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SI-Lab Annual Research Report 2021
SI Lab.
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The Signal & Images Laboratory is an interdisciplinary research group in computer vision, signal analysis, intelligent vision systems and multimedia data understanding. It is part of the Institute of Information Science and Technologies (ISTI) of the National Research Council of Italy (CNR). This report accounts for the research activities of the Signal and Images Laboratory of the Institute of Information Science and Technologies during the year 2021.

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

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SI-Lab Annual Research Report 2021

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ISTI-CNR

ABSTRACT The Signal & Images Laboratory (SI-Lab) is an interdisciplinary research group in computer vision, signal analysis, intelligent vision systems and multimedia data understanding. It is part of the Institute of Information Science and Technologies (ISTI) of the National Research Council of Italy (CNR). This report accounts for the research activities of the Signal and Images Laboratory of the Institute of Information Science and Technologies during the year 2021.

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 understanding. It is part of the Institute of Information Science and Technologies (ISTI) 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. The application fields of the lab range from cultural heritage to tourism, from mobility to entertainment, from security to environment, from healthcare and wellness to sustainable agriculture.

This report aims to give a global and comprehensive view of the activities that were carried on during 2021. After the spreading of the pandemic in the previous year, in 2021 the lab has faced the changes brought by the outbreak, reorganizing the way research and team work are carried out. 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.In Section III we summarize consolidated research topics on our main research fields while in Section IV, we describe the projects in which we were involved during the year 2021. Section V is a complete list of the publications, including thesis defended during 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 2020 and going through the whole of 2021.

During 2021, ample space was given to the following topics:

- Computer vision
- Artificial intelligence & intelligent systems
- Statistical signal processing
- Topological data analysis
- Human-computer interaction
- Inclusion and accessibility

The research had an impact on the following areas:

- Biological signal and image processing: Radiomics, Connectomics, Digital microscopy, Electrophysiology
- Assistive technologies: interactive systems for cognitive and motor rehabilitation, personalized and empathic assistance
- Computational Biology: networks of genic interactions, 3D chromatin structure, diffusion processes
- Edutainment: gesture and biofeedback capture, Audio/Video (AV) synthesis, Virtual and Augmented reality (VR, AR, XR)
- IT for Cultural Heritage: artwork image analysis, AR techniques, Structural health monitoring
- Smart cameras, embedded systems and pervasive intelligence in security environmental monitoring, urban intelligence and smart cities, intelligent transport systems
- Industry 4.0: Augmented reality, AI for predictive maintenance, real-time video processing, Acoustic AI
- Precision agriculture: intelligent systems for image-based detection and classification of threats
- Remote sensing and Earth observation: marine motoring, SAR image processing, Inland water bodies monitoring
- Integrated systems for smart energy management, sustainable buildings and the nautical sector

During the year results were obtained both in terms of scientific publications (as reported in Section V and at the level of international scientific collaborations. In general, thanks to the expertise gained over time and recent progress, the laboratory has been able to attract projects both in the application areas already explored (smart cities; cultural heritage; technologies for the sea; computational biology; eHealth, well being and active ageing) and in areas of more recent interest, for example, connected with the Factory of the Future, urban intelligence and precision agriculture. All the project activities are described in the dedicated paragraphs in Section IV and can also be consulted on the laboratory website http://si.isti.cnr.it/index.php/projects.

The lab is also actively participating in the establishment of the "AI@Edge" lab, an infrastructure for studying AI applications across the entire computational continuum, from sensors and low-power nodes to cloud resources. In particular, the SI-Lab will design and develop some use cases related, for instance, to ambient intelligence and physiological computing systems. In fact, it is envisaged to create a demonstrator on the theme of activity recognition in the health '& well-being field connected with the assessment of the healthiness and comfort of work and residence environments. The system, based on the data collected by wearable sensors, cameras and other ad hoc devices for indoor localization, will be able to recognize and understand the activities, the context in which they are carried out, and the dynamic social interactions. Response to various stimuli will be analyzed from a physiological computing point of view.

With regard to participation in international committees, we point out the constant participation in the ERCIM "Muscle" Working Group (https://wiki.ercim.eu/wg/MUSCLE/index.php/Main_Page). Furthermore, since 2018, the laboratory has managed the TC 16 of the IAPR dedicated to the topic "Algebraic and Discrete Mathematical Techniques in Pattern Recognition & Image Analysis" (http://iapr-tc16.isti.cnr.it/). Furthermore, the laboratory participates in Technical Committees of the IEEE Signal Processing Society in the context of "Machine Learning for Signal Processing".

A. RECENTLY ACQUIRED PROJECTS AND NEW PROPOSALS

During the period, various projects were acquired and activated, including two Tuscany Region projects under the "COVID19" Health call, one project with the Italian Space Agency (INTECS lead partner), one project with the European Space Agency (Mapsat lead partner), four projects POR CREO Tuscany Region FESR 2014-2020 RS tender 1. Other H2020 proposals are under evaluation.

B. ORGANIZATION OF WORKSHOPS AND CONFERENCES

During the period, the seventh edition of Image Mining was organized. Theory and Applications (IMTA - http://iapr-tc16.isti.cnr.it/IMTA2020/) as a satellite workshop of ICPR 2020 held online in January 2021. Furthermore, the ninth edition of the International Workshop on Computational Intelligence for Multimedia Understanding (IWCIM) at the end of September 2021, in hybrid online and on-site mode (Rhodes, Greece). Finally, a special online edition of Advanced Infrared Technologies and Applications (AITA - http://aita.isti.cnr.it/past_events/AITA2021/) was held in October 2021.

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 2021 several projects have been carried out at SI-Lab. Since signals, images and more general multimedia data are ubiquitous, the variety of project application 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 by 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.

- Medical Waste Treating 4.0 : *Sistema innovativo automatizzato per il trattamento e la nobilitazione dei rifiuti sanitari in chiave End of Waste - Innovative automated system for the treatment and ennobling of sanitary waste in an End of Waste (EoW) perspective*
- Smart Converting 4.0 : *L'intelligenza artificiale al servizio dell'automazione avanzata, dell'integrazione e dell'advanced safety delle linee di converting del tissue e del nonwoven – Artificial intelligence at the service of advanced automation, integration and safety of tissue and non-woven converting lines*
- LIFE Demo : *Low Impact Fully Enanched Design Modeling (for Modern Housing*

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 assited 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*
- Optimised : *An optimised path for the data flow and the clinical management of COVID-19 patients*
- 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*
- 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*
- TI ASSISTO : *Clinical monitoring of Covid-19 patients*
- TIGHT : *Tactile InteGration between Humans and arTificial systems*

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*
- RTOD : *Real-Time Object Detection thorough Machine Learning based on low-power GPU*
- S4E : *Safety & Security Systems for Sea Environment*

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

- SPaCe : *Smart Passenger Center*
- 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, funded by Barilla G. & R. Fratelli SpA, 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 treatments 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.
During 2021, the activity was focused on the development and validation of a number of Deep Learning models to detect and classify wheat stresses, specific diseases, damages, weeds and insects, in order to help farmers choose adaptive and optimal treatments to prevent crop losses. First field tests were performed by farmers, using a prototype of a mobile app connected to our servers cluster, to evaluate the Artificial Intelligence (AI) developed models and the full workflow of the operations.

B. 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 demographic change and the current economic context. Active and Assisted Living (AAL) are a possible solution to face them. AAL aims at improving the 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 us 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.

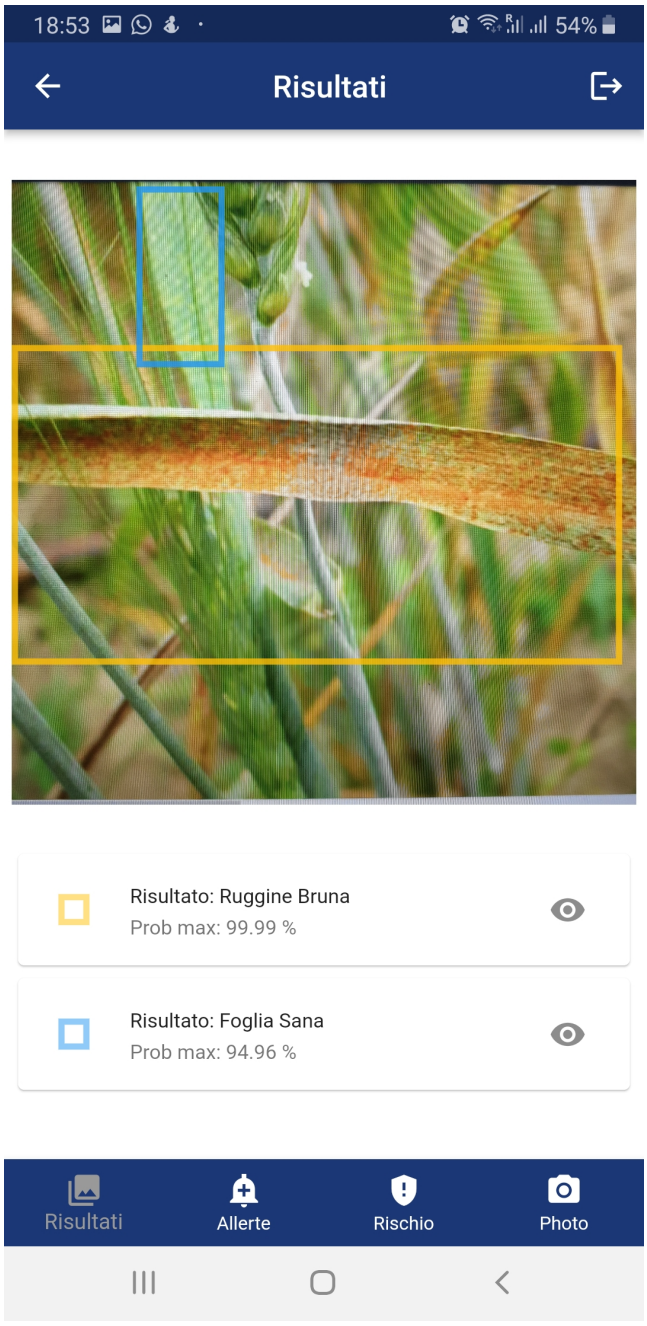

FIGURE 1. Agrosat+: an example of object detection and classification of the GranoScan App

The aim of GoodBrother is to increase awareness of the ethical, legal, and privacy issues associated with 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, policymakers, public services), stimulating new research and innovation. GoodBrother will offset the Big Brother sense of continuous monitoring by increasing user acceptance, exploiting these

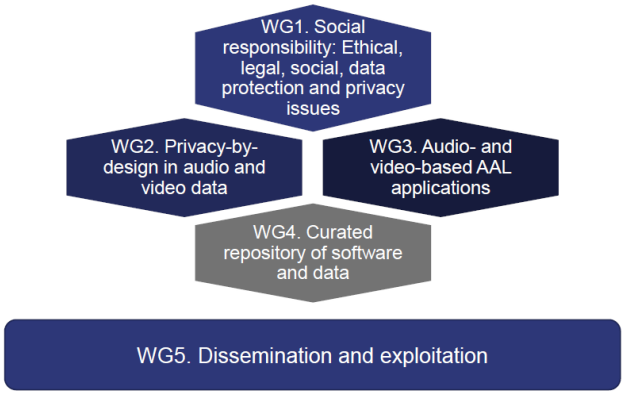

FIGURE 2. The Goodbrother's working groups

new solutions, and improving market reach. The Signals & Images Lab is contributing to privacy-preserving image and video analysis methods and as part of the Management Committee of the Action. The Cost Action TheGoodBrother 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 the 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.
During 2021 a comprehensive survey of the most recent advances in audio- and video-based monitoring technologies for AAL has been drafted as a collective effort of WG3, led by Sara Colantonio, to supply an introduction to AAL, its evolution over time and its main functional and technological underpinnings. In this respect, the report contributed to the field with the outline of a new generation of ethical-aware AAL technologies and a proposal for a novel comprehensive taxonomy of AAL systems and applications. Moreover, the report allowed non-technical readers to gather an overview of the main components of an AAL system, and the ways they function and interact with the end-users [183]. The description of the main components of AAL systems and their applications has been also included in a white paper on the "State of the art on ethical, legal, and social issues linked to audio-and video-based AAL solutions" [108].

C. LIFE DEMO

Low Impact Fully Enhanced Design Modeling (for Modern Housing)

Funded under: POR CReO Toscana 2020 - 2014-2020, ASSE 1 - AZIONE 1.1.5 SUB A1
Amount: EUR 158,288 (2,426,618)
Protocol: Prot. ISTI n. 0003531 (dated 04/10/2018)
Start date: 01 September 2020
End date: 31 December 2022
Coordinator: Siram-Veolia SpA, Florence
Other partners: Vivere il Legno Srl (Barberino-Tavarnelle,FI), Thermocasa Srl (Peccioli,PI), Elettro D Srl (Cenaia,PI)
Keywords: Assistive Technology; Home Automation; Industry 4.0

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

With the collaboration of four leading firms in the building industry, this project aims at establishing a set of best practices for the design and management of residential buildings through their entire life cycle, from the initial idea to decommissioning and disposal. This activity embodies the technological innovation devised in the 'fourth industrial revolution' paradigm and provides the development of different tools devoted to the realization of the digital twin of a building, including all the information related to its design, realization and maintenance, also allowing for the simulation of its structural and energy behaviour as a result of any stimulus from the environment or human intervention. To demonstrate the effectiveness of the procedures developed, a demo prototype will be built on the CNR campus at Pisa. This will also enable us to monitor continuously, through all the seasons, the thermal and structural performances of the building. During 2021 the supporting and enabling technologies within the paradigm 'Impresa 4.0', and the related norms, have been analyzed. On this basis, the procedure to be followed to realize the building information model (BIM) and the digital twin of our prototype has been assessed. The key roles for this process have been identified and distributed among the project partners. Starting from an initial sketch of the demo prototype, the ultimate design has been completed through a dynamical simulation of high-performance building materials and the technological facilities, the economic and environmental sustainability study, the definition of needs and performance requirements, the architectural solutions and the structural assessment. The descriptive technical report to apply for the needed building authorization has thus been produced.

D. MEDICAL WASTE TREATING 4.0

Sistema innovativo automatizzato per il trattamento e la nobilitazione dei rifiuti sanitari in chiave End of Waste - Innovative automated system for the treatment and ennobling of sanitary waste in an End of Waste (EoW) perspective

Website: http://si.isti.cnr.it/index.php/hid-project-category-list/208-project-medicalwaste
Funded under: POR CReO Toscana 2020
Amount (total): EUR 181,927 (2,898,129)

FIGURE 3. LIFE DEMO: 3D rendering of the demo prototype to be built.

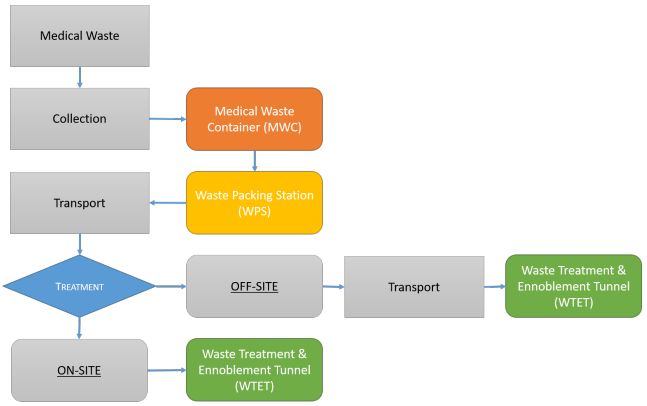

FIGURE 4. Workflow for the management of medical waste and key components to be developed by Medical Waste Treatment 4.0

Protocol: Prot. ISTI n. 1442/2021 (dated 20/04/2021)
Start date: 1 September 2020
End date: 31 December 2022
Coordinator: CISA Group
Other partners: SILMA, ACTA, LINARI
Keywords: Computer Vision; Circular Economy; Waste Sorting; Industry 4.0

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

The project aims to develop an innovative system that will allow for a radical revolution in medical waste management processes. In fact, in complete coherence with the principles of Industry 4.0 and through the convergence of advanced automation solutions, ICT and innovative materials, we intend to make it possible to treat and refine medical waste from an End of Waste perspective: what today represents waste, and therefore a cost will be transformed into new raw material, realizing the principles of the circular economy. The project is primarily concerned with an innovative, highly automated treatment and ennobling system, identified with the acronym of WTET (Waste Treatment and Ennoblement Tunnel). Through the WTET, the medical waste will be sterilized, treated and ennobled to lead to the creation of new raw materials, following cost-effective and sustainable regeneration paths. The project also provides for the development of the following additional innovative solutions for the entire logistics chain connected to the WTET: a) an innovative equipped collection and packaging station which, thanks to the use of advanced logic for control and support to operators during the primary differentiation phases will allow the intelligent delivery of waste; this station, called Waste Packing Station (WPS), will be located in the waste production areas and will be sensorized and interconnected to monitor the filling status of the appropriate waste containers, called Medical Waste Containers (MWC); b) the MWCs mentioned above, i.e. innovative configurable and modular containers for the separate collection of medical waste and their safe transport, suitably traceable using dedicated tags. They will be equipped with several compartments dedicated to various fractions of the waste and will also be made with recycled material, in complete consistency with the circular economy principles; c) an innovative system for the functionalization of recovered materials produced by WTET by depositing electrospun nanofibers. In fact, nanotechnologies will lead to the identification of prototypes to functionalize the recycled material (for example, non-woven fabric), to convert it into high-tech material for the production of valuable products such as HEPA filters and filters for surgical masks. All such solutions will make it possible to implement a revolutionary approach to the management of sanitary waste, also thanks to essential innovations in advanced materials and nanotechnologies that will be implemented: in particular, innovative materials will be used as compatibilizing additives, making it possible to regenerate and jointly enhance materials that otherwise cannot be combined.

The lab is primarily involved in the project to support the design of the overall systems by providing sensing and data processing functionalities. They will allow for increasing the automatization of the system, monitoring the process quantitatively and assessing the revenue that is possible to obtain by adopting circular economy principles. A critical aspect is represented by the primary waste sorting to be performed briefly after the waste has been produced. It is necessary to support operators during sorting without overloading their duties. Artificial intelligence and computer vision are helping in this context. Specifically, SI-Lab is designing a computer vision system to categorize waste and select the proper sorting procedure. During the year, preliminary studies on waste categories and materials have been conducted while collecting visual datasets is in progress.

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

Contact: Gabriele Pieri (gabriele.pieri@isti.cnr.it)

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 crucial 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 regard to sensors, interoperability and embedding skills. The development will always be guided by the objectives of scalability, modularity,

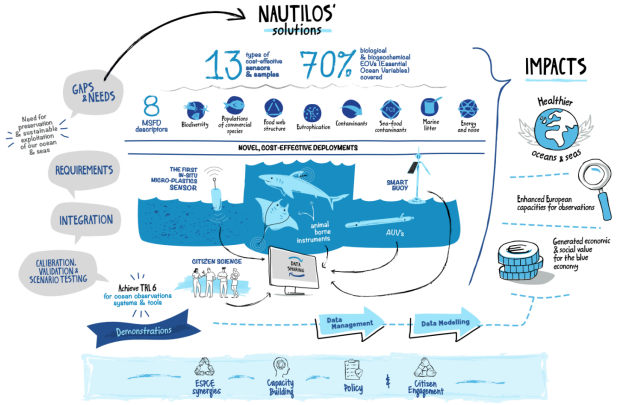

FIGURE 5. NAUTILOS Project Infographics.

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).

During 2021 the activities of Work Package 8 continue in line with the schedule for all Tasks. In Task 8.4 it proceeds toward the design and build of the data portal based on a graphical web interface supporting the project data collection and sharing; moreover, in the same Task, the design and development phase for the Citizen Science App has started. For Task 8.5, after the finalization of the state-of-the-art analysis of the image recognition and classification algorithms, activities in this task continue with the analysis and development of different algorithms developed for the various identified image analysis domains (mainly for underwater images and up-welling analysis).

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 patients' 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 a 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 robust 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 vital 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 work packages of the project and several meetings to set up the collaboration with the Tuscany Region towards the future sustainability of the BioBank.

In 2021, the partners agreed on most of the requirements and specifications of the Navigator infrastructure. After several meetings among the clinicians and sci-tech partners, the data model for the three cancer use cases was finalized. On the other side, the development platform of Navigator, hosted by the D4Science infrastructure, has been set in order to make

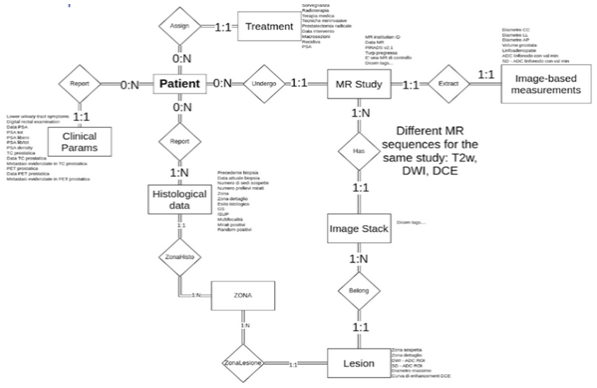

FIGURE 6. Navigator: the data model for MRI data for prostate cancer.

available algorithms and tools for the analysis of the data, which will soon be uploaded by the clinical centres.

G. OPTIMISED

An optimised path for the data flow and the clinical management of COVID-19 patients)

Funded under: Regione Toscana Bando COVID 19
Amount: EUR 35000
Project reference: Regione Toscana, decreto dirigenziale n.19049 (dated 17 November 2020
Start date: 26 February 2021
End date: 25 February 2023
Coordinator: AUOP
Other partners: University of Pisa, IFC-CNR Pisa, IFAC-CNR Florence, University of Florence, AUSL Toscana Centro Florence
Keywords: COVID-19; Deep Learning; Computed Tomography; Radiomics

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

The uniqueness and complexity of the SARS-CoV-2 disease still pose many critical challenges for the clinical care and management of COVID-19 patients. Many hospitals have struggled to find effective approaches to treat the infected citizens, as there were no tools to predict the evolution and the impact of the disease. The diagnostic test, based on the detection of the viral RNA by real-time PCR, does not provide any piece of information on the severity and the effects of the disease. In addition, the lack of "solid" evidence on the pathology has led to fragmented and inhomogeneous patient management. In some sites, as for instance at the Emergency Department of the Azienda USL Toscana Centro, the clinical and laboratory evaluation was coupled with a standard chest X-ray, whilst in other sites, as for instance, at the University Hospital of Pisa, patients also underwent a chest computed tomography and a lung ultrasound exam. These diverse diagnostic approaches have jeopardized the collection of data on the regional territories and now pose the

need for a careful analysis of the most effective procedure with respect to the clinical manifestation of the disease.

In this complex scenario, OPTIMISED will work to create a path for managing the data flow of COVID-19 patients based on a careful analysis of the retrospective imaging and clinical data. The analysis will serve to determine the potential and limits of the different imaging techniques as well as the role of innovative blood parameters. The knowledge acquired and integrated during the project will lead to a prognostic model based on risk stratification and effective recommendations for healthcare professionals about the most suitable patient management procedures.

The OPTIMISED path will be conceived to be easily exportable to other hospitals both in Tuscany and other regions, thus supporting the management of the current peaks of COVID-19, but also in anticipation of other future pandemics.

The SI-Lab team will work to design and train deep-learning models able to segment and label computed tomography images of COVID-19 patients. Chest CT imaging is considered in the project to estimate lung involvement and to extract quantitative bio-markers that may be relevant in outcome prediction. As a preliminary step in this respect, in 2021, we designed, trained, and tested a 2D FCNN model for the binary segmentation of chest CT imaging data. The model leverages an attention-based learning approach into an encoder-decoder architecture; hence, we named it Attention-FCNN. The network was preliminary trained and tested on a dataset of 25013 images, derived from 56 CT scans, retrospectively collected during the first period of COVID-19 outbreak in one of the clinical centres involved in the project. The dataset was split into two datasets, used for training (17177 sequential slices taken from 36 different patients) and testing (7836 images belonging to 20 patients) the 2D Attention-FCNN. Dice score computed on the test set reached the value of 85.1%.

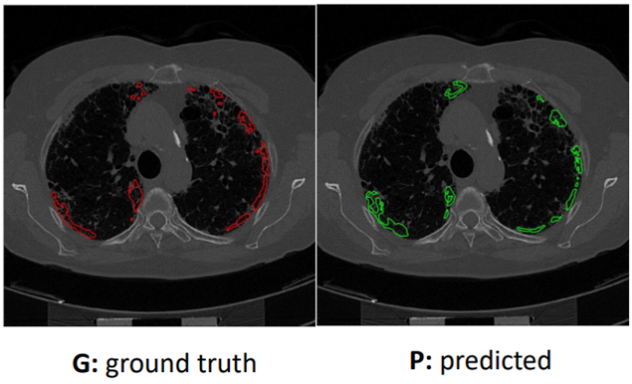

FIGURE 7. Optimised: an example of a ground truth mask (on the left) and the mask predicted by 2D Attention-FCNN

H. 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, behaviour 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 of 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 refining 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.

During 2021 the ground-truth database for ship classification has been populated with nearly 700 ground-truth ship records linked to the corresponding feature records extracted from a newly developed feature extractor. All the feature records equipped with their ground truth have been used to train several random forest models for supervised classification. Nearly 3000 different targets have been downloaded from the OpenSARShip public data set of Sentinel-1 images; the feature extracted will be soon fed into the database. A velocity estimation algorithm based on the Doppler history of the imaged target has been developed and evaluated by comparison to the existing wake-based algorithms.

I. 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 Mor-

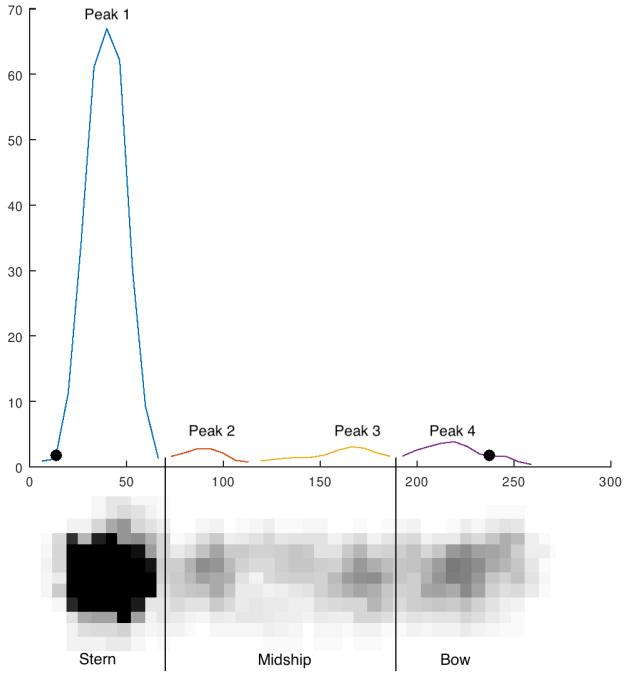

FIGURE 8. OSIRIS-FO: Scattering profile of a bulk carrier ship as estimated by the new feature extractor.

purgo, 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 prompt detect potential tumours. 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.

FIGURE 9. PINK diagnostic data types

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 overarching goal of the study is to evaluate the increased diagnostic accuracy in detecting cancers obtained with different combinations of imaging technologies, and find the most effective diagnostic pathway matching the characteristics of an individual patient. The PINK Study is reaching the final stages of its initial 5-year activity plan. So far, the 15 participating centres across Italy have recruited a total of 22,848 patients. Based on the analyses of the first 175 histopathological-proven breast cancers, mammographic sensitivity was estimated to be 61.7% (n = 108 cancers), whereas diagnostic accuracy increased by 35.5% (n = 44 cancers) when mammography was integrated with other imaging modalities (ultrasound and/or digital breast tomosynthesis). The increase was mainly determined by ultrasound alone.

J. 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

Website: https://www.platformuptake.eu
Funded by: H2020 SC1-HCC-02-2019
Project reference: Grant Agreement n. 875452
Amount (Total): EUR 81,172.5 (1,477,421.25)
Protocol: Prot. ISTI n. 0004538/2019 (dated 12/6/2019)
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 hindrance 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 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.

Submission of a research article and relative participation in "13th International Conference on Computational Collective Intelligence 29 September - 1 October 2021 Rhodes, Greece".

K. 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.

During 2021, the activities of PRAMA were focused mainly in the acquisition of several kinds of data (clinical, chemical, biochemical, imaging) that will be used to get an early diagnosis of the Alzheimer disease, and predict its prognosis. SILab is mainly involved in the subsequent step, i.e. the analysis and integration of the acquired data. In this respect, a preliminary study of the state of the art has been carried out, with a special focus on how to manage small and/or heterogeneous data-sets.

L. 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 leading 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. During 2021 the research activities of

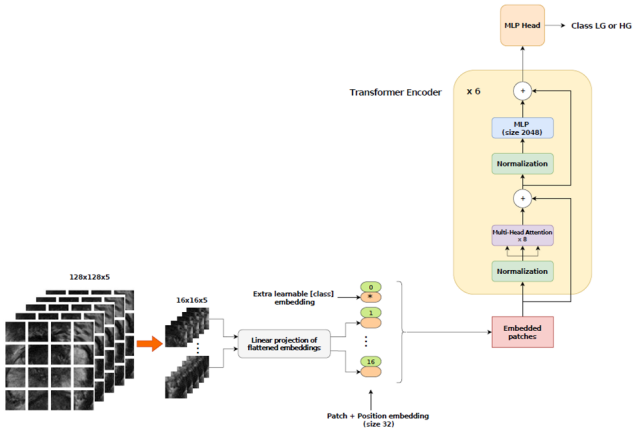

FIGURE 10. 3D vision transformers architecture used to predict prostate cancer aggressiveness.

SIlab in ProCAncer-I were focused mainly on MRI image preprocessing and on training AI-models on some already existing prostate cancer dataset (publicly available), in order to speed up the activities of AI-model developing, foreseen in the next two years. Also considerable effort has been devoted to activities related to AI model monitoring and AI trustworthiness guarantee.

M. RTOD

Real-Time Object Detection mediante Machine Learning basato su tecnologia Low-Power GPU

Funded under: Italian Space Agency
Amount:
Contract:
Start date: 9 September 2021
End date: 8 March 2023
Coordinator:
Other partners:
Keywords: Machine Learning; Embedded Systems

Contact: Gabriele Pieri (gabriele.pieri@isti.cnr.it)

The project RTOD (Real-Time Object Detection mediante Machine Learning basato su tecnologia Low-Power GPU), is funded by the Italian Space Agency, its main goal is to to develop a platform with a specific hardware and software based on Machine Learning techniques to recognise and classify objects in video streams to be used in spatial systems. This platform is proposed as a basic element for object detection and can be used in multiple contexts. The components that will be introduced in the projects span from a High-performance computational platform based on Low Power GPU, the real-time execution of recognition algorithms, an object detection system based on innovative Machine Learning techniques, and finally advanced validation techniques for these ML algorithms. The contribution of Signal and Images Lab in this period has been mainly concerning the study of existing HW and SW technologies to identify the available elements and the most appropriate methodologies for use within the project. Moreover, following the definition of the system requirements, the initial definition of the tests to validate the ML components and the entire aggregate system are being analysed.

N. 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 2022
Coordinator: iCampus
Other partners: University of Naples "Federico II", INGV, LASAP, Nexsoft
Keywords: Sea Technologies; Safety; Volunteered 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) [153], based on prior background acquired by the lab in the detection and management of oil spills [156], [157].

During the year, a mobile app for the the collection of crowdsourced information regarding undesired events at sea has been designed and realized. In details, aiming at promoting its wide usage, the application has been developed exploiting the software framework React Native [154]. Thanks to this, the application has been easily exported and built for both Android and iOS systems. It has been designed as simple as possible in order to promote its usage among volunteers, that could be discouraged by an excessive complexity. Thus, the application offers only a few essential functionalities with a basic and straightforward interface (see Figure 11). The application relies on a data server to store and retrieve the submitted reports. The data server is composed by a set of REST APIs, in charge of satisfying application requests, plus a PostGIS [165] database. PostGIS database allows providing complex queries that take into account spatial position and distances, such as retrieving reports in the nearby of the volunteer position. possible pollution events at sea. By converse, the app will provide helpful information and early warning for superior maritime safety. In the next months the app will be tested in several operational scenarios in the Leghorn area.

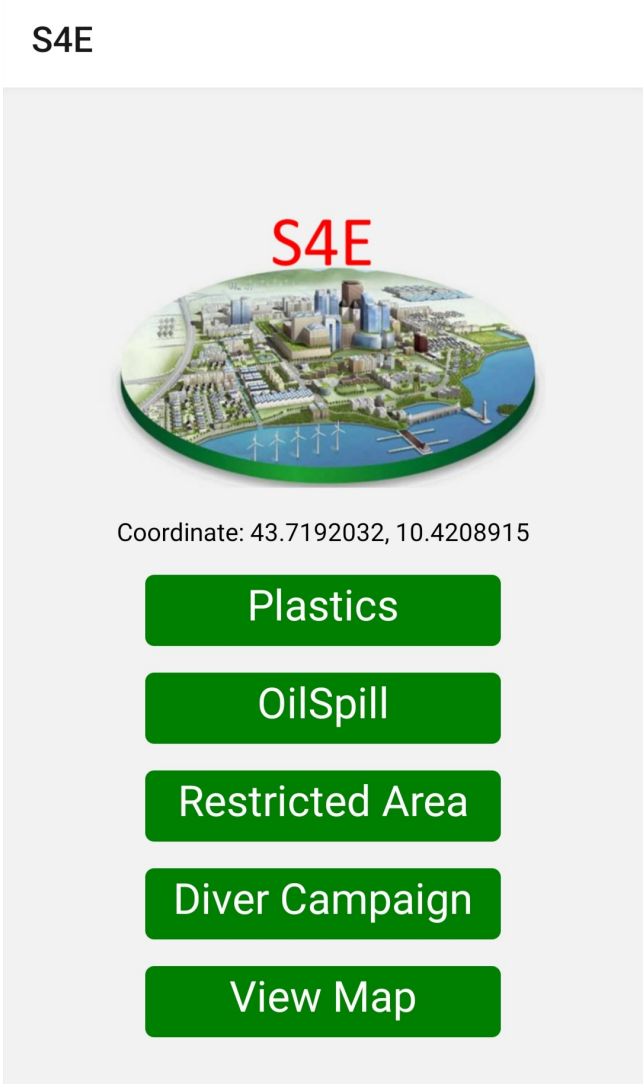

FIGURE 11. Opening screen of the app as reported in [155].

O. SMART CONVERTING 4.0

L'intelligenza artificiale al servizio dell'automazione avanzata, dell'integrazione e dell'advanced safety delle linee di converting del tissue e del nonwoven: lo smart converting 4.0 – Artificial intelligence at the service of advanced automation, integration and safety of tissue and non-woven converting lines: SMART CONVERTING 4.0

Funded under: POR CReO Toscana 2020
Amount (Total): EUR 140,675 (2,997,703)
Protocol: Prot. ISTI 0001500/2021 (dated 27/3/2021)
Start date: 1 September 2020
End date: 31 December 2022
Coordinator: Futura
Other partners: Sysdat.it, Alleantia, AME, Tecnopaper
Keywords: Artificial Intelligence; Acoustic Analysis; Predictive Maintenance; Location-based Services

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

Converting represents a very relevant segment within the paper industry. The raw materials processed include tissue paper and a wide range of non-woven (NW) fabrics. The converting business area has been characterised for several years by a high degree of technological and competitive turbulence, depending on the evolution of international markets and the technologies incorporated in the plants. Also, in relation to these dynamics in recent years, the converting lines have been progressively equipped with automation elements to optimise the processes, acting mainly at the level of a single machine. However, the potential for the use of Industry 4.0 philosophy and technologies in the converting sector is still largely unexplored and, therefore, not exploited. This research and development project aims to bridge this gap by developing disruptive technology innovations aimed at developing innovative tissue and non-woven converting lines that are more smart, automated, integrated, reliable and safe than those of state of the art. The main lever foreseen within the project to achieve this goal is the introduction of Artificial Intelligence as a ubiquitous methodology to allow the development of innovative solutions based on advanced automation and collaborative robotics and aimed at maximising self-regulation capacity, the interaction and advanced safety of the lines, as well as optimising the predictive maintenance systems of the lines themselves. Besides being breakthrough innovations (i.e. disruptive with respect to the state of the art

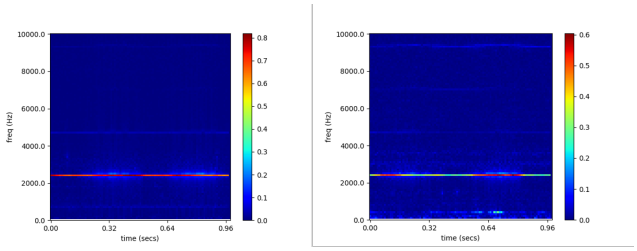

FIGURE 12. Artificial intelligence for acoustic data processing: visual comparison of spectrograms of a working engine (left: faulty conditions; right: healthy conditions)

in the sector), these solutions are also characterised by having a very broad and "transversal" application potential: in the context of this project, these solutions will be tested through the design and prototyping of three innovative systems based on robotic systems and advanced automation solutions: the core maker, for tissue converting, the calender and the splicer for non-woven converting. The new prototypes taht will be designed and developed will also be produced as a digital twin and will offer innovative functionalities, anticipating the emerging demands in the international market, allowing to obtain a holistic integration of the production and converting lines (in full correspondence with the principles of the fourth industrial revolution) and thus allowing to get an intense and sustainable competitive advantage over a long period.

The role of SI Lab in the project is related mainly to the introduction of artificial intelligence paradigms in two areas: acoustic data analysis e localisation services.

For the first aspect, it is common to say that an engine or machinery sings, meaning that the sound they emit is representative of perfect operating behaviours. Noise and vibrations are hints correlated to the maintenance status of non-visible or not otherwise appreciable parts and components of machinery, such as bearings, or the process the machinery is performing, such as cutting and grinding a product. Thanks to artificial intelligence, acoustic and vibrational analysis in the factory environment might provide relevant information about a plant during its operation. For instance, information collected by accelerometric sensors might be used to assess the Remaining Useful Life (RUL) of a bearing. At the same time, acoustic data obtained by directional microphones permits the collection of precise contactless information from the area of interest of a machine. Our ongoing experimentation shows that acoustic AI might be an ally of industrial IoT applications, allowing predictive maintenance and adaptive control of production processes.

For indoor localisation, it is envisaged that modern technologies, such as Ultra-Wide Band (UWB), might provide context-dependent information and support employees in their work. An additional dimension is investigated in the Smart Converting 4.0 project: safety. Indeed, the combination of localisation services and artificial intelligence can bring advanced safety features, especially in the presence of collaborative robotics, such as Automatic Guided Vehicles (AGV) or non-segregated robotic arms. Trajectories of operators, robots and devices can be tracked and analysed on a suitable multi-level architecture. When a real-time response is needed, processing can be done by ad hoc embedded devices directly connected to robots and vehicles. In such a way, their behaviours can be promptly modified, for instance, reducing the speed of a robotic arm or avoiding a collision between an AGV and an operator. Tracking objects such as Personal Protective Equipment (PPE) can also assure that operators are wearing adequate protection by checking the correlation between human and PPEs trajectories. In general, pattern analysis on the set of trajectories and business logic allow for defining and applying adaptive safety policies (see e.g. [51]). Collection of the trajectory data and pattern analysis permits a better insight into historical data, understanding the behaviour of operators, identifying areas where most of their effort is spent and possible bottlenecks, and devising improvements for a more efficient process. A demonstrator in the context of Smart Converting 4.0 is under active development.

P. SPACE

Smart Passenger Center

Funded under: POR CReO Toscana 2020
Amount (Total): EUR 126,089 (2,667,385)
Protocol:
Contract:
Start date: 1 October 2020
End date: 31 December 2022
Coordinator: Eikontech-Mermec
Other partners: Softhrod, Resiltech, Wondersys
Keywords: Intelligent Transport System; Pervasive Computing; Edge Computing; Privacy-by-design; Multiple People Tracking; Artificial Intelligence; Transport Security; Smart Surveillance

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

The Smart Passenger Center (SPaCe) is a fully integrated platform that aims to overcome the complexity of centralized management of public transport infrastructure and vehicles. The SPaCe artificial intelligence engine predicts threats and critical events and proposes countermeasures by examining the daily flows of people and correlating different data and events, thanks to machine learning and big data analytic. All this massive data comes from a pervasive smart camera network that constantly monitors activities in stations, trains, buses and other places of interest. In this work, we present the idea of this computer vision distributed sub-system, the state of the art of the techniques involved and the advanced functionalities that this intelligent surveillance system offers to the upper layers. Everything is developed following the privacy-by-design paradigm; namely, no real image is recorded or transmitted, but all the elaborations take place on the edge nodes of the system.

FIGURE 13. Privacy by design passengers analysis : the video streams are processed on edge and no image is stored permanently in all operations involving sensitive personal data. Besides people analytic SPaCe will offers auxiliary functionalities: supporting cleaning activities, reporting abandoned objects, identifying damage and vandalism, detecting smoke and fire

FIGURE 14. TiAssisto: a telemedicine system assisting SARS-Cov2 and pluripathologies patients

Q. TI ASSISTO

Clinical monitoring of Covid-19 patients

Funded under: Regione Toscana Bando COVID 19
Amount (Total):
Protocol:
Contract:
Start date: 19 February 2021
End date: 18 February 2023
Coordinator:
Other partners:
Keywords: Telemedicine; Multipathology; Multiparametric Monitoring; Artificial Intelligence; Decision Support System; Medical Imaging; Biomedical Computing

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

In the health frame, the TiAssisto project aims at developing and validating an innovative and intelligent platform of services, in order to improve early diagnosis and quality of life in patients diagnosed with Covid-19 with or without multiple pathologies, and to reduce hospital access . TiAssisto is based on telemedicine solutions to enable treatments with high quality standards, by using Artificial Intelligence and ICT. In phase 1 of the epidemic, paucisymptomatic Covid-19 patients at home were unable to have a follow-up and this led to their arrival at the hospital already in a phase of severe respiratory failure. Therefore the TiAssisto project will provide: education and empowerment of patients and caregivers; integrated services for healthcare professionals, including telemonitoring, signal and image processing, notification systems; clinical decision support based on artificial intelligence algorithms, knowledge extraction and inference on clinical data; analysis algorithms to evaluate cardiac and lung echo images acquired directly at the patient's home. All enrolled patients will be followed up with a follow up (1 month, 3 months, 6 months). TiAssisto is in line with the activities introduced by the Tuscany Region (DGRT n 464 of 3 April 2020) being able to integrate with the regional platform (Health Advisor) with the addition of televisit and teleconsultation activities, also associating an Intelligent Decision Support System Clinical and application of artificial intelligence algorithms for the automatic interpretation of ultrasound images. The project will provide a contribution to research and a potential self-financing service for the health system. During 2021 the activity was focused on the platform design and implementation, also taking into account already developed, tested and validated telemedicine systems in other healthcare contexts (see e.g. [143]), ensuring the feasibility of the proposed solutions.

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.

Throughout 2021, we investigated the usage of the haptic channel as a means of supporting orientation and navigation for indoor and outdoor environments, for persons with visual impairments. More specifically, the following activities were carried out:

- Design of a software architecture to enable an accessible and personalised user experience during the visit of an indoor complex environment. A metadata model was designed for the points of interest, that kept into account information fruition, both in terms of its physical accessibility and in terms of its presentation according to the users' profiles or preferences. Prototypes of web and mobile GUIs were also designed, for the back-end web application and for the Android navigation app, in which vibro-tactile and audio stimuli were used to highlight the presence of the points of interest and deliver information in real time.
- Development of an Android prototype for an interactive, vibro-tactile map. The purpose of this prototype was to assess the effectiveness of the haptic channel in helping users with visual impairments build mental representations of a physical environment, both indoor and outdoor.

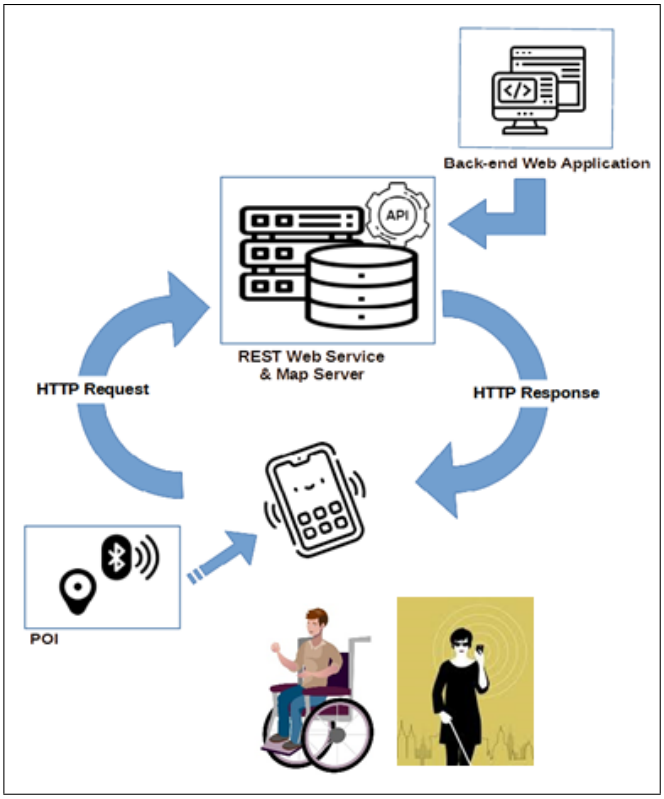

FIGURE 15. The typical flow of information between the various components in a mobile navigation system that exploits haptic feedback.

S. 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

FIGURE 16. Screenshot of animation present in the VERO augmented reality app.

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 a smartphone app. The 3D animated content will be carried out by digital artists, collaborators of Alma Artis Academy in Pisa, under the artistic supervision of the Collodi Foundation.

In 2021 the activities led to the publication of a book [83], a technical report [82], and the development of a technological system for the provision of AR content in outdoor scenarios [151], that has been tested and validated in the Pinocchio park [152].

T. 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 valuable 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 centre 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 calibrate better 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 [23], [189], [190].

The carried out activity in 2021 focused mainly on two branches:

- the study and implementation of a system based on video analysis for counting people in open spaces;
- the study of technologies based on sound processing for the analysis and recognition of parameters related to the creation of a system for monitoring public noise.

U. SCIENTIFIC COLLABORATION

1) S.C. 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 "Tabaracci" Assisted Living Facility (ALF) in Viareggio, 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.

2) S.C. 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, noise pollution and energy consumption.

3) S.C. 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 Technologies; 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 future activities.

4) S.C. with ALMA ARTIS

Protocol:
Start date:
End date:
Keywords: Computer Vision; Artificial Intelligence

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

The agreement between ISTI and Alma Artis provides for joint activity in the field of research and development of innovative technologies applied to art and cultural heritage. The activity includes teaching the subject of Interaction Design and assisting with the thesis work carried out in collaboration with the institute.

5) S.C. with SMA

Protocol:
Start date:
End date:
Keywords: Computer Vision; Artificial Intelligence

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

The agreement between ISTI and SMA concerns the development of interactive multimedia installations within the Pisan museum system. Currently, the TAU2 installation is still active at the exhibition "Hello Wold!" currently present in the Benedictine complex.

6) S.C. with the UO Otolaryngology, audiology and phoniatrics (UNIPI)

Study, implementation and application of software systems in the context of advanced multidisciplinary research in sectors ranging from the socio-health sector to biomedical (from Health to Well-being)

Protocol:
Start date: 18 November 2020
End date: 17 November 2025
Keywords: Decision support system; Signals and Images; Computer Vision; Artificial Intelligence

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

7) S.C. 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 2023
Keywords: Mountain Medicine; Artificial Intelligence

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

This project is about a set of research and applications in the field of mountain medicine that 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 [143]. A presentation was performed at an international conference [180]. An article on the effects of high-altitude was published too. The carried out activity in 2021 focused mainly on four branches:

- the completion of the study related to the lifestyle and acute mountain sickness conducted in the framework of the Save the Mountains on 804 volunteers;

- the completion of the study on the Alps related to effects of acute and sub-acute hypobaric hypoxia on oxidative stress;
- the completion of a study related to the effects of acupuncture on cerebral blood flow during normoxia and normobaric hypoxia;
- the presentation of the world of apps and the mountains at the SIMeM conference.

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: Integration of multiple resolution data in 3D chromatin reconstruction using ChromStruct
Authors: Caudai C. and Zoppè M. and Tonazzini A. and Merelli I. and Salerno E.
Journal: Biology (Basel)
Publisher: MDPI, Basel
DOI: 10.3390/biology10040338
Abstract: *The three-dimensional structure of chromatin in the cellular nucleus carries important information that is connected to physiological and pathological correlates and dysfunctional cell behaviour. As direct observation is not feasible at present, on one side, several experimental techniques have been developed to provide information on the spatial organization of the DNA in the cell; on the other side, several computational methods have been developed to elaborate experimental data and infer 3D chromatin conformations. The most relevant experimental methods are Chromosome Conformation Capture and its derivatives, chromatin immunoprecipitation and sequencing techniques (CHIP-seq), RNA-seq, fluorescence in situ hybridization (FISH) and other genetic and biochemical techniques. All of them provide important and complementary information that relate to the three-dimensional organization of chromatin. However, these techniques employ very different experimental protocols and provide information that is not easily integrated, due to different contexts and different resolutions. Here, we present an open-source tool, which is an expansion of the previously reported code ChromStruct, for inferring the 3D structure of chromatin that, by exploiting a multilevel approach, allows an easy integration of information derived from different experimental protocols and referred to different resolution levels of the structure, from a few kilobases up to Megabases. Our results show that the introduction of chromatin modelling features related to CTCF CHIA-PET data, histone modification CHIP-seq, and RNA-seq data produce appreciable improvements in ChromStruct's 3D reconstructions, compared to the use of HI-C data alone, at a local level and at a very high resolution.*
[44]

Title: AI applications in functional genomics
Authors: Caudai C. and Galizia A. and Geraci F. and Le Pera L. and Morea V. and Salerno E. and Via A. and Colombo T.
Journal: Computational and Structural Biotechnology Journal
Publisher: Chalmers University of Technology,, Göteborg , Svezia
DOI: 10.1016/j.csbj.2021.10.009
Abstract: *We review the current applications of artificial intelligence (AI) in functional genomics. The recent explosion of AI follows the remarkable achievements made possible by "deep learning", along with a burst of "big data" that can meet its hunger. Biology is about to overthrow astronomy as the paradigmatic representative of big data producer. This has been made possible by huge advancements in the field of high throughput technologies, applied to determine how the individual components of a biological system work together to accomplish different processes. The disciplines contributing to this bulk of data are collectively known as functional genomics. They consist in studies of: i) the information contained in the DNA (genomics); ii) the modifications that DNA can reversibly undergo (epigenomics); iii) the RNA transcripts originated by a genome (transcriptomics); iv) the ensemble of chemical modifications decorating different types of RNA transcripts (epitranscriptomics); v) the products of protein-coding transcripts (proteomics); and vi) the small molecules produced from cell metabolism (metabolomics) present in an organism or system at a given time, in physiological or pathological conditions. After reviewing main applications of AI in functional genomics, we discuss important accompanying issues, including ethical, legal and economic issues and the importance of explainability.*
[43]

Title: Insights on features' contribution to desalination dynamics and capacity of capacitive deionization through machine learning study
Authors: Saffarimiandoab F. and Mattesini R. and Fu W. and Kuruoglu E. E. and Zhang X.
Journal: Desalination (Amst.)
Publisher: Elsevier, Amsterdam , Paesi Bassi
DOI: 10.1016/j.desal.2021.115197
Abstract: *Parameter optimization in designing a rational*

capacitive deionization (CDI) process is usually performed to achieve both high electrosorption capacity and speed. This necessitates a clear understanding of system behavior and discriminating the features' role on desalination capacity from its dynamic. Machine learning (ML) modeling is widely employed for understanding various systems' behavior as an alternative for physics-based extrapolation models. Herein, various ML models are implemented with reasonable accuracies to unveil CDI electrode and operational features' local and global impacts on equilibrium desalination capacity, speed, and duration. Electrode specific surface area and electrolyte ionic concentration are determined to play the most significant roles in CDI by synergistically enhancing desalination capacity and speed. Increasing electrode micropore volume is detected to inhibit desalination and make ion removal sluggish. According to the established models, electrode nitrogen content extends desalination capacity without improving its dynamic. In addition, unlike the complex impacts from electrodes oxygen content on desalination capacity, it is shown that electrode oxygen content clearly elongates desalination time. This study demonstrates the strong abilities of the established ML models in explaining the underlying complex mechanisms in the CDI process.
[85]

Title: A generalized Gaussian extension to the Rician distribution for SAR image modeling
Authors: Karakus O. and Kuruoglu E. E. and Achim A.
Journal: IEEE transactions on geoscience and remote sensing
Publisher: Institute of Electrical and Electronics Engineers,, New York, N.Y. , Stati Uniti d'America
DOI: 10.1109/tgrs.2021.3069091
Abstract: *We present a novel statistical model, the generalized-Gaussian-Rician (GG-Rician) distribution, for the characterization of synthetic aperture radar (SAR) images. Since accurate statistical models lead to better results in applications such as target tracking, classification, or despeckling, characterizing SAR images of various scenes including urban, sea surface, or agricultural is essential. The proposed statistical model is based on the Rician distribution to model the amplitude of a complex SAR signal, the in-phase and quadrature components of which are assumed to be generalized-Gaussian (GG) distributed. The proposed amplitude GG-Rician model is further extended to cover the intensity of SAR signals. In the experimental analysis, the GG-Rician model is investigated for amplitude and intensity SAR images of various frequency bands and scenes in comparison to state-of-the-art statistical models that include Weibull, G, Generalized gamma, and the lognormal distribution. The statistical significance analysis and goodness-of-fit test results demonstrate the superior performance and flexibility of the proposed model for all frequency bands and scenes, and its applicability on both amplitude and intensity SAR images.*
[158]

Title: Modeling brain connectivity dynamics in functional magnetic resonance imaging via particle filtering
Authors: Ambrosi P. and Costagli M. and Kuruoglu E. E. and Biagi L. and Buonincontri G. and Tosetti M.
Journal: Brain informatics (Online)
Publisher: Springer, Berlin ; Heidelberg, Germania
DOI: 10.1186/s40708-021-00140-6; 10.1101/2021.01.19.427249
Abstract: *Interest in the studying of functional connections in the brain has grown considerably in the last decades, as many studies have pointed out that alterations in the interaction among brain areas can play a role as markers of neurological diseases. Most studies in this field treat the brain network as a system of connections stationary in time, but dynamic features of brain connectivity can provide useful information, both on physiology and pathological conditions of the brain. In this paper, we propose the application of a computational methodology, named Particle Filter (PF), to study non-stationarities in brain connectivity in functional Magnetic Resonance Imaging (fMRI). The PF algorithm estimates time-varying hidden parameters of a first-order linear time-varying Vector Autoregressive model (VAR) through a Sequential Monte Carlo strategy. On simulated time series, the PF approach effectively detected and enabled to follow time-varying hidden parameters and it captured causal relationships among signals. The method was also applied to real fMRI data, acquired in presence of periodic tactile or visual stimulations, in different sessions. On these data, the PF estimates were consistent with current knowledge on brain functioning. Most importantly, the approach enabled to detect statistically significant modulations in the cause-effect relationship between brain areas, which correlated with the underlying visual stimulation pattern presented during the acquisition.*
[166]

Title: Using localisation technologies and haptic feedback for a more inclusive society
Authors: Leporini B. and T Paratore M.
Journal: ERCIM news
Publisher: ERCIM., Le Chesnay
[37]

Title: Integrating wearable haptics and obstacle avoidance for the visually impaired in indoor navigation: a user-centered approach
Authors: Barontini F. and Catalano M. G. and Pallottino L. and Leporini B. and Bianchi M.
Journal: IEEE transactions on haptics (Print)
Publisher: IEEE Computer Society,, New York , Stati Uniti

d'America
DOI: 10.1109/toh.2020.2996748
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.*
[79]

Title: A System for Neuromotor Based Rehabilitation on a Passive Robotic Aid
Authors: Righi M. and Magrini M. and Dolciotti C. and Moroni D.
Journal: Sensors (Basel)
Publisher: Molecular Diversity Preservation International (MDPI),, Basel
DOI: 10.3390/s21093130
[150]

Title: Machine learning models and techniques applied to CTGAN-generated data
Authors: Moreign V. and Moreign Z. and Martinelli M.
Journal: Journal of machine learning research (Online)
Publisher: MIT Press,, [Cambridge, Mass.] , Stati Uniti d'America
[191]

Title: Acupuncture effects on cerebral blood flow during normoxia and normobaric hypoxia: results from a prospective crossover pilot study
Authors: Pecchio O. and Martinelli M. and Lupi G. and Giardini G. and Caligiana L. and Bonin S. and Scalese M. and Salvetti O. and Moroni D. and Bastiani L.
Journal: Technologies (Basel)
Publisher: MDPI, Basel, Svizzera
DOI: 10.3390/technologies9040102
[163]

Title: Effects of acute and sub-acute hypobaric hypoxia on oxidative stress: a field study in the Alps
Authors: Mrakic-sposta S. and Gussoni M. and Dellanoce C. and Marzorati M. and Montorsi M. and Rasica L. and Pratali L. and D'Angelo G. and Martinelli M. and Bastiani L. and Natale Di L. and Vezzoli A.
Journal: European journal of applied physiology (Print)
Publisher: Springer, Heidelberg ;, Germania
DOI: 10.1007/s00421-020-04527-x
[185]

Title: Patient perceptions and knowledge of ionizing radiation from medical imaging
Authors: Bastiani L. and Paolicchi F. : Faggioni L. and Martinelli M. and Gerasia R. and Martini C. and Cornacchione P. and Ceccarelli M. and Chiappino D. and Della Latta D. and Negri K. and Pertoldi D. and Negro D. and Nuzzi G. and Rizzo V. and Tamburrino P. and Pozzessere C. and Aringhieri G. and Caramella D.
Journal: JAMA network open
Publisher: American Medical Association, Chicago IL, Stati Uniti d'America
DOI: 10.1001/jamanetworkopen.2021.28561
[109]

Title: SST image processing for mesoscale patterns identification
Authors: Papini O. and Reggiannini M. and Pieri G.
Journal: Engineering proceedings (Basel)
Publisher: MDPI, Basel, Svizzera
DOI: 10.3390/engproc2021008005
Abstract: *Understanding the marine environment dynamics to accordingly design computational predictive tools represents a factor of paramount relevance to implement suitable policy plans. In this framework mesoscale marine events are important to study and understand since human related activities, such as commercial fishery, strongly depend on this type of phenomena. Indeed the dynamics of water masses affect the local habitats due to nutrients and organic substances transport, interfering with the fauna and flora development processes. Mesoscale events can be classified based on the presence of specific hydrodynamics features, such as water filaments, counter-currents or meanders originating from upwelling wind actions stress. In this paper a novel method to study these phenomena is proposed, based on the analysis of Sea Surface Temperature imagery captured by satellite missions (Metop, MODIS Terra/Aqua). Dedicated algorithms are presented, with the goal to detect and identify different observed scenarios based on the extraction and analysis of discriminating quantitative features. Promising*

results returned by the application of the proposed method to data captured within the maritime region in front of the southwestern Iberian coasts are presented.
[162]

Title: Online communication and body language
Authors: Paradisi P. and Raglianti M. and Sebastiani L.
Journal: Frontiers in behavioral neuroscience
Publisher: Frontiers Research Foundation,, Lausanne , Svizzera
DOI: 10.3389/fnbeh.2021.709365
[168]

Title: Learning topology: bridging computational topology and machine learning
Authors: Moroni D. and Pascali M. A.
Journal: Pattern recognition and image analysis
Publisher: Distributed by Allen Press,, Lawrence, KS , Stati Uniti d'America
DOI: 10.1134/s1054661821030184
[60]

Title: Smart parking systems: reviewing thelLiterature, architecture and ways forward
Authors: Biyik C. and Allam Z. and Pieri G. and Moroni D. and O'fraifer M. and O'connell E. and Olariu S. and Khalid M.
Journal: Smart cities (Basel)
Publisher: MDPI, Basel, Svizzera
DOI: 10.3390/smartcities4020032
[42]

Title: Analysis of diagnostic images of artworks and feature extraction: design of a methodology
Authors: Amura A. and Aldini A. and Pagnotta S. and Salerno E. and Tonazzini A. and Triolo P.
Journal: JOURNAL OF IMAGING
DOI: 10.3390/jimaging7030053
[2]

Title: Algoritmi di Image Analysis applicati alle immagini diagnostiche: nuove metodologie per l'analisi conoscitiva ed estrazione semi-automatica della mappatura del degrado
Authors: Amura A. and Aldini A. and Landi L. and Pisani L. and Salerno E. and Soro M. V. and Tonazzini A. and Torre M. and Triolo Paolo A. M. and Zantedeschi G.
Journal: Kermes
Publisher: Nardini., Firenze, Italia
[1]

Title: A procedure for the correction of back-to-front degradations in archival manuscripts with preservation of the original appearance
Authors: Savino P. and Tonazzini A.
Journal: Vietnam journal of computer science (Online)
Publisher: Springer, Berlin ; Heidelberg, Germania
DOI: 10.1142/s2196888822500099
[169]

Title: Challenges in the digital analysis of historical laminated manuscripts
Authors: Del Grosso A. M. and Fihri D. F. and Mohajir M. El and Tonazzini A. and Nahli O.
Journal: International Journal of Information Science and Technology
Publisher: [El Mohajir Mohammed], [S. l.], Marocco
[118]

B. BOOKS AND EDITORIALS

Title: Venturino Venturi e la Piazzetta dei Mosaici del Parco di Pinocchio
Authors: Matarese F. and Magrini M.
Abstract: *Nel cuore del Parco dedicato al burattino più famoso del mondo si trova un'opera straordinaria: una piazzetta quadrangolare di 30 m di lato, interamente mosaicata, che offre al visitatore un eccezionale crocevia artistico delle figure che popolano la storia di Pinocchio. Venturino Venturi, che insieme agli architetti Renato Baldi e Lionello De Luigi ha realizzato il progetto, ha dato vita a un ludus estetico spiazzante e fiabesco che continua a risuonare con elementi della contemporaneità, ispirando le nuove tecnologie digitali: la realtà aumentata infatti permetterà una visione inedita di questo spazio magico. Un'indagine su un grande artista del Novecento italiano, sulla sua opera maggiore e sul suo rapporto con Pinocchio, che lo ha accompagnato artisticamente ed esistenzialmente per tutta la vita, diventando un vero e proprio simbolo della sua poetica*
[83]

Title: La stella di Deotisalvi
Author: Tarabella L.
Abstract: *Deotisalvi è l'Architetto del secolo d'oro, il XII. Della sua vita non si sa niente. Forse veniva dall'Oriente. Forse era un frate. Di lui sono rimasti i suoi monumenti e, nelle parole di Silvano Burgalassi, i monumenti parlano di per sé ... perché ci sono. Questo è un racconto del tutto fantasioso sulla vita di Deotisalvi ispirato dalla geometria dei suoi monumenti. I monumenti della Piazza sono la mente e la vita artistica di Deotisalvi: una mente ed una vita*

spirituale e geometrica. E neanche matematica (caso mai aritmetica) ma geometrica.Perché la matematica come la pensiamo, la conosciamo e la utilizziamo ora all'epoca non esisteva. La geometria è nella Natura.La matematica è nella mente dell'uomo. La geometria è il collegamento tra l'uomo e la Natura.
[110]

Title: Fractional Diffusion and Medium Heterogeneity: The Case of the Continuous Time Random Walk
Authors: Vittoria Sposini and Silvia Vitali and Paolo Paradisi and Gianni Pagnini
DOI: 10.1007/978-3-030-69236-0_14
Abstract: *In this contribution we show that fractional diffusion emerges from a simple Markovian Gaussian random walk when the medium displays a power-law heterogeneity. Within the framework of the continuous time random walk, the heterogeneity of the medium is represented by the selection, at any jump, of a different time-scale for an exponential survival probability. The resulting process is a non-Markovian non-Gaussian random walk. In particular, for a power-law distribution of the time-scales, the resulting random walk corresponds to a time-fractional diffusion process. We relates the power-law of the medium heterogeneity to the fractional order of the diffusion. This relation provides an interpretation and an estimation of the fractional order of derivation in terms of environment heterogeneity. The results are supported by simulations.*
[184]

Title: Signals and images in sea technologies
Authors: Moroni D. and Salvetti O.
DOI: 10.3390/books978-3-0365-1355-3
Abstract: *Life below water is the 14th Sustainable Development Goal (SDG) envisaged by the United Nations and is aimed at conserving and sustainably using the oceans, seas and marine resources for sustainable development. It is not difficult to argue that Signals and Image technologies may play an essential role in achieving the foreseen targets linked to SDG 14. Indeed, besides increasing general knowledge of ocean health by means of data analysis, methodologies based on signal and image processing can be helpful in environmental monitoring, in protecting and restoring ecosystems, in finding new sensor technologies for green routing and eco-friendly ships, in providing tools for implementing best practices for sustainable fishing, as well as in defining frameworks and intelligent systems for enforcing sea law and making the sea a safer and more secure place. Imaging is also a key element for the exploration of the underwater world for various scopes, ranging from the predictive maintenance of sub-sea pipelines and other infrastructures to the discovery, documentation and protection of the sunken cultural heritage. The main scope of this Special Issue has been to investigate the techniques and ICT approaches, and in particular the study and application of signal- and image-based methods and, in turn, to explore the advantages of their application to the main areas mentioned above.*
[62]

C. CONFERENCE PAPERS

Title: TSXor: a simple time series compression algorithm
Authors: Bruno A. and Nardini F. M. and Pibiri G. E. and Trani R. and Venturini R.
DOI: 10.1007/978-3-030-86692-1_18
Abstract: *Time series are ubiquitous in computing as a key ingredient of many machine learning analytics, ranging from classification to forecasting. Typically, the training of such machine learning algorithms on time series requires to access the data in temporal order for several times. Therefore, a compression algorithm providing good compression ratios and fast decompression speed is desirable. In this paper, we present TSXor, a simple yet effective lossless compressor for time series. The main idea is to exploit the redundancy/similarity between close-in-time values through a window that acts as a cache, as to improve the compression ratio and decompression speed. We show that TSXor achieves up to 3× better compression and up to 2× faster decompression than the state of the art on real-world datasets.*
[21]

Title: UIP-net: a decoder-encoder CNN for the detection and quantification of usual interstitial pneumoniae pattern in lung CT scan images
Authors: Buongiorno R. and Germanese D. and Romei C. and Tavanti L. and De Liperi A. and Colantonio S.
DOI: 10.1007/978-3-030-68763-2_30
Abstract: *A key step of the diagnosis of Idiopathic Pulmonary Fibrosis (IPF) is the examination of high-resolution computed tomography images (HRCT). IPF exhibits a typical radiological pattern, named Usual Interstitial Pneumoniae (UIP) pattern, which can be detected in non-invasive HRCT investigations, thus avoiding surgical lung biopsy. Unfortunately, the visual recognition and quantification of UIP pattern can be challenging even for experienced radiologists due to the poor inter and intra-reader agreement. This study aimed to develop a tool for the semantic segmentation and the quantification of UIP pattern in patients with IPF using a deep-learning method based on a Convolutional Neural Network (CNN), called UIP-net. The proposed CNN, based on an encoder-decoder architecture, takes as input a thoracic HRCT image and outputs a binary mask for the automatic discrimination between UIP pattern and healthy lung parenchyma. To train and evaluate the CNN, a dataset of 5000 images, derived by 20 CT scans of different patients,*

was used. The network performance yielded 96.7% BF-score and 85.9% sensitivity. Once trained and tested, the UIP-net was used to obtain the segmentations of other 60 CT scans of different patients to estimate the volume of lungs affected by the UIP pattern. The measurements were compared with those obtained using the reference software for the automatic detection of UIP pattern, named Computer Aided Lungs Informatics for Pathology Evaluation and Rating (CALIPER), through the Bland-Altman plot. The network performance assessed in terms of both BF-score and sensitivity on the test-set and resulting from the comparison with CALIPER demonstrated that CNNs have the potential to reliably detect and quantify pulmonary disease in order to evaluate its progression and become a supportive tool for radiologists.
[173]

Title: Success and hindrance factors of AHA-oriented open service platforms
Authors: Carboni A. and Russo D. and Moroni D. and Barsocchi P. and Nikolov A. and Dantas C. and Guardado D. and Leandro A. F. and Van Staalduinen W. and Karanastasis E. and Andronikou V. and Ganzarain J. and Rus S. and Lievens F. and Oliveira Vieira J. and Juiz C. and Bermejo B. and Samuelsson C. and Ekström A. and Fernanda Cabrera-umpierrez M. F. and De Los Rios Peres S. and Van Berlo A.
DOI: 10.1007/978-3-030-88113-9_53
Abstract: *In the past years, there has been a flourishing of platforms dedicated to Active Assisted Living (AAL) and Active and Healthy Ageing (AHA). Most of them feature as their core elements intelligent systems for the analysis of multisource and multimodal data coming from sensors of various nature inserted in suitable IoT ecosystems. While progress in signal processing and artificial intelligence has shown how these platforms may have a great potential in improving the daylife of seniors or frail subjects, there are still several technological and non-technological barriers that should be torn down before full uptake of the existing solutions. In this paper, we address specifically this issue describing the outcome and creation process of a methodology aimed at evaluating the successful uptake of existing platforms in the field of AHA. We 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. For this, we contribute a detailed analysis structured along with the 4 main actions of mapping, observing, understanding, and defining. Our analysis focuses on Platforms, defined as operating environments, under which various applications, agents and intelligent services*
[22]

Title: Imaging e radiomica nell'ambito del progetto P.I.N.K.
Authors: Caudai C. and Colantonio S. and Franchini M. and Molinaro S. and Pascali M. A. and Pieroni S. and Salvatori M.
Abstract: *La presentazione introduce la linea di sviluppo dedicata alla radiomica nell'ambito dello studio P.I.N.K. Vengono introdotti gli aspetti e le potenzialità di Radiomics and Deep Learning per l'imaging medico , suportatti da alcuni esempi di applicazione. Vengono indicate le linee organizzative per implementare questa linea di sviluppo all'interno dello studio, affrontando gli aspetti tecnologici e modalità di attuazione previste.*
[45]

Title: A deep Learning approach for hepatic steatosis estimation from ultrasound imaging
Authors: Colantonio S. and Salvati A. and Caudai C. and Bonino F. and De Rosa L. and Pascali M. A. and Germanese D. and Brunetto M. R. and Faita F.
DOI: 10.1007/978-3-030-88113-9_57
Abstract: *This paper proposes a simple convolutional neural model as a novel method to predict the level of hepatic steatosis from ultrasound data. Hepatic steatosis is the major histologic feature of non-alcoholic fatty liver disease (NAFLD), which has become a major global health challenge. Recently a new definition for FLD, that take into account the risk factors and clinical characteristics of subjects, has been suggested; the proposed criteria for Metabolic Disfunction-Associated Fatty Liver Disease (MAFLD) are based on histological (biopsy), imaging or blood biomarker evidence of fat accumulation in the liver (hepatic steatosis), in subjects with overweight/obesity or presence of type 2 diabetes mellitus. In lean or normal weight, non-diabetic individuals with steatosis, MAFLD is diagnosed when at least two metabolic abnormalities are present. Ultrasound examinations are the most used technique to non-invasively identify liver steatosis in a screening settings. However, the diagnosis is operator dependent, as accurate image processing techniques have not entered yet in the diagnostic routine. In this paper, we discuss the adoption of simple convolutional neural models to estimate the degree of steatosis from echographic images in accordance with the state-of-the-art magnetic resonance spectroscopy measurements (expressed as percentage of the estimated liver fat). More than 22,000 ultrasound images were used to train three networks, and results show promising performances in our study (150 subjects).*
[178]

Title: Discriminating stress from cognitive load using contactless thermal imaging devices
Authors: Gioia F. and Pascali M. A. and Greco A. and Colantonio S. and Scilingo E. P.
DOI: 10.1109/embc46164.2021.9630860
Abstract: *This study proposes long wave infrared technology as a contactless alternative to wearable devices for stress*

detection. To this aim, we studied the change in facial thermal distribution of 17 healthy subjects in response to different stressors (Stroop Test, Mental Arithmetic Test). During the experimental sessions the electrodermal activity (EDA) and the facial thermal response were simultaneously recorded from each subject. It is well known from the literature that EDA can be considered a reliable marker for the psychological state variation, therefore we used it as a reference signal to validate the thermal results. Statistical analysis was performed to evaluate significant differences in the thermal features between stress and non-stress conditions, as well as between stress and cognitive load. Our results are in line with the outcomes of previous studies and show significant differences in the temperature trends over time between stress and resting conditions. As a new result, we found that the mean temperature changes of some less studied facial regions, e.g., the right cheek, are able not only to significantly discriminate between resting and stressful conditions, but also allow to recognize the typology of stressors. This outcome not only directs future studies to consider the thermal patterns of less explored facial regions as possible correlates of mental states, but more importantly it suggests that different psychological states could potentially be discriminated in a contactless manner.
[81]

Title: Sign Language GIFs exchange communication system: a PECS-based computer-mediated communication tool for the deaf
Authors: Zhilla C. and Galesi G. and Leporini B.
DOI: 10.1007/978-3-030-85607-6_64
Abstract: *Thanks to technological advances, Sign Language (SL), which is used by most deaf people, has gradually been freed from the need for face-to-face interaction. Deaf people used to communicating via SL may experience many problems in writing and reading text contents. Considering those difficulties, we propose a messaging system that integrates a Graphics Interchange Format (GIF) gallery representing phrases and words in SL to promote written communication closer to the needs of this user category.*
[50]

Title: LISA - Lingua Italiana dei Segni Accessibile: a progressive web app to support communication between deaf people and public administrations
Authors: Zhilla C. and Galesi G. and Leporini B.
DOI: 10.1007/978-3-030-91421-9_12
Abstract: *Most deaf people use Sign Language (SL) to communicate. This usually requires the presence of an SL interpreter to mediate and decode the communication with a non-deaf person. However, the presence of an SL interpreter to support a deaf person can be very difficult, expensive and not always possible, for example during the COVID-19 pandemic which requires limiting contact between people in presence. This work proposes a Progressive Web Application (PWA), called LISA, as a solution to facilitate communication between a deaf citizen and a non-deaf person, thanks to a remote Sign Language Interpreting Service (SLIS). The LISA prototype is designed to promote the communication of deaf citizens with the Public Administrations (PA). This real-time SLIS can be used flexibly on different types of devices (i.e. mobile and desk). This allows PA operators to easily respond to the needs of deaf citizens. Furthermore, to facilitate written communication and to overcome the difficulties encountered by deaf people in writing text messages, the LISA system integrates a text/SL gateway. The user selects items from a gallery of GIF images that represent simple pre-set phrases and words in SL, and the system can also convert them into text. This improves accessibility by offering a more suitable messaging tool than a text chat for the needs of the target population.*
[49]

Title: Verso la descrizione automatica delle immagini nell'editoria digitale accessibile: proposta di una tassonomia di immagini per gli algoritmi di intelligenza artificiale
Authors: De Martin C. and Leporini B. and Pellegrino G.
Abstract: *In questo contributo viene proposta una tassonomia di possibili tipologie di immagini da poter utilizzare per migliorare la composizione dei dataset di addestramento degli algoritmi di intelligenza artificiale da applicare ai task di classificazione e descrizione automatica delle immagini. Viene altresì sinteticamente illustrato il processo di validazione effettuato nello studio. 25 categorie sono state identificate nella tassonomia proposta.*
[46]

Title: Distance meetings during the Covid-19 pandemic: are video conferencing tools accessible for blind people?
Authors: Leporini B. and Buzzi M. and Hersh M.
DOI: 10.1145/3430263.3452433
Abstract: *Since the first lockdown in 2020, video conferencing tools have been becoming increasingly important for employment, education, and social interaction. This makes accessibility and usability of these tools essential. For instance, are the main functionalities fully accessible to all users? In this study we analyzed accessibility and usability by visually impaired people using screen readers and keyboard. This involved an inspection evaluation to test the most important features and a survey of visually impaired users to obtain information about the accessibility of three popular video conferencing tools: Zoom, Google Meet and MS Teams. The results showed that Zoom was preferred to Google Meet and MS Teams, but that none of the tools was fully accessible via keyboard and screen reader.*
[35]

Title: An enriched emoji picker to improve accessibility in mobile communications
Authors: Paratore M. T. and Buzzi M. C. and Buzzi M. and Leporini B.
DOI: 10.1007/978-3-030-85623-6_25
Abstract: *We present an emoji picker designed to enrich emojis selection on mobile devices using audio cues. The aim is to make emojis selection more intuitive by better identify their meanings. Unlike the typical emoji input components currently in use (known as "pickers"), in our component each emotion-related item is represented by both an emoji and a non-verbal vocal cue, and it is displayed according to a two-dimensional model suggesting the pleasantness and intensity of the emotion itself. The component was embedded in an Android app in order to exploit touchscreen interaction together with audio cues to ease the selection process by using more than one channel (visual and auditory). Since the component adds non-visual information that drives the emoji selection, it may be particularly useful for users with visual impairments. In order to investigate the feasibility of the approach and the acceptability/usability of the emoji picker component, a preliminary remote evaluation test involving both sighted and visually impaired users was performed. Analysis of the data collected through the evaluation test shows that all the participants, whether sighted or visually impaired, rated the usability of our picker as good, and also evaluated positively the model adopted to add semantic value to emojis.*
[186]

Title: Il mondo delle App e la montagna
Author: Martinelli M.
[127]

Title: New technology improves our understanding of changes in the marine environment
Authors: Pieri G. and Ntoumas M. and Martinelli M. and Chatzinikolaou E. and Martins F. and Novellino A. and Dimitrova N. and Keller K. and King A. and Smerdon A. and Mazza M. and Malardé D. and Cocco M. and Torres A. and Triantafyllou G. and Sá S. and João Bebianno M. and Sparnocchia S. and Kristiansen T. and Lusher A.
Abstract: *Existing European observation tools and services have the potential to take advantage of cutting-edge technologies to obtain a wide range of data at a much higher spatial resolution and temporal regularity and duration. The EU-funded NAUTILOS project will develop a new generation of sensors and samplers for physical, chemical, and biological essential ocean variables in addition to micro- and nano-plastics. The project will improve our understanding of environmental variations and anthropogenic impacts connected with aquaculture, fisheries, and marine litter. The project will integrate recently advanced marine technologies into different observing platforms and deploy them through innovative and cost-effective methods in a wide range of key environmental settings and EU policy-related applications. The project aims to complement and expand existing European observation instruments and services and further enable and democratise the monitoring of the marine environment for both traditional and non-traditional data users.*
[101]

Title: Mediterranean diet mitigates acute mountain sickness
Authors: Agazzi G. C. and Valoti P. and Bastiani L. and Denoth F. and Pratali Ll. and D'Angelo G. and Carrara B. and Parigi G. B. and Malanninom. and Spinelli A. and Calderoli A. and Orizio L. and Giardini G. and Salvetti O. and Moroni D. and Martinelli M. and Mrakic Sposta S.
Abstract: *A pilot study was conducted in the framework of the Save the Mountains initiative, an education and sustainability project, promoted by Italian Alpine Club of Bergamo, Bergamo section of the National Alpine Association, Province of Bergamo, Observatory for the Bergamasque Mountains and Alpine and Speleological Rescue. As a part of this study, an anonymous online questionnaire was designed and prepared, collecting lifestyle information (eating habits, alcohol, tobacco, sleep, exercise) of the mountaineers in order to recommend specific measures useful for staying in mountain areas and for preventing individual risk factors related to lifestyle and Acute Mountain Sickness (AMS): http://altamontagna.isti.cnr.it:8080/Stiledivita/. The study will continue the collection of questionnaire responses until at least the end of Summer 2021; at the time of writing (February 2021), 804 questionnaire responses were already collected and analyzed. The initial sample refers to the people who attended mountain huts in the Orobie Alps; then the online questionnaire form was publicly extended to other regions. About 99% of the interviewed people are Italian; the rest are Swiss, Polish, British and French people. Mean age is 48 years(+/-15), 62% males and 38% females. Only 8.8% of them answered they suffered from altitude sickness, but self-reported Lake Louise Score (LLS) classified the 21.3% of people with Acute Mountain Sickness (AMS), light AMS 15,4% and severe AMS 5,8% (To assess AMS the original LLS questionnaire was used: AMS is classified as severe when a headache is present and the LLS is greater than 5, it is instead light when there is a headache and the LLS is between 3 and 5, else is normal). The Mediterranean Diet's adherence, collected as the frequency of food items consumption, was assessed by the MEDI-LITE score, a validated questionnaire, ranging from 0 to 13. In this sample, a median score of 8 was found, while the 25th percentile corresponds to a score lower than 6 and the 75th percentile to a score greater than 9. The 14% of the sample resulted*

in being not adherent to the Mediterranean diet, the 51% was in the mean, the 35% was adherent. This study confirms that the predisposing factor most associated with the AMS is "having had the same episode in the past" (OR 2.50, CI 1.88/3.13), having sleep disturbs (OR 1.29, CI 1.03 /1.55), age (OR -0.03, CI -0.35/-0.02). Moreover, it underlines that lifestyle is important with respect to risk to develop the AMS: actually, despite the structural limitations of surveys, this study pointed out that lifestyle contributes to mitigating the risk of developing the AMS (Mediterranean diet score OR -0.34, CI -0.64 -> - 0.55). Gender, smoke and high physical activity are instead not significant. Future studies should investigate more deeply how lifestyle can change the impact on high altitude diseases.
[41]

Title: Image processing applied to temperature pattern identification
Authors: Papini O. and Pieri G. and Reggiannini M.
Abstract: *The objective of our work is to detect and classify mesoscale patterns in an upwelling ecosystem by analysing Sea Surface Temperature (SST) maps coming from satellite data. The poster shows how we organize this information in a "spaghetti plot", a tool that we use to analyse different trends of the SST in a target area for a period of time, and how we can associate those trends with different mesoscale patterns.*
[161]

Title: Mesoscale patterns identification through SST image processing
Authors: Reggiannini M. and Janeiro J. and Martins F. and Papini O. and Pieri G.
DOI: 10.5220/0010714600003061
[148]

Title: Learning topology: bridging computational topology and machine learning
Authors: Moroni D. and Pascali M. A.
DOI: 10.1007/978-3-030-68821-9_20
Abstract: *Topology is a classical branch of mathematics, born essentially from Euler's studies in the XVII century, which deals with the abstract notion of shape and geometry. Last decades were characterised by a renewed interest in topology and topology-based tools, due to the birth of computational topology and Topological Data Analysis (TDA). A large and novel family of methods and algorithms computing topological features and descriptors (e.g. persistent homology) have proved to be effective tools for the analysis of graphs, 3d objects, 2D images, and even heterogeneous datasets. This survey is intended to be a concise but complete compendium that, offering the essential basic references, allows you to orient yourself among the recent advances in TDA and its applications, with an eye to those related to machine learning and deep learning.*
[61]

Title: Estimation of sediment capacity of Aswan High Dam Lake utilizing remotely sensed bathymetric data: case study Active Sedimentation portion of Nubia
Authors: Negm A. and Hossen H. and Elsahabi M. and Makboul O. and Scozzari A.
DOI: 10.5194/egusphere-egu21-13628
Abstract: *This study deals with the quantitative estimation of the accumulated sediment capacity within the period from the initiation of the storage process of Lake Nubia in 1964 until 2012, by using field measurements and remote sensing data. The bed levels of the study area related to year 1964 were extracted from a tri-dimensional model of the lake derived from a topographic map, based on observations anterior to lake filling. This map was compared with the bed levels estimated for the year 2012, which were extracted from remote sensing data, with the aim to estimate the sediment capacity. The utilized technique for estimating the bathymetric data (depths) from satellite images relies on establishing a Multiple Linear Regression (MLR) model between in situ measurements and reflectance data from multi-spectral optical satellite observations. The Multiple Linear Regression (MLR) model showed good results in the correlation between field measurements and remote sensing data. The current approach provides flexibility as well as effective time and cost management in calculating depths from remote sensing data when compared to the traditional method applied by Aswan High Dam Authority (AHDA). This study is in the framework of a bilateral project between ASRT of Egypt and CNR of Italy, which is still running.*
[26]

Title: Investigating the possible measure to protect groundwater from polluted streams in arid and semi-arid regions: the Eastern Nile Delta case study
Authors: Abd-elaty I. and Zelenakova M. and Straface S. and Vranayová Z. and Abuhashim M. and Negm A. and Scozzari A.
DOI: 10.5194/egusphere-egu21-14734
Abstract: *Groundwater is the main source of drinking water in the Nile Delta. Unfortunately, it might be polluted by seepage from polluted streams. This study was carried out to investigate the possible measures to protect groundwater in the Nile delta aquifer using a numerical model (MT3DMS - Mass Transport 3-Dimension Multi-Species). The sources of groundwater contamination were identified and the total dissolved solids (TDS) was taken as an indicator for the contamination. Different strategies were investigated for mitigating the impact of polluted water: i) allocating polluted drains and canals in lower permeability layers; ii)*

installing cut-off walls in the polluted drains, and finally, iii) using lining materials in polluted drains and canals. Results indicated these measures effective to mitigate the groundwater pollution. In particular, the cut-off wall was effective for contamination reduction in shallow aquifers, whereas it had no effect in the deep aquifer, while lining materials in polluted drains and canals were able to prevent contamination and to protect the freshwater in the aquifers. It is worth mentioning that this study was partially supported by a bilateral project between ASRT (Egypt) and CNR (Italy).
[77]

Title: Feasibility of using Sentinel-3 in estimating Lake Nasser water depths
Authors: Khairy M. and Hossen H. and Elsahabi M. and Ghaly S. and Scozzari A. and Negm A.
DOI: 10.5194/egusphere-egu21-11958
Abstract: *After the construction of the Grand Ethiopian Renaissance Dam (GERD), Nasser Lake (NL)became one of the most challenging hot spots at both local and global level. It is one of the biggest manmade reservoirs in the world and the most important in Egypt. It is created in the southern part of the Nile River in Upper Egypt after the construction of Aswan High Dam (AHD). The water level in NL might fluctuate between 160 to 182 m above the mean sea level. Monitoring NL water depth is an expensive and time-consuming activity. This work investigates the possibility to use information from the Sentinel missions to estimate the depth of NL as an inland water body, in the frame of estimating storage variations from satellite measurements. In this preliminary study, we investigated the relationship between the radiance /reflectance of optical imagery from two instruments SLSTR and OLCI instruments hosted by the Sentinel-3A platform and in situ water depth data using the Lyzenga equation. The results indictaed that there was a reasonable correlation between Sentinel-3 optical data and in situ water depth data. Also, Heron's formula was used to estimate water storage variations of NL with limited in situ data. In addition, equations governing the relationship between water level and both surface area and water volume were worked out. This study is in the framework of a bilateral project between ASRT of Egypt and CNR of Italy, which is still running.*
[121]

D. TECHNICAL REPORTS

Title: Progetto DIONCOGEN. Rapporto Attività CNR-ISTI
Authors: Martinelli M. and Benassi A. and Bruno A. and Moroni D.
[130]

Title: SI-Lab Annual Research Report 2020
Authors: Leone G. R. and Righi M. and Carboni A. and Caudai C. and Colantonio S. and Kuruoglu E. E. and Leporini B. and Magrini M. and Paradisi P. and Pascali M. A. and Pieri G. and Reggiannini M. and Salerno E. and Scozzari A. and Tonazzini A. and Fusco G. and Galesi G. and Martinelli M. and Pardini F. and Tampucci M. and Buongiorno R. and Bruno A. and Germanese D. and Matarese F. and Coscetti S. and Coltelli P. and Jalil B. and Benassi A. and Bertini G. and Salvetti O. and Moroni D.
DOI: 10.32079/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.*
[176]

Title: Introduzione al trattamento del rumore nelle protesi acustiche
Authors: Righi M. and Bertini G.
DOI: 10.5281/zenodo.5792649
Abstract: *La presente nota, prende spunto da un argomento oggetto di un seminario effettuato in DAD per gli studenti del 3° anno del corso di laurea in Tecniche Audioprotesiche (aa 2020 - '21), nel quale sono state trattate le varie strategie adottate nelle protesi acustiche per diminuire gli effetti del rumore acustico sul parlato. Ultimamente alcune di tali tecniche adottano soluzioni basate su reti neuronali e criteri di intelligenza artificiale. Prima di illustrare le varie soluzioni viene anteposta una breve descrizione delle varie tipologie di rumore, la modalità della sua stima e gli effetti che può provocare sull'apparato uditivo umano. Viene dato un cenno anche ai tentativi proposti per rendere udibili alcuni particolari segnali non verbali, cioè vari tipi di allarmi, che invece è bene non vengano attenuati.*
[149]

Title: Efficient Improvements in Artificial Intelligence
Authors: Bruno A. and Moroni D. and Martinelli M.
[16]

Title: Barilla AgroSat+ Server, Client e Modelli
Authors: Bruno A. and Moroni D. and Martinelli M.
Abstract: *Server, Client e Modelli del Progetto Barilla AgroSat+*
[15]

Title: Barilla Agrosat+ Organi, aggiornamenti, confronti
Authors: Bruno A. and Moroni D. and Martinelli M.
Abstract: *Aggiornamenti e confronti. Progetto Barilla Agrosat+*
[14]

Title: TiAssisto - Obiettivo Operativo 4
Authors: Martinelli M. and Bruno A. and Moroni D.
Abstract: *Presentazione Kick-Off Meeting Bando Ricerca COVID-19 Regione Toscana Progetto TiAssisto Obiettivo Operativo 4.*
[132]

Title: Barilla Agrosat+ - Insetti, aggiornamento modelli, merge, gestore richiesta, et al.
Authors: Bruno A. and Moroni D. and Martinelli M.
Abstract: *Insetti, aggiornamento modelli, merge, gestore richiesta, et al.*
[10]

Title: Barilla AgroSat+ - Preparazione al "Test Day"
Authors: Bruno A. and Moroni D. and Martinelli M.
Abstract: *Nuovi modelli di AI, progetto Barilla Agrosat+ - Conclusione articolo.*
[11]

Title: Barilla Agrosat+ - Aggiornamento 09/21
Authors: Bruno A. and Moroni D. and Martinelli M.
Abstract: *Nuovi modelli, miglioramento, to-do list, situazione articolo, progetto Barilla Agrosat+*
[7]

Title: Barilla Agrosat+ Aggiornamento 10/21
Authors: Bruno A. and Moroni D. and Martinelli M.
Abstract: *Nuovi modelli, miglioramenti, to-do list, progetto Barilla Agrosat+*
[13]

Title: Barilla Agrosat+ - Aggiornamento 12/21
Authors: Bruno A. and Moroni D. and Martinelli M.
Abstract: *Nuovi modelli, miglioramenti, to-do list, progetto Barilla Agrosat+.*
[8]

Title: Progetto DiOncoGen CloudPathology - Secondo test di valutazione delle informazioni sul secondo dataset
Authors: Martinelli M. and Bruno A. and Moroni D.
Abstract: *Il presente documento fornisce i risultati del secondo test di valutazione del secondo dataset ricevuto nell'ambito del progetto DiOncoGen-CloudPathology.*
[131]

Title: Barilla Agrosat+ - Riorganizzazione task e nuovi modelli
Authors: Bruno A. and Moroni D. and Martinelli M.
Abstract: *Riorganizzazione task e nuovi modelli, integrazione app mobile, sito Web, modelli di AI, progetto Barilla Agrosat+ - Presentazione draft articolo.*
[12]

Title: Barilla Agrosat+ - Aggiornamento modelli e Beta release
Authors: Bruno A. and Moroni D. and Martinelli M.
Abstract: *Aggiornamento Modelli di AI, rilascio Beta release, progetto Barilla Agrosat+ - Presentazione nuovo draft articolo.*
[9]

Title: TiAssisto 0.0.3 - Analisi del flusso di funzionamento della piattaforma di telemedicina - Aggiornamento 26/7/2021
Authors: Bruno A. and Martinelli M. and Moroni D. and Bastiani L. and Pratali L. and Cicalini D. and Memmini S. and Tomei A.
Abstract: *Descrizione del flusso di funzionamento della piattaforma di telemedicina TiAssisto: aggiornamenti ed estensioni.*
[20]

Title: Improving Plant Disease Classification by Adaptive Minimal Ensembling
Authors: Bruno A. and Moroni D. and Dainelli R. and Rocchi L. and Toscano P. and Ferrari E. and Martinelli M.
Abstract: *Plant disease diagnosis is a challenging and time consuming process. In recent years, the evolution of neural network technologies has made it possible to improve automatic recognition. In this article, we propose a novel method to improve the state of the art in plant disease classification. Using as baseline EfficientNet, a recent and advanced family of architectures, we have devised and applied specific design choices, namely stratification, refining validation, regularization and minimal ensembling, using specific transfer learning, optimizer and accuracy test. Our method was tested on PlanVillage as baseline, a public reference dataset used to benchmark models' performances in this domain in both its original and augmented versions, with 55,448 and 61,486 images, respectively. We noticeably improved the state of the art of PlantVillage classification by achieving zero errors in both the original and augmented*

dataset. In addition, the proposed method requires fewer parameters than the previous state of the art. Results shown were obtained using PyTorch to train, test and validate the models; reproducibility is granted by the provision of exhaustive details including hyperparameters used in the experimentation. A Web interface is also made publicly available to test the proposed methods.
[19]

Title: SPaCe - Documento di studio e definizione delle tecnologie e degli algoritmi di analitica del trasporto pubblico
Authors: Leone G. R. and Moroni D. and Magrini M. and Pardini F. and Carboni A.
Abstract: *Nel contesto del progetto Space in questo documento verrà presentato uno studio e la definizione delle tecnologie applicabili al trasporto pubblico. I casi d'uso di interesse sono principalmente due: il caso d'uso su gomma, con riferimento a mezzi tipo bus cittadini, e il caso d'uso su rotaia, in riferimento al trasporto ferroviario. Gli obiettivi sono molteplici e riguardano principalmente il comportamento dei passeggeri a bordo o in attesa dei mezzi, la ricostruzione di un viaggio che consiste nella concatenazione di tratte effettuate su mezzi diversi, il controllo degli oggetti e il monitoraggio dello stato dei mezzi sia per questioni di sicurezza che di manutenzione degli stessi. In generale sono state identificate due macro aree di riferimento: Controllo degli spazi e Controllo dei passeggeri.*
[175]

Title: Studio Pink - Le linee di sviluppo
Authors: Pieroni S. and Franchini M. and Denoth F. and Colantonio S. and Tampucci M. and Fortunato L. and Molinaro S.
Abstract: *Questo documento descrive le linee di sviluppo dello studio P.I.N.K., già previste come parte integrante del progetto fin dall'avvio delle attività, che si fondano sull'attivazione di studi ad hoc trasversali alle diverse tematiche trattate. Sono di fatto tre linee di ricerca parallele che partono dalla solida base di conoscenza creata all'interno di P.I.N.K. nei suoi primi tre anni di vita: linea 1 riguardante Imaging e Radiomica, linea 2 riguardante la dosimetria personalizzata, linea 3 riguardante la nutrizione e stile di vita.*
[181]

Title: Technical report on the development and interpretation of convolutional neural networks for the classification of multiparametric MRI images on unbalanced datasets. Case study: prostate cancer
Authors: Pachetti E. and Colantonio S.
Abstract: *This report summarized the activities carried out to define, train and validate Deep Learning models for the classification of medical imaging data. The issue of unbalanced datasets was faced by applying some data augmentation techniques, based on transformation of the original images. Such techniques were compared to verify their impact in a frame where object morphology is relevant. Multimodal deep learning models were defined to exploit the information contained in heterogeneous imaging data and cope with data distribution imbalance. To verify the inner functioning of the deep learning models, the LIME algorithm was applied, thus checking that the regions that contribute to the classification were the real meaningful ones. The case study used to was the categorization of prostate cancer aggressiveness based on Magnetic Resonance Imaging (MRI) data. The aggressiveness was determined, as a ground truth, via tissue biopsy and expressed with a score from 2 to 10 known as Gleason Score, which is obtained as the sum of two values, each one from 1 to 5, associated with the two most common patterns in the tumor tissue histological sample.*
[67]

Title: TiAssisto - Obiettivo Operativo 3
Authors: Martinelli M. and Galesi G. and Tampucci M. and Moroni D.
[142]

Title: Una metodologia di sviluppo di applicazioni di realtà aumentata per i beni culturali applicata ad un caso di studio: il Parco di Pinocchio
Authors: Matarese F. and Magnavacca J. and Magrini M.
DOI: 10.32079/isti-tr-2021/004
Abstract: *Presentazione Kick-Off Meeting Bando Ricerca COVID-19 Regione Toscana - Progetto TiAssisto Obiettivo Operativo 3.*
[82]

Title: Ti Assisto - Sistema Informativo
Authors: Martinelli M. and Deluca R. and Moroni D.
Abstract: *Il sistema informativo, le piattaforme pregresse, privacy, requisiti*
[146]

Title: TiAssisto - Analisi del flusso di funzionamento della piattaforma di telemedicina
Authors: Cicalini D. and Martinelli M.
Abstract: *Lo scopo di questo rapporto è quello di iniziare a descrivere il flusso di funzionamento della piattaforma di telemedicina TiAssisto e di porre l'attenzione sui punti ancora da definire.*
[56]

Title: OSIRIS-FO - OSIRIS PDR Meeting - CNR-ISTI current status
Authors: Salerno E. and Martinelli M. and Reggiannini M. and Righi M. and Tampucci M.
Abstract: *ESA OSIRIS 2 Project - Current status of CNR-ISTI*
[76]

Title: TiAssisto - Analisi del flusso di funzionamento della piattaforma di telemedicina - Aggiornamento
Authors: Martinelli M. and Bastiani L. and Pratali L. and Memmini S. and Tomei A.
Abstract: *Lo scopo di questo rapporto è quello di iniziare a descrivere il flusso di funzionamento della piattaforma di telemedicina TiAssisto e di porre l'attenzione sui punti ancora da definire.*
[144]

Title: A tool for the temporal analysis of sea surface temperature maps
Author: Papini O.
DOI: 10.32079/isti-tr-2021/011
Abstract: *This document describes the usage of a tool that produces plots of the evolution of the sea surface temperature in a specified space-time window, extracting data from a series of NetCDF files.*
[160]

Title: NAUTILOS - External advisory board report 1
Author: Pieri G.
Abstract: *An annual report and evaluation provided by the External Advisory Board providing their overall assessment of NAUTILOS and advice on the future direction of the project. The following deliverable will be the report following their meeting after MM3 in M12.*
[98]

Title: NAUTILOS - POPD - Requirement No. 2
Authors: Pieri G. and Gianvincenzo A. and Novellino A. and Deluca R.
Abstract: *This document is intended to provide recommendation on the procedures of the Information Systems and is inspired by the principles of correctness and diligence and is adopted in compliance with the provisions contained in the Privacy code and in the General Data Protection Regulation of the European Union.*
[100]

Title: NAUTILOS - A - Requirement No. 3
Author: Pieri G.
Abstract: *This deliverable describes the general nature of the experiments with animals and the procedures that will be performed within NAUTILOS, in order to ensure animal welfare and adherence to EU Directive 2010/63/EU and the Three Rs guidelines principle. Moreover, information about existing expertise and experiences of the involved partners are reported.*
[96]

Title: NAUTILOS - NEC - Requirement No. 4
Author: Pieri G.
Abstract: *This deliverable describes the ethical issues concerning the research performed outside the EU, both in terms of ethical compliance with EU standards, and in terms of the detail of the materials that will be imported/exported from and to non-EU countries to a member state.*
[99]

Title: NAUTILOS - EPQ - Requirement No. 5
Author: Pieri G.
Abstract: *The deliverable presents and discusses the procedures and measures to mitigate environmental risks happening during the Project. Moreover, the application of health and safety procedures, conforming to the relevant guidelines and legislations are described, together with the measures minimising impact on endangered species or protected areas involved in the project activities.*
[97]

Title: NAUTILOS - H - Requirement No. 1
Authors: Pieri G. and Deluca R. and Chatzinikolaou E.
Abstract: *The procedures and criteria that will be used to identify/recruit research participants, as well as the informed consent procedures that will be implemented for the participation of humans external to NAUTILOS to the project activities and in regard to their data processing are presented in this document. Templates of the informed consent/assent forms and information sheets covering the voluntary participation and data protection issues, in the English version are provided.*
[104]

Title: NAUTILOS - Data Management Plan
Authors: Novellino A. and Colombo F. and Gianvincenzo A. Pieri G. and Tampucci M.
[27]

Title: Ship kinematics estimation based on doppler centroid deviation in synthetic aperture radar images
Author: Reggiannini M.

Abstract: *In this deliverable the Data Management Plan (DMP) of the project will be written, in compliance with the H2020 Data Management Guidelines, also based on inputs from WP8. It will outline a data management policy, including data to be generated by the project, their potential exploitation, curation and storage. Additionally, in line with the principles of Open Access to research data and publications generated through H2020 programmes, NAUTILOS will participate in the Open Research Data Pilot carried out by the European Commission.*
[147]

Title: Track-Hold System (THS): sperimentazione e validazione delle soluzioni tecnologiche derivanti dal progetto Track-Hold
Authors: Dolciotti C. and Magrini M. and Moroni D. and Righi M.
Abstract: *Il progetto Track-Hold System (THS), realizzato in struttura sanitaria e quindi in un ambito sanitario controllato e protetto, si inserisce nel più generale e ampio contesto della Robotic Assisted Therapy (RAT). La RAT rappresenta una metodica di riabilitazione, sia motoria che cognitiva, più avanzata e innovativa e si avvale di dispositivi robotici attivi, passivi e facilitanti, spesso dotati di sensori di rilevazione e tracciamento di movimenti sia volontari che involontari, e di protocolli multimediali appositamente elaborati per raggiungere il massimo livello possibile di rieducazione funzionale. La RAT, al pari delle metodiche convenzionali di riabilitazione (ad es Metodo Perfetti, Mirror Therapy, Biofeedback, etc.) richiede la stretta collaborazione tra i componenti del Team Multidisciplinare, che nella RAT, oltre al Medico e al Terapista, prevede la presenza del Fisiologo e dell'Ingegnere Biomedico ed Informatico.*
[47]

Title: Using random forests to classify vessels from naive geometrical features
Author: Salerno E.
Abstract: *This report is concerned with the application of Random Forest classification methods to the identification of ship types in moderate-resolution SAR images. After a brief presentation of the theory and and the features of this class of methods, we select an R package useful to train, test and execute the classifier. Some experiments are then reported using naive geometrical features extracted from a few thousands of targets in the OpenSARShip data set. All the ship chips extracted are derived from IW GRD Sentinel 1 C-band SAR images, accompanied by AIS and MarineTraffic ground-truth data. The ideal performance of this classifier is evaluated through the standard classification indices, with respect to the ship types that are sufficiently represented in the subsets considered.*
[75]

Title: Naive bayes for naive geometry: classifying vessels from length and beam
Author: Salerno E.
Abstract: *This report is concerned with the application of a Naive Bayes classification method to the identification of ship types in moderate-resolution SAR images. After a brief presentation of the principles behind the method, a simple implementation and an extensive experimentation on naive geometrical features extracted from a few thousands of targets in the OpenSARShip data set are presented. All the ship chips extracted are derived from IW GRD Sentinel 1 C-band SAR images, accompanied by AIS and MarineTraffic ground-truth data. The ideal performance of this Naive Bayes is evaluated through the standard classification indices, with respect to the ship types that are sufficiently represented in the subsets considered.*
[74]

Title: Multiple kernel learning to classify vessels from naive geometrical features
Author: Salerno E.
Abstract: *This report is concerned with the application of a Multiple Kernel Learning classification method to the identification of ship types in moderate-resolution SAR images. After a brief presentation of the theory and and the features of this class of methods, we select a few R packages useful to this aim, and delineate a procedure to select the relevant features and kernel functions, execute and test the classifier. Some experiments are then reported using naive geometrical features extracted from a few thousands of targets in the OpenSARShip data set. All the ship chips extracted are derived from IW GRD Sentinel 1 C-band SAR images, accompanied by AIS and MarineTraffic ground-truth data. The ideal performance of this classifier is evaluated through the standard classification indices, with respect to the ship types that are sufficiently represented in the subsets considered.*
[73]

Title: Geometric and scattering features for ship classification from Sentinel 1 SAR images
Author: Salerno E.
Abstract: *Following the evaluation of some ship classification strategies based on geometrical features, this report accounts for the use of scattering measurements in SAR images as additional features, in the hope of improving the classification performance. A set of eight scattering features has been selected and added to the already tested set of eight naive geometric features to explore the discriminating power of the whole feature set or any subset thereof. The algorithm chosen for this investigation is Random Forest,*

as implemented in the R package randomForest. The basic finding has been that, as opposed to some claims in the literature, the use of scattering features improves the classification performance even from images characterized by a moderate resolution, such as the ones provided by ESA's Sentinel 1 satellite-borne SAR.
[72]

E. MISCELLANEOUS

Title: FUTURE-AI: Guiding Principles and Consensus Recommendations for Trustworthy Artificial Intelligence in Medical Imaging
Authors: Lekadir, Karim and Osuala, Richard and Gallin, Catherine and Lazrak, Noussair and Kushibar, Kaisar and Tsakou, Gianna and Aussó, Susanna and Alberich, Leonor Cerdá and Marias, Kostas and Tsiknakis, Manolis and Colantonio, Sara and Papanikolaou, Nickolas and Salahuddin, Zohaib and Woodruff, Henry C and Lambin, Philippe and Martí-Bonmatí, Luis
DOI: 10.48550/ARXIV.2109.09658
[111]

Title: A software package for the study of REM-sleep microstructure
Authors: Barcaro U. and Magrini M.
[188]

Title: A software package for the study of REM-sleep microstructure
Authors: Magrini M. and Barcaro U.
[123]

Title: Introduzione a Thunkable
Author: Galesi G.
Abstract: *Slide della lezione effettuata il 26 Ottobre 2021 per il Corso di Laurea in Informatica Umanistica dell' Università di Pisa all'interno del corso 617AA: Tecnologie assistive per la didattica (aa 2021/22) con tema la piattaforma web per lo sviluppo di app Thunkable.*
[91]

Title: Esempi applicativi di app realizzate con Thunkable
Author: Galesi G.
Abstract: *Slide della lezione effettuata il 2 Novembre 2021 per il Corso di Laurea in Informatica Umanistica dell' Università di Pisa all'interno del corso 617AA: Tecnologie assistive per la didattica (aa 2021/22) con tema la piattaforma web per lo sviluppo di app Thunkable.*
[90]

Title: Modelling time-varying epidemiological parameters for COVID-19
Authors: Kuruoglu E. E. and Li Y.
[66]

Title: TiAssisto - Una piattaforma di tele-assistenza e tele-monitoraggio di pazienti affetti da Covid-19 - Incontro con i Medici di Medicina Generale coinvolti nel progetto
Author: Martinelli M.
Abstract: *Incontro con i Medici di Medicina Generale coinvolti nel progetto TiAssisto: descrizione della piattaforma di telemedicina di tele-assistenza e tele-monitoraggio di pazienti affetti da Covid-19.*
[128]

Title: On some scientific results of the ICPR-2020
Authors: Gurevich I. B. and Moroni D. and Pascali M. A. and Yashina V. V.
DOI: 10.1134/s1054661821030093
Abstract: *This special issue of PRIA is devoted to some scientific results and trends of the 25th International Conference on Pattern Recognition (Virtual, Milano, Italy, January 10–15, 2021). Two important events of ICPR-2020 are represented in this special issue: (1) The paper of Professor Ching Yee Suen (Centre for Pattern Recognition and Machine Intelligence, Department of Computer Science and Software Engineering, Concordia University, Montreal, QC, Canada)–the recent winner of IAPR very prestigious K.S. Fu Prize for a year of 2020. The paper based on his lecture "From handwriting to human personality and facial beauty" presented at the ICPR 2020; (2) Special issue "ICPR-2020 Workshop "Image Mining. Theory and Applications." The analysis of the scientific contribution of IMTA-VII-2021 allows us to draw the following conclusions: (1) The construction of a unified mathematical theory of image analysis is still far from complete. (2) There is considerable interest in the development of new mathematical methods for analyzing and evaluating information presented in the form of images. (3) There is a tendency to expand the mathematical apparatus in the development of new methods of image analysis and recognition by involving in this process areas of mathematics that were not previously used in image analysis. (4) The gap between the capabilities of new mathematical methods of image analysis and recognition and their actual use in solving applied problems remains significant. (5) There is an excessive use of neural networks in solving applied problems of image analysis and image recognition, and quite often without proper justification and interpretation of the results. The special issue includes articles based on the workshop papers selected by the IMTA-VII-2021 Program*

Committee for publication in PRIA. The PRIA special issue "Scientific Resume of the 25th International Conference on Pattern Recognition" is prepared by the National Committee for Pattern Recognition and Image Analysis of the Russian Academy of Sciences, the IAPR member society, and by the IAPR Technical Committee no. 16 on Algebraic and Discrete Mathematical Techniques in Pattern Recognition and Image Analysis.
[32]

Title: Special Issue "Remote sensing for maritime and water monitoring"
Authors: Pieri G. and Reggiannini M.
[102]

Title: Signals and Images in Sea Technologies
Authors: Moroni D. and Salvetti O.
DOI: 10.3390/jmse9010041
[63]

F. MASTER THESES

Title: PsicoTableau: sperimentazione artistica sui livelli di attivazione e valenza emotiva attuata mediante sensori biomedici
Author: Ratto C.
Abstract: *Questo lavoro di tesi consiste nello studio e nella realizzazione di un'installazione audiovisiva reattiva allo stato emotivo del visitatore. Sebbene il lavoro si inserisca in un panorama ormai ben consolidato come quello delle arti elettroniche interattive, la particolare modalità di interazione uomo-macchina che utilizza la caratterizza sufficientemente da renderla sicuramente non comune. Laddove la maggior parte delle opere interattive presuppone di utilizzare la presenza fisica e la gestualità per attivare e/o controllare i contenuti, siano essi audio video o cinetici, in questo lavoro si è scelto di utilizzare lo stato emotivo come impalpabile catalizzatore dei media. La filosofia adottata sposta quindi il valore estetico dell'opera dagli aspetti più "retinici" a quelli più concettuali: è il meccanismo in sé che costituisce l'operazione estetica, non (solo) i risultati/output che produce e controlla.*
[48]

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 [141].

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 [187]. 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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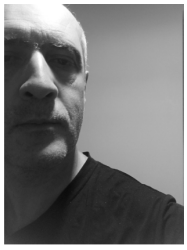

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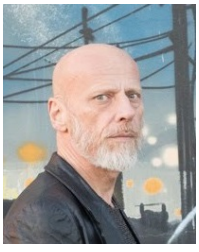

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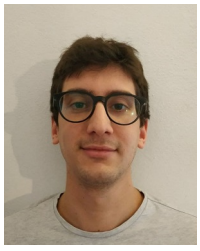

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