.* [42]

Title : Identifying Value-Increasing Actions for Cultural Heritage Assets through Sensitivity Analysis of Multicriteria Evaluation Results
Author : Salerno E.
Abstract : *This paper presents a brief overview of multicriteria decision making (MCDM) as applied to the evaluation of adaptive reuse projects for cultural heritage assets and proposes a strategy to plan interventions to increase their value. The value of an object can be defined from its fitness to fulfil specified objectives, its significance to the people who own or use it, its potential to produce revenues, and a host of other criteria depending on its nature. These criteria are often subjective, relying on judgements issued by several experts, stakeholders and decision makers. This is why the MCDM methods need to formalize the problem so as to make it suitable to be treated quantitatively. Moreover, its sensitivity to variable opinions must be studied to check the stability of the result. We propose to leverage sensitivity analysis to identify the lines of intervention that promise to be the most effective to increase the value of the asset. A simulated example illustrates this strategy. This approach*

promises to be useful when assessing the sustainability of a reuse or redevelopment project in the cases where the final destination of the asset is still under examination. [28]

B. BOOKS AND EDITORIALS

Title : ICT for Smart Water Systems: Measurements and Data Science

Editors : Scozzari A., Mounce S., Han D., Soldovieri F. and Solomatine D.

Publisher : Springer

DOI : 10.1007/978-3-030-61973-2

Abstract : *Today, Information and Communication Technologies (ICT) have a pervasive presence in almost every aspect of the management of water. There is no question that the collection of big data from sensing and the insights gained by smart analytics can bring massive benefits. This book focuses on new perspectives for the monitoring, assessment and control of water systems, based on tools and concepts originating from the ICT sector. It presents a portrait of up-to-date sensing techniques for water, and introduces concepts and implications with the analysis of the acquired data. Particular attention is given to the advancements in developing novel devices and data processing approaches. The chapters guide the reader through multiple disciplinary contexts, without aiming to be exhaustive, but with the effort to present relevant topics in such a highly multi-disciplinary framework. This book will be of interest to advanced students, researchers and stakeholders at various levels.* [10]

C. CONFERENCE PAPERS

Title : Digital safeguard of laminated historical manuscripts: the treatise "Poem in Rajaz on medicine" as a case study

Authors : Del Grosso A. M. and Fassi Fihri D. and El Mohajir M. and Nahli O. and Tonazzini A.

Source : CiSt'2020 - 6th IEEE Congress on Information Science & Technology, Agadir-Essaouira, Morocco, (postponed) 5-12 June 2021

Abstract : *In this paper, we analyze and discuss the characteristics of a system for the effective digital preservation and fruition of historical manuscripts degraded by the process of lamination. As a case study, we will make reference to the "Poem in Rajaz on medicine", written by Abubacer in the XII century, and conserved in the Al Quaraouiyine Library located in Fez, Morocco. The conceived system should have at least four main functionalities: image acquisition (i.e. digitization), image enhancement, text encoding, and linguistic analysis. Based on the evaluation of the manuscript damages, the acquisition set up should be designed in such a way to be able to avoid reflections as much as possible. Suitable digital image processing techniques should also be devised to correct the residual degradation and enhance the text for an easier legibility. Finally, semi-automatic transcription, scholarly encoding and linguistic analysis, to be performed on the virtually restored pages, should adapt existing tools to the specificity of the primary source writing system and language. The feasibility study for the realization of such a system is of general utility, in that it can provide guidelines for the digitization, the enhancement and the text encoding of the many laminated manuscripts conserved in other historical archives. On the other hand, from the cultural heritage point of view, the experimentation on the "Poem in Rajaz on medicine" could foster the systematic philological and ontological study of a unique piece of our documental heritage: the longest poem of medieval Islamic medical literature.* [52]

Title : App Inventor as a Developing Tool to Increase the Accessibility and Readability of Information: A Case Study

Authors : B. Leporini and G. Catanzaro

Source : 9th International Conference on Software Development and Technologies for Enhancing Accessibility and Fighting Info-exclusion (DSAI 2020), online, 2-4 December 2020, ACM Digital Library

Abstract : *In this work, App Inventor is presented as a potential tool to develop an accessible app in order to convey contents and information. As use case, we considered the readability of a leaflet used to provide useful information to the general public. Usually this type of contents is presented in a static PDF format, which cannot be easily read on a touch screen. In this work, App Inventor is used to convey information in a more interactive and readable way via a mobile app. The study was specifically aimed at investigating(1) the accessibility support provided by App Inventor, and (2) the usage of an interactive mobile app as a possible tool to enhance content readability on a touch-screen device. The designed app showed that accessibility is supported by App Inventor, although some minor issues have been detected in the user interface design. Finally a set of possible design suggestions has been proposed.* [47]

Title : Pilot study on music-heart entrainment in a pianist during a live performance

Authors : L. Sebastiani, M. Magrini, P. Orsini, F. Mastorci, A. Pingitore and P. Paradisi

Source : 11th Conference of the European Study Group on Cardiovascular Oscillations (ESGCO), Pisa, Italy, 15 July 2020, IEEE Xplore

DOI : 10.1109/ESGCO49734.2020.9158149

Abstract : *Entrainment between music features and heart rhythms have been reported but, to date, evidence in support of music-heart synchronization are still inconsistent. We studied the possible music-heart entrainment in a skilled pianist during a live performance before an audience. We recorded ECG before and during the concert. We derived the beat-to-*

beat RR time series and analyzed heart rate variability in the time domain and with non linear analysis, to evaluate the autonomic changes associated with 4 different music pieces. Results indicated an autonomic modulation specific for each piece and the decrease and increase of parasympathetic and sympathetic tone across the whole session. Also, for each music piece, analysis of correlation between the music envelope and the RR series revealed a negative correlation which could be the expression of the entrainment of music on heart rhythm. [81]

Title : ViDA 3D: Towards a View-based Dataset for Aesthetic prediction on 3D models
Authors : M. Angelini, V. Ferulli, F. Banterle, M. Corsini, M. A. Pascali, P. Cignoni and D. Giorgi
Source : Smart Tools and Apps for Graphics - Eurographics Italian Chapter Conference, 2020
DOI : 10.2312/stag.20201239
Abstract : *We present the ongoing effort to build the first benchmark dataset for aesthethic prediction on 3D models. The dataset is built on top of Sketchfab, a popular platform for 3D content sharing. In our dataset, the visual 3D content is aligned with aesthetics related metadata: each 3D model is associated with a number of snapshots taken from different camera positions, the number of times the model has been viewed in-between its upload and its retrieval, the number of likes the model got, and the tags and comments received from users. The metadata provide precious supervisory information for data-driven research on 3D visual attractiveness and preference prediction. The paper contribution is twofold. First, we introduce an interactive platform for visualizing data about Sketchfab. We report a detailed qualitative and quantitative analysis of numerical scores (views and likes collected by 3D models) and textual information (tags and comments) for different 3D object categories. The analysis of the content of Sketchfab provided us the base for selecting a reasoned subset of annotated models. The second contribution is the first version of the ViDA 3D dataset, which contains the full set of content required for data-driven approaches to 3D aesthetic analysis. While similar datasets are available for images, to our knowledge this is the first attempt to create a benchmark for aesthethic prediction for 3D models. We believe our dataset can be a great resource to boost research on this hot and far-from-solved problem.* [13]

Title : Le style de vie des montagnards
Authors : Agazzi G., Bastiani L., Pratali L., Valoti P., Carrara B., Parigi G. B., Malannino M., Spinelli A., Calderoli A., Orizio L., D'Angelo G., Giardini G., Moroni D., Sposta S. M. and Martinelli M.
Source : 5e Colloque de médecine de montagne et d'aventure, Parc du Mont-Orford, Quebec, Canada, 22-26 January 2020
Abstract : *La variation des visiteurs de montagne ces dernières années modifie de manière significative les problèmes du territoire montagnard: si d'une part le nombre de visiteurs temporaires augmente (touristes, travailleurs, etc...), d'autre part le nombre d'habitants diminue. Le premier, parmi les divers, élève la maladie aiguë de haute montagne (MAM) à un problème de santé publique non négligeable; le second conduit à une gestion moindre du territoire générant des problèmes directs et indirects, parmi ceux-ci, également favorisés par le réchauffement climatique, ainsi que la prolifération des tiques. Cette recherche a spécifiquement examiné les facteurs de risque individuels liés au mode de vie et à la MAM.* [35]

Title : Factory maintenance application using augmented reality
Authors : Coscetti S., Moroni D., Pieri G. and Tampucci M.
Source : 3rd International Conference on Applications of Intelligent Systems (APPIS2020), Las Palmas de Gran Canaria, Spain, 7-9 January 2020, ACM Digital Library
DOI : 10.1145/3378184.3378218
Abstract : *Tissue converting lines represent one of the key plant in the paper production field: with them, paper tissue is converted into its final form for domestic and sanitary usage. One of the key points of the tissue converting lines is the productivity and the possibility to follow conversion process at relativity low cost. Despite the actual lines have yet an high productivity, the study of the state of the art has shown that choke points still exist, caused by inadequate automation. In this paper, we present the preliminary results of a project which aims at removing such obstacle towards complete automation, by introducing a set of innovations based on ICT solutions applied to advanced automation. In detail, advanced computer vision and video analytics methods will be applied to pervasively monitor converting lines and to automatically extract process information in order to self-regulate specific machine and global parameters. Big data analysis methodologies will be also integrated to obtain new knowledge and infer optimal management models which could be used for the predictive maintenance. Augmented reality interfaces are being designed and developed to support converting line monitoring and maintenance, both ordinary and extraordinary. An Artificial Intelligence module provides suggestions and instructions to the operators in order to guarantee production level even in case of unskilled staff. The automation of such processes will improve factory safety, decrease manual interventions and, thus, will increase production line up-time and efficiency.* [79]

Title : Exploring WAI-Aria techniques to enhance screen reader interaction: the case of a portal for rating accessibility of cultural heritage sites
Authors : Buzzi M., Leporini B. and Romano F.
Source : Universal Access in Human-Computer Interaction. Design Approaches and Supporting Technologies. Springer,

Abstract : *Cultural heritage sites (museums, archaeological parks, exhibition spaces, etc.) do not always guarantee accessibility to all users, regardless of their abilities. Often services are not really as usable and functional as expected. Currently there is no website offering accessibility information on heritage sites in a format accessible to all. People with disability or their caregivers are forced to spend considerable time and effort to obtain accessibility information, sometimes encountering difficulties. The Axem portal aims to fill this gap by offering information on the degree of accessibility of cultural sites (museums, archaeological parks, libraries, art galleries, places of worship, exhibition spaces, etc.). It has been designed as a facility for people with disabilities and in general for all individuals who have special needs and require specific services. In this paper the Axem web site is presented as a case study to (1) investigate the use of web techniques for enhancing screen reading interaction, and (2) propose a portal to collect information on accessible services supported by the cultural sites. Regarding web accessibility, the use of WAI ARIA, an accessible web design, is discussed in order to improve screen reading interaction. Accessibility functions and features as well as the ranking algorithm for easy search and the rating mechanism are presented. This work offers a further contribution to the web accessibility field, while proposing a portal which could be exploited by cultural heritage sites and promote their accessible services to people with disability.* [50]

Title : SelfLens: A personal assistive technology to support the independence of people with special needs in reading information on food items
Authors : Galesi G., Giunipero L., Leporini B., Pagliucoli F., Quatraro A. and Verdi G.
Abstract : *Grocery shopping or handling food items (e.g. packets, boxes, etc.) can be a very difficult task for people with special needs. Object labels may contain much information that can be difficult to read because the data shown is a lot, and the text is difficult to read by many people. Blind people are unable to get that information autonomously, and many sighted persons (e.g. elderly people and visually-impaired) may have a lot of difficulty in reading labels. Several tools or applications are available on the market or have been proposed in the literature to support this type of activity (e.g. barcode or QR code reading), but they are limited and may require specific skills by the user. Moreover, repeatedly using an application to read label contents or to get additional information on a product can require numerous actions on a touch-screen device. This can make their use inaccessible or unusable for many users, especially while shopping or cooking. In this work, a portable tool is proposed to support people in simply reading the contents of labels and getting additional information, while they are at home or at the shop. Our study aims to propose a portable assistive technology which can be used by everyone both at home and in the shopping, independently from the personal skills and without requiring no smartphone or complex device, and that is a low-cost solution for the user. Such a product could be very useful for the people independence in a period like that one we are living due to the lockdown required by the Covid-19 situation.* [39]

Title : Lake water level estimated by a purely radiometric measurement: An experiment with the SLSTR radiometer onboard Sentinel-3 satellites
Authors : Scozzari A., Vignudelli S. and Negm A.
Abstract : *This work describes a preliminary study on the possible usage of the imaging radiometer SLSTR (Sea and Land Surface Temperature Radiometer) onboard the Sentinel-3 satellites for estimating quantitative parameters (extent and/or level) of inland water bodies. Various works in the literature propose a combination of optical imagery and radar altimetry to estimate water storage variations in inland water targets. This work wants to exploit the simultaneous acquisition offered by SRAL (Synthetic aperture Radar ALtimeter) and SLSTR instruments hosted by the Sentinel-3A/B platform. We present a practical case study, demonstrating how a strongly reduced subset of radiometric measurements can be enough representative of the status of the natural system under observation. In our approach, a subset of the collected radiance maps is extracted, based on the selection of the most variable pixels. Thus, a time series of average spectral radiances is built upon the reduced set of SLSTR data, and compared with satellite radar altimetry measurements. Preliminary results show a promising relationship between the timeseries generated by the two independent instruments, in terms of both general trend and seasonal dependence. Finally, by using the approximation proposed in this paper, a very light computational process can infer an estimation of water storage, when the natural system is fully identified on the basis of ground-truth data.* [11]

Title : ICT to Support Inclusive Education. Introduction to the Special Thematic Session
Authors : Hersh M., Leporini B. and Buzzi M.

Abstract : *This short paper introduces five papers about different ways in which technology can be used to support the education of disabled children and young people. The topics covered include music education (two papers), for children with intellectual impairments in orphanages and autistic learners respectively, science education for hearing impaired students, classroom participation at a distance for autistic students and a recommender app for open learning resources. The approaches used include games, exercises, body motions, animations, a quiz and a robot based system with audio, video and vibro-tactile interfaces. Most of them were successful, but only tested with a small number of children and young people. The presentation of these papers is introduced by a brief discussion of the role of ICT in making education accessible to disabled people. It notes that there has been a tendency to develop learning technologies for specific groups of disabled people rather than for all learners and this is borne out in the papers.* [54]

Title : Accessibility evaluation of video conferencing tools to support disabled people in distance teaching, meetings and other activities
Authors : Hersh M., Leporini B. and Buzzi M.
Source : ICCHP open access compendium "Future Perspectives of AT, eAccessibility and eInclusion", pp. 133–139, online, 09-11 September 2020
Download : Compendium
Abstract : *The current COVID-19 pandemic has transferred educational, work and other activities on-line and made it essential to be able to use videoconferencing tools. This raises many issues for disabled people, including the accessibility and usability of these tools. However, studies evaluating accessibility and usability of these tools seem to be lacking and this paper contributes to filling this gap. It has three main contributions: (i) the presentation of criteria to be used in this valuation; (ii) a preliminary study of the experiences of the two disabled authors; (iii) preliminary recommendations for tool developers.* [53]

D. POSTERS AND PRESENTATIONS

Title : Synergy between optical imaging radiometry and radar altimetry for inland waters: an experience with Sentinel-3 on the Nasser Lake
Authors : Scozzari A., Vignudelli S., Elsahabi M., Galal N., Khairy M. and Negm A.
Source : Presentation at EGU General Assembly 2020, 4-8/5/2020
DOI : 10.5194/egusphere-egu2020-18804
Abstract : *It is currently well known that a combination of stressors, such as climate change, human activities and new infrastructures might influence the storage capacity of strategic surface water reservoirs at a global level. The Nasser Lake is the biggest and most important lake in Egypt, located in the southern part of the Nile River in Upper Egypt. The expected impact of the Grand Ethiopian Renaissance Dam (GERD) on the future availability of the Nile water, together with the significant and rapid water level variations and sedimentation processes, make the Nasser Lake a particularly challenging place to be monitored in the next years. This work describes a preliminary study on the possible usage of the imaging radiometer SLSTR (Sea and Land Surface Temperature Radiometer) onboard Sentinel-3 for estimating water coverage extent in inland water contexts, in synergy with radar altimetry measurements provided by the SRAL (Synthetic aperture Radar ALtimeter) instrument. In particular, this work wants to exploit the simultaneous acquisition offered by SRAL and SLSTR instruments hosted by the Sentinel-3A/B platform. We introduce an alternative technique to the classical calculation of the whole water extent based on high-resolution imagery, essentially intended for the application to wide-swath short-revisit sensors. The proposed approach starts from the hypothesis that a much-reduced subset of pixels may carry enough information for assessing the status of the observed water body by estimating the water coverage percent within each single pixel. Such an assumption can rely only on the radiometric performance of the instrument, SLSTR in this case. The time-series of water levels by the SRAL instrument were obtained by using the 20 Hz product generated by the SARvatore processor run on the ESA GPOD (Grid Processing On Demand) platform. A time-series derived from SLSTR measurements has been generated by a simple feature extraction technique, based on the selection of pixels exhibiting the highest variability of the collected radiance. As expected, this subset essentially identifies particular spots on the coastlines of the target, as a consequence of its morphological characteristics. Preliminary results show a promising relationship between the time-series generated by the two independent measurements and between the available in situ data as well. Under the hypothesis of a time-invariant system (i.e., characterised by no significant morphological changes), once an area-level-volume relationship is identified, volume estimations can be inferred by either altimetric or radiometric measurements per se. Thus, the simultaneous observation by the two instruments represents a relevant opportunity for cross-validating the acquired data. Moreover, the approximation experimented in this work gives the perspective of a very light computational process for expedite water storage estimations in large surface reservoirs, provided that the natural system is fully identified on the basis of ground-truth data.* [12]

Title : SelfLens: a portable tool to facilitate all people in getting information on food items
Authors : Galesi G., Giunipero L., Leporini B. and Verdi G.
Source : AVI'20 - International Conference on Advanced Visual Interfaces, Ischia Island, Italy, 28 September - 02 October 2020, ACM Digital Library
DOI : 10.1145/3399715.3399941
Abstract : *Independently selecting food items while shop-*

ping, or storing and cooking food items correctly can be a very difficult task for people with special needs. Product labels on food packaging contain an ever-increasing amount of information, which can also be in a variety of languages. The amount of information and also the features of the text can make it difficult or impossible to read, in particular for those with visual impairments or the elderly. Several tools or applications are available on the market or have been proposed to support this type of activity (e.g. barcode or QR code reading), but they are limited and may require the user to have specific digital skills. Moreover, repeatedly using an application to read the label contents can require numerous steps on a touch-screen, and consequently be time-consuming. In this work, a portable tool is proposed to support people in reading the contents of labels and acquiring additional information, while they are using the item at home or shopping at the supermarket. The aim of our study is to propose a simple portable assistive technology tool which 1) can be used by anyone, regardless of their digital personal skills 2) does not require a smartphone or complex device, 3) is a low-cost solution for the user. [40]

Title : A User-Centered Approach to Artificial Sensory Substitution for Blind People Assistance
Authors : F. Barontini, G.C. Bettelani, B. Leporini, G. Averta and M. Bianchi
Abstract : *Artificial sensory substitution plays a crucial role in different domains, including prosthetics, rehabilitation and assistive technologies. The sense of touch has historically represented the ideal candidate to convey information on the external environment, bothcontact-related and visual, when the natural action-perception loop is broken or not available. This is particularly true for blind people assistance, in which touch elicitation has been used to make content perceivable (e.g. Braille text or graphical reproduction), or to deliver informative cues for navigation. However, despite the significant technological advancements for what concerns both devices for touch-mediated access to alphanumeric stimuli, and technology- enabled haptic navigation supports, the majority of the proposed solutions has met with scarce acceptance in end users community. Main reason for this, in our opinion, is the poor involvement of the blind people in the design process. In this work, we report on a user-centric approach that we successfully applied for haptics-enabled systems for blind people assistance, whose engineering and validation have received significant inputs from the visually-impaired people. We also present an application of our approach to the design of a single-cell refreshable Braille device and to the development of a wearable haptic system for indoor navigation. After a summary of our previous results, we critically discuss next avenues and propose novel solutions for touch-mediated delivery of information for*

navigation, whose implementation has been totally driven by the feedback collected from real end-users. [18]

Title : Estimating Relative and Absolute Sea Level Rise and Vertical Land Movement Rates in the Adriatic Sea with in situ observations and the ESA SL_CCI altimetry dataset
Authors : De Biasio F., Vignudelli S., Scozzari A., Papa A., Zecchetto S. and Baldin G.
Abstract : *Considerable efforts are made by space agencies and scientists to develop consistent and long-term satellitebased datasets: the European Space Agency (ESA) Climate Change Initiative (CCI) initiative Sea Level Project (SLCCI) is being producing climate-oriented altimeter sea level products optimized for the coastal zone, a monthly-mean gridded product covering the global ocean at 0.25x0.25 degrees (1993-2015). Based on this heritage, the operational production of climateoriented altimeter sea level products has been taken over by the European Copernicus Climate Change Service (C3S) with a daily-mean product gridded at 0.125x0.125 degrees covering the global ocean 1993-present. In parallel, refined products are expected in the second phase of the SLCCI project. We made a comparison of the SLCCI satellite altimetry dataset with sea level time series at selected tide gauges in the Mediterranean Sea, focusing on Venice and Trieste. There the coast is densely covered by civil settlements and industrial areas with a strongly rooted seaside tourism, and tides and storm-related surges reach higher levels than in most of the Mediterranean Sea, causing damages and casualties as in the recent storm of November 12th, 2019: the second higher water registered in Venice since 1872. Moreover, in the Venice area the ground displacements exhibit clear negative trends which deepen the effects of the absolute sea level rise. Several authors have pointed out the synergy between satellite altimetry and tide gauges to corroborate evidences of ground displacements. Here we exploit the long satellite-altimetry dataset duration and the high quality of sea-level time series at selected tide gauges of the Mediterranean Sea, to estimate the ground displacement rates. While in Venice, in the period 1993-2015, a relative sea level rise trend of about +6.17±1.51 mm y-1 has been determined from tide gauge at Acqua Alta Platform, 14 km offshore, in Trieste the tide gauge registered a trend of +4.10±1.38 mm y-1. Similarly, the altimetry product reports at the closest grid points absolute sea level rise rates of +4.02±1.27 mm y-1 (Venice) and +1.15±1.35 mm y-1 (Trieste). The estimated vertical land displacement rates, following the direct approach [Cazenave et al. 2009], resulted -1.79±0.72 mm y-1 (Venice), and -2.95±0.75 mm y-1 (Trieste). The estimated fitting slopes [Vignudelli et al., 2019] are the object of our investigation using the generalized least mean square procedure with constraints [Menke, 1989]. A partial validation of the resulting estimates has been made against Global Positioning System-derived (GPS) time series*

at selected stations. This work will contribute to identify problems and challenges to extend the sea level climate record to the coastal zone with quality comparable to open ocean, and also to assess the suitability of altimeter-derived absolute sea levels as a tool to estimate subsidence where permanent GPS receivers are not available. The Northern Adriatic is a laboratory to assess this tool, in particular considering the prospect of coming refined global products that are being generated within the ESA SLCCI extension (CCI+) project. [33]

Title : Inland radar altimetry for intermediate scale water bodies with nadir specular echoes and a constellation of small satellites
Authors : Abileah R., Vignudelli S. and Scozzari A.
Source : ESA Coastal Altimetry Workshop, pp. 24–25, ESA-ESRIN, Frascati, 4/2/2020-7/2/2020
Abstract : *We previously reported (COASTALT Workshop 8, Lake Konstanz, 2017; 25-years..., Ponta Delgada, 2018) on the prevalence of quasi-specular echoes from intermediate scale (50m to 250 m) inland water bodies. Specularity is a boon and bane for Inland radar altimetry. The boon is that specular echoes allow very precise range measurements with coherent 'zero-Doppler' summing of a few individual echoes (IEs). (Accuracy of <1 cm was shown with Envisat IEs.) Also, land interference is virtually eliminated. The bane is that such water echoes can only be detected when the satellite nadir is directly over the water surface. The echoes SNR fall perceptibly squinting off nadir. The implication is that with current large spacecraft altimeters only a very small fraction of water bodies are encountered. Also, water level slope (discharge) cannot be measured. Radar altimetry cannot fulfill the hydrologists' data requirements. Inland altimetry requires a paradigm shift away from large spacecraft. A wide range of Earth observations and other LEO uses are already migrating to swarms of small satellites (ESA APIES, NASA RainCube , and SpaceX Starlink). The same idea is appropriate for inland altimetry where specular echoes reduce the required radar power 20-40 dB and so much smaller satellites can be used. A constellation of 1000 can provide 100% geographical coverage, water levels and discharge, at 10-day repeat cycles. We used several Sentinel 3A/B data sets to evaluate water level measurements with specular echoes and extrapolate to smaller satellites. First set is of the Arno River which is 100 m wide, just wide enough to have one full S3 burst over water. Water levels over three years (45 revisits) are compared with river gauges maintained by Centre for Meteorological and Hydrological Monitoring, Tuscany Region, Italy. A second data set is multiple passes over Salar de Uyuni compared with surface topography measured by Borsa et al 2008. And a third data set of passes over 800 m wide Silsersee Lake (Switzerland) were there is no ground truth but multiple bursts provide inter-data accuracy and further insight on application to larger water bodies. We degrade SNR on these data sets to*

extrapolate performance with small sat radars. Details on the algorithms used in this analysis will be provided and illustrated in a companion poster presentation. [75]

Title : The algorithm for processing specular echoes
Authors : Abileah R., Vignudelli S. and Scozzari A.
Source : ESA Coastal Altimetry Workshop, pp. 26–26, ESA-ESRIN, Frascati, 4/2/2020-7/2/2020
Abstract : *The poster will be a companion to the Inland radar altimetry for intermediate scale water bodies paper to provide extra time and setting to explain the processing (re-trackingg') specular echoes. The processing flow will be described and illustrated step-by-step in the poster and with live in-the-cloud processing. [For live demo we'll need WiFi and a small stand for a laptop.] The processing is little changed since the 2017 paper. Steps in processing IEs into range measurements are (1A) a water map from EO images (such as Google Earth) , (1B) identify a string of consecutive echoes over water. (2) Verifying that there is actually water with Doppler (expected to be zero), echo power (exceeding a threshold), and coherence (1). (3) Verifying surface roughness below threshold. (4) Coherently sum IEs into a waveform profile. (5) A parametric fit to two or three range gates to derive sub-gate range accuracy. For the intermediate water bodies (50-250 m) processing is based on one or two S3 bursts. There are special considerations for very narrow (<50 m), and wide (>250 m) rivers or lakes. For <50 there is a fair chance the water body will fall in the gaps between S3 bursts so there are no nadir water IEs. The algorithm can be nudged a bit to handle those cases. For >250 there will be several bursts to combine optimally and some probability that the water surface will have variable roughness scales.* [74]

E. TECHNICAL REPORTS

Title : Deep learning for time series
Author : Martinelli M.
Source : ISTI-CNR Technical Report
Abstract : *The main purpose of this technical report is only to introduce to the use of the "pandas" open source, BSD-licensed library1. and of the TensorFlow framework2 for forecasting time series. The use case chosen is of great relevance, the application is a mere experiment that a posteriori can find a confirmation: data is used for SARS Cov-2 spread forecasting too, it is fair to reiterate that these are only a kind of study notes. This is not an epidemiological study, moreover forecasts are strongly based on the number of suspected cases, that is most probably higher than reported, of course on the behaviour of citizens, and on other unpredictable factors. Moreover a recent study3 supposes that most infective people are asymptomatic.* [56]

Title : Uso di tecniche di sparse independent component analysis per l'estrazione di regioni di interesse in opere pittoriche e grafiche

Author : Salerno E.

Source : ISTI-CNR Technical Report

Abstract : *In questa nota si mostra come, in certe applicazioni legate alle tecnologie dell'informazione per lo studio del patrimonio culturale, possano essere applicati metodi di separazione cieca delle componenti basati sulla sparsità e non sull'indipendenza statistica. Nelle applicazioni in cui sia necessario estrarre da immagini di opere pittoriche o manoscritti delle regioni di interesse isolate spazialmente, le condizioni di sparsità sono teoricamente verificate già nello spazio delle immagini, e non occorre passare a uno spazio trasformato per poterle imporre alla soluzione del problema. Da due algoritmi recentemente proposti in letteratura, sono stati derivati e sperimentati i corrispondenti operanti direttamente nello spazio delle immagini. Uno di essi impone solo il requisito di sparsità, mentre l'altro aggiunge anche un vincolo di incorrelazione. Gli esperimenti sono condotti su due immagini reali, una relativa a un dipinto acquisito nel visibile e nell'infrarosso e una a un manoscritto acquisito su entrambe le facce nelle tre bande rossa, verde e blu dello spettro visibile.* [31]

Title : Integration of analysis of the hierarchical process and dempster-shafer theory for cooperative evaluation tasks

Author : Salerno E.

Source : ISTI-CNR Technical Report

Abstract : *This note gives some details on the application of Saaty's Analysis of Hierarchy Process and the Dempster-Shafer theory for an evaluation problem that embeds a multicriterion decision and an expert judgement on a number of value indicators. These two tasks are assumed to be entitled to two groups of experts. The judgement matrices issued by the first group are geometrically averaged and the related criteria are prioritized by the analysis of hierarchy process. Then, the judgements from the second group of experts are translated into a fuzzy language and fused through the Dempster-Shafer theory. Finally, the masses resulting from this process are propagated up the hierarchy using the previously computed priorities.* [29]

Title : Creare un documento accessibile

Authors : Leporini B. and Galesi G.

Source : ISTI Technical reports, 2020

Abstract : *Istruzioni che indicano i comandi da tastiera da eseguire in Microsoft Word e LibreOffice Writer per favorire l'acquisizione di competenze base per la redazione di documenti accessibili a tutti, comprese le persone che utilizzano tecnologie assistive. Istruzioni realizzate nell'ambito dell'accordo di collaborazione stipulato tra CRA ed ISTI-CNR in tema di accessibilità.* [15]

Title : How to effectively implement a multimedia telegram bot

Authors : Galesi G. and Martinelli M.

Source : ISTI Technical reports, 2020

Abstract : *The purpose of this document is to describe the creation of a multimedia BOT for Telegram. A bot is a third-party software application that run inside Telegram and performs automated jobs, responding to requests from human users. Users can interact with bots by sending them messages and commands. It is possible to control a bot using HTTPS requests by means of the Telegram Bot API 2 . For the server part a script written in PHP will be described.* [41]

Title : Flusso Modulo IA. - Barilla AgroSat+

Authors : Bruno A., Moroni D. and Martinelli M.

Source : Project Report, Barilla AgroSat+, 2020

Abstract : [4]

Title : AgroSat+ Workflow riconoscimento-AI

Authors : Martinelli M. and Moroni D.

Source : Project Report, Barilla AgroSat+, 2020

Abstract : *Report per la realizzazione di un engine di riconoscimento automatico delle immagini.* [63]

Title : Barilla AgroSat+ Primo prototipo

Authors : Martinelli M. and Moroni D.

Source : Project Report, Barilla AgroSat+, 2020

Abstract : *Primo prototipo per progetto Barilla Agrosat+.* [60]

Title : Barilla AgroSat+ Secondo prototipo

Authors : Martinelli M. and Moroni D.

Source : Project Report, Barilla AgroSat+, 2020

Abstract : *Secondo prototipo per progetto Barilla Agrosat+* [61]

Title : Barilla AgroSat+: Protocollo di Comunicazione

Authors : Bruno A., Moroni D., Martinelli M., Rocchi L., Dainelli R. and Toscano P

Source : Project Report, Barilla AgroSat+, 2020

Abstract : *Protocollo di Comunicazione Progetto Barilla Agrosat+* [6]

Title : Barilla AgroSat+: Interazione App-Server e Modelli

Authors : Bruno A., Moroni D., Martinelli M., Rocchi L., Dainelli R. and Toscano P

Source : Project Report, Barilla AgroSat+, 2020

Abstract : *Interazione App-Server e Modelli per il Progetto Barilla AgroSat+* [5]

Title : Barilla AgroSat+ Terzo aggiornamento
Authors : Martinelli M. and Moroni D.
Source : Project Report, Barilla AgroSat+, 2020
Abstract : *Terzo e quarto prototipo per progetto Barilla Agrosat+* [62]

Title : Barilla AgroSat+ Quarto aggiornamento
Authors : Benassi A., Bruno A., Galesi G., Moroni D., Pardini F., Ovidio Salvetti O. and Martinelli M.
Source : Project Report, Barilla AgroSat+, 2020
Abstract : *Prototipi vari per progetto Barilla Agrosat+* [2]

Title : Forecasting industrial components life cycle: Futura Prototype 1
Authors : Martinelli M., Moroni D., Pardini F., Benassi A. and Salvetti O.
Source : ISTI-CNR Technical reports
Abstract : *The purpose of this research report is to describe the first working prototype able to forecast the life cycle of an industrial component by Futura S.p.A.* [66]

Title : Analisi di immagini tomografiche ad alta risoluzione attraverso reti neurali convoluzionali per lo studio delle interstiziopatie polmonari
Authors : Buongiorno R., Colantonio S. and Germanese D.
Source : ISTI Technical reports, 2020
DOI : 10.32079/ISTI-TR-2020/007
Abstract : *Le interstiziopatie polmonari (Interstitial Lung Disease, ILD) sono patologie croniche che causano la cicatrizzazione del parenchima polmonare e dell'interstizio alveolare e la compromissione della funzionalità respiratoria. Dal momento che sono più di 200 le patologie raggruppate nella categoria delle ILD, una precisa identificazione è fondamentale per individuare la terapia migliore e formulare una prognosi. L'esame radiologico di riferimento è la tomografia computerizzata del torace ad alta risoluzione (High Resolution Computed Tomography, HRCT) e rappresenta un passaggio cruciale nel processo di diagnosi; nell'analizzare le immagini, infatti, il radiologo deve stabilire se vi è Usual Interstitial Pneumoniae (UIP), ovvero presenza di pattern istopatologici tipici della malattia, e valutarne l'estensione, correlata con la gravità delle alterazioni fisiologiche. Tuttavia, l'incidenza rara delle interstiziopatie fa sì che non tutti i radiologi abbiano un grado di esperienza adatto a individuare visivamente l'anomalia. Inoltre, la malattia si diffonde lungo tutti i polmoni e la segmentazione manuale risulta faticosa. Nel tentativo di rimediare alla variabilità intra- ed inter-osservatore, sono state sviluppate tecniche per il riconoscimento automatico dei pattern UIP; vi sono approcci basati sull'analisi dell'istogramma e della texture dell'immagine ma, dal momento che i classificatori sono stati addestrati su label definite da operatori clinici diversi, presentano comunque un bias che è causa di identificazioni errate, o mancate, dei pattern. Il deep learning, invece, si distingue dalle tecniche tradizionali perché fornisce strumenti che imparano autonomamente a classificare i dati. L'obiettivo del lavoro è stato, quindi, progettare e sviluppare la UIP-net, una rete neurale convoluzionale ad-hoc per la segmentazione automatica dei pattern UIP in immagini HRCT di pazienti con Fibrosi Idiopatica Polmonare (IPF), che è una sotto-categoria delle ILD.* [77]

Title : Sensitivity analysis to plan meliorative actions on a cultural heritage asset evaluated through a multicriteria decision making method
Author : Salerno E.
Source : ISTI Technical reports
Abstract : *This paper proposes a strategy to increase the value of any asset relevant to cultural heritage, measured through a multicriteria decision making method. The value of any object can be defined on the basis of its fitness to fulfil specified objectives, its significance to the people who own or use it, its potential to produce revenues, and a host of additional criteria depending on its nature. The multiple criteria on which the analysis is based are often of subjective nature, relying on judgements issued by several experts, stakeholders and decision makers. It is thus important to assess the sensitivity of the result to possible perturbations of the data. Here we propose to exploit the sensitivity analysis to identify a set of suitable lines of intervention to improve the value of the asset.* [30]

Title : Optical/SAR data and system Integration for Rush Identification of Ship models OSIRIS 2 - ESA Project The Ground Truth Data Base
Authors : Martinelli M., Reggiannini M., Righi M., Salerno E. and Tampucci M.
Source : Project Report, OSIRIS 2, 2020
Abstract : *Presentazione Kick-Off Meeting* [70]

Title : OSIRIS-FO
Authors : Martinelli M., Moroni D., Reggiannini M., Righi M., Salerno E. and Tampucci M.
Source : Project report, ESA OSIRIS-FO, 2020
Abstract : *OSIRIS-FO Ship Classification and Ship Kinematics Estimation* [67]

Title : Primo test di valutazione delle informazioni - Progetto CloudPathology-DiOncoGen
Authors : Martinelli M. and Moroni D.
Source : Project Report, CloudPathology-DiOncoGen, 2020

Abstract : *Il presente documento fornisce i risultati del primo test di valutazione delle informazioni ricevute nell'ambito del progetto CloudPathology-DiOncoGen.* [64]

Title : Secondo test di valutazione delle informazioni - Progetto CloudPathology-DiOncoGen
Authors : Martinelli M. and Moroni D.
Source : Project Report, CloudPathology-DiOncoGen, 2020
Abstract : *Il presente documento fornisce i risultati del test di valutazione del secondo set di informazioni ricevuto nell'ambito del progetto CloudPathology-DiOncoGen.* [65]

Title : Nautilos - D1.1: Report on Management Procedures
Authors : Pieri G. and Dimitrova N.
Source : Project Report, Nautilos, D.1.1, 2020
Abstract : *The report on management procedures will describe the project's management and organisational structure, the management tools to be utilised, including the project management toolkit and the restricted partner space (ownCloud), the project's planning and scheduling as well as a set of internal project policies (deliverables assurance procedure and the internal consortium communication).* [43]

Title : Un sistema per la riabilitazione neuromotoria basato su di un ausilio robotico passivo
Authors : Magrini M., Righi M., Moroni D. and Dolciotti C.
Source : ISTI Technical Reports 2020/010, 2020
DOI : 10.5281/zenodo.4327651
Abstract : *Il laboratorio Segnali ed Immagini dell'Istituto ISTI del CNR di Pisa, in collaborazione con Wearable Robotics ha sviluppato un sistema HW/SW orientato alla riabilitazione di soggetti con problemi neuro-motori, in particolare derivanti da situazioni post-ictus. Gli esercizi riabilitativi consentiti dal sistema, compiuti sotto la guida di un operatore, si basano sulla manipolazione di un dispositivo HW (Track-Hold di Wearable Robotics) che permette l'esecuzione di movimenti scaricando il peso dell'arto superiore, in modo da rendere l'esercizio puramente neurologico e non faticoso per l'apparato muscolare. Il controllo dell'esecuzione degli esercizi viene fornito da un apposito software realizzato da ISTI, in grado di analizzare i movimenti compiuti e di fornire una valutazione delle capacità neuromotorie del soggetto.* [55]

F. MISCELLANEOUS

PRESENTATION : Augmented reality and intelligent systems in Industry 4.0
Authors : Benassi A., Carboni A., Colantonio S., Coscetti S., Germanese D., Jalil B., Leone R., Magnavacca J., Magrini M., Martinelli M., Matarese F., Moroni D., Paradisi P., Pardini F., Pascali M., Pieri G., Reggiannini M., Righi M., Salvetti O.and Tampucci M.

Source : Presentation at ARTES, 12/11/2020
DOI : 10.5281/zenodo.4277713
Abstract : *This presentation was delivered in the framework of Artes 4.0 seminars. It deals with the application of computer vision, intelligent systems and AR/VR/MR/XR technologies to Industry 4.0.* [3]

PRESENTATION : IA - Intelligenza Artificiale
Author : Martinelli M.
Source : Presentation
DOI : 10.5281/zenodo.4404694
Abstract : *Una introduzione all'Intelligenza Artificiale (IA). La nascita e gli approcci dell'IA. le applicazioni rese possibili dal Deep Learning; etica e rischi dell'utilizzo non controllato delle nuove tecnologie; applicazioni in ambito sanitario, industriale e nell'agricoltura di precisione co-realizzate al CNR.* [57]

MONOGRAPHY : Radiazioni Ionizzanti e Popolazione Generale. Cosa sanno gli Italiani delle procedure radiologiche in Medicina
Authors : Bastiani L., Paolicchi F., Martinelli M. and Gerasia R.
Publisher : CNR, Roma, Italy, 2020
Abstract : *Il volume presenta i risultati del progetto RadIoPoGe "Radiazioni Ionizzanti, Popolazione Generale", promosso dall'Istituto di Fisiologia Clinica (IFC) e dall'Istituto di Scienza e Tecnologie dell'Informazione "A. Faedo" (ISTI) del CNR di Pisa e coordinato dall'Azienda Ospedaliero Universitaria Pisana (AOUP). RadIoPoGe si è mosso in due direzioni: descrivere il grado di conoscenza da parte della popolazione rispetto alle radiazioni ionizzanti impiegate nella diagnostica medica e dare agli operatori sanitari gli strumenti per demistificare idee preconcette fornendo un'informazione mirata ai pazienti. Il progetto ha coinvolto per alcuni anni molti centri Italiani e migliaia di nostri concittadini hanno regalato un po' del loro tempo per consentire la raccolta dei dati che sono presentati in questo volume. I risultati ottenuti costituiscono un prezioso riferimento per Medici, TSRM e Fisici Sanitari che possono trovarvi spunti utili per comunicare efficacemente ai pazienti il proprio impegno volto a minimizzare i rischi delle radiazioni ionizzanti e a massimizzare i livelli di qua- lità dei servizi di diagnostica per immagini.* [19]

MONOGRAPHY : Radiazioni Ionizzanti e Popolazione Generale - RadIoPoGe
Authors : Caramella D., Paolicchi F., Dore A., Feriani G., Aringhieri G., Pozzessere C., Di Coscio L., Marcheschi A., Grattadauria S., Bastiani L., Trivellini G., Serasini L., Banti D., Martinelli M., Benassi A., Galesi G., Pardini F., Salvetti O., Chiappino D., Micaela P., Rinaldi R., Della Latta D., Martini C., Curlo I., Rossi G., Cornacchione P., Giardina

M., Carnevali F., Iacovone S., Pertoldi D., Favat M., Contato E., Pelati C., Baccarin F., Negro D., Pizzi M., Gelmi C., Carlevaris P., Rossato C., Ribaudo K., Ceccarelli M., Saba L., Muntoni E., Caoci D., Busonera C., Spano A., Tronci A., Mura M., Giannoni D., Tamburrino P., Leggieri V., Rizzo V., Farese R., Pastore S., Rossetti F., Nuzzi G., Calligari D., Cioce P., Di Fuccia G., Liparulo M., Petriccione G., Romano S., Stringile M., Travaglione G., Negri J., Marinelli E., Angelini G., Gerasia R. and Lo Sardo C.

Publisher : CNR, Roma, Italy, 2020
Abstract : *Report Finale progetto RadIoPoGe.* [23]

TEACHING : Segnali e Immagini
Author : Martinelli M. and Benassi A.
Abstract : *Materiale didattico per il corso "Altre attività utili per l'inserimento nel mondo del lavoro", rif. Prof. Ing. Andrea Ginghiali, Ingegneria Biomedica* [59]

TEACHING : Cosa sa la popolazione generale delle radiazioni ionizzanti?
Authors : Paolicchi F., Martinelli M. and Bastiani L.
Abstract : *Materiale del Corso "Il monitoraggio informatico della dose" Pisa 30/1/2020 - Aula Della Radiodiagnostica 1, Ospedale Di Cisanello, Pisa.* [34]

G. MASTER THESES

Title : Analisi di immagini tomografiche ad alta risoluzione attraverso reti neurali convoluzionali per lo studio delle interstiziopatie polmonari
Author : R. Buongiorno
Tutors : S.Colantonio and D.Germanese
Abstract : *The term Interstitial Lung Disease (ILD) refers to a large group of lung disorders, most of which cause scars of the interstitium, usually referred to as pulmonary fibrosis. Fibrosis reduces the ability of the air sacs to capture and carry oxygen into the bloodstream, leading to a progressive loss of the ability to breathe. Although ILDs are rare if taken individually, together they represent the most frequent cause of non-obstructive chronic lung disease. Nowadays, there are more than 200 different types of ILDs with varying causes, prognosis and therapies. Thus, identifying the correct type of ILD is necessary to make an accurate diagnosis. The Idiopathic Pulmonary Fibrosis (IPF) is a chronic, progressive fibrosing interstitial pneumonia, which is classified among the ILDs with the poorest prognosis. The high variability and unpredictability of IPF course have traditionally made its clinical management hard. The recent introduction of antifibrotic drugs has opened novel therapeutic options for mild to moderate IPF. In this respect, treatment decisions highly rely on the assessment and quantification of IPF impact on the interstitium and its progression over time. High-Resolution Computed Tomography (HRCT) has demonstrated to have a key role in this frame, as it represents a non-invasive diagnostic modality to evaluate and quantify the extent of lung interstitium affected by IPF. In fact, IPF shows a typical radiological pattern, called Usual Interstitial Pneumonia (UIP) pattern, whose presence is usually assessed by radiologists to diagnose IPF. The HRCT features that characterize the UIP pattern are the presence and positioning of specific lung parenchymal anomalies, known as honeycombing , ground-glass opacification and fine reticulation. These anomalies appear in the HRCT scans with specific textural characteristics that are detected via a visual inspection of the imaging data. Assessing the diffusion of these anomalies is instrumental to understand the impact of IPF and to monitor its evolution over time. Quantitative and reliable approaches are in high demand in this respect, as the visual examination by radiologists suffers, by its nature, of poor reproducibility. To overcome this issue, much research is being conducted to develop new techniques for automatic detection of lung diseases that may support radiologists during the diagnostic pathway, particularly in HRCT image analysis. Indeed, HRCT images evaluation by a Machine Learning (ML)- based algorithm might provide low-cost, reliable, real time automatic identification of UIP pattern with human-level accuracy in order to objectively quantify the percentage of lung volume affected by the disease in a reproducible way. The purpose of this study was to develop a tool for UIP pattern recognition in HRCT images of patients with IPF using a deep-learning method based on a Convolutional Neural Network (CNN), called UIP-net. UIP-net takes as input a lung HRCT image with 492x492 pixels and outputs the corresponding binary map for the discrimination of disease and normal tissue. To train and evaluate the CNN, a dataset of 5000 images, derived by 20 CT scans from the same scanner, was used. The network performance yielded 83.7% BF-score and 84.6% sensitivity but in order to refine the binary masks produced by UIP-net, a post-processing operation was carried out. With post-processing, vessels, air-ways and tissue wrongly classified as belonging to the lungs were removed from the outputted masks. After post-processing, the results increased to 96.7% BF-score and 85.9% sensitivity. Thus, the network performance, in terms of BF-score and sensitivity, demonstrated that CNNs have the potential to reliably detect disease in order to evaluate its progression and become a supportive tool for radiologists. Future works include adding more data to the training set in order to add multiple layers to the network to distinguish and quantify the different HRCT features of UIP pattern, improving the reproducibility and reliability of the CNN and using it for the detection of HRCT manifestations of Covid-19.* [76]

VI. SOFTWARE & INFRASTRUCTURES

THIS section reports the software packages and infrastructures that have seen significant progress during the year. They are very different in purposes and nature, being TELEECO a web consultation system, Chromstuct a scientific software for computational biology, and TAUMUS a software heritage initiative to keep track of pioneering work in computer music carried out in Pisa in the 70ies.

A. TELEECO

Teleconsulto ecografico polmonare per la medicina di emergenza

Author : Martinelli M., Salerno D., Guerrini E., Bulletti F., Barbieri G., Pratali L., Ghiadoni L., Rugna M., Magazzini S., Ponchietti S. and Spinelli S.

Online: https://teleeco.isti.cnr.it:8181/Teleeco/

Contact: Massimo Martinelli (massimo.martinelli@istc.cnr.it)

Description : TELEECO is a Web teleconsultation system for the Emergency Health Service of the central Tuscan Health Authority to provide a second evaluation of signs, symptoms and ultrasound images. Starting from the results of a former EC project e-Rés@mont, these activities were conducted in collaboration with the CNR Institute of Clinical Physiology. Artificial Intelligence-based methods provide classifications of pathologies, and clinical decision support theory provides suggestions based on clinical protocols and physicians' knowledge [68].

B. CHROMSTRUCT

Reconstruction of 3D chromatin structure from chromosome conformation capture data

Source : Software, 2018, ISTI-CNR, Pisa, 2018-388694
DOI : 10.13140/RG.2.2.26123.39208

Contact: Claudia Caudai (claudia.cauda@isti.cnr.it)

Description: This Python code provides an estimate of the 3D structure of the chromatin fibre in cell nuclei from the contact frequency data produced by a 'Chromosome conformation capture' experiment. The only input required is a text file containing a general real matrix of contact frequencies. The code features a GUI where all the tune-able parameters are made available to the user. The fibre is divided in independent segments whose structures are first estimated separately and then modelled as single elements of a lower-resolution fibre, which is treated iteratively in the same way until it cannot be divided anymore into independent segments. The full-resolution chain is then reconstructed by another iterative procedure. See the Readme file and the cited references for more detail.

C. TAUMUS

Software controlling the real-time computer-music system TAU2-TAUMUS

Description: TAUmus is the software controlling the real-time computer-music system TAU2-TAUMUS, developed in the 70's of the XX century at IEI and CNUCE in Pisa under the leadership of Maestro P. Grossi [82]. Thanks to the SWHAP@Pisa project under the framework of the UNESCO initiative Software Heritage, the software has been carefully collected and organized together with original raw materials. The repository has a branch containing a small excerpt of the development history of the source code: some samples of session scripts that use the TAUmus commands to generate computer music on the audio-terminal TAU2 and a few IBM 360 FORTRAN files from the TAUmus command interpreter itself.

Repository: https://github.com/Unipisa/TAUmus-Workbench
Contact: Massimo Magrini (massimo.magrini@isti.cnr.it)

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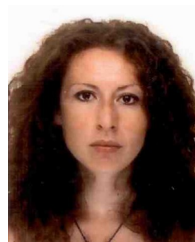
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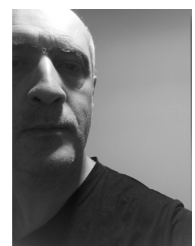
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